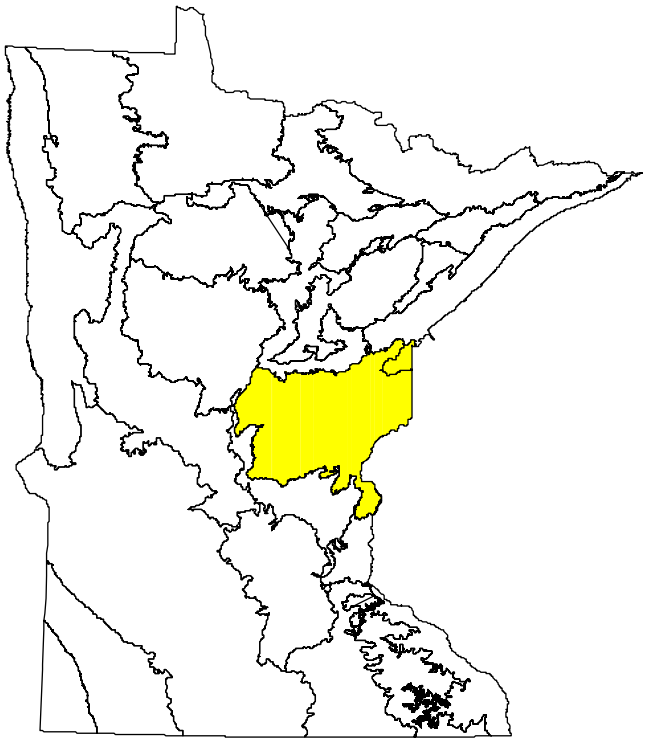
Mille Lacs Uplands

Subsection Forest Resource Management Plan

Strategic Direction and Stand Selection Results

- Final -



Minnesota Department of Natural Resources

June 2008

Division of Forestry Planning Document

Printed June 2008

This document is on the Internet at www.dnr.state.mn.us/forestry/subsection/millelacs

Information about the Division of Forestry Subsection Forest Resource Management Plan (SFRMP) process can be found at www.dnr.state.mn.us/forestry/subsection

Abstract: This document presents the final plan outlining strategic direction for forest management of DNR administered lands in the Mille Lacs Uplands subsection. It includes the criteria used to select stands for the initial seven years of management, lists the stands that satisfy those criteria, and identifies new access needs resulting from stand selection.

Mille Lacs Uplands SFRMP Team Members

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This document was prepared for the Minnesota Department of Natural Resources Division of Forestry by the consultant team of Pro-West & Associates, Inc. (Walker, MN) and Applied Insights^{north} (Duluth, MN).

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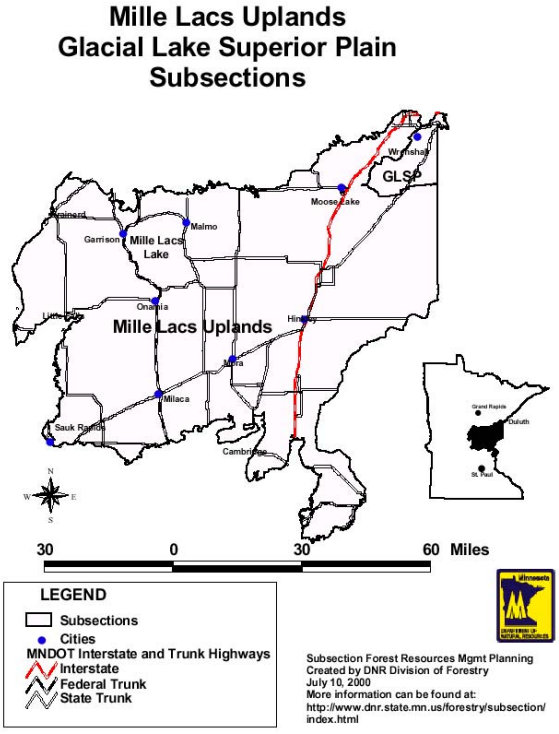
1. Introduction

Mille Lacs Uplands Subsection – A Brief Description

The planning area is approximately 3,498,533 acres. More than 357,000 acres of that area (about 10 percent) is administered by state agencies, mainly the Forestry and Wildlife Divisions of Minnesota Department of Natural Resources (DNR). Portions of three Ecological Classification System (ECS) Subsection***s*** are included. The majority of the land area is in the Mille Lacs Uplands, a small amount is in the Glacial Lake Superior Plain, and a tiny portion is in the St. Croix Moraines Subsection. Approximately 40 percent of the Mille Lacs Uplands and 66 percent of the GLSP is forested. Most of the St. Croix Moraines is included in Interstate State Park, and is therefore not affected by this planning process.

The Mille Lacs Uplands covers the large area of Superior Lobe ground moraines and end moraine in east central Minnesota. Gently rolling till plains and drumlin fields are the dominant landforms in this ecoregion. The jewel of this region is Mille Lacs Lake, well known for walleye fishing. This subsection is unique because of its soils, brown and red till deposited by the Superior Lobe originating from an ice accumulation center located east of James Bay, Canada. As it flowed southwest into eastern and central Minnesota, the glacier carved out the Lake Superior basin. In the southern portion of the subsection, upland hardwoods consisting of red oak, sugar maple, basswood and aspen-birch were common before settlement. Presently, forestry, recreation, and some agriculture are the most common land uses.

Figure 1.1 Mille Lacs Uplands Subsection

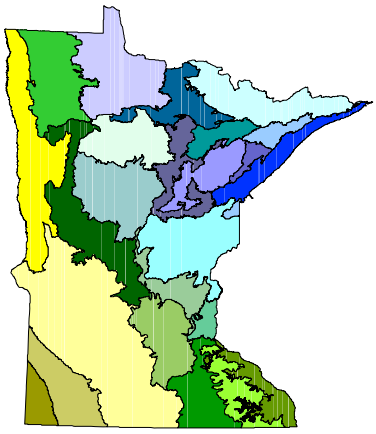


More information on forest resources in the subsection can be found in the assessment document or on the Web site: www.dnr.state.mn.us/forestry/subsection/millelacs/final_plan/index.html

SFRMP Description and Process

What is an ECS Subsection?

Minnesota ECS Subsections



The DNR has developed an ecological classification system (ECS) as a tool to help identify, describe, and map ecosystems. ECS units are defined by climatic, geologic, hydrologic, topographic, soil and vegetation data. The DNR ECS divides the state into 6 levels of ecological units, each level nested together with the next higher level. Subsections are the third level down in the ECS hierarchy in Minnesota. There are 17 forested subsections in the state, with an average size of over 1 million acres.

What Is a DNR Subsection Forest Resource Management Plan?

A SFRMP is a DNR plan for vegetation management on forestlands administered by the DNR Forestry and Wildlife Divisions. Vegetation management includes actions that affect the composition and structure of forest and brush lands, such as timber harvesting, thinning, prescribed burning, and reforestation. The geographic area covered by this plan is a subsection rather than administrative boundary such as counties or DNR administrative areas. The SFRMP considers the condition and management of lands by other agencies, but only proposes forest management direction on DNR-administered lands.

Key Products of the Planning Process

There are two key products:

- **Desired future forest composition (DFFC) goals.** These goals include long-term (i.e., 50-100+ years) and short-term (i.e., 10 years) desired changes in the structure and composition of vegetation on DNR-administered lands in the subsection. These goals include the amount of various cover types within the subsection, age-class distribution of cover types, and the geographic distribution of cover types and age classes across the subsection. Assessment information and planning issues guide DFFC goals.
- **List of DNR stands to be treated over a seven-year period**. The plan identifies forest stands on DNR Forestry- and Wildlife-administered lands that are proposed for treatment (e.g., harvest, thinning, regeneration, prescribed burning, and re-inventory over the seven-year planning period). Forest stands were selected using criteria developed to move DNR lands toward the desired future forest composition. Examples of criteria include stand age, site productivity, size, number and species of trees, soils, and stand location. There are many decisions and considerations that went into developing these criteria and the list of stands proposed for treatment. Examples include identification of areas to be managed as old growth and older forests, normal harvest age, or as riparian zones and visually sensitive travel corridors; age and cover-type distributions; and regeneration, thinning, and prescribed burning needs. Decisions are made based on the management activities (including no action) that will best move a forest landscape toward DFFC goals.

Who Developed the SFRMP?

An interdisciplinary team comprised of DNR Forestry, Fish and Wildlife, Ecological Services, and other division staffs had primary responsibility for the work and decision-making involved with the subsection plan. Managers of adjacent county, federal, tribal, and industrial forestlands were invited to provide information about the condition of their forestlands and future management direction.

SFRMP Process

Table 1.1 outlines the steps in the DNR SFRMP process. This document represents the fifth and final step in the process.

Table 1.1 Steps in the SFRMP Process

Step 1	**Initiating the Planning Process** • Form interdisciplinary team. • Develop mailing list of public/stakeholders. • Establish Web site for subsections. • Inform the public of planning efforts, schedule, and opportunities for involvement.
Step 2	**Assessment and Issue Identification** • Assemble forest resource assessment information for the subsection. • Identify preliminary list of issues to be addressed in the subsection plan. • Distribute Preliminary Issues and Assessment document for public review and comment.
Step 3	**Strategies, DFFC, and Stand Selection Criteria** • Finalize list of issues to be addressed in the plan based on public input from Step 2. • Develop strategies to address the final list of issues. • Establish DFFC goals for DNR lands in the subsection. • Develop stand selection criteria to help identify DNR forest stands for treatment over the 10-year planning period to move toward the DFFC goals. • Distribute Strategic Direction document for public review and comment.
Step 4	**Draft List of Stands to Be Treated and New Access Needs** • Finalize strategies, DFFC goals, and stand selection criteria based on public input from Step 3. • Identify DNR forest stands to be considered for treatment over the 10-year planning period. • Identify new access needs associated with the list of stands to be treated. • Distribute 10-Year Stand Selection Results and New Access Needs document for public review and comment.
Step 5	**Final Plan** • Summarize public comments and develop DNR responses. • Present revised plan to department for commissioner's approval. • Commissioner approves final plan. • Distribute final plan, including summary of public comments and DNR responses.

2. Desired Future Forest Composition: An Overview

Desired future forest composition (DFFC) is a broad vision of desired forest landscape condition in the long-term future. The focus of DFFC in this plan is what is the desired forest composition looking ahead 50 years or more. DFFC consists of goals, and strategies, which have been developed to move towards these goals. This plan is for a seven-year period, which will begin to move us towards the DFFC. As new SFRMP plans are developed, the DFFC will be re-evaluated according to new information available at that time and the desires of the DNR, stakeholders, and the general public.

In developing the DFFC for state lands in the Mille Lacs Uplands Subsection, the team considered DNR statewide goals, objectives, and strategies for forest resources (DNR Directions 2000).

Land type association (LTA) is the ECS landscape level below the subsection. LTA analyses were completed by team members and were used in developing the DFFC goals for the subsection. There are 30 LTAs in the subsection, similar LTAs were grouped for analysis (total of 22 LTA groups were identified). The wildlife habitat analysis from grouped LTAs helped shape the desired future forest composition for the entire subsection estimated to best meet wildlife habitat needs. DFFCs were developed for forest cover type composition, within-stand composition, age structure, patch size, ecological processes, and wildlife management emphasis. Emphasis of plant and wildlife species may vary by LTA. The broad trends and composition goals from the LTA/ecosystem type analyses will help direct where and to what degree within the subsection certain management approaches and prescriptions should be applied to achieve the subsection DFFCs.

Range of natural variability (RNV) information, i.e., estimates of the range of forest composition occurring historically (pre-European settlement) based on natural disturbance regimes resulting from fire and wind, was used as one of the tools in developing DFFC long-term goals in the LTA analyses. The DNR recognizes that RNV data was developed at the ECS section level/

Management decisions taken to move towards the DFFCs must consider the ecological, economic, and social aspects of the actions needed to get there. While managing towards the DFFC during this seven-year management period, we intend to continue to provide a relatively stable supply of timber from state lands to support local economies and communities while sustaining the other forest resources.

In Section III, *Final Issues, DFFC, and Recommended Strategies,* DFFC goals and the associated strategies are presented to address the issues. This section presents an outline of the DFFC goals and the associated strategies. Strategies may appear under more than one DFFC..

Issue 1. Biological Diversity

A. Age-class structure

DFFC 1: Forests in the Mille Lacs Uplands, Glacial Lake Superior Plain, and St. Croix Moraines (planning area) are diverse in age and structure and there are both older and young, regenerating forests.

Strategies:

a. Use harvest planning to improve the age class distribution of all forest types in the

subsection.

b. Designate stands as extended rotation forest (ERF) that include a variety of age classes.

c. Include short-lived (early successional) species such as aspen, jack pine, and birch in ERF areas.

d. Continue to harvest aspen stands that are classified as "high risk" due to age, and will be maintained as aspen, at an accelerated rate.

e. Model current and future forest age-class distributions for the planning area, annually.

f. Ensure that the oldest age classes are present on the landscape in adequate amounts.

g. Continue to refine the list of old-growth forests by evaluating and prioritizing within existing old-growth teams.

h. Coordinate with Minnesota County Biological Survey and other programs to identify additional old-growth forests.

i. Use ERF designation to buffer impacts to designated old-growth forests.

j. Plan timber sale access to minimize undesirable recreational impacts to designated old-growth forests and adjacent special management zones.

DFFC 2: At least 10 percent of lands administered by the Divisions of Forestry and Wildlife in the planning area are managed as older forest.

Strategies:

a. Identify opportunities to locate ERF in specific riparian, corridor, and Wildlife Management Areas, and adjacent to designated old-growth forests.

b. Identify some highly productive forest lands for management as ERF, for the production of high quality timber.

c. Emphasize early successional species such as aspen, jack pine, and birch in these ERF areas, in addition to typically long-lived (later successional) species.

d. Concentrate ERF in areas that have historically supported the oldest forests, and the highest proportion of older forests, in the planning area. Such areas provide site conditions and have experienced disturbance regimes that allow the development of old forests.

e. Categorize each Landtype Association (LTA) (or LTA group) by its ability to develop and maintain older forests.

f. Participate in the identification of LTAs that are appropriate for open landscape management; these LTAs may not be the best choices for ERF.

g. Consider existing large patches and identified forested corridors as areas of ERF concentration.

DFFC 3: ERF areas are located where they will provide the desired timber quality and old forest attributes.

Strategies:

a. Allocate ERF on two levels (or scales), both of which are below the subsection

level:

- At the unit or landscape level/LTA level -- at this level historical disturbance regimes are most important.
- At the stand level -- at this level existing corridors, riparian zones, and old-growth special management zones are important.

b. Concentrate ERF in areas of the subsection(s) that have historically supported the oldest forests and highest proportion of older forests. Such areas provide site conditions and have experienced disturbance regimes that allow the development of old forests.

- Identify major disturbance regimes for the planning area.
- Plot DNR releves classified by Native Plant Community System (i.e., fire-dependent vs. mesic hardwood) and native plant community class.
- Use this releve map to help decide where to concentrate ERF.
- Create a bearing tree cover for each Landtype Association (LTA) in the planning area and use that to estimate average tree age and age-class distributions for each LTA
- Use tree age and age-class distribution information to help inform decisions about how much ERF is desirable and where it should be located.
- Continue to work to achieve ERF goals during future planning periods.

c. LTAs provide the best landscape unit for basing decisions on allocation of ERF; in general, these units are homogeneous enough in terms of environmental conditions that each can be categorized by its ability to develop and maintain older forests.

d. The Division of Wildlife has identified certain LTAs that are appropriate for brushland management; these LTAs may not be the best choices for ERF.

e. Large patches and corridors identified by the SFRMP team's spatial concerns work group should be considered as areas of ERF concentration.

B. Vegetation diversity

DFFC 1: Native plant communities that were historically well represented in the planning area are well represented today.

Strategies:

a. Identify those species that were historically more common and the native plant communities in which they thrived, and focus regeneration and reintroduction efforts in those areas.

b. Place a high priority on efforts to map the occurrence of native plant communities and native plant community systems in the subsection(s).

c. Continue to develop capability to use native plant community and soil data to make decisions about appropriate forest cover types for a site.

d. Use native plant community keys to guide forest management decisions in the subsections; there will be a number of options from which to choose on any given site.

e. Identify stands most appropriate for conversion to other types using site index,

risk criteria, native plant community, and soils data.

f. Work to achieve natural regeneration if possible, use artificial regeneration when necessary, and make a commitment to protect regeneration.

DFFC 2: Benefits derived from efforts to regenerate forests after harvest are maximized.

Strategies:

a. Develop management plans specific to the needs of forest types that have been identified as lacking adequate regeneration (see specific cover-type notes in this document).

b. Engage in routine monitoring and evaluation of regeneration efforts.

c. Work closely with Division of Wildlife resource managers to ensure that population goals for wildlife and regeneration plans are not in conflict in a given area.

d. Continue to experiment with regeneration strategies that appear less vulnerable to depredation.

e. Take every precaution to avoid damage to the site during harvest; this is often at the root of regeneration problems, which are then compounded by faulty regeneration practices.

f. Document successes and failures in regeneration efforts in order to avoid repeating errors.

g. Protect soils and enhance regeneration by regulating season of harvest when necessary.

h. Follow Forest Development Manual (Minnesota DNR, 1994-5) guidelines for harvesting, site preparation, and artificial regeneration to ensure greatest chance of success in artificial regeneration.

i. Use Ecosystem Classification System (ECS) field guides to help ensure DNR resource managers make sound decisions in artificial regeneration projects.

j. Completely document all species within the project area (all woody species that occupy a site, not just the species of interest).

DFFC 3: The amount of white pine in the subsection has increased by 100 percent over 2002 levels.

Note: Historically, white pine most often occurred as a component in other forest types rather than as a pure type. It is most successfully introduced in stands with some residual overstory***;*** therefore, reaching this goal may not actually effect a significant change in the number of acres of white pine cover type.

Strategies:

a. Implement the guidelines provided by Minnesota DNR's *White Pine Management Policy* (Minnesota DNR, 1998).

b. Focus regeneration efforts in areas where white pine was historically abundant in the planning area, where there is a low incidence of blister rust, and where slopes are adequate to permit air drainage.

c. Make a commitment to protect natural and planted white pine regeneration in focus areas from depredation; enlist the support of other DNR divisions and volunteers, where possible.

DFFC 4: The amount of white cedar in the subsection has increased over 2002 levels; an improved age-class structure indicates greatly improved regeneration success.

Note: Protection and management of white cedar inclusions for improved regeneration may, or may not, significantly change type acres.

Strategies:

a. Identify native plant communities in the subsection that support the growth of upland and lowland white cedar.

b. Focus regeneration efforts on areas that have existing white cedar, especially those surrounded by large contiguous patches of forest.

c. Continue to refrain from harvesting upland white cedar in the subsection until adequate regeneration is identified or established in focus areas.

DFFC 5: The birch cover type has increased by 50 percent over 2002 levels and shows a greatly improved age-class distribution.

Strategies:

a. Identify native plant communities in the planning area that support the growth of quality birch.

b. Engage in regeneration efforts, including site preparation and planting, if needed to ensure adequate birch regeneration in selected areas, e.g., in gaps created in mixed hardwood stands.

c. Ensure that birch inclusions are managed for regeneration.

d. Ensure that harvest of decadent birch stands in the subsection be addressed as a high priority to maximize chances for natural regeneration.

e. Combine Strategy (d) with post-harvest preparation techniques to improve regeneration.

f. Implement the recommendations of current research into sustainable harvest of birch bark from live, standing trees[1].

DFFC 6: Healthy butternut specimens on state and private lands are protected pending the development of trees resistant to butternut canker.

Strategies:

a. Continue to implement butternut harvest moratorium on state lands (Minnesota DNR, 1992).

DFFC 7: The aspen cover type is reduced by 5 percent from 2002 levels by selective removal of aspen to favor an existing species, natural stand conversion through succession, replanting, or under planting with another species.

[1] The subject of ongoing collaborative research by DNR, the Natural Resources Conservation Service, and the Mille Lacs Band of Ojibwe.

Strategies:

a. Identify stands that can be maintained as mixed aspen and conifers by retaining and enhancing advanced conifer regeneration.

b. Identify aspen stands that are "high risk" due to disease and could be converted to another type.

c. Use historical records, native plant community, soil, and wind firmness data to determine appropriate conversion, if natural conversion is not apparent.

d. Reserve long-lived conifer types as clusters in hardwood stands for seed sources.

e. Encourage and nurture natural succession to mixed hardwoods on appropriate sites.

DFFC 8: Specific areas are managed to maintain open landscapes needed to maintain populations of species of management concern.

Strategies:

a. Collaborate with Divisions of Wildlife and Ecological Services to identify specific open landscapes that will provide the most benefit to associated wildlife species and maintain those areas as non-forest.

b. Provide maps of critical open landscape habitat areas for use by those involved in land-use planning efforts.

c. Collaborate with other divisions and other landowners to actively maintain open landscapes in designated areas using appropriate management techniques.

DFFC 9: State Nurseries have access to sources of seed and other propagation materials from a variety of environments. These sources are identified and protected in the course of forest management.

Strategies:

a. Encourage field personnel to document location of specimens or populations appropriate for use as seed sources. Sugar maple, basswood, white pine, yellow birch, oak species, and bigtooth aspen are of particular interest for use in tree improvement programs.

b. Identify and document pure stands of tree species that are easily accessible.

c. Use locally adapted seed.

d. Manage several stands of trees within a subsection for seed production as a way of maintaining sufficient diversity when the seed is deployed for regeneration.

e. Use seed collected from several stands of trees to increase variation among planted or seeded stands.

f. Mille Lacs Uplands falls within the Central Minnesota seed zone (Minnesota DNR, 1989). Using seed from this seed zone (even if the seed is from another subsection) has been determined to be appropriate and will further increase genetic diversity among planted or seeded stands.

g. When establishing a seed production area, it is important to develop several acres with each acre retaining ten to fifteen trees. This will result in a sufficient number of trees providing ample genetic material to have a good "mix" and

sufficient genetic variation. Establishing several seed production areas will increase genetic diversity.

DFFC 10: The oak type (red oak, bur oak, and white oak) has increased slightly (2 percent) over 2002 acreage. Oak stands are managed using even-aged or two-aged systems, with even-aged predominant.

Strategies:

a. Avoid thinning and other management when oaks are under severe stress from drought and/or defoliation.

b. Examine stands when basal area reaches 120 sq. ft per acre.

c. Thin stands to produce seven to fifteen cords per acre before regeneration harvest.

d. Accept other high quality species in wet-mesic communities.

e. Regenerate by use of shelterwood harvests, post-harvest timber stand improvement, weeding, and possibly planting to retain oak.

f. Evaluate sapling stands for precommercial release and thinning.

g. Consider using prescribed fire to regenerate oak on dry-mesic communities.

h. Re-examine stands on ten to fifteen year intervals.

i. Initiate regeneration harvest on sites that meet criteria.

j. Consider converting poor sites (SI less than 55) to a more appropriate cover type for the site.

DFFC 11: Northern Hardwood stands average sixty to eighty years of age with representatives of all age classes. Stands have between eighty and one hundred forty sq. ft of basal area, with most being maintained between eighty and one hundred twenty sq. ft. After the year 2122, northern hardwood acres should be equally divided among basal area classes 80 – 100, 101 – 120, and 121 – 140 for perpetuity.

Note: Although the goal is to maintain northern hardwood acres, we may see a slight decrease in acres as some sites that have been identified as low quality hardwood sites are converted to a more suitable cover type for the site.

Strategies:

a. Thin stands to produce an average of seven cords per acre at harvest.

b. Identify low-quality hardwood stands for conversion or rehabilitation using a clear-cut technique.

c. Thin better quality northern hardwood stands for long-term stand improvement.

d. Complete native plant community classification for each site to assess its potential for future management.

DFFC 12: New infestations of invasive exotic species on public forest land are rare, and the spread of existing populations is controlled.

Strategies:

a. Continue to develop educational materials that help adjacent landowners recognize exotic species and understand appropriate control methods.

b. Balance the need for recreational trails with the risk of introducing exotic species into all public forest areas.

c. Understand and communicate the distinction between invasive and non-invasive exotic species.

C. Wildlife habitat diversity

DFFC 1: State lands contribute important habitat and population support for the 439 permanent and regular resident wildlife species that exist in Minnesota. Populations for various species are monitored and habitats for game and nongame species are valued and protected.

Strategies:

a. Identify wildlife management species for the subsection that represent the various habitat and ecological processes necessary to ensure overall sustainability and viability of wildlife.

b. Work with the Divisions of Wildlife and Ecological Services to define which wildlife species can be identified as representative wildlife management species.

c. Use wildlife resource assessment information about representative wildlife management species to guide/support forest management decisions concerning: 1) species distribution and population estimates, 2) habitat associations, 3) landscape habitat elements, 4) site level habitat elements, 5) management practices, and 6) monitoring and adaptive management strategies.

d. Participate in designation of open landscape complexes to be maintained as habitat for open-landscape-dependent wildlife species.

e. Identify and maintain long-lived conifer secondary species in hardwood stands as winter cover.

f. Identify and maintain mast species as leave trees on harvest sites.

D. Ecologically significant areas

DFFC 1: Areas of unusual ecological significance are valued and protected as areas for study and conservation of both plant and animal rare species, sources of biological diversity, and ecological benchmarks.

Strategies:

a. Consult the most up-to-date rare features database layer available through the DNR Geographic Information Systems data library.

b. Flag stands that include a rare feature element during stand selection.

c. Following stand selection, DNR Ecological Services Division will confer with Forestry staff (on Forestry-administered lands) and Wildlife staff (on Wildlife-administered lands) to determine adjustments (if needed) in proposed treatments to protect the element occurrence.

d. Work with the Divisions of Ecological Services and Wildlife to identify areas of high biological diversity on State land that are not already protected by Scientific and Natural Areas, state Parks, or Wildlife Management Areas, and consider giving them special management to conserve their unique assets.

e. Determine the kind of forest resource management that is required to conserve each high biological diversity area, if appropriate.

f. Consider including high biological diversity areas in ERF management areas and/or in forested corridor areas, as appropriate.

DFFC 2: Forested rivers in the planning area have high water quality providing important habitat for fish, amphibians, and invertebrates, including a number of federally listed mussel species.

Strategies:

a. Adhere to MFRC voluntary site-level guidelines for trout streams when conducting forest management activities in riparian areas of rivers and streams that contain trout or listed mussel species and MFRC standard riparian area voluntary site-level guidelines (Minnesota FRC, 1999) in other riparian areas

Issue 2. Forest Spatial Patterns

A.Connectivity

DFFC 1: Forested connections between existing large blocks of forested land and riparian areas are maintained and enhanced to provide for wildlife movement, protect water resources, and prevent habitat fragmentation and consequent isolation of native plants and animals.

Strategies:

a. Identify and maintain existing connections between large blocks of forest land.

b. Establish a corridor, a minimum of one-quarter mile (1320 feet) in width. This may or may not always be in the same location.

c. Manage forests in the designated corridor for a minimum average basal area of 60 sq. ft per acre. Where the management goal within the corridor is to maintain an even-aged species (aspen, jack pine, red pine, etc.) no more than one-half the width of the corridor may be less than 60 sq. ft of basal area at any one time. Any Division of Forestry-approved management activity that maintains these stand characteristics is acceptable.

d. Work with other land managers (federal, tribal, and county) to maintain forest land in the corridor in forested status. This will mean involving them and getting "buy-in" to the concept of establishing a forested corridor.

B. Patch management

DFFC 1: Forests are managed for a variety of patch sizes. Large, contiguous patches of forest are maintained in designated areas, while other parts of the Mille Lacs uplands are managed for smaller or medium size patches.

Strategies:

a. Plan subsection timber harvests taking into consideration the desired future distribution of patch sizes.

b. Conserve existing large contiguous mature forest areas to provide critical habitat for multiple forest interior species, e.g., red-shouldered hawk nest sites.

c. Manage existing large blocks of state forest land, and blocks of state forest land that are adjacent to large blocks on other ownerships, for large patches, giving priority to those areas in Strategy b, above.

d. Continue to use information on historical disturbance regimes to help refine planning for management of large, medium, or small patches.

e. Continue to increase the proportion of state forest land managed according to uneven-aged management regimes as a way of achieving a more desirable patch size distribution.

f. Manage state forest lands in the planning area to achieve the following distribution of patch sizes (percent of Forestry and Wildlife lands):

Very large (640 acres +)	10%
Large (250-639 acres)	15%
Medium (100-249 acres)	40%
Small (40-99 acres)	25%
Very small (< 40 acres)	10%

g. Take care to maintain existing patches in the very large and large size categories.

C. Fragmentation

DFFC 1: Forest managers carefully consider forest road construction. There is a high level of collaboration with federal and private landowners and local units of government to identify opportunities to share and minimize road construction.

Strategies:

a. Plan the fate of new roads and trails prior to construction so that appropriate action can be taken to either maintain them, or obliterate them from the forest. It is undesirable to have roads developing in an unplanned way as a result of recreational use of logging trails.

b. Follow the DNR State Forest Road Manual (Minnesota DNR, 1994-6) for development of new roads.

c. Adhere to Forestry-Wildlife Guidelines to Habitat Management (Minnesota DNR, 1985-2) Roads and Trails section.

d. Contact county land departments and other appropriate land managers (e.g., Tribal governments, The Nature Conservancy) to arrange cooperative use of existing roads to keep new road construction to a minimum.

e. Provide a draft of road access needs for public review as part of the forest esource planning process.

Issue 3. Timber Productivity

A. Identification and management of highly productive sites

DFFC 1: *Timberlands* in the planning area are highly productive. They produce good quality hardwood and softwood logs for manufacturing and export, as well as a good quantity of *pulpwood* to supply Minnesota's pulp and paper industries.

Strategies:

a. Identify areas that are good examples of their type, occur on wind firm soils, can be managed for production of high quality hardwoods, and/or include large contiguous forested patches for wildlife habitat. Consider thinning healthy aspen types in ERF as well as dense hardwoods and conifers to produce quality timber for the future.

b. Use Site-Level Guidelines for all activities to ensure that site quality is maintained.

c. Increase hardwood-marking efforts as resources allow.

d. Use ECS and local knowledge to identify aspen stands that would be appropriate for conversion to mixed hardwoods, and manage these for quality hardwoods using selective harvest and thinning techniques.

e. Identify advance regeneration of long-lived conifers in less productive aspen stands, and plan for their conversion to pine, spruce, and fir types.

f. Improve production of quality aspen by continuing to harvest high-risk aspen stands that are to be maintained in the aspen type at a high rate, to avoid conversion to other types.

g. Investigate potential for thinning aspen to increase growth and produce high-quality logs on selected sites.

h. Use site-level ecosystem classification keys to identify the native plant community type on a given site and make decisions to manage for appropriate forest types. Sites that are managed for appropriate forest types, have good access, and where managers are committed to continuous improvement have the greatest potential for optimizing timber productivity for the present and the future.

i. Focus management activities intended to help stands approach their full production potential on sites with fewest conflicting priorities (rare features, old-growth forest, poor access, etc.).

B. Utilization and marketing of forest resources

DFFC 1: Utilization of species and grades of timber are optimized to maximize the benefits these resources provide.

Strategies:

a. Promote the use of lesser-utilized species and identify potential markets for underutilized species to DNR resource managers.

b. Communicate changes in wood and non-timber forest product markets to DNR resource managers.

C. Increase site-level productivity

DFFC 1: Ecosystem classification tools have helped DNR resource managers identify species most likely to be productive on a specific site, as indicated by soil and native plant community information.

Strategies:

a. Use ECS and local knowledge to identify stands that would be appropriate for conversion to mixed hardwoods, and manage these for quality hardwoods using selective harvest and thinning techniques.

b. Use ECS keys and historical information to identify sites appropriate for introduction or enhancement of long-lived conifer species.

c. Use ECS keys to help identify forest types that may be more productive than those currently on sites that are marginally productive.

d. Use innovative silvicultural techniques appropriately to manage for structural diversity and improved timber quality.

DFFC 2: Diverse, high-quality mixed hardwood stands are managed by skilled forest managers and selectively harvested by highly trained logging professionals for continuous quality improvement and production of timber, while maintaining forest cover and establishing regeneration.

Strategies:

a. Increase hardwood-marking efforts as resources allow.

b. Identify thinning opportunities to enhance quality of all timber types.

c. Continue to make use of contract hardwood marking crews to improve the growth and quality of hardwood stands.

D. Improved forestry data management

DFFC 1: Forest inventory data are detailed and current enough to be relied upon in a wide variety of planning and analysis projects. Forestry databases provide a link between generations of forest managers with respect to both strategic and operational decisions that have been made for a specific forested community.

Strategies:

a. Create a priority reinventory list each planning period.

b. Support the development and use of databases that include planning elements in addition to inventory elements.

Issue 4. Public involvement and collaboration

A. Forest stewardship planning

Note: Private land management is outside the scope of Subsection Forest Resource Management Plans. However, promotion of consistent goals and actions across ownerships can help achieve this plan's vision and goals.

DFFC 1: Progress toward the vision for the subsection(s) forests (or DFFCs) is enhanced by engaging nonindustrial private forest landowners, providing a level

of consistency across ownerships with regard to forest management in a given landscape unit.

Strategies:

a. Consider the differences between private and public lands when developing DFFCs for the planning area. A one-size-fits-all future condition statement is not likely to be implemented or result in diverse and resilient ecosystems.

b. Develop a concise summary of landscape-level ecological conditions that can be used by stewardship plan preparers to help private landowners understand past, present, and future ecosystems. This will help landowners select realistic management objectives that are compatible with ecological and economic conditions.

c. Prepare or revise management prescriptions tailored to conditions in the planning area so that they can be incorporated into Forest Stewardship Plans.

B. Collaboration with other landowners

DFFC 1: Minnesota DNR resource managers routinely collaborate with other landowners to develop consistent goals and landscape-level strategic plans.

Strategies:

a. Continue efforts to coordinate plans and management projects with federal and county land managers. Provide federal, tribal, and county managers the opportunity to participate in developing management plans for state lands. Review and comment on management plans for federal-, tribal-, and county-managed natural resources.

b. In counties that have land departments, send copies of annual vegetation management work plans to the county land commissioner to allow coordination of vegetation management and road access projects.

c. In counties that do not have land departments, offer to assist county auditors or the county board to develop land management plans for tax-forfeit land that will be retained in county ownership, as time and resources permit.

d. When feasible, develop joint contracts (e.g., site preparation, tree planting) on state and county lands to avoid duplication of effort and achieve economies of scale.

e. Maintain contact with other resource managers in the planning area and monitor their strategic planning documents as a way of maintaining an awareness of their long and short-term forest management goals.

f. Take advantage of opportunities to collaborate with other resource managers as resources allow.

DFFC 2: Losses due to forest insects and diseases on private and state forest land are minimized, as are the effects of pest management on nontarget species.

Strategies:

a. Inform adjacent landowners of insect or disease incidents on state land and assist them to make informed decisions about protecting their trees and property.

b. When a private landowner adjacent to state land is actively suppressing a forest

pest infestation and that pest also exists on adjacent state lands, the state should consider appropriately treating the pest also.

c. Follow guidelines established by Division of Forestry forest health specialists with regard to insect and disease outbreaks.

DFFC 3: State forest lands are managed in a manner that minimizes conflicts among users, adjacent landowners, and in-holders, while maintaining management options.

Strategies:

a. When planning management activities, always make adjacent landowners aware of the plan and the purpose.

b. Maintain awareness of, and respect for, ownership boundaries.

c. Clearly mark and post all boundaries with signs where possible.

C. Public involvement and review

DFFC 1: The public is involved in forest management planning during designated review periods.

Strategies:

a. Encourage and actively solicit public input into forest management activities such as planning.

DFFC 2: DNR Forest managers minimize the visual and aural impact of forest management activities on users of state forests, thereby supporting and enhancing multiple-use values of state forest land.

Strategies:

a. Apply visual quality management guidelines. Be particularly considerate of scenic values in areas classified as most sensitive (e.g., high-use recreational areas, adjacent to recreational lakes and streams, solitude areas).

b. Manage expectations and perceptions by informing and educating stakeholders about the need for and expected impacts of management activities prior to, during, and after the activity.

DFFC 3: Forest managers have stakeholder support for employment of a full suite of forest management options as appropriate to reach identified goals.

Strategies:

a. Use opportunities to communicate to the public about management options, risks, and benefits as they arise.

b. Use historical disturbance regime and range of natural variation data as they become available to help determine appropriate management techniques for landscape areas.

c. Document management prescriptions and choices as they are made, to facilitate communication and public education.

d. Use pre-treatment monitoring and post-treatment monitoring as learning and communication tools to justify choices and outcomes.

3. Final Issues, DFFC, and Recommended Strategies

This chapter provides details on each management issue within the Mille Lacs Uplands Subsection. For each issue there is a discussion followed by one or more desired future forest conditions (goals for management), and a series of strategies to achieve those conditions.

The area covered by this plan is characterized by an abundance of public land, a diversity of forested and non-forested habitats, a significant amount of recreational activity, a diversity and abundance of water resources, and an increasing number of full-time residents. Forest and wildlife managers, with the help of public input and review, put together a comprehensive list of issues to be addressed during this planning period.

Interwoven through most of the issues is recognition of the value of maintaining and enhancing biological diversity in the subsection in order to increase the resilience of the forested landscape, i.e., its resistance to disease and disturbance and ability to provide a variety of resources. The *means* of accomplishing the desired level of biological diversity was less easy to determine. However, many months of discussion, investigation, and analysis have produced a desired future forest condition that the team agrees is conducive to maintaining the desired level of biological diversity. It should be noted that, throughout this plan, management activities seen as necessary to the accomplishment of the DFFC goals have been described without consideration of current resource (fiscal and personnel) limitations.

Some special conditions currently exist in the landscapes under consideration, necessitating development of management prescriptions that may, in some cases, appear to depart from traditional management regimes. Considerable innovation and creativity have been brought to bear in addressing the many forest resource challenges discovered as forest inventory data were analyzed. In many cases, this is the first time that DNR resource managers in Minnesota have had the tools available to enable them to take this kind of in-depth look at the resource and its future condition.

Global climate change is a concern throughout the state. Predictions are that climate change will affect the size, frequency, and intensity of disturbances such as fires and wind events. It will affect the survival of existing plant and animal species and their distributions. Even at modest levels, independent studies are finding mounting evidence that climate change influences plant and animal ranges and behavior[2] and that some species may not be able to adapt to the rate of change. Increases in the reproductive capacity and survival of exotic species, insect pests, and pathogens will almost certainly affect forests and wildlife. Certain tree species, such as black spruce, balsam fir, birch, and jack pine will respond negatively to increased soil warming and decreased soil moisture. Carbon sequestration by forests and wetlands may be affected because of accelerated decomposition rates. Because this is a statewide and global issue, the SFRMP merely recognizes the potential for long-term effects and identifies maintenance of biological diversity and maintenance of forested corridors as the major mitigating strategies during the current planning period.

[2] Nature- January 2, 2003: Terry L. Root etal., "Fingerprints of Global Warming on Wild Animals and Plants" Stanford University and Camille Parmesan "A Globally Coherent Fingerprint of Climate Change Impacts Across Natural Systems" University of Texas.

Biological Diversity

This plan recognizes the need to protect the biological diversity inherent in the forests of east-central Minnesota. One of the ways this will be addressed is by planning to maintain and/or enhance the forest types that have historically been present in the subsections (including birch, white pine, and tamarack) and are currently significantly less common. Another is by identifying old forest on the landscape and allowing native plant communities in those areas to develop through careful harvest management. Old-growth forests and Scientific and Natural Areas (SNAs) are other sources of biological diversity that will be carefully protected in these subsections. Special attention was given during the planning process to the management of forest types currently suffering from inadequate regeneration, creating a concern that the type will "die out" in the foreseeable future. These forest types include white cedar, white pine, red oak, and white birch. Where a strategy involved increasing the acres of one forest type, commensurate decreases in one or more other forest types were identified where possible.

A small area on the north edge of Mille Lacs Lake (Mille Lacs Beach Ridges) has been recommended for SNA designation. This area is recognized as a geologically significant one by the DNR Divisions of Forestry, Wildlife, and Ecological Services. There was full agreement among team members that this designation would be appropriate.

As a way of increasing coordination between Division of Forestry and Division of Wildlife planning processes, the DNR Forest Resource Issues Team ("FRIT") asked the subsection planning teams to use the SFRMP process to consider designation of priority open landscape complexes identified by the DNR Division of Wildlife

One aspect of translating biological diversity objectives into on-the-ground forest management involves quantifying and locating stands to be designated as extended rotation forest. The thirty Landtype Associations (LTAs) in the planning area were grouped into twenty-two LTA groups on the basis of landscape features and historical disturbance regime. Minnesota DNR *Extended-Rotation Forest Guidelines* (1994) for the Division of Forestry provide criteria for appropriately locating ERF on the landscape. Some of the recommended locations are, adjacent to designated old-growth forest, in riparian areas, in areas where large forest patches are desired for wildlife habitat, and in areas that can provide a high quality timber resource. In addition, the Mille Lacs Uplands SFRMP team used historical disturbance regime data, wildlife habitat data, and the range of natural variation, to help identify specific parts of the subsection(s) where more or less old forest would be appropriate. For example, habitat requirements for red-shouldered hawk populations in the planning area were considered by the team when locating ERF in the subsection. Historical amounts of old (>70 years) forest in the subsection(s) ranged from 50 to 72 percent; amounts of aspen ERF recommended ranged from 0 to 100 percent in the LTA groups.

ERFs are intended to provide a suite of "old forest" characteristics on the landscape in the context of a productive, working forest. This is in contrast to old-growth forests, SNAs, and other reserved forest land areas where harvest is not an explicit part of the management plan. Because some kind of harvest will be conducted in ERF areas at some time, a forest with this designation can be any age at a given time; the final harvest merely being delayed to provide more old forest "services" to the landscape. Early successional species such as aspen and birch are critically important for designation as ERF because they are typically managed through even-age harvests, and the typical rotation ages are short (40-60 years). With continuous improvement in data collection and increasing understanding of ecological systems, DNR personnel anticipate being able to refine the designation of ERF areas in future planning periods.

Table 3.1 summarizes the distribution of *acres* of state-administered forest between normal rotation and extended rotation management regimes. Percentage prescribed ERF is a simple

ERF percentage of the total cover-type acres; forest in the prescribed ERF areas could be any age.

Table 3.1. Extended Rotation Forests in the Mille Lacs Upland and Glacial Lake Superior Plain*

Cover Type	Cover-type Acres	Normal Rotation Acres	ERF	Prescribed ERF (%)
Ash/lowland hardwoods	18,537	10,905	7,632	41%
Aspen/ Balm of Gilead	99,109	72,436	26,673	27%
Birch	9,934	7,832	2,102	21%
Northern Hardwoods	46,147	21,811	24,336	53%
Oak/central hardwoods	21,101	12,666	8,435	40%
White Pine	551	0	551	100%
Red Pine	6,770	5,519	1,251	18%
Jack Pine	2,010	1,858	152	8%
Scots Pine	25	25	0	0%
White Spruce	2,705	1,640	1,065	39%
Balsam Fir	2,983	2,761	222	7%
Norway Spruce	5	5	0	0%
Lowland Black Spruce	11,375	7,685	3,690	32%
Tamarack	10,342	8,605	1,737	17%
White Cedar	235	131	104	44%
Upland Black Spruce	124	102	22	18%
Red Cedar	9	9	0	0%
Other species	393	267	126	32%
TOTALS	**232355**	**154334**	**78098**	34%

*Commercial state forest land administered by DNR Divisions of Forestry and Wildlife, excluding state parks.

Table 3.2 indicates, for a group of early-successional tree species, what the normal rotation ages are (determined by Mean Annual Increment (MAI) data), and what proportion of the forest of each type is over the normal rotation age, currently and what is predicted at the end of the current planning periods. Forest over normal rotation age in both normal and extended rotation areas gives an indication of the amount of old forest in the planning area.

Table 3.2. Forest* Over Normal Rotation Age (Mille Lacs Uplands, Glacial Lake Superior Plain, and St. Croix Moraines)

Forest Type	Acres	Normal Rotation Age	Acres over Normal Rotation Age	2004 Percent Old Forest	2011 Predicted Old Forest
Aspen	99,109	40	32,454	33%	19%
Birch	9,934	50	8,146	82%	47%
Jack Pine	2,010	40	1,331	66%	18%
Black Spruce	11,375	100	2,770	24%	24%
Tamarack	10,342	80	4,109	40%	42%

*Commercial forest land administered by DNR Divisions of Forestry and Wildlife, excluding state parks and designated old-growth forest.

The SFRMP team's biological diversity work group placed LTAs in the planning area into groups for a variety of reasons, including small amounts of public land, proximity to each other, and similarity of disturbance regime. As noted previously in the text, designation of ERF was based on recommendations from DNR field staff, historical disturbance regime, and range of natural variation. Table 3.3 lists the LTA groups in the planning area, a total acreage for each LTA group, and percentages of prescribed ERF for each group and each individual LTA. Because of the importance of early successional species in ERF designation, aspen acres, aspen prescribed ERF, and the biological diversity work group's recommendation for aspen prescribed ERF are also given.

Table 3.3. Extended Rotation Forests[1] by LTA Group

LTA Grp	LTA Name	Total[3] [4] Acres	LTA% ERF	Group% ERF All species	Aspen Acres[5]	%Aspen ERF	Group % Aspen ERF	Recommended[2] Group % Aspen ERF
1	Bruno Moraine	17959	11	16	7427	10	11	25-35
	Duxbury Moraine	60387	18		25384	12		
2	Malmo Peatlands	4207	70	98	1094	36	36	25-35
3	Kathio Moraine	5894	61	63	1360	21	29	25-35
	Mille Lacs Moraine	4358	65		374	60		
4	Eastside Till Plain	1901	40	40	209	17	17	15-25
5	Three Rivers Peatlands	37629	68	58	17422	65	61	25-35
	Solana Till Plain	10158	20		1766	22		

LTA Grp	LTA Name	Total [3] [4] Acres	LTA% ERF	Group% ERF All species	Aspen Acres [5]	%Aspen ERF	Group % Aspen ERF	Recommended[2] Group % Aspen ERF
6	Pine Lake Till Plain	668	27	47	352	45	51	25-35
	Finlayson Till Plain	4338	50		2996	51		
7	Ann Lake Drumlin Plain	38239	41	39	16004	27	25	15-25
	Pierz Drumlin Plain	2022	16		1374	10		
	Milaca Till Plain	84	100		4	100		
8	Brainerd Drumlin Plain	1272	37	0	204	45	45	10-35
9	Kettle River Drumlin Plain	2844	36	38	1838	44	44	25-35
10	Willow River Sand Plain	4507	6	7	526	8	8	0-10
11	Nickerson Moraine	11174	13	16	4328	15	15	25-35
12	St. Croix Terraces	15803	24	24	11683	18	18	35-45
13	Cloverdale Sand Plain	902	12	28	806	13	24	15-25
	Brooke Park Till Plain	475	58		287	55		
14	Stanchfield Lake Plain	734	12	11	266	6	6	15-25
15	Elm Park Till Plain	5	0	0	0	0		
16	Mora Sand Plain	331	0	0	313	0	0	15-25
17	Rush City Moraine	90	79	86	2	100	100	15-25
18	Riverton Moraine	698	2	3	446	0	0	10-35
19	Chisago Moraine	0	-	-	-	-	0	100
	Almelund Moraine	0	-	-	-	-		
20	Nokay Sand Plain	1126	97	9	455	4	4	10-35
21	Douglas Lake-Modified Till Plain	2971	30	30	1382	2	2	
22	Duesler Lake Plain	1089	35	65	579	17	25	
	Nemadji Lake Plain	113	55		65	95		
	Totals	**231978**	**34%**	**34%**	**98946**	**27%**	**27%**	

[1] Reference to ERF is prescribed ERF in all columns.

[2] Recommended by Mille Lacs Uplands SFRMP Biodiversity Work Group, based on historical disturbance regime and range of natural variation.

[3] Does not include designated old-growth forest, future old-growth forest (and old-growth forest candidates), or stands with timber harvest restricted or prohibited.

[4] Does not include any forest land within State Park boundaries.

[5] Includes Balm of Gilead acres

Current and desired future species composition of the forests in the planning area is summarized in Table 3.4.

Table 3.4.Desired Future Composition of Commercial Forest Types (Mille Lacs Uplands and Glacial Lake Superior Plain)

Cover type	Present (2004) Acres	DFFC 2011 Acres	DFFC 2051 Acres	Change needed
Ash and Lowland Hdwds	18,537	18,537	18,537	maintain
Aspen/BAM[1]	99,109	97,127	93,898	-5 percent
Birch	9,934	14,911	14,911	+48%
Northern hardwoods	46,147	46,147	46,147	maintain
Oak and Central Hdwds	21,101	21,101	21,523	+2%
White pine	556	556	556	+100% increase as a component in other forest types[2]
Red pine	6,780	6,780	6,780	maintain
Jack pine	2,010	2,010	2,010	maintain
Scots pine	25	25	0	-100%
White spruce	2,705	2,705	2,705	maintain
Balsam fir	2,940	2,940	2,940	maintain
Norway spruce	5	5	0	-100%
Black Spruce (lowland)	11,375	10,806	10,806 (estimate)	Convert mistletoe infected stands to tamarack (–5%)
Tamarack	10,342	10,859	10,859 (estimate)	+5%
White cedar	235	235	235	maintain w/regeneration
Black spruce (Upland)	119	119	119	maintain
Red cedar	9	9	9	maintain

[1] Balm of Gilead

[2] Little change is expected in white pine cover type acres.

Issue 1. Age-class structure

DFFC 1: Forests in the Mille Lacs Uplands, Glacial Lake Superior Plain, and St. Croix Moraines (planning area) are diverse in age and structure and there are both older and young, regenerating forests.

Strategies:

a. Use harvest planning to improve the age class distribution of all forest types in the subsection.

b. Designate stands as extended rotation forest (ERF) that include a variety of age classes.

c. Include short-lived (early successional) species such as aspen, jack pine, and birch in ERF areas.

d. Continue to harvest aspen stands that are classified as "high risk" due to age, and will be maintained as aspen, at an accelerated rate.

e. Model current and future forest age-class distributions for the planning area, annually.

f. Ensure that the oldest age classes are present on the landscape in adequate amounts.

g. Continue to refine the list of old-growth forests by evaluating and prioritizing within existing old-growth teams.

h. Coordinate with Minnesota County Biological Survey and other programs to identify additional old-growth forests.

i. Use ERF designation to buffer impacts to designated old-growth forests.

j. Plan timber sale access to minimize undesirable recreational impacts to designated old-growth forests and adjacent special management zones.

DFFC 2: At least 10 percent of lands administered by the Divisions of Forestry and Wildlife in the planning area are managed as older forest.

Strategies:

a. Identify opportunities to locate ERF in specific riparian, corridor, and Wildlife Management Areas, and adjacent to designated old-growth forests.

b. Identify some highly productive forest lands for management as ERF, for the production of high quality timber.

c. Emphasize early successional species such as aspen, jack pine, and birch in these ERF areas, in addition to typically long-lived (later successional) species.

d. Concentrate ERF in areas that have historically supported the oldest forests, and the highest proportion of older forests, in the planning area. Such areas provide site conditions and have experienced disturbance regimes that allow the development of old forests.

e. Categorize each Landtype Association (LTA) (or LTA group) by its ability to develop and maintain older forests.

f. Participate in the identification of LTAs that are appropriate for open landscape management; these LTAs may not be the best choices for ERF.

g. Consider existing large patches and identified forested corridors as areas of ERF concentration.

DFFC 3: ERF areas are located where they will provide the desired timber quality and old forest attributes.

Strategies:

a. Allocate ERF on two levels (or scales), both of which are below the subsection level:

- At the unit or landscape level/LTA level -- at this level historical disturbance regimes are most important.
- At the stand level -- at this level existing corridors, riparian zones, and old-growth special management zones are important.

b. Concentrate ERF in areas of the subsection(s) that have historically supported the oldest forests and highest proportion of older forests. Such areas provide site conditions and have experienced disturbance regimes that allow the development of old forests.

- Identify major disturbance regimes for the planning area.
- Plot DNR releves classified by Native Plant Community System (i.e., fire-dependent vs. mesic hardwood) and native plant community class.
- Use this releve map to help decide where to concentrate ERF.
- Create a bearing tree cover for each Landtype Association (LTA) in the planning area and use that to estimate average tree age and age-class distributions for each LTA
- Use tree age and age-class distribution information to help inform decisions about how much ERF is desirable and where it should be located.
- Continue to work to achieve ERF goals during future planning periods.

c. LTAs provide the best landscape unit for basing decisions on allocation of ERF; in general, these units are homogeneous enough in terms of environmental conditions that each can be categorized by its ability to develop and maintain older forests.

d. The Division of Wildlife has identified certain LTAs that are appropriate for brushland management; these LTAs may not be the best choices for ERF.

e. Large patches and corridors identified by the SFRMP team's spatial concerns work group should be considered as areas of ERF concentration.

Issue 2. Vegetation diversity

DFFC 1: Native plant communities that were historically well represented in the planning area are well represented today.

Strategies:

a. Identify those species that were historically more common and the native plant communities in which they thrived, and focus regeneration and reintroduction efforts in those areas.

b. Place a high priority on efforts to map the occurrence of native plant communities and native plant community systems in the subsection(s).

c. Continue to develop capability to use native plant community and soil data to make decisions about appropriate forest cover types for a site.

d. Use native plant community keys to guide forest management decisions in the subsections; there will be a number of options from which to choose on any given site.

e. Identify stands most appropriate for conversion to other types using site index, risk criteria, native plant community, and soils data.

f. Work to achieve natural regeneration if possible, use artificial regeneration when necessary, and make a commitment to protect regeneration.

DFFC 2: Benefits derived from efforts to regenerate forests after harvest are maximized.

Strategies:

a. Develop management plans specific to the needs of forest types that have been identified as lacking adequate regeneration (see specific cover-type notes in this document).

b. Engage in routine monitoring and evaluation of regeneration efforts.

c. Work closely with Division of Wildlife resource managers to ensure that population goals for wildlife and regeneration plans are not in conflict in a given area.

d. Continue to experiment with regeneration strategies that appear less vulnerable to depredation.

e. Take every precaution to avoid damage to the site during harvest; this is often at the root of regeneration problems, which are then compounded by faulty regeneration practices.

f. Document successes and failures in regeneration efforts in order to avoid repeating errors.

g. Protect soils and enhance regeneration by regulating season of harvest when necessary.

h. Follow Forest Development Manual (Minnesota DNR, 1994-5) guidelines for harvesting, site preparation, and artificial regeneration to ensure greatest chance of success in artificial regeneration.

i. Use Ecosystem Classification System (ECS) field guides to help ensure DNR resource managers make sound decisions in artificial regeneration projects.

j. Completely document all species within the project area (all woody species that occupy a site, not just the species of interest).

DFFC 3: The amount of white pine in the subsection has increased by 100 percent over 2002 levels.

Note: Historically, white pine most often occurred as a component in other forest types rather than as a pure type. It is most successfully introduced in stands with some residual overstory***;*** therefore, reaching this goal may not actually effect a significant change in the number of acres of white pine cover type.

Strategies:

a. Implement the guidelines provided by Minnesota DNR's *White Pine Management Policy* (Minnesota DNR, 1998).

b. Focus regeneration efforts in areas where white pine was historically abundant in the planning area, where there is a low incidence of blister rust, and where slopes are adequate to permit air drainage.

c. Make a commitment to protect natural and planted white pine regeneration in focus areas from depredation; enlist the support of other DNR divisions and volunteers, where possible.

DFFC 4: The amount of white cedar in the subsection has increased over 2002 levels; an improved age-class structure indicates greatly improved regeneration success.

Note: Protection and management of white cedar inclusions for improved regeneration may, or may not, significantly change type acres.

Strategies:

a. Identify native plant communities in the subsection that support the growth of upland and lowland white cedar.

b. Focus regeneration efforts on areas that have existing white cedar, especially those surrounded by large contiguous patches of forest.

c. Continue to refrain from harvesting upland white cedar in the subsection until adequate regeneration is identified or established in focus areas.

DFFC 5: The birch cover type has increased by 50 percent over 2002 levels and shows a greatly improved age-class distribution.

Strategies:

a. Identify native plant communities in the planning area that support the growth of quality birch.

b. Engage in regeneration efforts, including site preparation and planting, if needed to ensure adequate birch regeneration in selected areas, e.g., in gaps created in mixed hardwood stands.

c. Ensure that birch inclusions are managed for regeneration.

d. Ensure that harvest of decadent birch stands in the subsection be addressed as a high priority to maximize chances for natural regeneration.

e. Combine Strategy (d) with post-harvest preparation techniques to improve regeneration.

f. Implement the recommendations of current research into sustainable harvest of birch bark from live, standing trees[3].

DFFC 6: Healthy butternut specimens on state and private lands are protected pending the development of trees resistant to butternut canker.

Strategies:

[3] The subject of ongoing collaborative research by DNR, the Natural Resources Conservation Service, and the Mille Lacs Band of Ojibwe.

a. Continue to implement butternut harvest moratorium on state lands (Minnesota DNR, 1992).

DFFC 7: The aspen cover type is reduced by 5 percent from 2002 levels by selective removal of aspen to favor an existing species, natural stand conversion through succession, replanting, or under planting with another species.

Strategies:

a. Identify stands that can be maintained as mixed aspen and conifers by retaining and enhancing advanced conifer regeneration.

b. Identify aspen stands that are "high risk" due to disease and could be converted to another type.

c. Use historical records, native plant community, soil, and wind firmness data to determine appropriate conversion, if natural conversion is not apparent.

d. Reserve long-lived conifer types as clusters in hardwood stands for seed sources.

e. Encourage and nurture natural succession to mixed hardwoods on appropriate sites.

DFFC 8: Specific areas are managed to maintain open landscapes needed to maintain populations of species of management concern.

Strategies:

a. Collaborate with Divisions of Wildlife and Ecological Services to identify specific open landscapes that will provide the most benefit to associated wildlife species and maintain those areas as non-forest.

b. Provide maps of critical open landscape habitat areas for use by those involved in land-use planning efforts.

c. Collaborate with other divisions and other landowners to actively maintain open landscapes in designated areas using appropriate management techniques.

DFFC 9: State Nurseries have access to sources of seed and other propagation materials from a variety of environments. These sources are identified and protected in the course of forest management.

Strategies:

a. Encourage field personnel to document location of specimens or populations appropriate for use as seed sources. Sugar maple, basswood, white pine, yellow birch, oak species, and bigtooth aspen are of particular interest for use in tree improvement programs.

b. Identify and document pure stands of tree species that are easily accessible.

c. Use locally adapted seed.

d. Manage several stands of trees within a subsection for seed production as a way of maintaining sufficient diversity when the seed is deployed for regeneration.

e. Use seed collected from several stands of trees to increase variation among planted or seeded stands.

f. Mille Lacs Uplands falls within the Central Minnesota seed zone (Minnesota DNR, 1989). Using seed from this seed zone (even if the seed is from another

subsection) has been determined to be appropriate and will further increase genetic diversity among planted or seeded stands.

g. When establishing a seed production area, it is important to develop several acres with each acre retaining ten to fifteen trees. This will result in a sufficient number of trees providing ample genetic material to have a good "mix" and sufficient genetic variation. Establishing several seed production areas will increase genetic diversity.

DFFC 10: The oak type (red oak, bur oak, and white oak) has increased slightly (2 percent) over 2002 acreage. Oak stands are managed using even-aged or two-aged systems, with even-aged predominant.

Strategies:

a. Avoid thinning and other management when oaks are under severe stress from drought and/or defoliation.

b. Examine stands when basal area reaches 120 sq. ft per acre.

c. Thin stands to produce seven to fifteen cords per acre before regeneration harvest.

d. Accept other high quality species in wet-mesic communities.

e. Regenerate by use of shelterwood harvests, post-harvest timber stand improvement, weeding, and possibly planting to retain oak.

f. Evaluate sapling stands for precommercial release and thinning.

g. Consider using prescribed fire to regenerate oak on dry-mesic communities.

h. Re-examine stands on ten to fifteen year intervals.

i. Initiate regeneration harvest on sites that meet criteria.

j. Consider converting poor sites (SI less than 55) to a more appropriate cover type for the site.

DFFC 11: Northern Hardwood stands average sixty to eighty years of age with representatives of all age classes. Stands have between eighty and one hundred forty sq. ft of basal area, with most being maintained between eighty and one hundred twenty sq. ft. After the year 2122, northern hardwood acres should be equally divided among basal area classes 80 – 100, 101 – 120, and 121 – 140 for perpetuity.

Note: Although the goal is to maintain northern hardwood acres, we may see a slight decrease in acres as some sites that have been identified as low quality hardwood sites are converted to a more suitable cover type for the site.

Strategies:

a. Thin stands to produce an average of seven cords per acre at harvest.

b. Identify low-quality hardwood stands for conversion or rehabilitation using a clear-cut technique.

c. Thin better quality northern hardwood stands for long-term stand improvement.

d. Complete native plant community classification for each site to assess its potential for future management.

DFFC 12: New infestations of invasive exotic species on public forest land are rare, and the spread of existing populations is controlled.

Strategies:

a. Continue to develop educational materials that help adjacent landowners recognize exotic species and understand appropriate control methods.

b. Balance the need for recreational trails with the risk of introducing exotic species into all public forest areas.

c. Understand and communicate the distinction between invasive and non-invasive exotic species.

Issue 3. Wildlife habitat diversity

DFFC 1: State lands contribute important habitat and population support for the 439 permanent and regular resident wildlife species that exist in Minnesota. Populations for various species are monitored and habitats for game and nongame species are valued and protected.

Strategies:

a. Identify wildlife management species for the subsection that represent the various habitat and ecological processes necessary to ensure overall sustainability and viability of wildlife.

b. Work with the Divisions of Wildlife and Ecological Services to define which wildlife species can be identified as representative wildlife management species.

c. Use wildlife resource assessment information about representative wildlife management species to guide/support forest management decisions concerning: 1) species distribution and population estimates, 2) habitat associations, 3) landscape habitat elements, 4) site level habitat elements, 5) management practices, and 6) monitoring and adaptive management strategies.

d. Participate in designation of open landscape complexes to be maintained as habitat for open-landscape-dependent wildlife species.

e. Identify and maintain long-lived conifer secondary species in hardwood stands as winter cover.

f. Identify and maintain mast species as leave trees on harvest sites.

Issue 4. Ecologically significant areas

DFFC 1: Areas of unusual ecological significance are valued and protected as areas for study and conservation of both plant and animal rare species, sources of biological diversity, and ecological benchmarks.

Strategies:

a. Consult the most up-to-date rare features database layer available through the DNR Geographic Information Systems data library.

b. Flag stands that include a rare feature element during stand selection.

c. Following stand selection, DNR Ecological Services Division will confer with Forestry staff (on Forestry-administered lands) and Wildlife staff (on Wildlife-administered lands) to determine adjustments (if needed) in proposed treatments

to protect the element occurrence.

d. Work with the Divisions of Ecological Services and Wildlife to identify areas of high biological diversity on State land that are not already protected by Scientific and Natural Areas, state Parks, or Wildlife Management Areas, and consider giving them special management to conserve their unique assets.

e. Determine the kind of forest resource management that is required to conserve each high biological diversity area, if appropriate.

f. Consider including high biological diversity areas in ERF management areas and/or in forested corridor areas, as appropriate.

DFFC 2: Forested rivers in the planning area have high water quality providing important habitat for fish, amphibians, and invertebrates, including a number of federally listed mussel species.

Strategies:

a. Adhere to MFRC voluntary site-level guidelines for trout streams when conducting forest management activities in riparian areas of rivers and streams that contain trout or listed mussel species and MFRC standard riparian area voluntary site-level guidelines (Minnesota FRC, 1999) in other riparian areas

Forest Spatial Patterns

There are a number of considerations involved with forest spatial patterns including forest fragmentation, patches, and corridors and connectivity.

During the assessment phase of this plan, patch-size data were unavailable. However, a work group conducted an analysis of the current resource as part of the determination of the desired future forest condition. The following seven forest-type combinations were used to group stands into patches:

- Aspen, birch, and Balm of Gilead
- Northern hardwoods, central hardwoods, and oak
- Ash, lowland hardwoods, cottonwood, and willow
- Red pine and jack pine
- White pine
- Tamarack, white cedar, lowland black spruce
- White spruce, balsam fir, and upland black spruce

Two size class categories for each of the above groups were resulting in a total of 14 possible combinations.

No rivers large enough to break up patches occur on state land within the Mille Lacs Uplands. However, state, county, and township roads do break up a number of patches. Data on state forest roads were not available. The group determined that class 4, 5, and 6 forest roads were not significant in the fragmentation of patches, although class 1, 2, or 3 forest roads could be. A map of the entire planning area was produced, showing patch sizes on state land.

Recognizing there is uncertainty about the ideal patch size distribution and lack of data specific to Minnesota, this plan reflects an planning team agreement that the interim goal will be to maintain the percentage of large patches (250 acres and larger), combine or conduct adjacent harvests in patches smaller than forty acres to create patches in the size class 100-249 acres. A two percent reduction in patches less than forty acres will be the seven-year goal. Management for patches will involve foresters looking for opportunities to conduct adjacent cuts (creating a larger patch), or avoid fragmenting existing large patches with harvest activities.

Table 3.5 shows current patch size distribution, and possible goals, with percentages and numbers of acres. The numbers confirmed that Minnesota DNR resource managers have tended in the past to create smaller patches (Cloquet Area average harvest size is about 18 acres). Team members pointed out that harvest size and patch size were not the same thing; a large patch could contain a number of smaller adjacent harvests occurring over a period of time.

Table 3.5. Current and Desired Patch Sizes in the Planning Area

Patch size Class	Goal % In class	Current % In class	No. of Patches In class	Acres in Class
640+	10%	18%	65	68,572
250-639	15%	20%	210	79,958
100-249	40%	20%	505	77,852
40-99	25%	20%	1,238	76,934
<40	10%	23%	6,634	88,226
	Totals		8,652	391,542

Designation and management of areas as Open Landscape Complexes[4] is another tool related to forest spatial concerns. This plan supports the designation of nine LTAs as priority open landscape management areas. Because many of the recommended priority open landscape designations are dominated by nonindustrial private forest land ownership, management would emphasize collaboration with stewardship planning efforts. The team agreed it would be appropriate to emphasize open landscape management goals through Stewardship Planning, modified timber sale prescriptions, and adjustment of rotation age, in areas designated Open Landscape Complexes. Figure 3.1 is a map showing those LTAs identified as priority open landscapes.

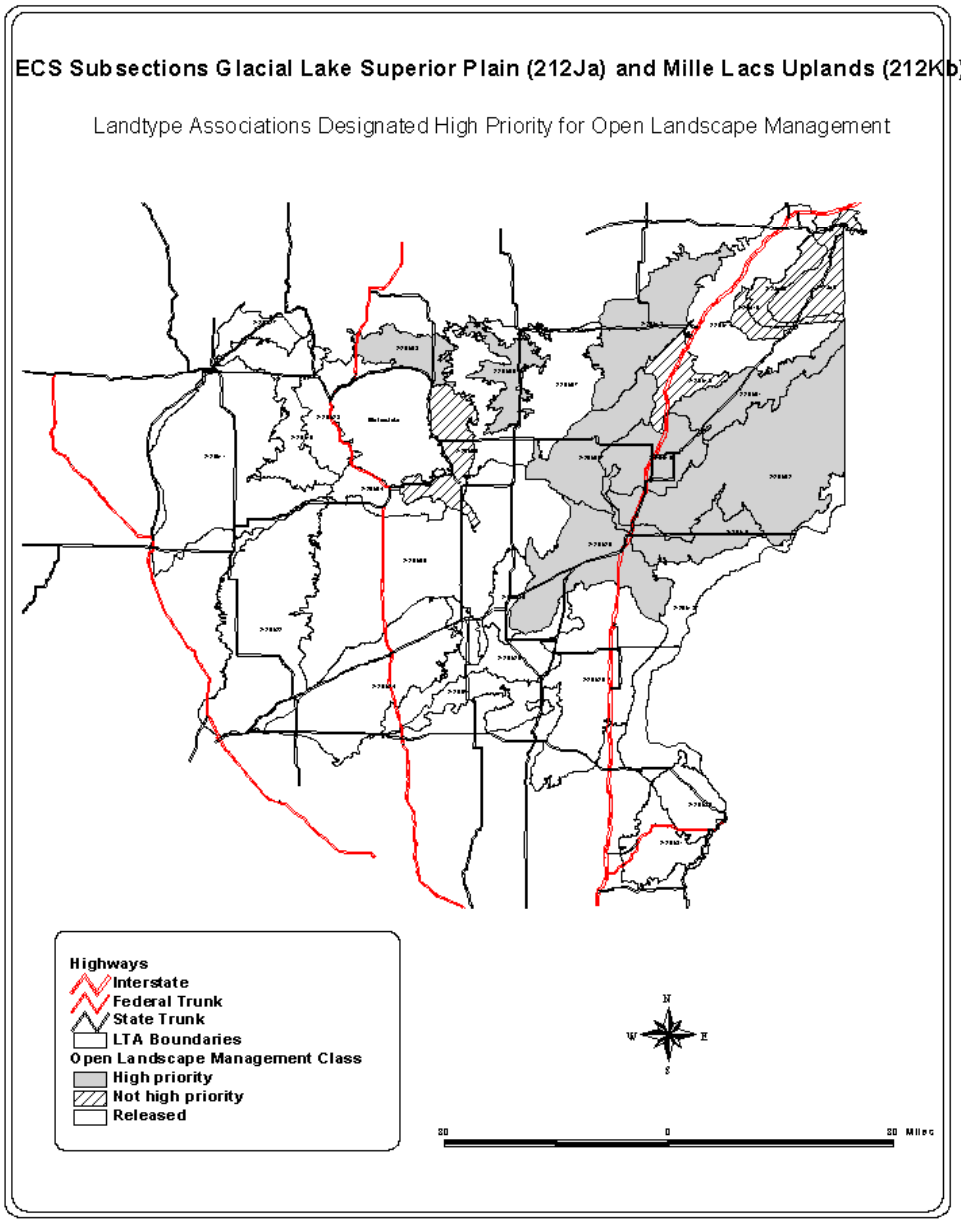
The priority Open Landscape LTAs are:

- 212Kb01 / Bruno Moraine
- 212Kb02 / Duxbury Moraine
- 212Kb03 / Malmo Peatlands

[4] Minnesota Department of Natural Resources, Division of Wildlife. 2002. An assessment of open landscapes for management of brushland wildlife habitat in northern and central Minnesota. Minnesota Department of Natural Resources Wildlife Resource Assessment Report 1. Minnesota Department of Natural Resources, St. Paul, Minnesota. 572 pp.

- 212Kb06 / Three Rivers Peatlands
- 212Kb08 / Pine Lake Till Plain
- 212Kb12 / Kettle River Drumlin Plain
- 212Kb15 / Finlayson Till Plain
- 212Kb19 / Cloverdale Sand Plain
- 212Kb25 / Brook Park Till Plain

Figure 3.1. Landtype Associations (LTAs) Identified as Priority Open Landscapes



Issue 1. Connectivity

DFFC 1: Forested connections between existing large blocks of forested land and riparian areas are maintained and enhanced to provide for wildlife movement, protect water resources, and prevent habitat fragmentation and consequent isolation of native plants and animals.

Strategies:

a. Identify and maintain existing connections between large blocks of forest land.

b. Establish a corridor, a minimum of one-quarter mile (1320 feet) in width. This may or may not always be in the same location.

c. Manage forests in the designated corridor for a minimum average basal area of 60 sq. ft per acre. Where the management goal within the corridor is to maintain an even-aged species (aspen, jack pine, red pine, etc.) no more than one-half the width of the corridor may be less than 60 sq. ft of basal area at any one time. Any Division of Forestry-approved management activity that maintains these stand characteristics is acceptable.

d. Work with other land managers (federal, tribal, and county) to maintain forest land in the corridor in forested status. This will mean involving them and getting "buy-in" to the concept of establishing a forested corridor.

Issue 2. Patch management

DFFC 1: Forests are managed for a variety of patch sizes. Large, contiguous patches of forest are maintained in designated areas, while other parts of the Mille Lacs uplands are managed for smaller or medium size patches.

Note: Current patch size data for the planning area are included in Appendix I.

Strategies:

a. Plan subsection timber harvests taking into consideration the desired future distribution of patch sizes.

b. Conserve existing large contiguous mature forest areas to provide critical habitat for multiple forest interior species, e.g., red-shouldered hawk nest sites.

c. Manage existing large blocks of state forest land, and blocks of state forest land that are adjacent to large blocks on other ownerships, for large patches, giving priority to those areas in Strategy b, above.

d. Continue to use information on historical disturbance regimes to help refine planning for management of large, medium, or small patches.

e. Continue to increase the proportion of state forest land managed according to uneven-aged management regimes as a way of achieving a more desirable patch size distribution.

f. Manage state forest lands in the planning area to achieve the following distribution of patch sizes (percent of Forestry and Wildlife lands):

Very large (640 acres +)	10%
Large (250-639 acres)	15%
Medium (100-249 acres)	40%

Small (40-99 acres)	25%
Very small (< 40 acres)	10%

g. Take care to maintain existing patches in the very large and large size categories.

Issue 3. Fragmentation

DFFC 1: Forest managers carefully consider forest road construction. There is a high level of collaboration with federal and private landowners and local units of government to identify opportunities to share and minimize road construction.

Strategies:

a. Plan the fate of new roads and trails prior to construction so that appropriate action can be taken to either maintain them, or obliterate them from the forest. It is undesirable to have roads developing in an unplanned way as a result of recreational use of logging trails.

b. Follow the DNR State Forest Road Manual (Minnesota DNR, 1994-6) for development of new roads.

c. Adhere to Forestry-Wildlife Guidelines to Habitat Management (Minnesota DNR, 1985-2) Roads and Trails section.

d. Contact county land departments and other appropriate land managers (e.g., Tribal governments, The Nature Conservancy) to arrange cooperative use of existing roads to keep new road construction to a minimum.

e. Provide a draft of road access needs for public review as part of the forest resource planning process.

Timber Productivity

Even as the DNR's Division of Forestry broadens its definition of forest management to include environmental and social elements by emphasizing a variety of non-fiber outputs and amenities such as visually sensitive areas, old-growth forest, wilderness areas, and SNAs in its management plans, the continued local and global demand for paper and wood products requires continued attention to timber production. The DNR understands that sustaining the forest base is only possible when there is a successful merging of strong economies with healthy communities and thoughtful stewardship of natural resources. A vibrant economy ensures that programs that maintain a quality environment are affordable and that communities remain viable. Improved productivity of the forest resource will complete this triad and help carry forward the goal of long-term sustainability. Tools and methods that are being applied to improve productivity of forest land in these subsections include:

- Application of an ECS to identify native plant communities,
- Intermediate harvests and thinning prescriptions,
- Application of tree improvement techniques.

Improving the productivity of Minnesota's commercial forest lands through the use of these methods and the Site-Level Forest Management Guidelines (Minnesota Forest Resources Council, 1999) will help improve the quantity and quality of fiber produced on the diminishing number of acres available for commercial harvest.

White pine is a species that has declined very significantly in the planning area during the past 100 years (ten to fifteen-fold declines are common in the Mille Lacs Uplands). In 1997 the Minnesota Legislature authorized the White Pine Initiative to increase the presence of white pine in Minnesota. In 1998, the DNR, County Land Departments, and USFS began an accelerated program of white pine planting. Since the beginning of the initiative, many millions of white pine seedlings have been planted on forestlands in the state.

There is a significant cost to white pine restoration. DNR Division of Forestry estimates the cost per acre of planting and protecting white pine to be around $545. Achieving the Mille Lacs Uplands ambitious goals for white pine restoration will be dependent upon identification of adequate funding.

Some DNR resource managers have expressed the opinion that a lack of age diversity in oak stands, and a related lack of successful oak regeneration is one of the most critical forest management problems faced in these subsections. The aspen age-class imbalance is well recognized, but concerns about the subsections' valuable oak resources have generally been overlooked. This resource (mostly red oak) received special attention during the planning process. A program to achieve a level of successful oak regeneration and to protect it from depredation is being implemented as part of this planning effort (see Appendix G).

Management plans for the current period will be marked by concern over the current age imbalance in many forest types, most notably aspen. The aspen resource in the subsection(s) is dominated by older forest that has already lost much of its merchantable volume and some of its ability to regenerate naturally.

During initial discussions, the SFRMP team assumed that the appropriate management approach would be to harvest all aspen with a "high risk" designation as soon as possible. Such a strategy would have achieved the goal of removing the older aspen, but would also perpetuate the existing problem for the future. Therefore, the team began using simple spreadsheet models to investigate ways that management strategies could be adapted to achieve the desired future age class structure for aspen, produce a reasonably steady flow of products, and still address the current concern over high risk stands. The strategy presented herein achieves those goals and results in 2,369 acres of aspen that will be available for examination each year of the current planning period. It would also move the aspen cover type toward the DFFC goals of reducing the aspen type by 5 percent during the next ten years, and increasing the acres of mixed, coniferous, and birch forests.

In contrast to more northerly subsections, this planning area is characterized by an important northern hardwood resource. Today's hardwood forests in Minnesota are a result of the confluence of a number of events during the late 1800s and early 1900s. Minnesota's forests were thought to be inexhaustible, and great logging camps were established throughout the state to harvest as much timber as possible during the winter months. The best trees were cut and hauled to the nearest waterway, where spring thaws would flush them downstream to the nearest holding pond and sawmill. The poorly shaped and smaller trees remained to provide the genetic basis for today's forests. Minnesota DNR's forest managers work under a system whereby they can only achieve forest management objectives through the institution of the public timber auction, and for many years, the low-quality, crooked, and stunted trees that made up many of Minnesota's hardwood forests found no ready markets. It requires active management to remove some of the dead, down, and deformed trees, thereby giving the best trees room to grow resources to achieve their full potential. Recently there has been a renewed commitment by DNR resource managers to improve the quality of hardwood forests. Coincidentally, hardwood pulp markets have also started to improve slightly.

As a result of their history, there is very little diversity in the ages of the mixed hardwood forests in these subsections. However, age-class distribution is not considered to be a problem in these forest types because the goal will be to manage many of them as all-age stands, i.e., individual trees or groups of trees will be selected, and there may be no final harvest in many cases.

The DNR estimates timber harvest levels at both the individual subsection/area level, and at the statewide level. At the subsection level, annual allowable cut (AAC) begins with the Cooperative Stand Assessment (CSA) inventory of state-owned lands. This inventory is a stand level inventory, that provides information on covertype, stand size, stocking and composition, plus stand age, health and condition, and some measures of site productivity.

During subsection planning process, the team determines desired future forest conditions (DFFCs) for a 50 year planning horizon. This includes percentages of desired covertypes (including patch size, and orientation) age structure, and establishing a percentage of each major covertype to be managed on extended rotation periods (minimum level is 10%).

Beginning with area regulation, the team then determines the AAC (in acres) for each covertype; that can be harvested within the constraints of ERF, current age structure, and the DFFC covertype goals for the next seven-year period. Once that is established, the team then does stand selection by year for the planning period until the appropriate number of acres by covertype is identified. The DNR does not currently use a harvest scheduling model, but is considering the purchase and use of a commercially available model in the next year.

It is important to note, that AAC levels for some covertypes during the current seven-year planning cycle are not considered sustainable for the long term. Because of the current age structure of some covertypes, the team proposes to accelerate harvest in some old stands of early successional species (e.g., aspen, jack pine) in the next seven-year planning horizon. At the same time the team projects anticipated harvest levels for the next fifty years, where sustainable levels are set within a fifty-year planning horizon.

At the statewide level, the Department uses both CSA, and the Forest Inventory and Analysis (FIA) permanent plot system as the basis for monitoring AAC. Comparing the data developed from each of these inventory systems, we are able to establish a sustainable harvest threshold by covertype, for all DNR-administered forest lands that are available for timber harvest.

This harvest level threshold is used as a check against the sum of the individual plans, and to provide interested stakeholders an estimate of sustainable volume. However, the individual subsection/area plans form the basis for the harvest activities, not the statewide estimate.

Issue 1. Identification and management of highly productive sites

DFFC 1: *Timberlands* in the planning area are highly productive. They produce good quality hardwood and softwood logs for manufacturing and export, as well as a good quantity of *pulpwood* to supply Minnesota's pulp and paper industries.

Strategies:

a. Identify areas that are good examples of their type, occur on wind firm soils, can be managed for production of high quality hardwoods, and/or include large contiguous forested patches for wildlife habitat. Consider thinning healthy aspen types in ERF as well as dense hardwoods and conifers to produce quality timber for the future.

b. Use Site-Level Guidelines for all activities to ensure that site quality is maintained.

c. Increase hardwood-marking efforts as resources allow.

d. Use ECS and local knowledge to identify aspen stands that would be appropriate for conversion to mixed hardwoods, and manage these for quality hardwoods using selective harvest and thinning techniques.

e. Identify advance regeneration of long-lived conifers in less productive aspen stands, and plan for their conversion to pine, spruce, and fir types.

f. Improve production of quality aspen by continuing to harvest high-risk aspen stands that are to be maintained in the aspen type at a high rate, to avoid conversion to other types.

g. Investigate potential for thinning aspen to increase growth and produce high-quality logs on selected sites.

h. Use site-level ecosystem classification keys to identify the native plant community type on a given site and make decisions to manage for appropriate forest types. Sites that are managed for appropriate forest types, have good access, and where managers are committed to continuous improvement have the greatest potential for optimizing timber productivity for the present and the future.

i. Focus management activities intended to help stands approach their full production potential on sites with fewest conflicting priorities (rare features, old-growth forest, poor access, etc.).

Issue 2. Utilization and marketing of forest resources

DFFC 1: Utilization of species and grades of timber are optimized to maximize the benefits these resources provide.

Strategies:

a. Promote the use of lesser-utilized species and identify potential markets for underutilized species to DNR resource managers.

b. Communicate changes in wood and non-timber forest product markets to DNR resource managers.

Issue 3. Increase site-level productivity

DFFC 1: Ecosystem classification tools have helped DNR resource managers identify species most likely to be productive on a specific site, as indicated by soil and native plant community information.

Strategies:

a. Use ECS and local knowledge to identify stands that would be appropriate for conversion to mixed hardwoods, and manage these for quality hardwoods using selective harvest and thinning techniques.

b. Use ECS keys and historical information to identify sites appropriate for introduction or enhancement of long-lived conifer species.

c. Use ECS keys to help identify forest types that may be more productive than those currently on sites that are marginally productive.

d. Use innovative silvicultural techniques appropriately to manage for structural

diversity and improved timber quality.

DFFC 2: Diverse, high-quality mixed hardwood stands are managed by skilled forest managers and selectively harvested by highly trained logging professionals for continuous quality improvement and production of timber, while maintaining forest cover and establishing regeneration.

Strategies:

a. Increase hardwood-marking efforts as resources allow.

b. Identify thinning opportunities to enhance quality of all timber types.

c. Continue to make use of contract hardwood marking crews to improve the growth and quality of hardwood stands.

Issue 4. Improved forestry data management

DFFC 1: Forest inventory data are detailed and current enough to be relied upon in a wide variety of planning and analysis projects. Forestry databases provide a link between generations of forest managers with respect to both strategic and operational decisions that have been made for a specific forested community.

Strategies:

a. Create a priority reinventory list each planning period.

b. Support the development and use of databases that include planning elements in addition to inventory elements.

Public Involvement and Collaboration

Private land management is outside the scope of Subsection Forest Resource Management Plans, however, progress toward the vision and goals identified here can be enhanced by the creation of products that are useful for promoting consistent goals across ownerships.

Several forest health concerns have achieved high visibility in the subsections, including gypsy moth, oak wilt, two line chestnut borer (in oak), dwarf mistletoe infestations in black spruce forests, and a defoliator complex in tamarack forests. Where specific management actions have been identified to minimize the effects of these, they are listed in the notes for individual cover types.

Issue 1. Forest stewardship planning

DFFC 1: Progress toward the vision for the subsection(s) forests (or DFFCs) is enhanced by engaging nonindustrial private forest landowners, providing a level of consistency across ownerships with regard to forest management in a given landscape unit.

Strategies:

a. Consider the differences between private and public lands when developing DFFCs for the planning area. A one-size-fits-all future condition statement is not likely to be implemented or result in diverse and resilient ecosystems.

b. Develop a concise summary of landscape-level ecological conditions that can be used by stewardship plan preparers to help private landowners understand past, present, and future ecosystems. This will help landowners select realistic

management objectives that are compatible with ecological and economic conditions.

c. Prepare or revise management prescriptions tailored to conditions in the planning area so that they can be incorporated into Forest Stewardship Plans.

Issue 2. Collaboration with other landowners

DFFC 1: Minnesota DNR resource managers routinely collaborate with other landowners to develop consistent goals and landscape-level strategic plans.

Strategies:

a. Continue efforts to coordinate plans and management projects with federal and county land managers. Provide federal, tribal, and county managers the opportunity to participate in developing management plans for state lands. Review and comment on management plans for federal-, tribal-, and county-managed natural resources.

b. In counties that have land departments, send copies of annual vegetation management work plans to the county land commissioner to allow coordination of vegetation management and road access projects.

c. In counties that do not have land departments, offer to assist county auditors or the county board to develop land management plans for tax-forfeit land that will be retained in county ownership, as time and resources permit.

d. When feasible, develop joint contracts (e.g., site preparation, tree planting) on state and county lands to avoid duplication of effort and achieve economies of scale.

e. Maintain contact with other resource managers in the planning area and monitor their strategic planning documents as a way of maintaining an awareness of their long and short-term forest management goals.

f. Take advantage of opportunities to collaborate with other resource managers as resources allow.

DFFC 2: Losses due to forest insects and diseases on private and state forest land are minimized, as are the effects of pest management on nontarget species.

Strategies:

a. Inform adjacent landowners of insect or disease incidents on state land and assist them to make informed decisions about protecting their trees and property.

b. When a private landowner adjacent to state land is actively suppressing a forest pest infestation and that pest also exists on adjacent state lands, the state should consider appropriately treating the pest also.

c. Follow guidelines established by Division of Forestry forest health specialists with regard to insect and disease outbreaks.

DFFC 3: State forest lands are managed in a manner that minimizes conflicts among users, adjacent landowners, and in-holders, while maintaining management options.

Strategies:

a. When planning management activities, always make adjacent landowners aware of the plan and the purpose.

b. Maintain awareness of, and respect for, ownership boundaries.

c. Clearly mark and post all boundaries with signs where possible.

Issue 3. Public involvement and review

DFFC 1: The public is involved in forest management planning during designated review periods.

Strategies:

a. Encourage and actively solicit public input into forest management activities such as planning.

DFFC 2: DNR Forest managers minimize the visual and aural impact of forest management activities on users of state forests, thereby supporting and enhancing multiple-use values of state forest land.

Strategies:

a. Apply visual quality management guidelines. Be particularly considerate of scenic values in areas classified as most sensitive (e.g., high-use recreational areas, adjacent to recreational lakes and streams, solitude areas).

b. Manage expectations and perceptions by informing and educating stakeholders about the need for and expected impacts of management activities prior to, during, and after the activity.

DFFC 3: Forest managers have stakeholder support for employment of a full suite of forest management options as appropriate to reach identified goals.

Strategies:

a. Use opportunities to communicate to the public about management options, risks, and benefits as they arise.

b. Use historical disturbance regime and range of natural variation data as they become available to help determine appropriate management techniques for landscape areas.

c. Document management prescriptions and choices as they are made, to facilitate communication and public education.

d. Use pre-treatment monitoring and post-treatment monitoring as learning and communication tools to justify choices and outcomes.

4. Stand Selection Criteria

This section defines the criteria that was used to narrow the large forest inventory of state lands in the subsection to a pool (list) of stands from which stands was selected for treatment during this planning period. It provides timber management recommendations and establishes stand treatment (timber harvest, field survey needed, and other prescriptions) levels for the seven-year plan for each commercial forest type.

Ash/Lowland hardwoods

Cover-type status

Very little harvesting, other than partial cuts, has occurred in this cover type in recent years. There is a total of 18,674 acres in these two cover types in the planning area.

Rotation age determination

No rotation age established; high quality normal and extended rotation stands with basal area greater than 99 sq. ft/acre and diameter at breast height (DBH) greater than 7 inches will be selected for examination.

Management recommendations

1. Low-quality ash/lowland hardwood stands (with a site index (SI) of under 45) would be left to evolve with no activity planned unless associated with other work adjacent to the type in portions of the stand that have higher site indices.
2. When the SI is over 45 the stand would be managed as an uneven-aged stand. The maximum crop tree diameter class to be managed for will be 14 inches on the better sites and 12 inches on the poorer sites. Entry would be on a 20-year cycle. All management activities would use commercial timber harvest as a tool, and prescriptions would favor mixed-species composition.
3. Existing uneven-aged stands would be maintained by selective harvest so that the remaining stand after the harvest is composed of all age classes with approximately the same basal area for trees under 10 inches as for those over 10 inches.
4. For stands that are currently even-aged, the harvest would be planned to create other age classes by small patch harvest to allow for regeneration.
5. Forest health concern: dieback from poor drainage/drought and temporarily above-average water table levels (i.e., high risk) would not be used as criteria for going into a stand. These stands would be reserved to allow them to increase in vigor.

Figures 4.1 and 4.2 show the current distribution of ash in the planning area as a change from historical levels, and the current age-class distribution of this forest type.

Figure 4.1. Change in Ash Abundance From Historical Levels

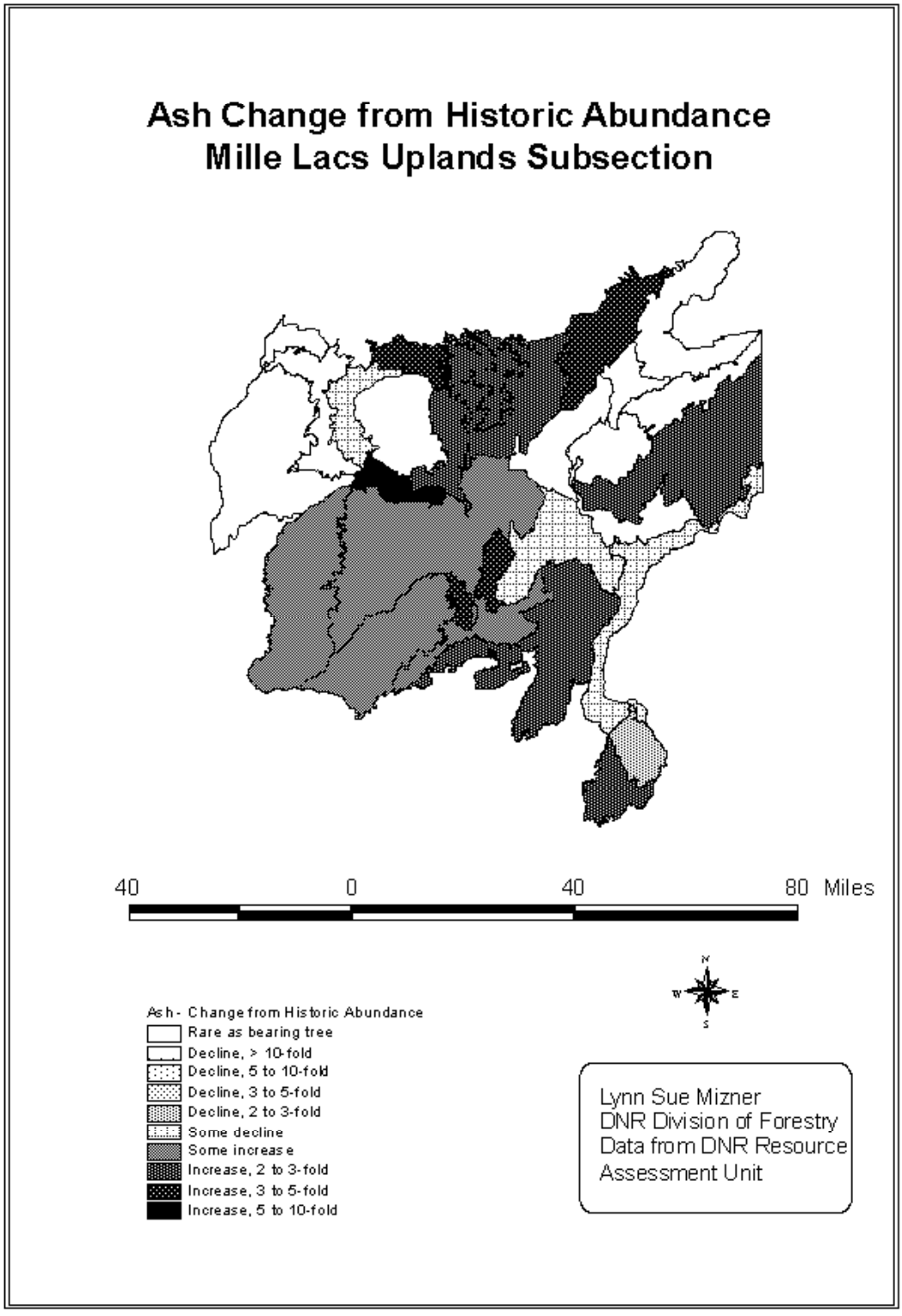
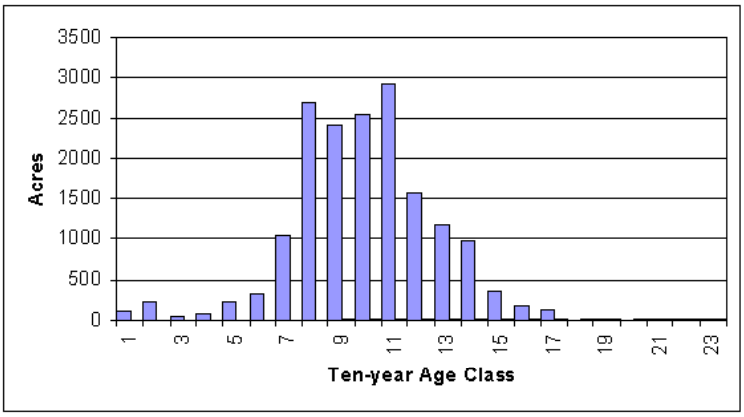


Figure 4.2. Current Age-Class Distribution of Ash Forests



Aspen/Balm of gilead

Cover-type status

There are 98,946 acres of the cover type in the subsection. Despite an increased harvest level in the last 20 years, the acreage of overmature stands has increased, so that 39 percent of this cover type is currently over rotation age. The amount of older aspen/balm will be reduced over the next 10 to 15 years, with or without harvest, due to the existing age structure and succession stage. Extended rotation forest (ERF) status has been given to 26,590 acres of aspen and Balm of Gilead. Current effective ERF is 41.3 percent.

Aspen forests are an important resource for industry in the state of Minnesota; they are also important as wildlife habitat. The Division of Wildlife provided data indicating Landtype Associations (LTAs) in the planning area they consider to be most critical for management of aspen on shorter rotations (Appendix J). Pulp and paper manufacturers who depend on the aspen resource can also benefit from management of aspen at these rotation ages. Other interests include the production of high quality sawlogs and provision of older aspen forest to provide wildlife and other environmental services. Some eastern LTAs in the planning area provide opportunities for management of aspen at these longer rotations because the climate, soil, and topography are more conducive to the healthy survival of older aspen forest. In addition, aspen clones will be harvested in northern hardwood forests that are otherwise managed on an all-age management regime; the harvest of these 1 to 3 acre clones will provide young aspen inclusions in small patches required by some life stages of wildlife.

Figures 4.3 and 4.4 show the current abundance of aspen/Balm of Gilead by LTA as compared to historical levels, and the current age class distribution of this forest type.

Figure 4.3. Change in Aspen Abundance from Historical Levels

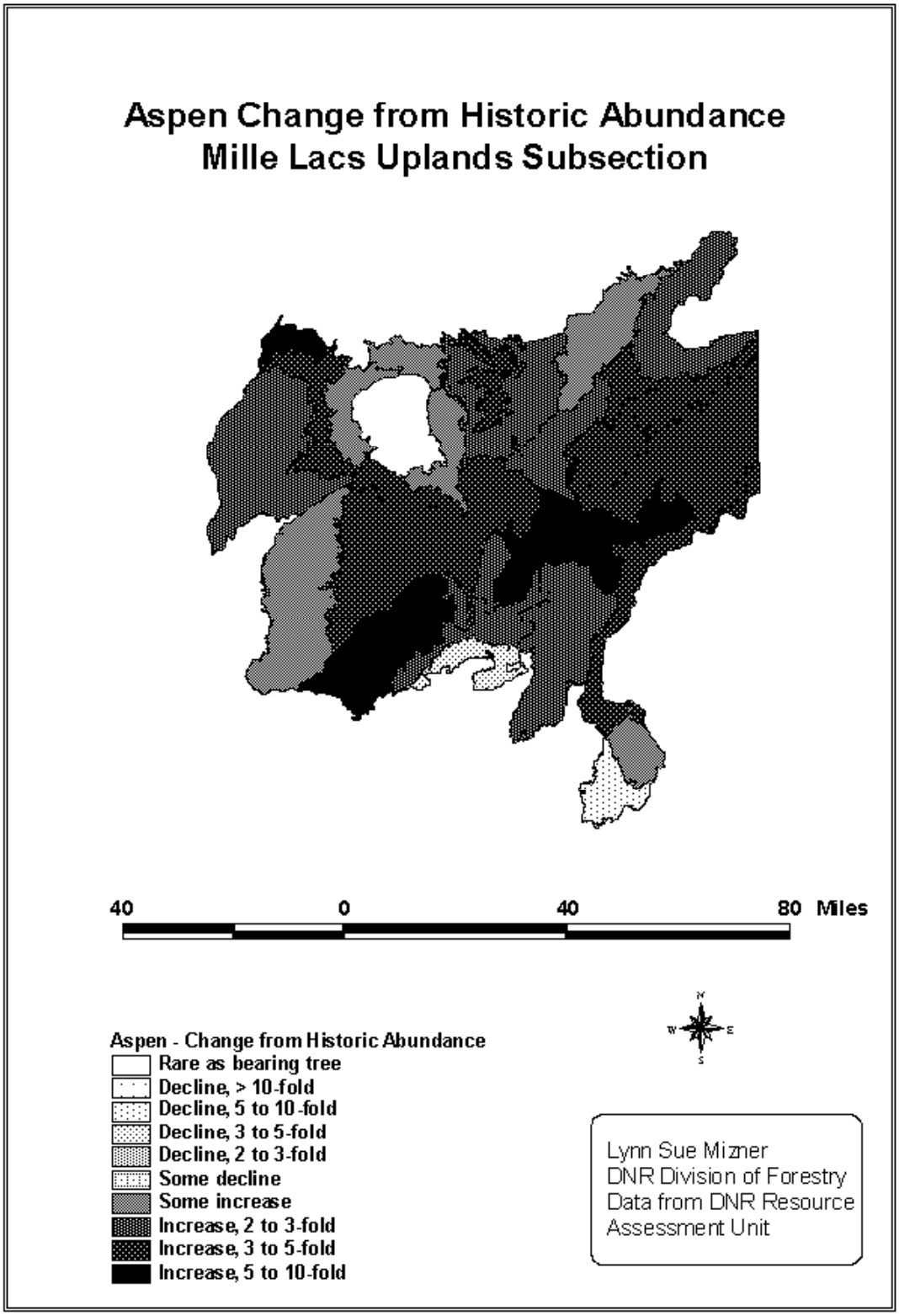
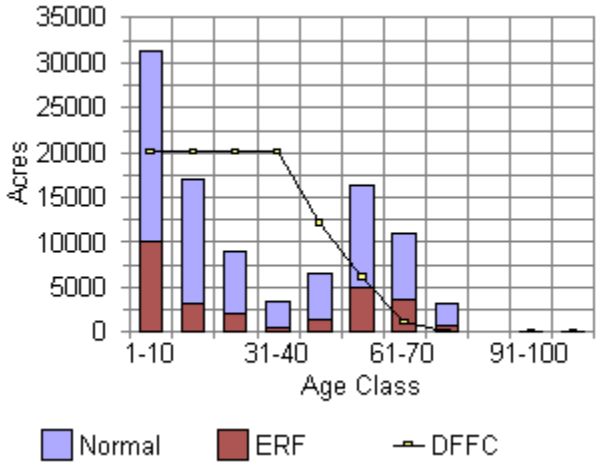


Figure 4.4 shows the current age-class distribution of aspen and Balm of Gilead in the planning area. The chart bars are divided to indicate the proportions of ERF and normal rotation forest.

Figure 4.4. Current Age-Class Distriubtion of Aspen and Balm of Gilead Forests



The current age-class distribution of aspen and Balm of Gilead in the planning area, including normal rotation acres and ERF acres; the desired future age class distribution is represented by a dark line.

Rotation age determination

Decay in this forest type is correlated with stand age rather than site quality or soil type. This correlation is nearly a straight-line relationship. Total rot as a percentage of gross growth in well- stocked stands rises from 21 percent at age 30 to 81 percent at age 80. Mean annual increment (MAI) data for the subsection show a decline in volume at age 40, which was determined to be an appropriate normal rotation age for the subsection, however see caveats under management recommendations (below). Extended rotation age was determined to be 55 years.

Management recommendations

1. The desired maximum age before harvest is 60 years, due to concerns about reduced merchantability and inadequate regeneration.
2. Some areas in the subsection have the potential to sustain quality aspen stands for much longer than 40 years; DNR resource managers will determine suitability for these areas to be managed for older aspen. In those areas, longer rotation periods, and higher basal area triggers, and implementing intermediate thinning on high-quality sites can provide both ample fiber production and the production of high volume, quality sawtimber and veneer.
3. Due to the short life span of aspen in these subsections (apart from the areas mentioned in number 2 above), thinning potential for aspen is limited, unlike the northern subsections in the state.
4. Managers estimate they will find that 20 percent of the type over the age of 60 will have changed through succession into a more diverse hardwood and/or conifer type. These natural changes may be enhanced and accelerated through management.

5. In addition, 5 percent of aspen type in the 40 to 60-year age class will be targeted as opportunities to promote high quality hardwoods. Opportunities for conifer enrichment will be sought through the use of Ecosystem Classification System (ECS) tools.
6. In the second planning period, 5 percent of the 40 to 60-year age class will again be targeted for hardwood enhancement and conifer enrichment as indicated by ECS tools.

Birch

The Mille Lacs Uplands Subsection Forest Resource Management Plan assessment brought to light a potentially serious situation with the birch resource in the subsection. Much of the birch occurs in mixed stands of hardwoods, or hardwoods and conifers, but even looking at stands dominated by birch, it was clear that by the time the currently overmature stands were harvested there would be no birch resource coming in behind them. During the first public review period, public comments indicated this was a valued resource, one that should be protected and increased.

The goal for the planning period is to maintain as much of the birch type as possible, through harvest of all salvage pool stands and as many stands over rotation age as possible. Birch that reaches advanced age and begins to decline is more difficult to regenerate naturally, and saving those older stands will be a priority. Opportunities to enhance natural seeding through seasonal or equipment modifications will also be sought. The DFFC for birch is a 100 percent increase in the type, but planting and other efforts to increase the type may be deferred until the next planning period.

Cover-type status

There are approximately10,000 acres in the subsection; 80 percent is over the age of 50 years, and 9 percent is over the age of 80 years. The birch type is rapidly being lost in the subsection; at the same time, a 50 percent increase in birch has been identified as a strategic goal. Much of the type is decadent, being well over rotation age, and there is a severe age class imbalance. Opportunities for enhancement should be sought. Current effective ERF is 66.8 percent.

Figure 4.5 shows the current abundance of birch by LTA as compared to historical levels.

Figure 4.6 shows the current age-class distribution of birch in the planning area. The chart bars are divided to indicate the proportions of ERF and normal rotation forest.

Figure 4.5. Change in Birch Abundance from Historical Levels

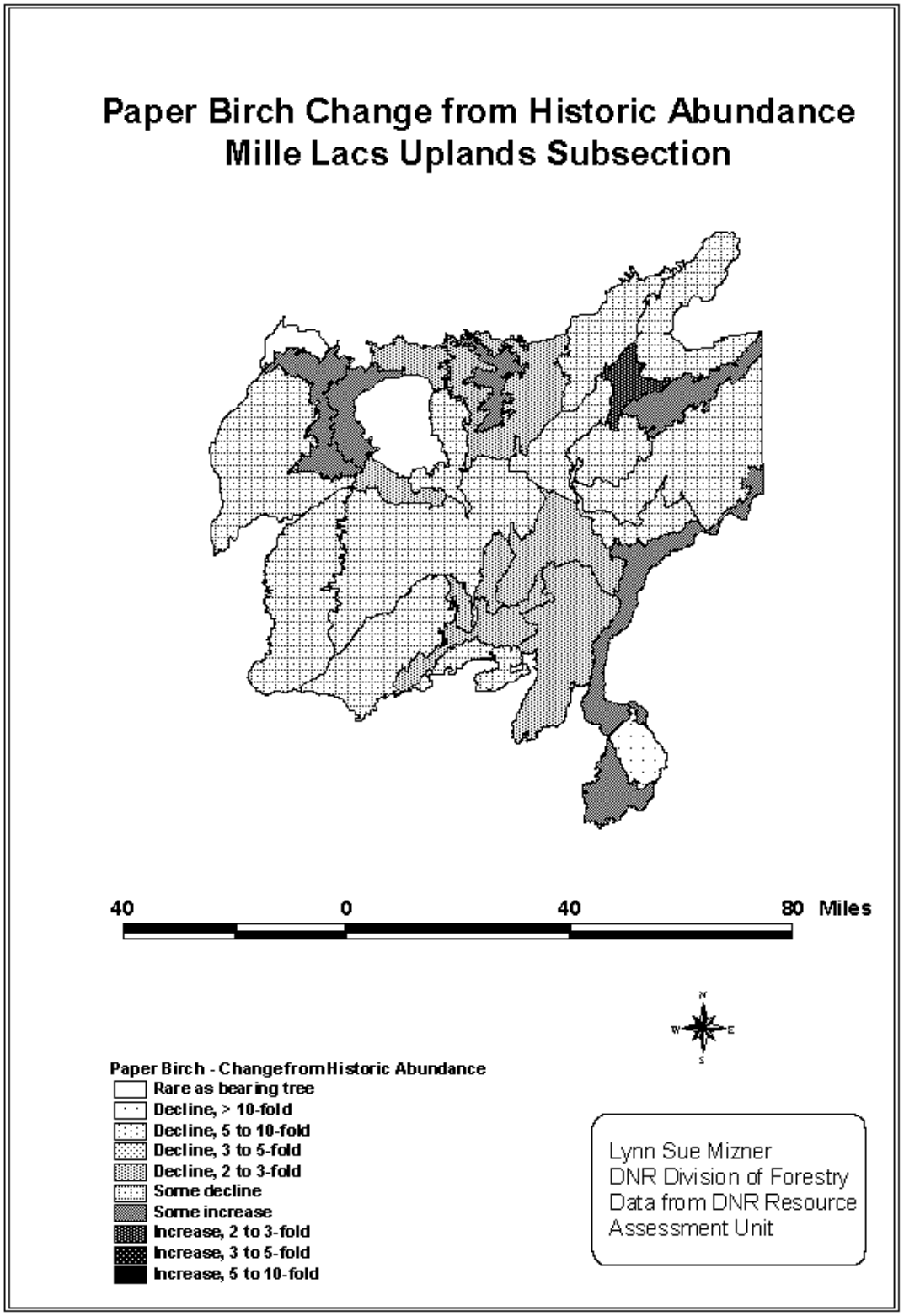
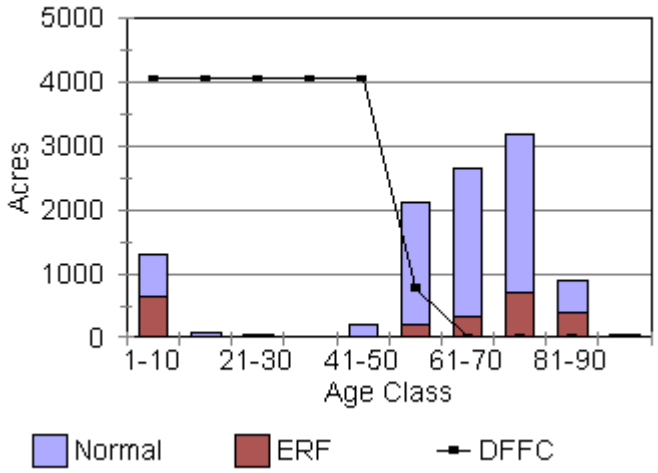


Figure 4.6 Current Age-Class Distribution of Birch Forests



The current age-class distribution of birch in the planning area, including normal rotation acres and ERF acres; the desired future age class distribution is represented by a dark line.

Needs identified

1. Money is needed for timber stand improvement work in birch (burning, scarification after harvest, containerized or bare-root nursery stock, seeds, fences (exclosures), and critter control).
2. Nursery stock will be needed during the second planning cycle for birch enhancement projects.

Rotation age determination

1. Data based on Cooperative Stand Assessment (CSA) for the subsections show that MAI peaks around age 50.
2. Recommended rotation age is 50 and extended rotation age is 60 years.

Management recommendations

1. Examine all stands that meet the criteria, leaving residual other species to reduce aspen sprouting (522 acres/year).
2. Conversion of other types to meet the DFFC of 100 percent increase in birch type is not expected to occur during the first planning cycle due to the priority of dealing with the extreme age-class imbalance in existing stands. A high priority will be given to efforts to retain the current acres as birch.
3. Share planned birch harvest maps with Mille Lacs Band of Ojibwe.
4. Assume that 30 percent of birch over the age of 40 years may have naturally converted to other types.
5. The desired maximum age before harvest is 60 years due to concerns about reduced merchantability and inadequate regeneration.

Northern hardwoods

Stands will be selected for examination on the basis of basal area rather than age. Where stands are evaluated and the site is found to be potentially better suited for management as a different forest type, or as a mixed hardwood and conifer forest, a management prescription will be developed to reflect that. Field staff will have many options available to them as they work to maximize the potential of these stands. These options include thinning, even-age harvest, small gap harvests, shelterwood harvests, and individual tree selection or partial cut harvest. These options will result in increased biological diversity and improved quality and appearance in the subsections' mixed hardwood forests.

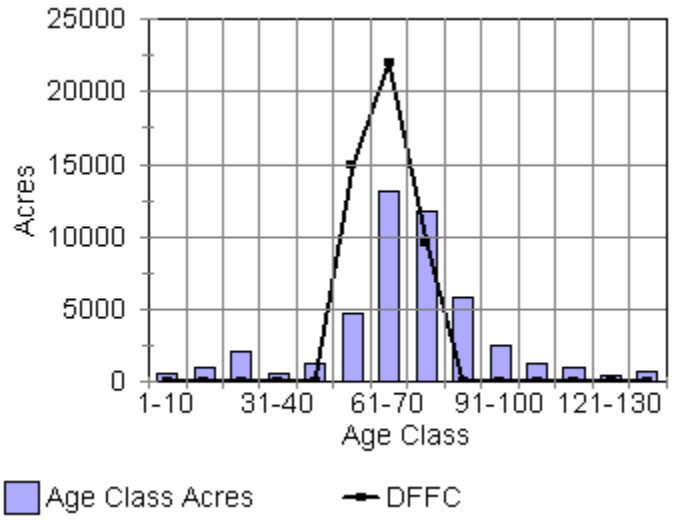
Thinning will be an important management strategy for northern hardwoods in these subsections. The examination list will include all stands with greater than 120 sq. ft of basal area (9,209 acres), and approximately 80 percent of those will have a thinning prescription.

Cover-type status

There is a total of 46,231 acres of this type in the subsection, 64 percent of which is between the ages of 51 and 80 years. ERF management has been designated on 53 percent of the cover type by area; the implications of that designation for selectively managed types are still being discussed.

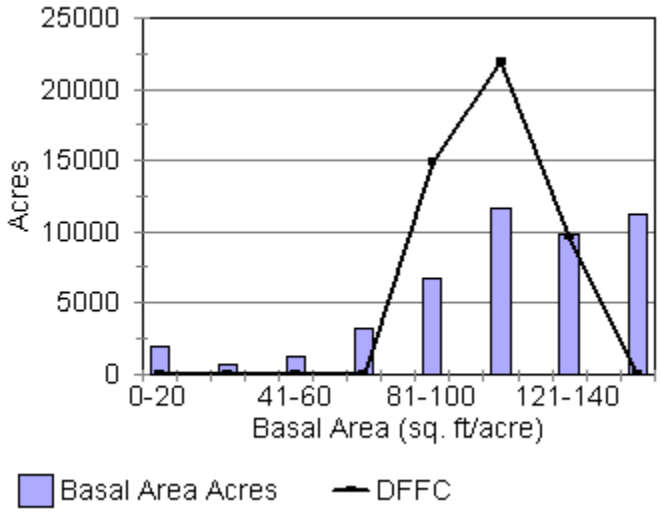
Figures 4.7 and 4.8 show northern hardwoods data as both age class distribution and basal area distribution, because basal area is often used as a selection criterion for selectively managed forest types.

Figure 4.7. Current Age-Class Distribution of Northern Hardwoods Forests



The current age-class distribution of northern hardwoods in the planning area, including normal rotation acres and ERF acres; the desired future age class distribution is represented by a dark line.

Figure 4.8. Current Basal Area Distribution of Northern Hardwoods Forests



The current basal area distribution of northern hardwoods in the planning area, including normal rotation acres and ERF acres; the desired future basal area distribution is represented by a dark line.

Rotation age determination

Northern hardwoods will be identified for examination based on basal area of 120 sq. ft/acre rather than on the basis of age.

Management recommendations

1. Thin stands to produce an average of 7 *cords* per acre at harvest.
2. Identify low-quality hardwood stands for conversion or rehabilitation using a clear-cut prescription.
3. Better-quality northern hardwood stands will be thinned for long-term stand improvement.
4. Native plant community classification will be completed for each site to assess potential for future management.

Oak and Central hardwoods

Red oak is a forest type common to many of the native plant communities represented in these subsections. It is a component in many northern and central hardwood stands and also occurs in relatively pure stands. Red oak is also a species that is very valuable commercially and provides an important food source for wildlife. For these reasons there is a great deal of concern about the future of the red oak forests in this part of Minnesota. Modeling undertaken during the planning process has revealed a crisis in recruitment of red oak into the forest canopy, which means that although there is currently abundant regeneration of red oak in the forest understory, it is not making it to maturity. When the current forests reach rotation age and are harvested, there will be nothing in intermediate age classes to take their place. The reasons for this potential problem include the lack of fire in the forest and the inability of oak seedlings to compete against more shade-tolerant species in the understory.

The original assumption was that red oak stands in the subsections would be thinned according to standard management practice; discussions and modeling revealed that this would not adequately address the future condition. Therefore, the red oak management plan will provide for regeneration through shelterwood harvest, or release of existing advance oak regeneration, on approximately 200 acres per year. A critical factor in the success of these efforts will be protection of the young oak forests from depredation. A cooperative oak regeneration work plan was developed by Division of Wildlife and Division of Forestry staff members on the subsection team (see Appendix L, page 135). Criteria for selection of sites on which to focus oak regeneration efforts will include: native plant community, environmental damage to existing oaks (e.g., frost cracks), insect and disease concerns, accessibility of the sites for exclosure maintenance and prescribed burning, and existing investments in planting and protection.

Cover-type status

The cover type is 20,864 acres in size, 71 percent is between 61 and 80 years old. ERF designation has been applied to 40 percent of the type (8,259 acres). The 272 acres of central hardwoods are located west of Onamia in the Rum River State Forest. Approximately 1,000 acres of the oak type is bur oak, the majority is red oak

Figure 4.9 shows the current abundance of red oak by LTA as compared to historical levels.

Figure 4.10 shows the current abundance of bur oak by LTA as compared to historical levels.

Figures 4.11 and 4.12 show acres of red oak by both age class and basal area class, because basal area is most often used as a criterion to select stands at various management stages.

Figure 4.9. Change in Red Oak Abundance from Historical Levels

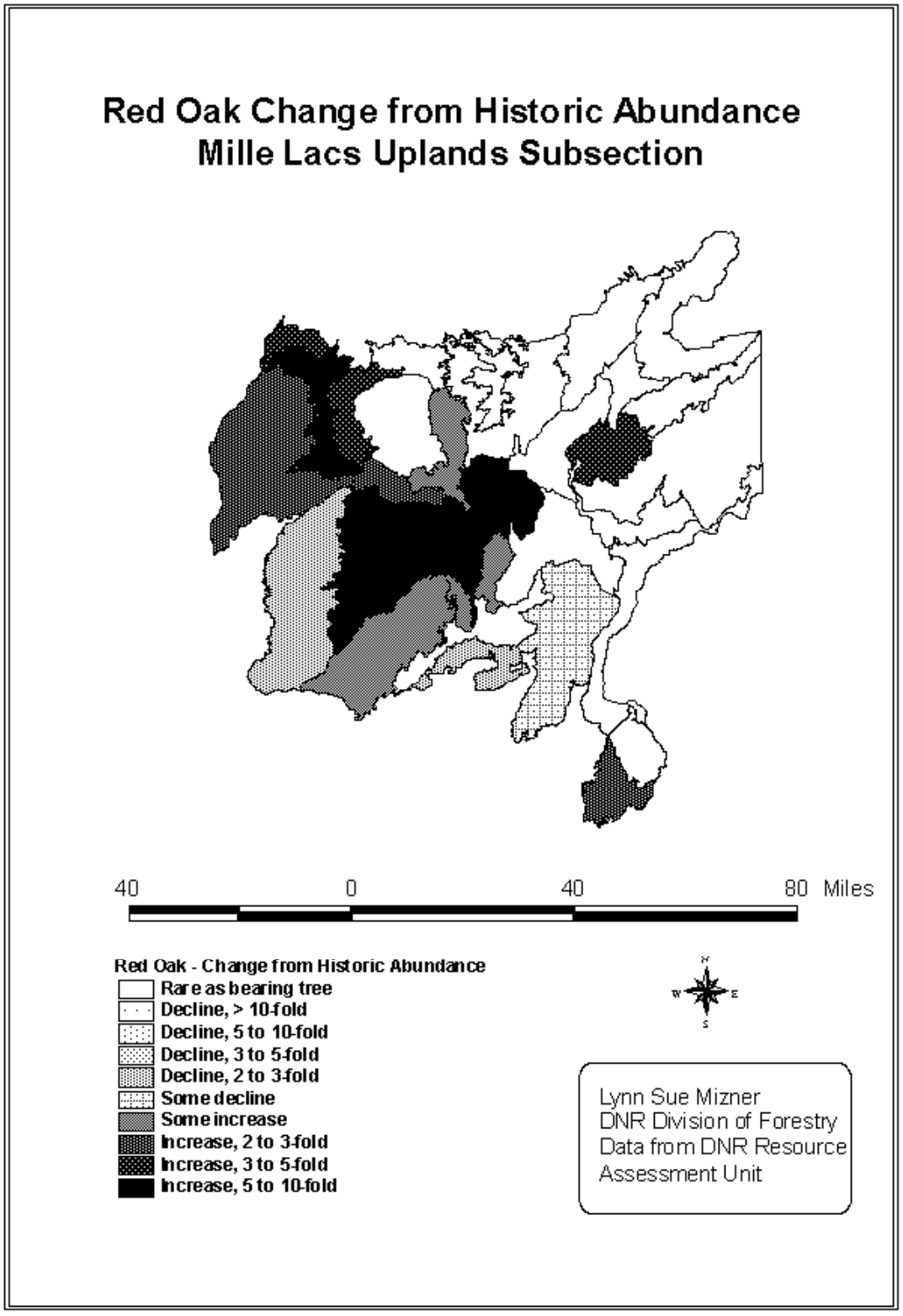


Figure 4.10. Change in Bur Oak Abundance from Historical Levels

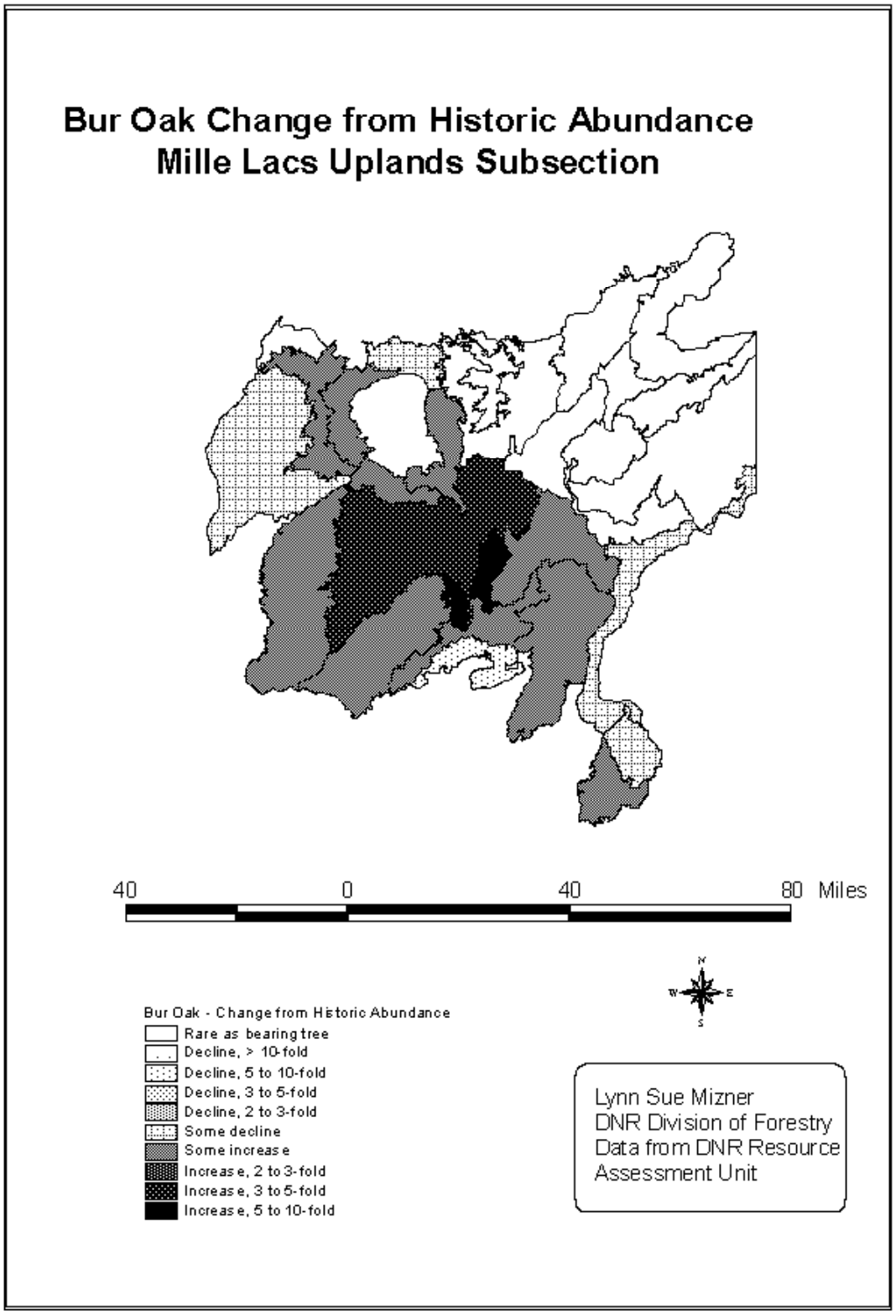
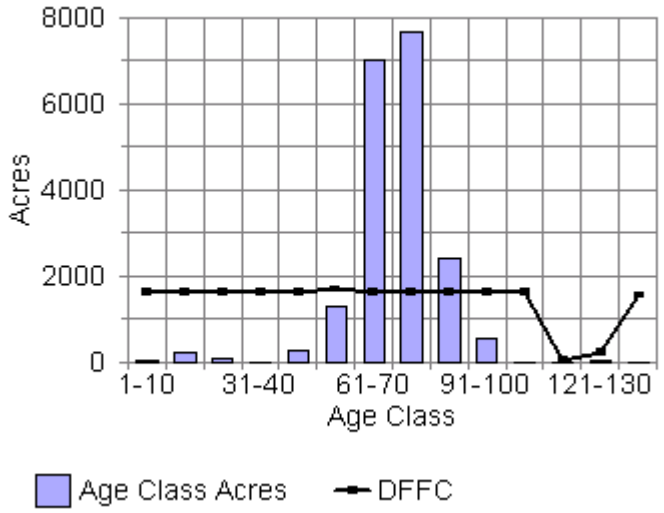
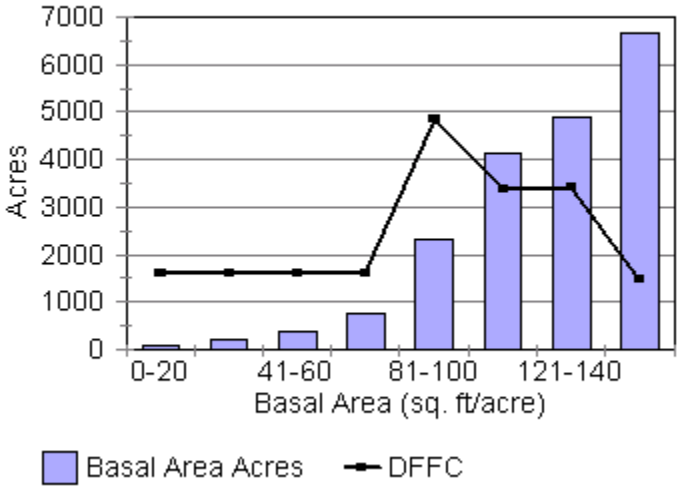


Figure 4.11. Current Age-Class Distribution of Oak Forests



The current age-class distribution of red oak in the planning area, including normal rotation acres and ERF acres; the desired future age-class distribution is represented by a dark line.

Figure 4.12. Current Basal Area Distribution in Oak Forests



The current basal area distribution of red oak in the planning area, including normal rotation acres and ERF acres; the desired future basal area distribution is represented by a dark line.

Rotation age determination

Regeneration harvests initiated on following ("normal"/ERF rotation age): Excellent sites (SI 75+) and 24-inch DBH (~100/150-175 years); good sites (SI 65-74) and 20-inch DBH (~100-120/120-150 years); average site (SI 55-64) and 16-20-inch DBH (120+/120+ years).

Stands meeting a selection criterion of 120 sq. ft of basal area will be thinned.

Management recommendations

1. Examine stands when basal area reaches 120 sq. ft./acre.
2. Beyond initial examination, all management will be contingent upon stand condition (see forest health concerns Appendix K).
3. Conduct crown-release thinning prior to regeneration harvest.
4. When conducting final harvest, consider maintaining adjacent mature trees to provide mast for wildlife habitat.
5. Accept other high quality species on wet-mesic communities.
6. Regenerate by use of shelterwood harvests, post-harvest timber stand improvement, weeding and cleaning when competition overtops oak seedlings, and possibly planting to retain oak if needed.
7. Evaluate sapling stands for precommercial release and thinning.
8. Consider use of prescribed fire to regenerate oak on dry-mesic communities.
9. Re-enter stands on 10 to 20-year intervals for thinning.

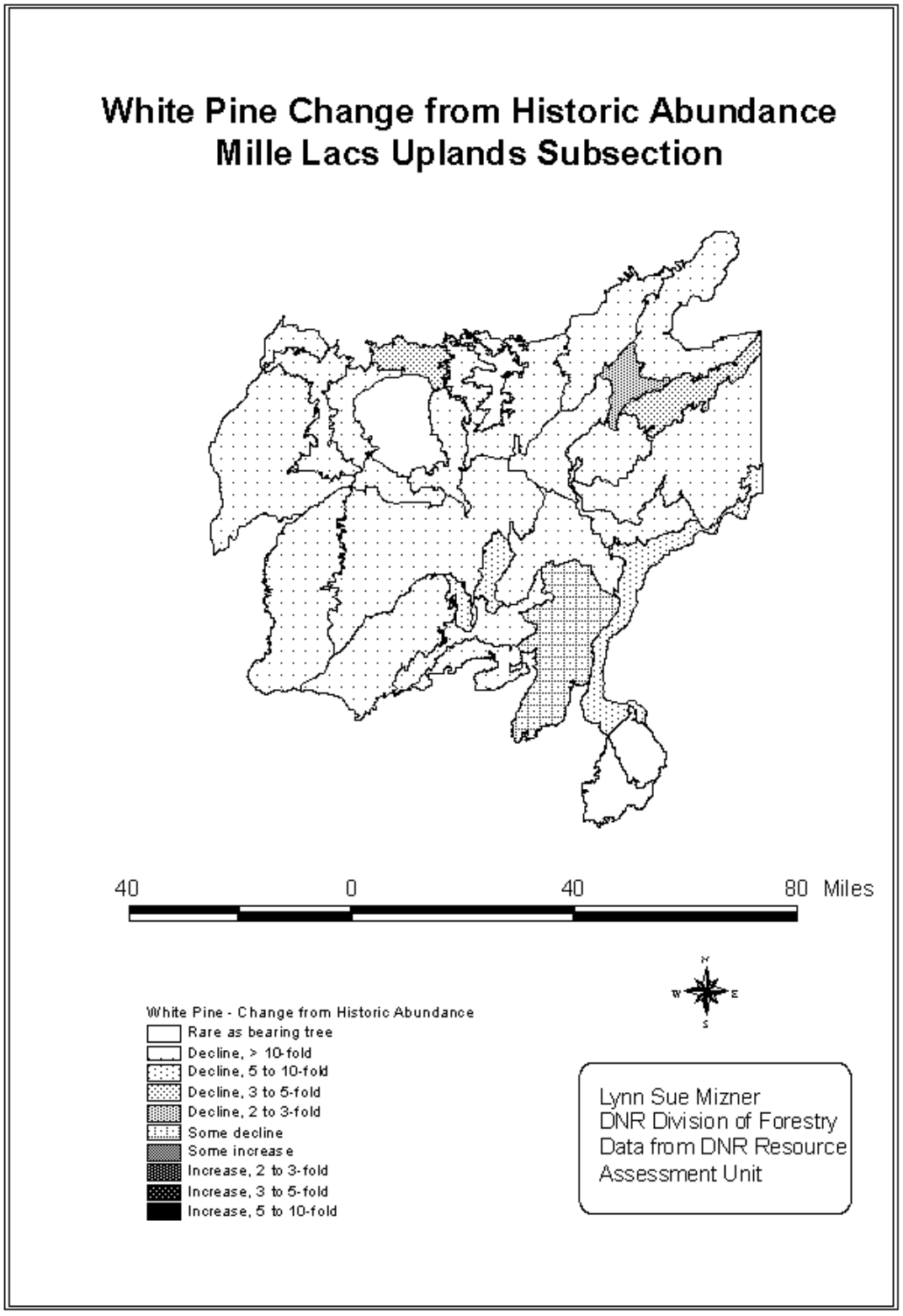
White pine

Cover-type status

There are only 551acres of this cover type in the subsection, only 4 percent of which is over 110 years old; 82 acres have basal area over 119 sq. ft/acre and will be examined.

Figure 4.13 shows the current abundance of white pine by LTA as compared to historical levels.

Figure 4.13.Change in wWhite Pine Abundance from Historical Levels



Rotation age determination

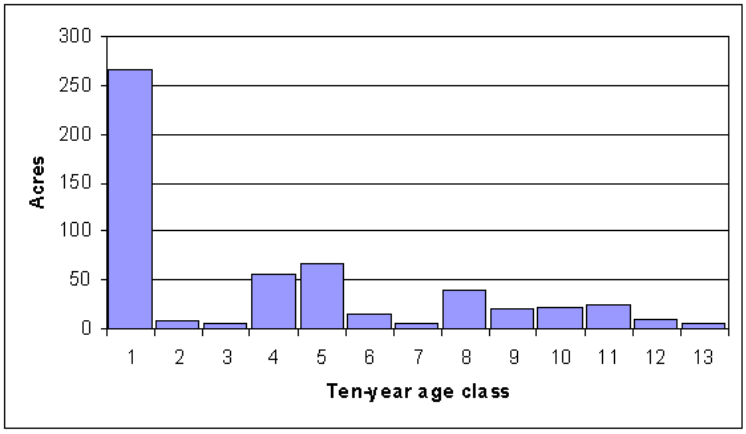
All white pine is now managed under extended rotation prescriptions; the recommended rotation age is 180.

Management recommendations

1. Stands of merchantable size and basal area greater than 119 sq. ft/acre would be thinned at ten-year intervals.
2. Every third thinning would be a group selection harvest, with the goal of establishing a new age class within the stand. Timing of the first group selection harvest would depend on stand condition and seed production.
3. Representatives (10 percent) of the oldest cohort in the stand would be retained at all times: *no final harvest.*
4. Stands with age greater than 30 years total 275 acres and would be candidates for thinning.

Figure 4.14 shows the current age-class distribution of white pine in the planning area.

Figure 4.14. Current Age-Class Distribution of White Pine Forests



Red pine

Cover-type status

There are 6,780 acres in the subsection, 63 percent of which is over age 30 and would be candidates for thinning. None has reached the rotation age of 120 years, however 1,717 total acres have a basal area over 119 sq. ft/acre and will be examined. .

Figure 4.15 shows the current abundance of red pine by LTA as compared to historical levels.

Figure 4.16 shows the current age-class distribution of red pine in the planning area. The chart bars are divided to indicate the proportions of ERF and normal rotation forest.

Figure 4.15.Change in Red Pine Abundance from Historical Levels

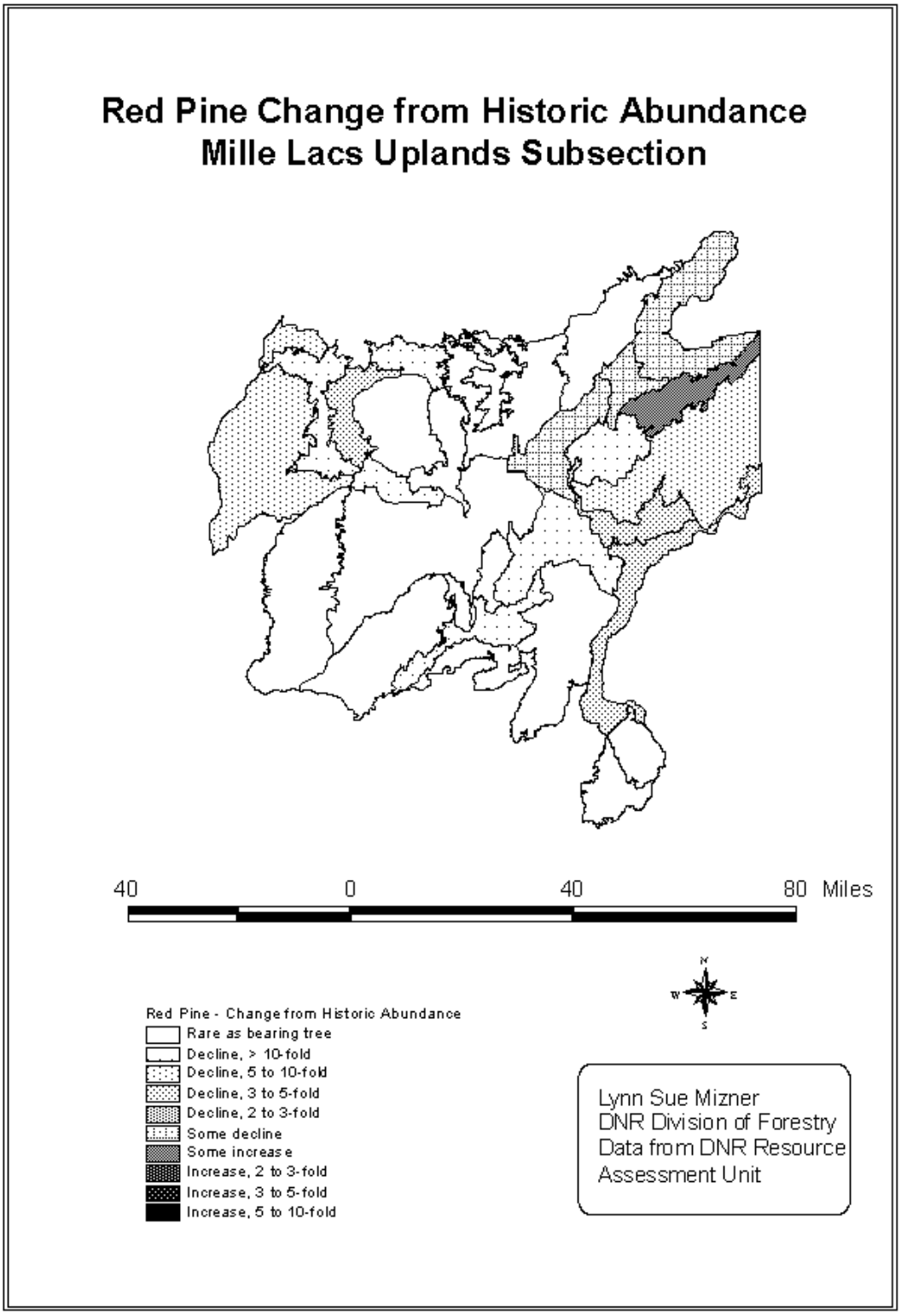
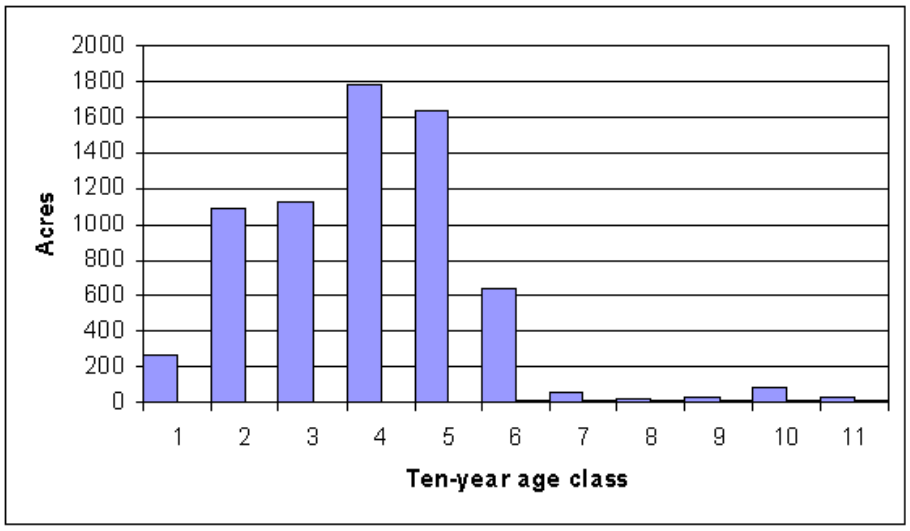


Figure 4.16. Current Age-class Distribution of Red Pine Forests



Management recommendations

1. The normal rotation age will be 120 years.
2. Intermediate thinning would begin when stand basal area reaches 119 sq. ft/acre and would continue at 10-year intervals.

Jack pine

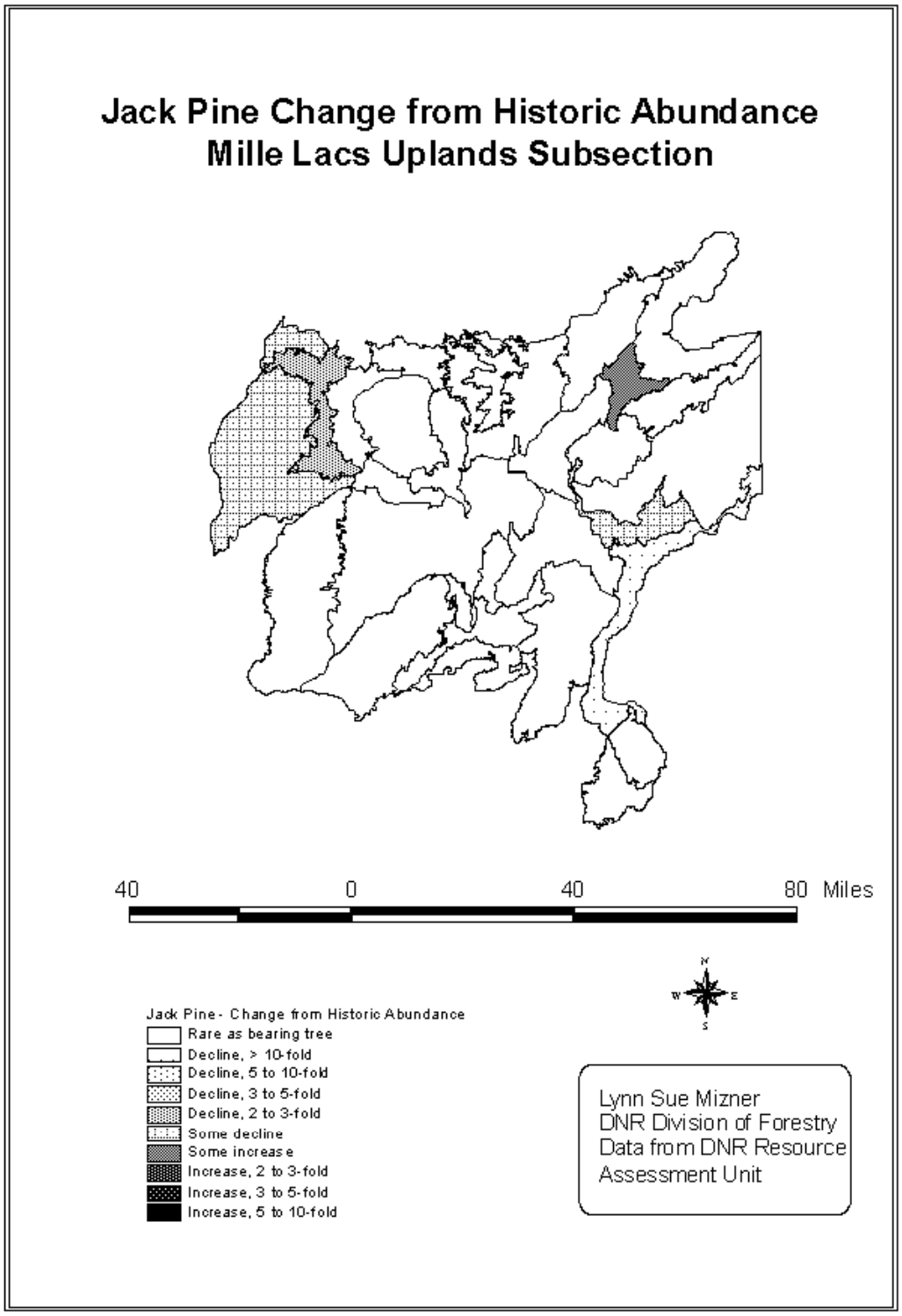
Cover-type status

There are 2,010 acres of jack pine in the planning area; 1,247 acres are currently over the rotation age of 40 years. Most of the planning area is at the southern edge of the jack pine range, and the species doesn't hold well beyond rotation age. Nevertheless, 152 acres have been designated as ERF.

Figure 4.17 shows the current abundance of jack pine by LTA as compared to historical levels.

Figure 4.18 shows the current age-class distribution of jack pine in the planning area.

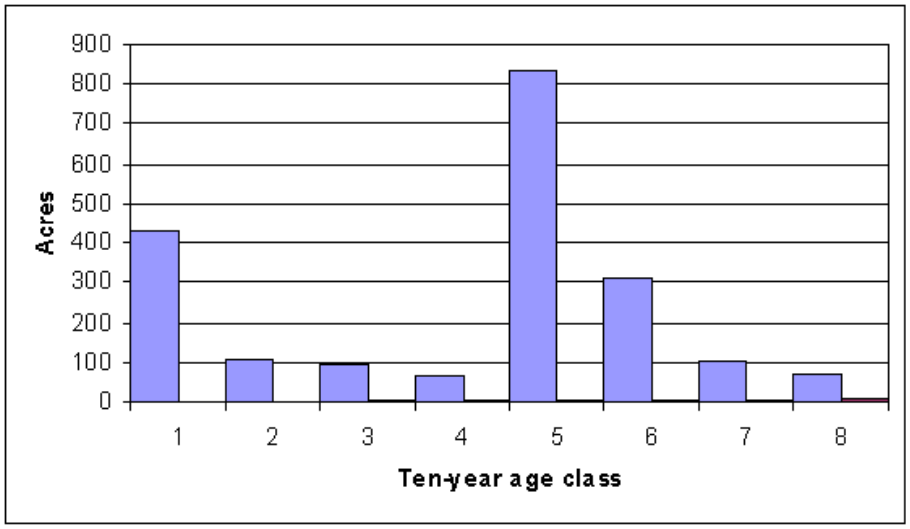
Figure 4.17.Change in Jack Pine Abundance from Historical Levels



Rotation age determination

A normal rotation age of 40 years is recommended; maximum harvest age is the ERF rotation age of 60 years.

Figure 4.18. Current Age-Class Distribution of Jack Pine Forests



Management recommendations

Even-aged management would be used on all stands.

Scots pine

Cover-type status

There is one stand in the Mille Lacs Uplands subsection (in southern Pine County). Consistent with DFFCs, this stand will be converted to a native species at rotation age.

White spruce

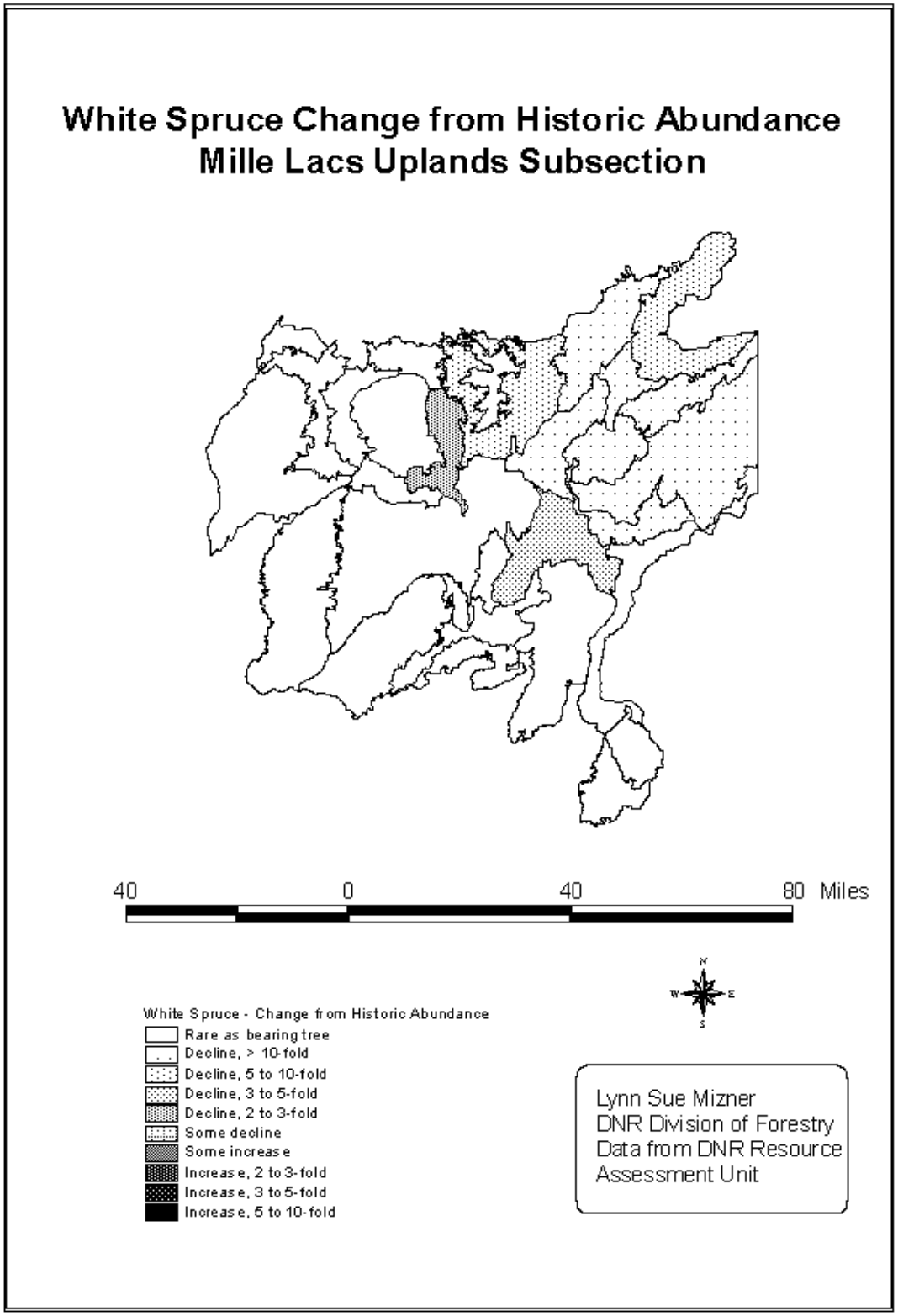
Cover-type status

There are 2,705 acres of this type in the subsection, 42 percent of which is over the age of 30 years. Only one stand is 117 years of age and two are approaching 90 years of age. The majority of the cover type is of plantation origin. ERF designation has been applied to 1,065 acres.

Figure 4.19 shows the current abundance of white spruce by LTA as compared to historical levels.

Figure 4.20 shows the current age-class distribution of white spruce in the planning area.

Figure 4.19.Change in White Spruce Abundance from Historical Levels



Rotation age determination

The suggested normal rotation age is 90 years; extended rotation age is 120 years of age.

Figure 4.20. Current Age-Class Distribution of White Spruce Forests

Management recommendations

1. Stands would be first thinned between the ages of 25 and 40 years.
2. Subsequent thinning would occur at 10 to 20-year intervals, with the goal of maintaining a minimum live crown ratio of 40 percent.
3. Thinning operations would discriminate against balsam fir.

Norway spruce

Cover-type status

There is one 5-acre stand near General Andrews Nursery. Consistent with DFFCs, this stand will be converted to a native species at rotation age. Management will be similar to that for white spruce.

Balsam fir

Cover type status

There are 2,940 acres of the cover type in the subsection, 68 percent of which are over the rotation age of 60 years.

Figure 4.21 shows the current abundance of balsam fir by LTA as compared to historical levels.

Figure 4.22 shows the current age-class distribution of balsam fir in the planning area.

Figure 4.21 .Change in Balsam Fir Abundance from Historical Levels

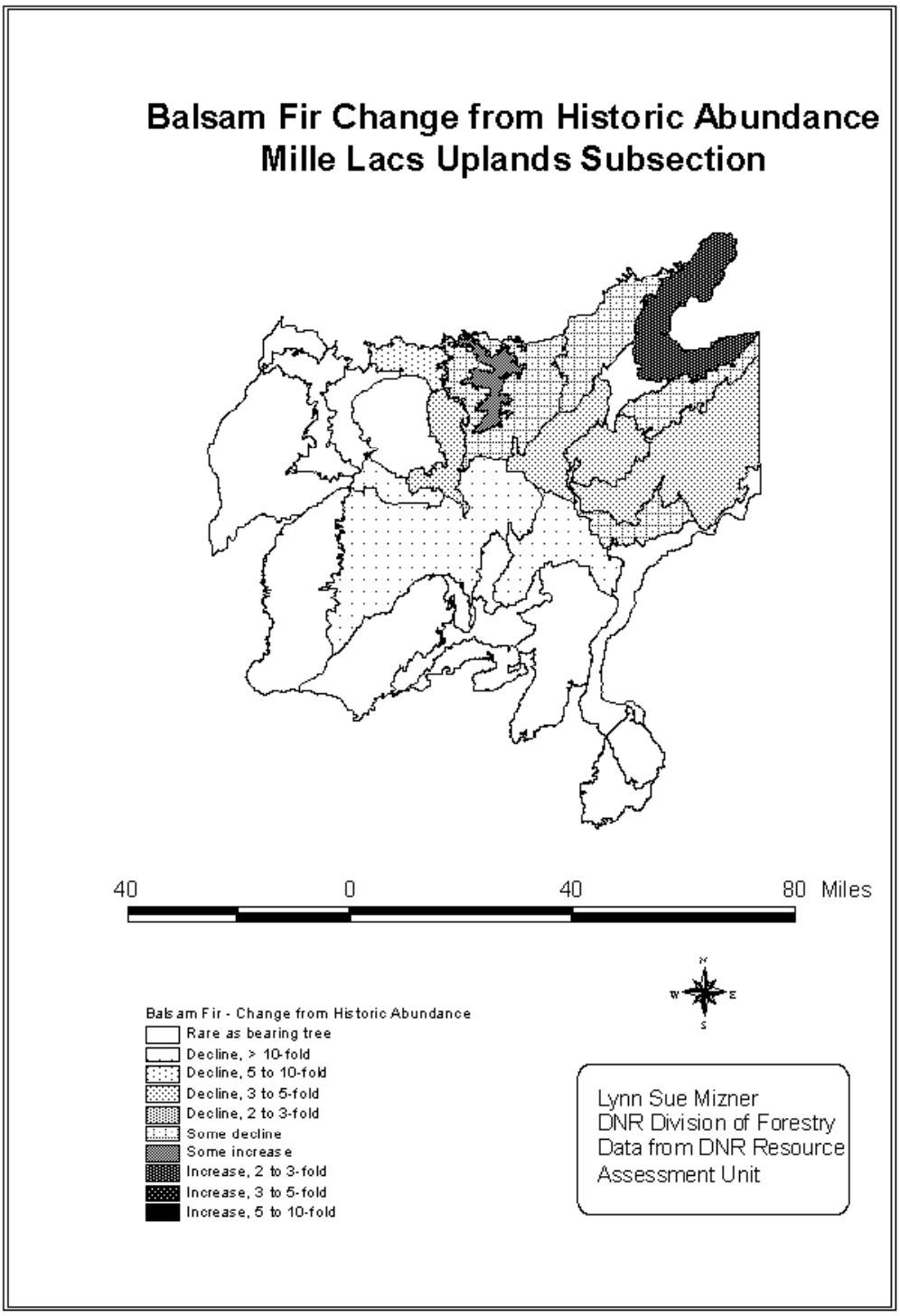
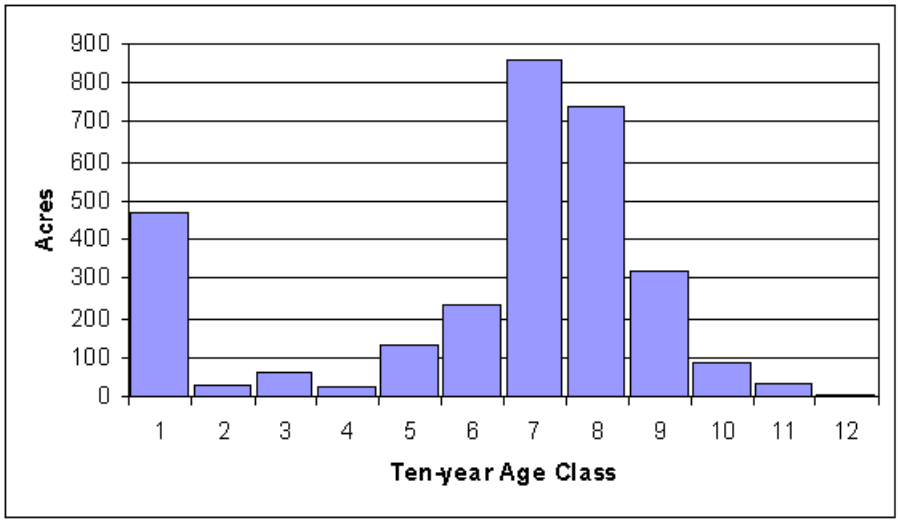


Figure 4.22. Current Age-Class Distribution of Balsam Fir Forests



Rotation age determination

The *Manager's Handbook for Balsam Fir* recommended rotation age is 60 years; this is consistent with MAI data for the subsection. Extended rotation age is 70 years; 222 acres, or 8 percent of the type, is designated ERF.

Black spruce (lowland)

A parasitic plant, mistletoe, is an issue; a salvage pool of affected stands will be created and given a high priority for treatment. Heavily affected stands may be targeted for conversion to tamarack. The planning team agreed that, should resources available for management be limited, lower quality (low SI) stands could be held over until the next planning period with no anticipated detrimental effects.

Cover-type status

Approximately 11,458 acres of lowland black spruce in the subsection were divided into three site-quality classes for management purposes and 1,714 acres meet the stand-selection criteria. Black spruce stands over the average normal rotation age of 100 years make up 25 percent of the type in these subsections; 14 percent of the type meets the accepted definition of "effective ERF".

Figure 4.23 shows the current abundance of black spruce by LTA as compared to historical levels.

Figure 4.24 shows the age-class distribution of lowland black spruce in the planning area and the proportions of ERF and normal rotation acres.

Figure 4.23 .Change in Black Spruce Abundance from Historical Levels

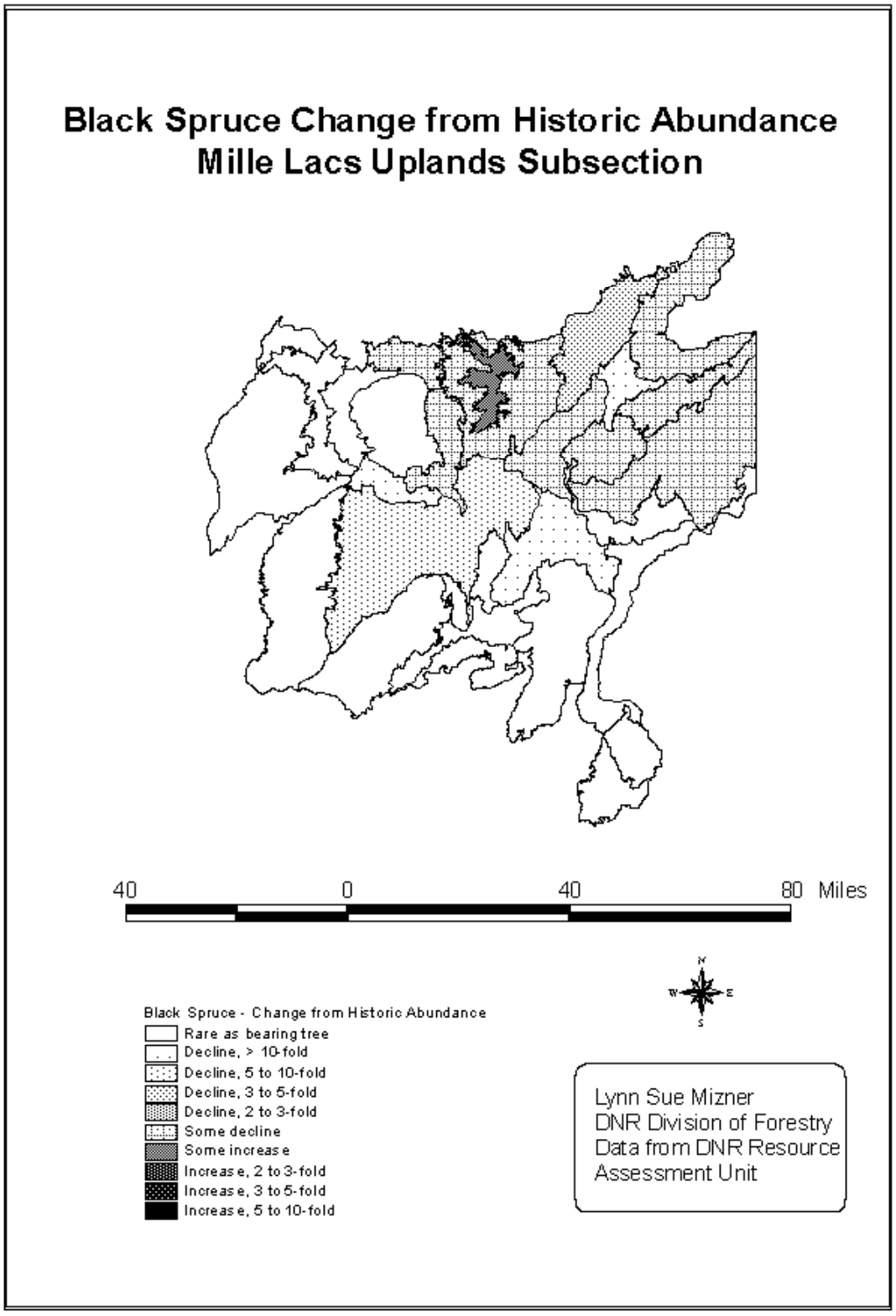
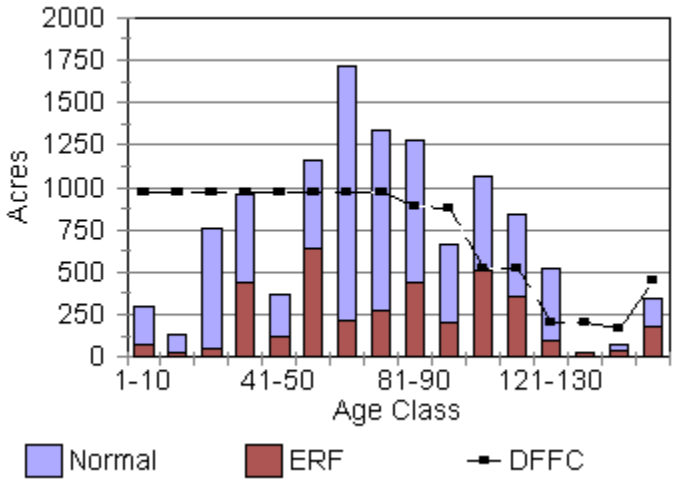


Figure 4.24. Current Age-Class Distribution of Lowland Black Spruce Forests



The current age-class distribution of lowland black spruce in the planning area, including normal rotation acres and ERF acres; the desired future age class distribution is represented by a dark line.

Rotation age determination

1. Rotation age based on SI class: High (80), Medium (100), and Low (120).
2. Field experience indicates high SI stands begin to break up after age 80. Low SI stands can be held much longer without high losses, unless mistletoe is present.

Management recommendations

1. Examine salvage pool stands
2. Mistletoe is an issue; a salvage pool of affected stands will be created and given a high priority for treatment
3. Evaluate potential for reseeding salvage cuts or planting to tamarack
4. If less than 1,000 acres in salvage pool, look at high site index stands over rotation age.
5. Stagnant black spruce stands are merchantable but typically not part of the timber harvest plan.
6. Lower SI stands can be held over until the next planning period with no anticipated detrimental effects.

Tamarack

Three SI classes (stagnant, medium quality, and high quality) were established for tamarack in the planning area. No treatment is planned for the stagnant stands during the current planning period.

Tamarack was historically more common as a forest type in these subsections and the type will be increased as opportunities arise for conversion of lowland black spruce affected by dwarf mistletoe, however, increasing the amount of tamarack brings with it another set of health concerns. Larch case bearer and European larch beetle are current health concerns in the planning area. Management plans may be affected by efforts to control these insects or to salvage affected stands.

Cover-type status

There are 10,372 acres of this cover type in the subsection, 38 percent of which is over the average normal rotation age of 80 years. Current effective ERF is 43 percent.

Figure 4.25 shows the current abundance of tamarack by LTA as compared to historical levels.

Figure 4.26 shows the age-class distribution of tamarack in the planning area and the proportions of ERF and normal rotation acres.

Figure 4.25 Change in Tamarack Abundance from Historical Levels

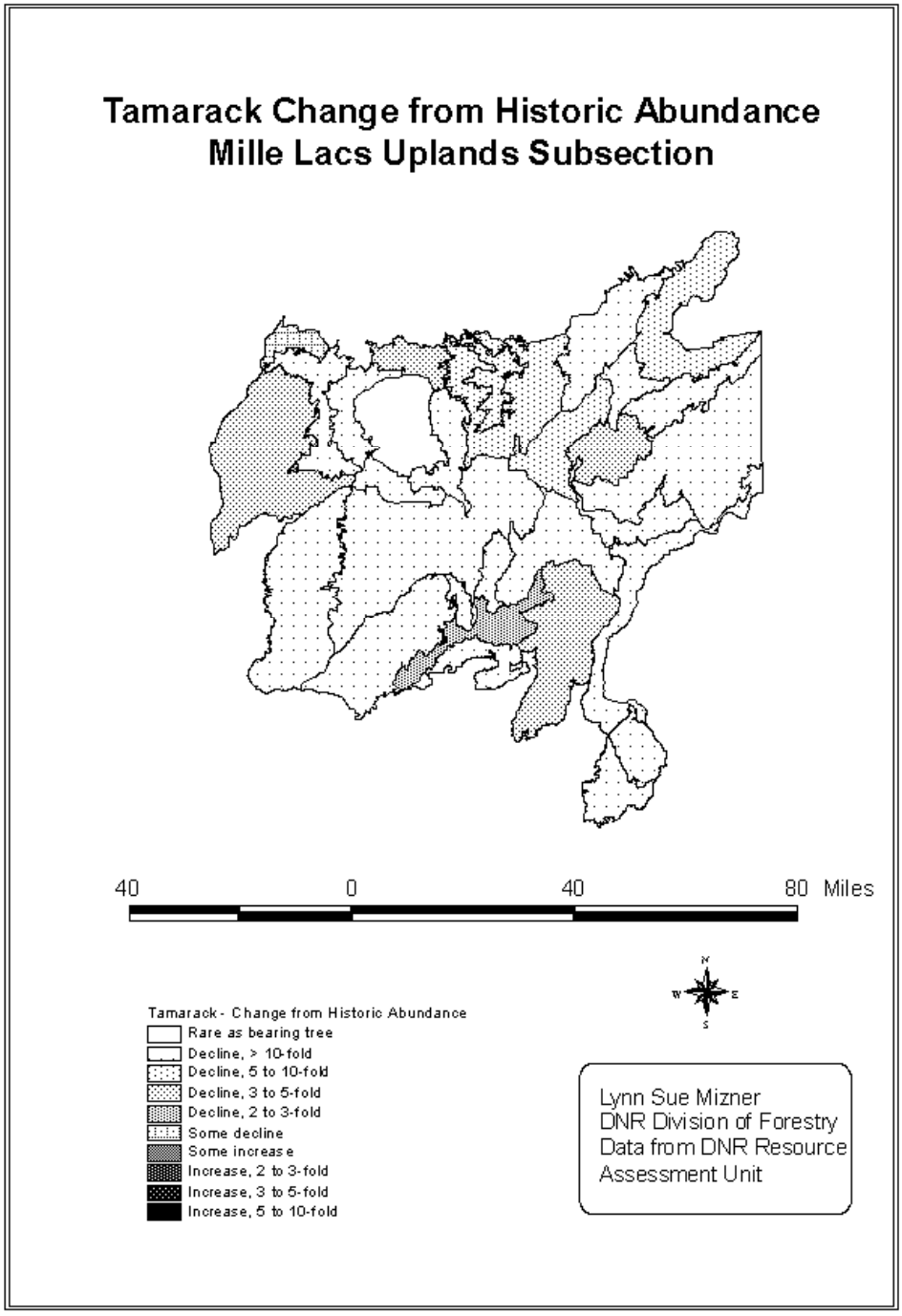
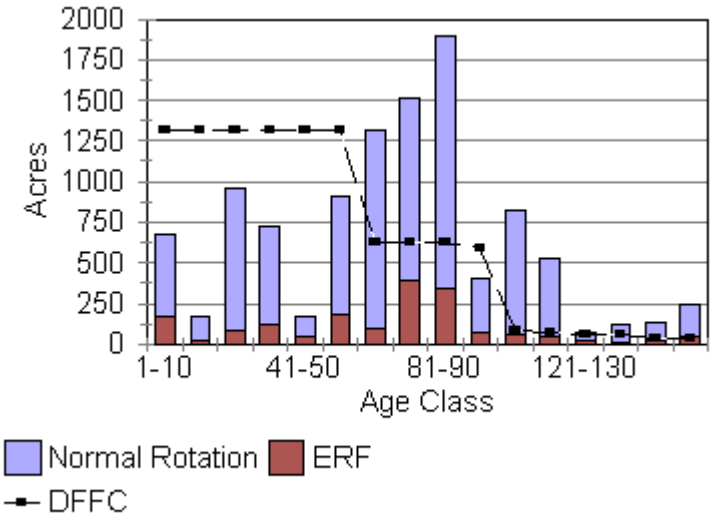


Figure 4.26. Current Age-Class Distribution of Tamarack Forests



The current age-class distribution of tamarack in the planning area, including normal rotation acres and ERF acres; the desired future age class distribution is represented by a dark line.

Rotation age determination

MAI data based on statewide Forest Inventory Analysis (FIA) shows a plateau for higher SI between ages 45-65, with a gradual decline thereafter. The MAI for lower SI tamarack is nearly flat until age 110 and declines thereafter.

Management recommendations:

1. Examination would be based on site index class, defined as follows:

   Lower quality sites (SI 24 to 39); rotation age 100 years

   Higher quality sites (SI 40+); rotation age 60 years.

2. Stands severely affected by the defoliator complex (larch case bearer, European larch beetle, etc.) may require additional salvage treatments.

White cedar

Cover-type status

White cedar was rare as a bearing tree in this subsection, and continues to be a rare forest type (235 acres in the subsection). One 6-acre stand is less than 60 years old. The oldest stands are150 years old.

Even though it was historically present in low numbers in most of the planning area, white cedar provides important elements of wildlife habitat. One approach to protecting white cedar regeneration from depredation is to focus efforts in forests that are being managed in ways that are less conducive to creating deer habitat (e.g., in areas that are being managed for larger patches). Trying to make sure that coarse woody debris (CWD) is present over the long term to provide nursery microhabitats will also be important for cedar. That would be one reason for maintaining the existing cedar forests. If cedar can be harvested again in the future, a healthy dose of leave trees, canopy cover and protection of CWD

(along with advance regeneration) will help ensure that northern white cedar has the seedbeds it needs for future germination and establishment.

Minnesota's Native Vegetation: A key to natural communities (p.26) indicates that upland white cedar forests occur "in fire-protected areas (see Figure L-2 in Appendix L), typically on mineral soils. Upland white cedar forest occurs on diverse topographies, from very steep, well-drained slopes to gentle, wet-mesic slopes that grade into depressions containing white cedar swamp or other lowland types. Soils in upland white cedar forests tend to have relatively high levels of calcium."

In contrast, "white cedar swamps occur on wet mineral soils or well-decomposed peat soils on level to gently sloping (<3%) terrain along the margins of peatlands, along drainage courses, and in moist habitats where the vegetation and litter is rarely dry enough to burn, or in areas protected from fire by topographic breaks."

Rotation age determination

The *Manager's Handbook for Northern White Cedar* indicates that MAI is relatively flat for many years. Suggested rotations for maximum sawtimber production range from 110 years for SI 40 to 160 years for SI 20.

Management recommendations

1. Area Forestry and Wildlife staff should work together to look for opportunities for cedar management. Upland cedar and higher SI stands of lowland cedar would be considered for treatment first.
2. Identify areas appropriate for special management efforts for cedar regeneration.
3. Focus efforts in forests that are being managed in ways that are less conducive to creating deer habitat (e.g., in areas that are being managed for larger patches).
4. Ensure that coarse woody debris (CWD) is present over the long term to provide nursery microhabitats for cedar regeneration.
5. White cedar has been identified as an "under-utilized species," however, managers are reluctant to promote its use until regeneration efforts can be shown to be successful

Table 4.1. Summary of Stand Selection Criteria (Mille Lacs Uplands/ Glacial Lake Superior Plain/St. Croix Moraines)

a. Forest types typically managed using even-age management techniques or modifications thereof:

	"Normal" Selection Criteria			ERF Selection Criteria				Remarks
Forest Type	**Rotation/Selection Age**	**Condition/ Size Class**	**%Mortality or %Affected**	**Rotation Age**	**Condition/ Size Class**	**%Mortality or %Affected**	**Max Harvest Age**	**Remarks**
Aspen/Balm of Gilead	>39	= HR	>10% M	>54	= HR	>10% M	60	
Balsam fir	>59	= HR		>89	=HR			
Birch	>49	= HR	>10% M	>59	= HR		60	Regeneration will be a high priority
Black spruce lowland SI < 29	>119	= HR	Mistletoe >10% A	>179	= HR	Mistletoe >10% A		Potential sites for tamarack planting/seeding
Black spruce lowland SI 29 -39	>99	= HR	Mistletoe >10% A	>149	= HR	Mistletoe >10% A		Potential sites for tamarack planting/seeding
Black spruce lowland SI > 39	>60	= HR	Mistletoe >10% A	>79	= HR	Mistletoe >10% A		Potential sites for tamarack planting/seeding
Tamarack SI 24-39	>99	= HR		>149	= HR			Historically more common than 2001 levels; Insect and disease concerns
Tamarack SI > 39	>59	= HR		>99	= HR			Historically more common than 2001 levels; Insect and disease concerns
Jack pine	>39	= HR		>59	= HR	= HR	60	Marginal quality in the subsections

Oak	SI >75: 100 SI 65-74: 100-120 SI 55-64: 120+	Age >70 and Basal area <120	<10% affected (see App I)	SI>75:150-175 SI 65-74: 120 - 150 SI 55-64: 120+	>119 BA	<10% affected		Criteria for selection of 200 acres/year for regeneration harvest are: stand has environmental damage (Damage>49 and Percent affected >50)
Northern hardwoods	>70	BA<120		>70	BA<120			Potential sites for birch reintroduction or conifer enhancement

High risk (HR): HR stands were identified based on one or more of the following reasons: stands coded as high risk in CSA forest inventory; significant insect or disease damage to the main species in the stand; or a very old stand, e.g., aspen over sixty years old.

a. Forest types typically managed using selective-harvest techniques

	NORMAL HARVEST CRITERIA			ERF HARVEST CRITERIA			Remarks
Forest Cover Type	**Rotation/ selection Age**	**Condition/Size Class**	**%Mortality or %Affected**	**Rotation Age**	**Condition/ Size Class**	**%Mortality or %Affected**	
Ash/lowland hardwoods	N/A	SI>44 BA>99 DBH>7”					
Northern hardwoods	>119	BA>119		>179	BA>119		100% of stands will be thinned
White pine	N/A			>179	BA>119		All managed as ERF; all selected stands will be thinned.
Red pine all sites	>29	BA>119		>179	BA>119		None currently near rotation age; selected stands will be thinned
Red pine SI <65	>79						Selected sites will be thinned
Red pine SI >65	>64						Selected sites will be thinned
White spruce	>89			>119			Selected sites will be thinned

High risk (HR): HR stands were identified based on one or more of the following reasons: stands coded as high risk in CSA forest inventory; significant insect or disease damage to the main species in the stand; or a very old stand, e.g., aspen over sixty years old.

Text Description of Mille Lacs Uplands Stand Selection Criteria.

Aspen and Balm of Gilead

Condition Class 1 (Those stands that will not survive or will have a substantial volume loss. Includes stands that which should be treated immediately, i.e. 0-5 years.)

Or

Percent Mortality greater than 10 percent

Or

Percent of trees affected by damage is greater than 25 percent

Or

Current stand age is greater than 59 years

White pine

Condition Class 1 (Those stands that will not survive or will have a substantial volume loss. Includes stands that which should be treated immediately, i.e. 0-5 years.)

Or

White pine blister rust is present *and* Stand mortality is greater than 10 percent

Or

Percent of trees affected by damage is greater than 10 percent.

Or

Current basal area is greater than 119 square feet.

Ash

Site Index is greater than 44

And

Current basal area is greater than 99 square feet

And

Diameter at breast height is greater than 7 inches

Lowland hardwoods

Site Index is greater than 44

And

Current basal area is greater than 99 square feet

And

Diameter at breast height is greater than 7 inches

Jack pine

Condition Class 1 (Those stands that will not survive or will have a substantial volume loss. Includes stands that which should be treated immediately, i.e. 0-5 years.)

Or

Stand mortality is greater than 10 percent

Or

Current age is greater than 60 years

Or

Stand is non-ERF and current age is greater than 39 years.

White spruce

Current age is greater than 29 years

And

Current basal area is greater than 119 square feet

Or

Condition Class is 1 (Those stands that will not survive or will have a substantial volume loss. Includes stands that which should be treated immediately, i.e. 0-5 years.)

Birch

Birch decline is present

Or

Condition Class is 1 (Those stands that will not survive or will have a substantial volume loss. Includes stands that which should be treated immediately, i.e. 0-5 years.)

Or

Stand mortality is greater than 10 percent

Or

Stand age is greater than 80 years.

Note: Stands with birch decline are tagged for examination regardless of age or percent affected.

Tamarack

Stand is non-ERF, site index is less than 40 and current age is greater than 99 years

Or

Stand is non-ERF, site index is greater than 39, and current age is greater than 59

Or

Condition Class is 1 (Those stands that will not survive or will have a substantial volume loss if not harvested). Includes stands that which should be treated immediately, i.e. 0-5 years.)

Or

Stand is ERF, site index is less than 40, and current age is greater than 149 years

Or

Stand is ERF and site index is greater than 39, and current age is greater than 99 years

Balsam fir

Condition Class is 1 (Those stands that will not survive or will have a substantial volume loss. Includes stands that which should be treated immediately, i.e. 0-5 years.)

Or

Current stand age is greater than 79 years

Or

Stand mortality is greater than 10 percent and current age is greater than 59 years

Lowland black spruce

Dwarf mistletoe is present and more than 25 percent of the stand is affected

Or

Stand is non-ERF, site index is less than 30 and current age is greater than 119 years

Or

Stand is ERF, site index is less than 30 and current age is greater than 179 years

Or

Stand is non-ERF, site index is less than 40 and greater than 29 and current age is greater than 99 years

Or

Stand is ERF, site index is less than 40 and greater than 29, and current age is greater than 149

Or

Stand is non-ERF, site index is greater than 39, and current age is greater than 59

Or

Stand is ERF, site index is greater than 39 and current age is greater than 79

Red Pine

Current age is less than 30 years

And

Current basal area is greater than 119 square feet

Or

Current age is greater than 29 years

And

Current basal area is greater than 119 square feet

Northern Hardwoods

Low volume pool

Current basal area is less than 120 square feet

And

Current age is greater than 70 years

Thinnin***g*** pool

Current basal area is greater than 119 square feet

Oak

Stand is non-ERF

And

Stand age is greater than 100 years

And

Site index is greater than 75

And

Diameter at breast height is greater than 24 inches

(no stands met these criteria)

High risk pool for regeneration

Environmental damage is present in the stand (windthrow, drought, stem breakage, fire, flooding, hail damage, open cracks, etc.)

And

More than 50 percent of the stand is affected

Or

Current stand age is greater than 69 years

And

Current basal area is less than 120 square feet

And

Last stand exam was before 2000.

Or

Current basal area is greater than 119 square feet.

Central Hardwoods

Low volume pool

Current basal area is less than 129 square feet

And

Current age is greater than 70 years

Thinning pool

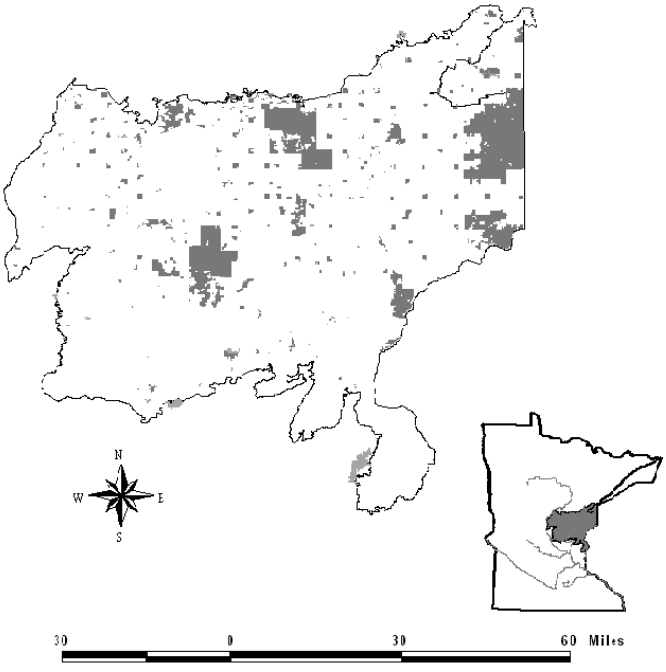
Current basal area is greater than 119 square feet.

5. Seven-Year Stand List & New Access Needs

The Mille Laces Uplands strategic document provided a wide-ranging set of criteria for the selecting of stands to be managed over the next seven years. The reader is referred to that document, including proposed changes to it as identified above, for the details on the selection criteria.

Over the next seven years every stand on the list will be field visited to determine the actual type of management, if any, to be conducted on it. Stands have been selected on the basis of the DNR's inventory database and a certain degree of field knowledge of individual stands. However, the exact condition of each stand truly will not be known until the field visits are made.

Figure 5.1. Division of Forestry- and Section of Wildlife-Administered Lands in the Mille Lacs Uplands and Glacial Lake Superior Plains Subsections.



The range of decisions about each stand's possible management include:

a. Update the inventory database to reflect current field conditions but propose no active management. This will often be the decision for Low Density (aka High Risk Low Value) stands that are naturally succeeding to a desired new cover type. It will also be applied to stands where active management is not desired or feasible.

b. Harvest and convert to new cover type.

c. Harvest and regenerate into existing cover type.

d. Conduct various timber stand improvements to enhance stand vigor, diversity, ecological characteristics and functions, or productivity.

The following tables provide summaries of the 7-year stand list. Table 5.1 shows the distribution of the selected stands by cover type by area office within the subsection.

Table 5.1 Selected 7-Year Stand Acres by Cover Type by Area Office

Cover Type	Brainerd	Aitkin	Cloquet	Little Falls	Sandstone	Cambridge	Total
Ash / Lowland Hardwoods	78	1,010	5	595	2,008	26	3,722
Aspen / Balm of Gilead	95	3,905	1,862	1,062	8,238	74	15,236
Birch	95	181	855	14	1,785		2,930
Northern &Central Hdwds	324	4,614	508	5,044	5,551	14	16,055
Oak	1,152	1,564	224	2,435	3,151		8,526
White Pine		5		8			13
Red Pine	32	58	26	16	1,152	5	1,289
Jack Pine	12	51	4		825		892
White Spruce		97	26	42	127		292
Balsam Fir		14	63		779		856
Black Spruce, lowland	12	219	4	15	676		926
Tamarack	83	443	8	100	638		1,272
Stagnant Black Spruce		692					692
Stagnant Tamarack		39					39
Total Selected Acres	1,883	12,892	3,585	9,331	24,930	119	52,740
Total DNR Timberland[1] Acres in Subsection	4,919	56,853	17,610	36,113	124,051	891	240,438
% Selected Acres of Timberland Acres	38%	23%	20%	26%	20%	13%	22%

[1] Timberland does not include DNR reserved (e.g., designated old-growth forest, and state parks) or nonproductive forest lands (e.g., stagnant spruce, tamarack, and cedar; offsite aspen; or non-forest lands). There are approximately 264,000 acres of reserved and nonproductive DNR forestlands in the Mille Lacs Uplands Subsection.

Table 5.2 summarizes the generalized annual treatments for each forest cover type under the proposed 7-year stand list.

Table 5.2 Summary of Annual Treatment Acres by Cover Type under Proposed 7-Year Stand List

Cover Type	Timber Harvest Acres[1]	Intermediate Treatment Acres[2]	Non-Timber Products[3]	Field Visit Acres[4]	Total Acres
Ash / Lowland Hardwoods	31	3,624		67	3,722
Aspen / Balm of Gilead	9,829	340		5,066	15,236
Birch	2,386	55		507	2,930
Northern &Central Hdwds	3,220	12,561	69	203	16,053
Oak	1,846	6,334		347	8,527
White Pine		5		8	13
Red Pine	118	1,156		14	1,288
Jack Pine	876	11		4	891
White Spruce	3	231		58	292
Balsam Fir	845			11	856
Black Spruce, lowland	883			42	925
Tamarack	1,179	4		89	1,272
Stagnant Black Spruce			692		692
Stagnant Tamarack			39		39
Total	**21,197**	**24,321**	**800**	**6,416**	**52,726**

[1] Management actions include even-aged harvest, seed tree harvest, shelterwood harvest, and uneven-aged harvest. These figures include both normal and extended rotation forest (ERF) stands.

[2] Management actions include thinning and management for understory.

[3] Management actions include harvest of boughs and decorative tree tips.

[4] Management actions include on-site visit, re-inventory, and stands identified as High Risk Low Volume (HRLV) requiring field assessments to determine management direction (nearly all acres in this column fall under the HRLV activity). All stands meeting the HRLV stand pool criteria will be assigned a field visit prescription, whether in ERF or normal forest management areas. It is estimated that approximately half of these acres may result in timber harvest; others may result in a "natural conversion" to a different forest type.

Tables 5.3 – 5.7 summarize the generalized annual treatments for each forest cover type under the proposed 7-year stand list for each Division of Forestry administrative area.

Table 5.3 Summary of Annual Treatment Acres by Cover Type for Brainerd Area

Cover Type	Timber Harvest Acres[1]	Intermediate Treatment Acres[2]	Non-Timber Products[3]	Field Visit Acres[4]	Total Acres
Ash / Lowland Hardwoods		78			78
Aspen / Balm of Gilead	16			79	95
Birch	95				95
Northern &Central Hdwds	136	156		32	324
Oak	177	941		34	1,152
White Pine					0
Red Pine		18		14	32
Jack Pine	12				12
White Spruce					0
Balsam Fir					0
Black Spruce, lowland	12				12
Tamarack	83				83
Stagnant Black Spruce					0
Stagnant Tamarack					0
Total	**531**	**1,193**	**0**	**159**	**1,883**

[1] Management actions include even-aged harvest, seed tree harvest, shelterwood harvest, and uneven-aged harvest. These figures include both normal and extended rotation forest (ERF) stands.

[2] Management actions include thinning and management for understory.

[3] Management actions include harvest of boughs and decorative tree tips.

[4] Management actions include on-site visit, re-inventory, and stands identified as High Risk Low Volume (HRLV) requiring field assessments to determine management direction (nearly all acres in this column fall under the HRLV activity). All stands meeting the HRLV stand pool criteria will be assigned a field visit prescription, whether in ERF or normal forest management areas. It is estimated that approximately half of these acres may result in timber harvest; others may result in a "natural conversion" to a different forest type.

Table 5.4 Summary of Annual Treatment Acres by Cover Type for Aitkin Area

Cover Type	Timber Harvest Acres[1]	Intermediate Treatment Acres[2]	Non-Timber Products[3]	Field Visit Acres[4]	Total Acres
Ash / Lowland Hardwoods	13	996			1,009
Aspen / Balm of Gilead	3,580	98		227	3,905
Birch	108	48		26	182
Northern &Central Hdwds	572	4,042			4,614
Oak	399	1,165			1,564
White Pine		5			5
Red Pine	23	35			58
Jack Pine	51				51
White Spruce		97			97
Balsam Fir	14				14
Black Spruce, lowland	219				219
Tamarack	419			23	442
Stagnant Black Spruce			692		692
Stagnant Tamarack			39		39
Total	**5,398**	**6,486**	**731**	**276**	**12,891**

[1] Management actions include even-aged harvest, seed tree harvest, shelterwood harvest, and uneven-aged harvest. These figures include both normal and extended rotation forest (ERF) stands.

[2] Management actions include thinning and management for understory.

[3] Management actions include harvest of boughs and decorative tree tips.

[4] Management actions include on-site visit, re-inventory, and stands identified as High Risk Low Volume (HRLV) requiring field assessments to determine management direction (nearly all acres in this column fall under the HRLV activity). All stands meeting the HRLV stand pool criteria will be assigned a field visit prescription, whether in ERF or normal forest management areas. It is estimated that approximately half of these acres may result in timber harvest; others may result in a "natural conversion" to a different forest type.

Table 5.5 Summary of Annual Treatment Acres by Cover Type for Cloquet Area

Cover Type	Timber Harvest Acres[1]	Intermediate Treatment Acres[2]	Non-Timber Products[3]	Field Visit Acres[4]	Total Acres
Ash / Lowland Hardwoods		5			5
Aspen / Balm of Gilead	879	30		953	1,862
Birch	406			449	855
Northern &Central Hdwds	75	375		59	509
Oak	100	124			224
White Pine					0
Red Pine		26			26
Jack Pine				4	4
White Spruce	3			23	26
Balsam Fir	52			11	63
Black Spruce, lowland	1			2	3
Tamarack	4	4			8
Stagnant Black Spruce					
Stagnant Tamarack					
Total	**1,520**	**564**	**0**	**1,501**	**3,585**

[1] Management actions include even-aged harvest, seed tree harvest, shelterwood harvest, and uneven-aged harvest. These figures include both normal and extended rotation forest (ERF) stands.

[2] Management actions include thinning and management for understory.

[3] Management actions include harvest of boughs and decorative tree tips.

[4] Management actions include on-site visit, re-inventory, and stands identified as High Risk Low Volume (HRLV) requiring field assessments to determine management direction (nearly all acres in this column fall under the HRLV activity). All stands meeting the HRLV stand pool criteria will be assigned a field visit prescription, whether in ERF or normal forest management areas. It is estimated that approximately half of these acres may result in timber harvest; others may result in a "natural conversion" to a different forest type.

Table 5.6 Summary of Annual Treatment Acres by Cover Type for Little Falls Area

Cover Type	Timber Harvest Acres[1]	Intermediate Treatment Acres[2]	Non-Timber Products[3]	Field Visit Acres[4]	Total Acres
Ash / Lowland Hardwoods		595			595
Aspen / Balm of Gilead	1,035	10		17	1,062
Birch	14				14
Northern &Central Hdwds	1,219	3,805		20	5,044
Oak	481	1,809		145	2,435
White Pine				8	8
Red Pine		16			16
Jack Pine					0
White Spruce		7		35	42
Balsam Fir					0
Black Spruce, lowland	15				15
Tamarack	35			65	100
Stagnant Black Spruce					
Stagnant Tamarack					
Total	**2,799**	**6,242**	**0**	**290**	**9,331**

[1] Management actions include even-aged harvest, seed tree harvest, shelterwood harvest, and uneven-aged harvest. These figures include both normal and extended rotation forest (ERF) stands.

[2] Management actions include thinning and management for understory.

[3] Management actions include harvest of boughs and decorative tree tips.

[4] Management actions include on-site visit, re-inventory, and stands identified as High Risk Low Volume (HRLV) requiring field assessments to determine management direction (nearly all acres in this column fall under the HRLV activity). All stands meeting the HRLV stand pool criteria will be assigned a field visit prescription, whether in ERF or normal forest management areas. It is estimated that approximately half of these acres may result in timber harvest; others may result in a "natural conversion" to a different forest type.

Table 5.7 Summary of Annual Treatment Acres by Cover Type for Sandstone Area

Cover Type	Timber Harvest Acres[1]	Intermediate Treatment Acres[2]	Non-Timber Products[3]	Field Visit Acres[4]	Total Acres
Ash / Lowland Hardwoods	17	1,941		50	2,008
Aspen / Balm of Gilead	4,245	203		3,790	8,238
Birch	1,745	7		33	1,785
Northern &Central Hdwds	1,219	4,184	69	79	5,551
Oak	689	2,294		168	3,151
White Pine					0
Red Pine	95	1,057			1,152
Jack Pine	814	11			825
White Spruce		127			127
Balsam Fir	779				779
Black Spruce, lowland	636			40	676
Tamarack	638				638
Stagnant Black Spruce					
Stagnant Tamarack					
Total	**10,877**	**9,824**	**69**	**4,160**	**24,930**

[1] Management actions include even-aged harvest, seed tree harvest, shelterwood harvest, and uneven-aged harvest. These figures include both normal and extended rotation forest (ERF) stands.

[2] Management actions include thinning and management for understory.

[3] Management actions include harvest of boughs and decorative tree tips.

[4] Management actions include on-site visit, re-inventory, and stands identified as High Risk Low Volume (HRLV) requiring field assessments to determine management direction (nearly all acres in this column fall under the HRLV activity). All stands meeting the HRLV stand pool criteria will be assigned a field visit prescription, whether in ERF or normal forest management areas. It is estimated that approximately half of these acres may result in timber harvest; others may result in a "natural conversion" to a different forest type.

Table 5.8 Summary of Annual Treatment Acres by Cover Type for Cambridge Area

Cover Type	Timber Harvest Acres[1]	Intermediate Treatment Acres[2]	Non-Timber Products[3]	Field Visit Acres[4]	Total Acres
Ash / Lowland Hardwoods		9		17	26
Aspen / Balm of Gilead	74				74
Birch					0
Northern &Central Hdwds				14	14
Oak					0
White Pine					0
Red Pine		5			5
Jack Pine					0
White Spruce					0
Balsam Fir					0
Black Spruce, lowland					0
Tamarack					0
Stagnant Black Spruce					0
Stagnant Tamarack					0
Total	**74**	**14**	**0**	**31**	**119**

[1] Management actions include even-aged harvest, seed tree harvest, shelterwood harvest, and uneven-aged harvest. These figures include both normal and extended rotation forest (ERF) stands.

[2] Management actions include thinning and management for understory.

[3] Management actions include harvest of boughs and decorative tree tips.

[4] Management actions include on-site visit, re-inventory, and stands identified as High Risk Low Volume (HRLV) requiring field assessments to determine management direction (nearly all acres in this column fall under the HRLV activity). All stands meeting the HRLV stand pool criteria will be assigned a field visit prescription, whether in ERF or normal forest management areas. It is estimated that approximately half of these acres may result in timber harvest; others may result in a "natural conversion" to a different forest type.

Patches

Forest patches were considered in selecting stands for the seven-year list. Maintaining or increasing patch size was an integral aspect of stand selection. Often this was accomplished simply by selecting a stand for harvest situated between or adjacent to previously harvested stands. In other cases stands that were identified based on treatment criteria were not selected if they were part of a designated large old patch and could be held to a later date. See Appendix I for a summary of patch size determination and goals.

New Access Needs

All stands on the seven-year stand list were evaluated relative to the need for new access routes and whether or not access across federal lands was required. This was done in keeping with the strategic objective to minimize the miles of new roads. Existing access routes or previously used corridors of disturbance will be followed whenever feasible. All access route development, maintenance, reconstruction, and closure will follow the Voluntary Site-level Forest Management Guidelines developed by the MFRC.

A statewide policy on post-harvest management of forest access routes was under development when this step in the Mille Lacs Uplands SFRMP was being completed. As such, the identification and categorizing of new access routes in the Mille Lacs Uplands SFRMP may not have been totally consistent with the policy. The following guidelines are anticipated to be consistent with that policy and will be implemented in the Mille Lacs Uplands Subsection until statewide direction is in place. First, upon completion of timber sale activities, temporary access routes not anticipated to be needed over the next five -seven years would be abandoned. Second, access routes that will be needed intermittently will be designated "minimum maintenance roads" or "natural resource management routes." Depending upon location and other site-specific factors, these routes may be open to motorized vehicles or may have their access gated or controlled by other means. These routes will receive periodic inspection and maintenance as necessary to protect water quality.

No stands in the Mille Lacs Uplands Subsection will require a United States Department of Agriculture (USDA) Forest Service Road Use Permit to secure access for management. Nor will any USDA Forest Service Special-Use Permit to cross USDA Forest Service land via a national forest nonsystem road or new access route be needed.

The process for reporting road access needs in the SFRMP process was not complete at the time the Mille Lacs Uplands teams completed the stand examination list; however, area timber program foresters were surveyed to determine their anticipated access needs. None of the areas anticipated needing to construct additional access, reporting that there was adequate access to the selected stands using existing trails and winter roads. At a later time, a work group reviewed the data and determined that there are some situations where stands may not be served by an existing access route. Therefore, area teams will meet as part of the periodic review and update of the Mille Lacs SFRMP to identify the access routes for each selected stand. The access plan will completed as soon as possible and be added to the plan later as an addendum.

Appendix A. Seven-Year Stand Selection List

The following table identifies the stands selected for the Mille Lacs Uplands Subsection seven-year plan. The data fields are as follows:

- Area: The subsection has six primary DNR Forestry area offices – Aitkin, Brainerd, Cambridge, Cloquet, Little Falls, and Sandstone.
- Location ID: The unique number identifying the stand within a given township and range. The combination of twp/rge/rdir/stand provides the unique identifier for each stand.
- Sec / Twp / Rge: Legal description of the stand (section, township, and range).
- Cover type: The forest cover type assigned to the stand.
- Acres: Harvested or managed acres within the stand (total acres may be more).
- Age: Current age of the stand as of 2005.
- Preliminary Prescription: The proposed general action to be taken to achieve a desired management objective based on information available at the time of stand selection. This will be verified or revised based on a subsequent field visit. See glossary for definitions.
- Year: Fiscal Year (FY = July 1 through June 30). The FY when the stand examination is planned to be completed. If the stand evaluation finds the stand conditions suitable for timber harvest and a timber appraisal is completed, the estimated year the appraised timber will be offered for sale.

The stand list is available on-line at www.dnr.state.mn.us/forestry/subsection/millelacs

Appendix B. List of Selected Stands Containing White Pine

The following two tables identify the stands selected for the Mille Lacs Uplands Subsection 7-year plan that are either typed in the DNR forest inventory as white pine cover type (i.e, white pine is the predominant species by volume) or stands that contain white pine as a secondary species. The data fields are as follows:

- Area: The subsection has six primary DNR Forestry area offices – Aitkin, Brainerd, Cambridge, Cloquet, Little Falls, and Sandstone.
- Location ID: The unique number identifying the stand within a given township and range. The combination of twp/rge/rdir/stand provides the unique identifier for each stand.
- Sec / Twp / Rge: Legal description of the stand (section, township, and range).
- Cover type: The forest cover type assigned to the stand.
- Acres: Harvested or managed acres within the stand (total acres may be more).
- Age: Current age of the stand as of 2005.
- Preliminary Prescription: The proposed general action to be taken to achieve a desired management objective based on information available at the time of stand selection. This will be verified or revised based on a subsequent field visit. See glossary for definitions.
- Year: Fiscal Year (FY = July 1 through June 30). The FY when the stand examination is planned to be completed. If the stand evaluation finds the stand conditions suitable for timber harvest and a timber appraisal is completed, the estimated year the appraised timber will be offered for sale.

Table B.1. Stands With a White Pine Component on the Seven-Year Stand Examination List

Area	Location ID	Stand	Sec	Twp	Rng	Cover Type	Acres	Age	Preliminary Prescription	Year
Sandstone	t03919w1190121	121	19	39	19	Red pine	21	55	Commercial Thinning	2005
Sandstone	t03919w1200131	131	20	39	19	Jack pine	4	57	Clearcut with Reserves	2006
Sandstone	t03919w1300172	172	30	39	19	Lowland Hardwoods	50	103	On-Site Visit	2005
Sandstone	t03925w1050029	29	5	39	25	Red pine	17	33	Commercial Thinning	2006
Little Falls	t03926w1100188	188	10	39	26	White pine	8	45	On-Site Visit	2007
Sandstone	t04025w1310356	356	31	40	25	Aspen	9	64	High Risk Low Volume	2006
Sandstone	t04025w1360351	351	36	40	25	Oak	66	77	On-Site Visit	2006
Little Falls	t04026w1080036	36	8	40	26	Oak	7	98	Commercial Thinning	2007
Little Falls	t04027w1170104	104	17	40	27	Tamarack	10	82	Seed Tree	2005
Sandstone	t04116w1080072	72	8	41	16	Aspen	76	69	On-Site Visit	2007
Sandstone	t04116w1100083	83	10	41	16	Northern Hardwoods	12	84	Clearcut with Reserves	2007
Sandstone	t04117w1010020	20	1	41	17	Aspen	15	67	Reinventory	2007
Little Falls	t04125w1190622	622	19	41	25	Oak	32	78	Commercial Thinning	2006
Little Falls	t04125w1190286	286	19	41	25	Oak	22	69	Commercial Thinning	2006
Little Falls	t04125w1320533	533	32	41	25	Northern Hardwoods	4	88	Clearcut with Reserves	2006

Area	Location ID	Stand	Sec	Twp	Rng	Cover Type	Acres	Age	Preliminary Prescription	Year
Sandstone	t04217w1160006	6	16	42	17	Aspen	18	55	Clearcut with Reserves	2006
Sandstone	t04217w1160007	7	16	42	17	Aspen	3	55	Clearcut with Reserves	2006
Sandstone	t04217w1360166	166	36	42	17	Oak	33	62	Commercial Thinning	2005
Sandstone	t04222w1070011	11	7	42	22	Aspen	121	65	High Risk Low Volume	2006
Little Falls	t04225w1330094	94	33	42	25	Ash	6	132	Commercial Thinning	2006
Sandstone	t04317w1120131	131	12	43	17	Northern Hardwoods	21	70	Shelterwood	2006
Sandstone	t04317w1120162	162	12	43	17	Aspen	4	66	High Risk Low Volume	2006
Sandstone	t04320w1080033	33	8	43	20	Red pine	6	107	Commercial Thinning	2007
Sandstone	t04320w1360172	172	36	43	20	Aspen	56	66	Clearcut with Reserves	2007
Sandstone	t04320w1360175	175	36	43	20	Aspen	62	66	Clearcut with Reserves	2007
Sandstone	t04320w1360178	178	36	43	20	Aspen	21	66	Clearcut with Reserves	2007
Brainerd	t04328w1130096	96	13	43	28	Oak	5	78	Commercial Thinning	2006
Brainerd	t04328w1160015	15	16	43	28	Birch	23	77	Clearcut with Reserves	2006
Brainerd	t04328w1160098	98	16	43	28	Red pine	12	97	Commercial Thinning	2006
Sandstone	t04416w1050026	26	5	44	16	Balsam fir	19	95	Seed Tree	2006
Sandstone	t04416w1170272	272	17	44	16	Ash	111	145	Commercial Thinning	2006
Sandstone	t04416w1200390	390	20	44	16	Northern Hardwoods	4	80	Commercial Thinning	2005
Sandstone	t04416w1300464	464	30	44	16	Aspen	17	68	High Risk Low Volume	2006
Sandstone	t04417w1240261	261	24	44	17	Tamarack	6	82	Seed Tree	2006
Sandstone	t04417w1340418	418	34	44	17	Oak	5	77	Commercial Thinning	2006
Sandstone	t04417w1350417	417	35	44	17	Oak	19	77	Commercial Thinning	2006
Sandstone	t04420w1200051	51	20	44	20	Balsam fir	7	87	Seed Tree	2007
Sandstone	t04420w1200053	53	20	44	20	Balsam fir	5	83	Seed Tree	2007
Sandstone	t04420w1200054	54	20	44	20	Northern Hardwoods	11	88	Commercial Thinning	2007
Sandstone	t04421w1360055	55	36	44	21	Northern Hardwoods	33	76	Clearcut with Reserves	2007
Aitkin	t04425w1360082	82	36	44	25	Oak	37	97	Commercial Thinning	2006
Brainerd	t04428w1300111	111	30	44	28	Oak	17	84	Commercial Thinning	2006
Sandstone	t04516w1020035	35	2	45	16	Tamarack	5	97	Seed Tree	2005
Sandstone	t04516w1050068	68	5	45	16	Tamarack	29	91	Seed Tree	2006
Sandstone	t04516w1120139	139	12	45	16	Tamarack	6	80	Seed Tree	2005
Sandstone	t04516w1120147	147	12	45	16	Tamarack	7	80	Seed Tree	2005
Sandstone	t04516w1200313	313	20	45	16	Tamarack	14	121	Seed Tree	2006
Sandstone	t04516w1290507	507	29	45	16	Northern Hardwoods	6	80	Commercial Thinning	2006
Sandstone	t04517w1010043	43	1	45	17	Lowland Black Spruce	7	74	Clearcut with Reserves	2006
Sandstone	t04517w1210300	300	21	45	17	Tamarack	5	97	Seed Tree	2006
Sandstone	t04517w1360448	448	36	45	17	Ash	58	128	Commercial Thinning	2007
Sandstone	t04517w1360470	470	36	45	17	Tamarack	9	84	Seed Tree	2006
Aitkin	t04524w1240164	164	24	45	24	Red pine	8	37	Commercial Thinning	2005
Aitkin	t04526w1090168	168	9	45	26	White pine	5	49	Commercial Thinning	2005

Area	Location ID	Stand	Sec	Twp	Rng	Cover Type	Acres	Age	Preliminary Prescription	Year
Aitkin	t04526w1160148	148	16	45	26	Birch	53	50	Clearcut with Reserves	2005
Aitkin	t04527w1020185	185	2	45	27	Ash	62	130	Commercial Thinning	2011
Aitkin	t04527w1120022	22	12	45	27	Ash	31	130	Commercial Thinning	2011
Cloquet	t04619w1360009	9	36	46	19	Tamarack	4	103	Commercial Thinning	2005
Brainerd	t04629w1360068	68	36	46	29	Birch	35	59	Clearcut with Reserves	2006
Cloquet	t04815w1300021	21	30	48	15	Aspen	21	59	Reinventory	2006
Cloquet	t04817w1110151	151	11	48	17	Aspen	11	49	On-Site Visit	2006
Cloquet	t04817w1120019	19	12	48	17	Aspen	8	70	On-Site Visit	2006
Cloquet	t04916w1320077	77	32	49	16	Aspen	17	72	High Risk Low Volume	2005
Cloquet	t04917w1360054	54	36	49	17	Aspen	15	63	On-Site Visit	2005

Appendix C. Glossary

This glossary contains commonly accepted definitions for words used in forestry and natural resource management. Several that apply to sensitive topics were expressly referenced in the report.

Acre: An area of land containing 43,560 square feet, roughly the size of a football field, or a square that is 208 feet on a side. A "forty" of land contains 40 acres and a "section" of land contains 640 acres.

Age class: An interval, commonly 10 years, into which the age range of trees or forest stands is divided for classification or use.

Age-class distribution: The proportionate amount of various age classes of a forest or forest cover type within a defined geographic area (e.g., ECS subsection).

All aged: An uneven-aged stand that represents all ages or age classes, from seedlings to mature trees.

Annual work plan: The annual work responsibilities in a DNR Forestry area documented for the fiscal year.

Artificial regeneration: Renewal of a forest stand by planting seedlings or sowing seeds.

Assessment: A compilation of information about trends and conditions related to natural and socio-economic resources and factors. The initial round of SFRMPs will focus primarily on trends and conditions of forest resources. Standard core assessment information sources and products have been defined.

Balanced: As used in this document, for even-aged managed forest types, the condition in which there is a relatively equal number of acres in each 10-year age class out to rotation (final harvest) age. As a result of of applying the DNR ERF guideline, this balanced age-class distribution, as a DFFC, does not imply a truncating of age classes and therefore no old forest. The balanced age-class distribution DFFC language assumes future age-class distributions will include a "tail" of older forest maintained primarily through ERF management.

Basal area (BA): The cross-sectional area of a tree taken at 4.5 feet above the ground. BA is often used to measure and describe the density of trees within a geographic area using an estimate of the sum of the BA of all trees expressed per unit of land area (e.g., BA per acre).

Biodiversity (biological diversity): The variety and abundance of species, their genetic composition, and the communities and landscapes in which they occur, including the ecological structures, functions, and processes occurring at all of these levels.

Board feet: A unit of measuring wood volumes equaling 144 cubic inches. A board foot is commonly used to measure and express the amount of wood in a tree, sawlog, veneer log, or individual piece of lumber. For example, a 16-inch DBH standing tree that is 80 feet tall contains approximately 250 board feet of wood; a tree with a 30-inch DBH that is 80 feet tall contains about 1,000 board feet or one thousand board foot (MBF). A piece of lumber 1 foot by 1 foot by 1 inch contains one board foot of lumber.

Clear-cut: The removal of all or most trees during harvest to permit the reestablishment of an even-aged forest. This harvest method is used to regenerate shade-intolerant species such as aspen and jack pine.

Coarse filter: The management of lands from a local to landscape scale that addresses the needs of all or most species, communities, environments, and ecological processes. Use of a coarse-

filter approach (Wildlife, forests, and forestry: principles of managing forests for biological diversity, Malcolm Hunter, 1990), assumes that a broad range of habitats encompassing the needs of most species will be met and their populations will remain viable on the landscape.

Competition: The struggle between trees to obtain sunlight, nutrients, water, and growing space. Every part of the tree, from the roots to the crown, competes for space and food.

Connectivity: An element of spatial patterning in which patches of vegetation such as forest types, native plant communities, or wildlife habitats are connected to allow the flow of organisms and processes between them.

Conversion: A change through forest management from one tree species to another within a forest stand or site.

Cooperative stand assessment (CSA): The forest stand mapping and information system the DNR uses to inventory the approximately 5 million acres (7,800 square miles) owned and administered by the state. The spatial information and stand attributes are maintained in the Forest Inventory Module (FIM).

Cord: A pile of wood four feet high, four feet wide, and eight feet long, measuring 128 cubic feet, including bark and air space. Actual volume of solid wood may vary from 60 to 100 feet cubic feet, depending on size of individual pieces and how tightly the wood is stacked. In the Lake States, pulpwood cords are usually four feet by four feet by 100 feet and contain 133 cubic feet. Pulpwood volume of standing trees is estimated in cords. For example, a 10-inch DBH tree that is 70 feet tall is about 0.20 cords; five trees of this size would equal one cord.

Corridor: A defined tract of land connecting two or more areas of similar habitat type through which wildlife species can travel.

Cover type: The tree species having the greatest presence (volume for older stands, number of trees for younger stands) in a forest stand. A stand in whic the major species is aspen would be called an aspen cover type.

Cover-type distribution: The location and/or proportionate representation of cover types in a forest or geographic area.

Critical habitat: Habitat or habitat elements that must be present and properly functioning to assure the continued existence of the species in question.

Crop tree: A tree selected or retained to be a component of a future commercial harvest.

Cubic foot: A wood volume measurement containing 1,728 cubic inches, such as a piece of wood measuring one foot on a side. A cubic foot of wood contains approximately six to 10 usable board feet of wood. A cord of wood equals 128 cubic feet.

Desired future forest composition (DFFC): A broad vision of landscape vegetation conditions in the long-term future. For the purposes of the initial round of subsection planning, DFFCs will focus on future desired forest composition looking ahead 50 years. DFFCs may include aspects such as 1) the amount of various forest cover types within the subsection, 2) the age-class distribution of forest cover types, 3) the distribution of forest cover types across the subsection and the related level of management for even-aged forest, and 4) ERF.

Disturbance: Any event, either natural or human induced, that alters the structure, composition, or functions of an ecosystem. Examples include forest fires, insect infestation, windstorms, and timber harvesting.

Disturbance regime: Natural or human-caused pattern of periodic disturbances such as fire, wind, insect infestations, or timber harvest.

Dominant trees: Trees that are in the upper layer of the forest canopy, larger than the average trees in the stand.

Early successional forest: The forest community that develops immediately following removal or destruction of vegetation in an area. Plant succession is the progression of plants from bare ground (e.g., after a forest fire or timber harvest) to mature forest consisting primarily of long-lived species such as sugar maple and white pine. Succession consists of a gradual change of plant and animal communities over time. Early successional forests commonly depend on and develop first following disturbance events (e.g., fire, windstorms, or timber harvest). Examples of early successional forest tree species are aspen, paper birch, and jack pine. Each stage of succession provides different benefits for a variety of species.

Ecological classification system (ECS): A method to identify, describe, and map units of land with different capabilities to support natural resources. This is done by integrating climatic, geologic, hydrologic, topographic, soil, and vegetation data.

Ecological integrity: The degree, in general, to which the elements of biodiversity and the processes that link them together and sustain the entire system are complete and capable of performing desired functions. Exact definitions of integrity are relative and may differ depending on the type of ecosystem being described.

Ecologically important lowland conifers (EILC): Stands of black spruce, tamarack, and cedar, including stagnant lowland conifer stands, that are examples of high-quality lowland conifer NPCs. Designated EILC stands will be reserved from treatment during this 10-year planning period. Future management/designation of these stands is yet to be determined.

Endangered species: A plant or animal species that is threatened with extinction throughout all or a significant portion of its range in Minnesota.

Even aged: A forest stand composed of trees of primarily the same age or age class. A stand is considered even aged if the difference in age between the youngest and oldest trees does not exceed 20 percent of the rotation age (e.g., for a stand with a rotation age of 50 years, the difference in age between the youngest and oldest trees should be 10 years).

Exotic species: Any species, including its seeds, eggs, spores, or other biological material capable of propagating the species, that is not native to an ecosystem, and whose introduction does or is likely to cause economic or environmental harm or harm to human health.

Extended rotation forest (ERF): A forest stands for which harvest age is extended beyond the normal or economic harvest age. ERF provides larger trees, old-forest wildlife habitat, and other nontimber values. Additional detail regarding management of ERF on DNR-administered lands is contained in the DNR ERF Guidelines (1994). **Prescribed ERF** is the cover-type acreage designated for management as ERF. Stands designated as ERF will be held beyond the recommended normal rotation (harvest) age out to the established ERF rotation age(s). A stand of any age can be prescribed as ERF. **Effective ERF** is defined as the portion of the prescribed ERF acreage that is actually over the normal rotation age for the cover type at any one time.

Fine filter: Management that focuses on the welfare of a single or only a few species (e.g., For individual nests, colonies, and habitats) rather than the broader habitat or ecosystem. A fine-filter approach (Hunter, 1990) considers the specific habitat needs of selected individual species that may not be met by the broader coarse-filter approach.

Forest inventory and analysis (FIA): A statewide forest survey of timber lands jointly conducted by the DNR and the USFS that periodically, through a system of permanent plots, assesses the current status of, and monitors recent trends in, forest area, volume, growth, and removals.

Forest Inventory Module (FIM): The FIM provides a database and application through which field foresters can maintain an integrated and centralized inventory of the forests on publicly owned lands managed by the DNR. In the field, foresters collect raw plot and tree data. Those data are summarized in stand-level data that are linked to a spatial representation of stand boundaries. FIM is part of the DNR's Forestry Information System (FORIST).

Forest land: All lands included in the forest inventory, from aspen and pine cover types to stagnant conifers, muskeg, lowland brush, and lakes.

Forest management: The practical application of biological, physical, quantitative, managerial, economic, social, and policy principles to the regeneration, management, use, and conservation of forests to meet specified goals and objectives while maintaining the productivity of the forest. Forest management includes management for aesthetics, fish, recreation, urban values, water, wilderness, wildlife, wood products, and other forest resource values.

Forest road: A temporary or permanent road connecting remote parts of a forest to existing public roads. Forest roads provide access to public land for timber management, fish and wildlife habitat improvement, fire control, and recreation. The Division of Forestry has three classifications for roads and access routes: system roads, minimum maintenance roads, resource management access routes, and temporary access routes.

Forest stand: A group of trees occupying a given area and sufficiently uniform in species composition, age, structure, site quality, and condition so as to be distinguishable from the forest on adjoining areas.

Forestry Information System (FORIST): The Forestry Information System (FORIST) is a collection of integrated spatial applications software and data sets supporting day-to-day operations across the Division of Forestry. The first two parts of the system are in operation: Forest Inventory Module (FIM) and Silviculture and Roads Module (SRM). A Timber Sales Module is scheduled to be operational in 2006.

Fragmentation: The breakup of large and contiguous ecosystems into patches separated from each other by different ecosystem types; the breakup of a contiguous or homogeneous natural habitat through conversion to different vegetation types, age classes, or uses. **Forest fragmentation** occurs in landscapes with distinct contrasts between land uses, such as between woodlots and farms. **Habitat fragmentation** occurs where a contiguous or homogeneous forest area of a similar cover type and age is broken up into smaller, dissimilar units. For example, a conifer-dominated forest (or portion of it) is fragmented by clear-cutting if part of it is converted to another type, such as an aspen-dominated forest.

Game species: In this plan, terrestrial species that are hunted and trapped.

Gap: The space occurring in forest stands when individual trees or groups of trees die or blow down. **Gap management** uses timber harvest to emulate this type of forest spatial pattern.

Geographic information system (GIS): Computer software used to manipulate, analyze, and visually display inventory and other data and prepare maps from them.

Group selection: A process of harvesting patches of selected trees to create openings in the forest canopy and encourage reproduction of uneven-aged stands.

Growth stage: As presented in *Field Guide to the Native Plant Communities of Minnesota: The Laurentian Mixed Forest Province,* periods of stand maturation when the mixture of trees in the canopy is stable. Growth stages are separated by periods of transition, in which tree mortality is high and differs among species, usually involving the death of early successional species and replacement by shade-tolerant or longer-lived species.

Habitat: An area in which a specific plant or animal normally lives, grows, and reproduces; the area that provides a plant or animal with adequate food, water, shelter, and living space.

High risk/low volume (HRLV): Stands with one or more of the following traits: 1) stands coded as high risk in CSA forest inventory, 2) stands with significant insect or disease damage to the main species in the stand, 3) stands over normal rotation age at the time of survey with a total stand volume less than or equal to eight cords per acre (low volume), 4) or very old stands, e.g., aspen over 80 years old.

Landform: Any physical, recognizable form or feature of the earth's surface having a characteristic shape and produced by natural causes. Examples of major landforms are plains, plateaus, and mountains. Examples of minor landforms are hills, valleys, slopes, eskers, and dunes. Together, landforms make up the surface configuration of the earth. The "landform" concept involves both empirical description of a terrain (land-surface form) class and interpretation of genetic factors ("natural causes").

Landscape: A general term referring to geographic areas that are usually based on some sort of natural feature or combination of natural features. They can range in scale from very large to very small. Examples include watersheds (from large to small), the many levels of the ECS, and MFRC regional landscapes. The issue being addressed usually defines the type and size of landscape to be used.

Landscape region: A geographic region defined by similar landforms, soils, climatic factors, and potential native vegetation. The landscape region used for this planning effort is the subsection level of the ECS.

Leave trees: Live trees selected to remain on a site to provide present and future benefits, such as shelter, resting sites, cavities, perches, nest sites, foraging sites, mast, and coarse woody debris.

Legacy patch: An area within a harvest unit that is excluded from harvest; this area is representative of the site and is to maintain a source area for recolonization, gene pool maintenance, and establishment of microhabitats for organisms that can persist in small patches of mature forest.

Managed acres: Timberland acres available for timber management purposes.

Management pool: In this plan, the acres available for timber management purposes.

Mast: Nuts, seeds, catkins, flower buds, and fruits of woody plants that provide food for wildlife.

Marketable timber: Merchantable timber that is accessible now.

Mature tree: A tree that has reached the desired size or age for its intended use. Size and age will vary considerably depending on the species and the intended use.

Merchantable timber: Trees or stands having the size, quality, and condition suitable for marketing under a given economic condition, even if not immediately accessible for logging.

Mesic: Moderately moist.

Minimum maintenance road: A state forest road used for forest management access on an intermittent, as-needed basis. Minimum maintenance roads generally remain open to motorized vehicles. They are not maintained to the level where low-clearance licensed highway vehicles can travel routinely on them. The travel surface may be graveled or may be of native soils. These roads are graded and graveled as needed for forest management purposes.

Mixed forest conditions: In this plan, refers to vegetative composition and structure moving toward the mix and relative proportion (e.g., dominated by, common, occasional, or scattered) of species found in the native plant community for that site. Tree species mix and proportion depends not only on the targeted growth stage (based on the rotation age for the desired cover type) but also species found in older growth stages.

Mixed forest or stand: A forest or stand composed of two or more prominent species.

Mortality: Death or destruction of forest trees as a result of competition, disease, insect damage, drought, wind, fire, or other factors.

Multiaged stand: A stand with two or more age classes.

Multiple use: Using and managing a forested area to provide more than one benefit simultaneously. Common uses may include wildlife, timber, recreation, and water quality..

Native plant community (NPC): A group of native plants that interact with each other and with their environment in ways not greatly altered by modern human activity or by introduced organisms. These groups of native plants form recognizable units, such as an oak forest, prairie, or marsh, that tend to reoccur over space and time. Native plant communities are classified and described by physiognomy, hydrology, landforms, soils, and natural disturbance regimes (e.g., wildfires, windstorms, normal flood cycles).

Natural disturbances: Disruption of existing conditions by natural events such as wildfires, windstorms, drought, flooding, insects, and disease. The scale may range from one tree to thousands of acres.

Natural regeneration: The growth of new trees from one of the following: (a) seeds naturally dropped from trees or carried by wind or animals, (b) seeds stored on the forest floor, or (c) stumps that sprout or roots that sucker.

Nonforest land: Land that has never supported forests and land formerly forested where use for timber management is precluded by development for other uses such as crops, improved pasture, residential areas, city parks, improved roads, and power-line clearings.

Nongame species: In this plan, nongame species include amphibians, reptiles, and those mammal and bird species that are not hunted or trapped.

Normal rotation age: For even-aged managed cover types, the rotation age set by the SFRMP team for non-ERF timberland acres. It is based on the culmination of MAI (CMAI), other data related to forest productivity that also consider wood quality, and local knowledge.

Old forest: A forest stand of any particular forest cover type whenever its age exceeds the normal rotation age established by the landscape team for that cover type. In this plan, it does not include designated old growth, state park lands, SNAs, and other state forest lands that are reserved from timber harvest.

Old-forest conditions: Forest that has the age and structural conditions typically found in mature to very old forests, such as large-diameter trees, large snags, downed logs, mixed species composition, and greater structural diversity. Old-forest conditions typically develop at stand ages greater than the normal rotation ages identified for even-aged managed forest cover types.

Old-growth forests: Forests defined by age, structural characteristics, and relative lack of human disturbance. Old-growth forests are essentially free from catastrophic disturbances, contain old trees (generally over 120 years old), large snags, and downed trees. Additional details on the management of old-growth forests on DNR-administered lands are contained in the 1994 Old-Growth Guidelines.

Overmature: A tree or even-aged stand that has reached an age at which it is declining in vigor and health and reaching the end of its natural life span resulting in a reduced commercial value because of size, age, decay, and other factors.

Overstocked: The situation in which trees are so closely spaced that they are competing for resources, resulting in less than full growth potential for individual trees.

Overstory: The canopy in a stand of trees.

Partial cut: A cutting or harvest of trees where only some of the trees in a stand are removed.

Patch: An area of forest that is relatively homogeneous in structure, primarily in height and stand density, and differs from the surrounding forest. It may be one stand or a group of stands.

Plantation: A stand composed primarily of trees established by planting or artificial seeding.

Prescribed burn: A deliberate burn of wild lands (e.g., forests, prairie or savanna) in either their natural or modified state and under specified conditions within a predetermined area to meet management objectives for the site; a fire ignited under known conditions of fuel, weather, and topography to achieve specific objectives.

Prescription: A planned treatment (clear-cut, selective harvest, thin, reforest, reserve, etc.) designed to change current stand structure to one that meets management goals. A written statement that specifies the practices to be implemented in a forest stand to meet management objectives. These specifications reflect the desired future condition at the site and landscape level and incorporate knowledge of the special attributes of the site.

Pulpwood: Wood cut or prepared primarily for manufacture into wood pulp or chips, for subsequent manufacture into paper, fiberboard, or chipboard. Generally, trees 5 to 12 inches DBH are used.

Pure stand: An area or stand composed principally of one species, conventionally at least 80 percent, based on numbers, BAs, or volumes.

Range of natural variation (RNV): The expected range of conditions (ecosystem structure and composition) to be found under naturally functioning ecosystem processes (natural climatic fluctuations and disturbance cycles such as fire and windstorms). RNV provides a benchmark (range of reference conditions) to compare with current and potential future ecosystem conditions.

Rare Features Database is maintained by the Natural Heritage and Nongame Research Program and is comprised of locational records of the following features:

- ***Rare plants.*** Species listed as federally endangered, threatened, or as candidates for federal listing; all species state listed as endangered, threatened, or special concern. Several rare species are also tracked currently have no legal status but need further monitoring to determine their status.
- ***Rare animals.*** Species listed as federally endangered or threatened (except the gray wolf) are tracked, as well as all birds, small mammals, reptiles, amphibians, mussels, and butterflies listed as state endangered, threatened, or of special concern.
- ***Natural communities***. Functional units of landscape that are characterized and defined by their most prominent habitat features - a combination of vegetation, hydrology, landform, soil, and natural disturbance cycles. Although natural communities have no legal protection in Minnesota, the Natural Heritage Program, Nongame Research Program, and the Minnesota County Biological Survey have evaluated and ranked

community types according to their relative rarity and endangerment throughout their range. Locations of high-quality examples are tracked in the Rare Features Database.

- ***Geologic features***. Noteworthy examples of geologic features throughout Minnesota are tracked if they are unique or rare, extraordinarily well preserved, widely documented, highly representative of a certain period of geologic history, or very useful in regional geologic correlation.
- ***Animal aggregations***. Certain types of animal aggregations, such as nesting colonies of waterbirds (herons, egrets, grebes, gulls and terns), bat hibernacula, prairie chicken booming grounds, and winter bald eagle roosts are tracked regardless of the legal status of the species that comprise them. The tendency to aggregate makes these species vulnerable because a single catastrophic event could result in the loss of many individuals.

Rare species: A plant or animal species that is designated as endangered, threatened, or a species of special concern by the state of Minnesota (including all species designated as endangered or threatened at the federal level), or an uncommon species that does not (yet) have an official designation, but whose distribution and abundance need to be better understood.

Regeneration: The act of renewing tree cover by establishing young trees naturally (e.g., stump sprouts, root suckers, natural seeding) or artificially (e.g., tree planting, seeding).

Regional landscapes: The MFRC divided Minnesota into eight regional landscapes based on ecological, socioeconomic, and administrative factors. These landscapes form the basis for planning and coordination across all forest ownerships. The subsections included in this plan are in the MFRC Northeast Region.

Regulated: Refers to forest growing stock organized and controlled for a desired and sustainable yield of forest products. Age and size classes of trees are generally represented in a relatively equal proportion, and are growing at rates through which an approximately equal annual yield of products is obtained indefinitely. This can be equal amounts in all age classes, but it doesn't have to be. The age class distribution proposed in this plan for types managed primarily under even-aged systems has relatively equal acres for age classes up to normal rotation age, then declining acres in age-classes out to the extended or maximum rotation age.

Release: Free a tree or group of trees from competition that is overtopping or closely surrounding it.

Resource management access route: A route used only for forest management access on an intermittent, as-needed basis. Resource-management routes are of similar or lesser character than minimum-maintenance roads and are gated or otherwise closed to public use.

Riparian area: The area of land and water forming a transition from aquatic to terrestrial ecosystems along streams, lakes, and open water wetlands.

Riparian management zone (RMZ): The portion of a riparian area where site conditions and landowner objectives are used to determine management activities that address riparian resource needs. It is the area where riparian guidelines apply.

Rotation age: The period of years between when a forest stand (primarily even-aged) is established (regeneration) and when it receives its final harvest. This time period is an administrative decision based on economics, site condition, growth rates, and other factors.

Sapling: A tree that is one to five inches DBH.

Sawlog: A log large enough to produce lumber or other products that can be sawed. Its size and quality vary with the utilization practices of the region.

Sawtimber: Trees that yield logs suitable in size and quality for the production of lumber.

Scarify: To break up the forest floor and topsoil preparatory to natural regeneration or direct seeding.

Scientific and natural area (SNA): An area established by the DNR Division of Ecological Services to preserve natural features and rare resources of exceptional scientific and educational value.

Seedbed: The soil or forest floor on which seed falls.

Seed tree: Any tree that bears seed; specifically, a tree left standing to provide the seed for natural regeneration.

Selective harvest: A management option used for shade-tolerant specie in which single scattered trees or small groups of trees are removed at relatively short intervals. The continuous establishment of reproduction is encouraged and an all-aged stand is maintained.

Shelterwood harvest: A harvest cutting in which trees are removed in a series of two or more cuttings to allow the establishment and early growth of new seedlings under partial shade and protection of older trees. Shelterwood harvest produces an even-aged forest.

Silviculture: The art and science of establishing, growing, and tending stands of trees; the theory and practice of controlling the establishment, composition, growth, and quality of forest stands to achieve desired conditions or management objectives.

Silviculture and Roads Module (SRM): A database and application through which field foresters can record planned and actual forest development prescriptions (e.g., site preparation, tree planting projects, timber harvest, road maintenance) and follow-up surveys on publicly owned lands managed by the Division of Forestry and other divisions. SRM supports the geographic description of the extent of a development project separate from FIM stand boundaries. A variety of maps and other reports can be generated by the module. SRM will also produce maps and reports that roll up DNR Forestry area data to the regional or stateRM is part of FORIST.

Site index (SI) : A species-specific measure of actual or potential forest productivity or site quality, expressed in terms of the average height of dominant trees at specific key ages (usually 50 years in the eastern United States).

Site preparation: Treatment of a site (e.g., hand or mechanical clearing, prescribed burning, or herbicide application) to prepare it for planting or seeding and to enhance the success of regeneration.

Site productivity: The relative capacity of a site to sustain a production level over time; the rate at which biomass is produced per unit area (e.g., cords per acre growth of timber).

Size class: A category of trees based on diameter class. The DNR's forest inventory has size classes such as 1 = 0–0.9 inches diameter; 2 = 1–2.9 inches; 3 = 3–4.9 inches; 4 = 5–8.9 inches; 5 = 9–14.9 inches. Size classes also may be broken down as as seedling, sapling, pole timber, and sawtimber.

Slash: The unused and generally unmarketable accumulation of woody material (e.g., limbs, tops, cull logs, and stumps) that remains in the forest after timber harvesting.

Snag: A standing dead tree.

Soil productivity: The capacity of soils in their normal environment to support plant growth.

Special concern species: A plant or animal species that is extremely uncommon in Minnesota or has unique or highly specific habitat requirements and deserves careful monitoring. Species on the periphery of their ranges may be included in this category, as well as species that were once threatened or endangered but now have increasing or stable and protected populations.

Special management zone (SMZ): A buffer immediately surrounding designated old-growth forest stands. It is intended to minimize edge effects and windthrow damage to old-growth stands. Minimum width is 330 feet from the edge of the old-growth stand. Timber harvest is allowed in the SMZ, but there are limits on how much can be clear-cut at any given time.

Stand: A contiguous group of trees similar in age, species composition, and structure, and growing on a site of similar quality, to be a distinguishable forest unit. A forest is composed of many stands. A **pure stand** is composed of essentially a single species (e.g., a red pine plantation). A **mixed stand** is composed of a mixture of species (e.g., a northern hardwood stand consisting of maple, birch, basswood, and oak). An **even-aged stand** is one in which all of the trees are essentially the same age, usually within 10 years of age for aspen and jack pine stands. An **uneven-aged stand** is one in which a variety of ages and sizes of trees are growing together on a uniform site (e.g., a northern hardwood stand with three or more age classes).

Stand age: In the DNR's forest inventory, the average age of the main species within a stand.

Stand density: A measure of the amount of trees or wood per unit area. Density usually is evaluated in terms of BA, numbers of trees, volume, or percent crown cover.

Stand examination list: DNR forest stands to be considered for treatment (e.g., harvest, thinning, regeneration, prescribed burning, reinventory) over the planning period based on established criteria (e.g., rotation age, SI, BA, desired future cover-type composition,). These stands will be assigned preliminary prescriptions and most will receive the prescribed treatment. However, prescriptions may change for some stands because of new information on the stand gathered during a field visit.

Stand selection criteria: Criteria used to help identify stands to be treated as determined by the subsection team. Criteria will likely be based on factors such as rotation ages, SI, BA, cover-type composition, understory composition, and location. Factors considered in developing stand selection criteria will include 1) desired forest composition goals, 2) timber growth and harvesting, 3) old-growth forests, 4) extended and normal-rotation forests, 5) riparian areas, 6) wildlife habitat, 7) age and cover-type distributions, 8) regeneration, 9) thinning, and 10) prescribed burning needs.

State forest road: Any permanent road constructed, maintained, or administered by the DNR for the purposes of accessing or traversing state forest lands.

Stocking: An indication of the number of trees in a stand relative to the desirable number for best growth and management (e.g., well-stocked, overstocked, partially stocked); a measure of the proportion of an area actually occupied by trees.

Strategic planning: A process to plan for desired future states. Strategic planning includes aspects of a plan or planning process that provide statements and guides for future direction. The geographic, programmatic, and policy focus can range from very broad and general to more specific. Strategic planning is usually long term (at least five years, often longer). It usually includes an assessment of current trends and conditions (e.g., social, natural resource), opportunities, and threats; identification of key issues; and the resulting development of goals (e.g., desired future conditions), strategies, and objectives. Vision and mission statements may also be included.

Stumpage: The value of a tree as it stands in the forest uncut; uncut trees standing in the forest.

Stumpage price: The value a timber appraiser assigns to standing trees, or the price a logger or other purchaser is willing to pay for timber as it is in the forest.

Subsection: One level within the ECS. From largest to smallest in terms of geographic area, the ECS is composed of the following levels: province, section, subsection, land type association, land type, land type phase. Subsections areas are generally 1 to 4 million acres in Minnesota, with the average being 2.25 million acres. Seventeen subsections are scheduled for the SFRMP process.

Subsection forest resource management plan (SFRMP): A DNR plan for vegetation management on forest lands administered by DNR divisions of Forestry and Fish and Wildlife that uses ECS subsections as the basic unit of delineation. Initial focus is to identify forest stands and road access needs during the 10-year plan. There is potential to be more comprehensive in the future.

Succession: The natural replacement, over time, of one plant community with another.

Sucker: A shoot arising from below ground level from a root. Aspen regenerates from suckers.

Suppressed: The condition of a tree characterized by low growth rate and low vigor due to competition from overtopping trees or shrubs.

Sustainability: The ability to protect and restore the natural environment while enhancing economic opportunity and community well-being. Sustainability addresses three related elements: the environment, the economy, and the community. The goal is to maintain indefinitely all three elements in a healthy state. Something is sustainable if it meets the needs of the present without compromising the ability of future generations to meet their own needs.

System road: A major state forest road that provides forest management and recreational access. It may be connected to state, county, or township public road systems. System roads are used at least weekly and often daily. They are generally gravel-surfaced, and are maintained to allow travel by licensed highway vehicles.

Temporary access route: An access route on state forest land not fitting the definition of minimum maintenance road or temporary access road. A temporary access route has to be abandoned and the site reclaimed so evidence of a travel route is minimized. The level of effort needed to effectively abandon temporary accesses will vary depending on location (e.g., swamp/winter vs. upland route), remoteness, and recreational use pressures.

Thermal cover: A habitat component (e.g., white cedar, balsam fir, or jack pine stand) that provides wildlife protection from the cold in winter and heat in summer; vegetative cover used by animals against the weather.

Thinning: A silvicultural treatment made to reduce the density of trees in a forest stand primarily to improve growth, enhance forest health, or recover potential mortality. **Row thinning** is where selected rows are harvested (usually the first thinning), providing equipment operating room for future selective thinnings. **Selective thinning** is where individual trees are marked or specified (e.g., by diameter, spacing, or quality) for harvest. **Commercial thinning** is thinning after the trees are of merchantable size for timber markets. **Precommercial thinning** is done before the trees reach merchantable size, usually in overstocked (very high density in terms of stems per acre) stands, to provide more growing space for crop trees that will be harvested in future years.

Threatened species: A plant or animal species that is likely to become endangered within the foreseeable future throughout all or a significant portion of its range in Minnesota.

Timber productivity: The quantity and quality of timber produced on a site; the rate at which timber volume is produced per unit area over a period of time (e.g., cords per acre per year). The relative capacity of a site to sustain a level of timber production over time.

Timber stand improvement (TSI): A practice in which the quality of a residual forest stand is improved by removing less desirable trees and large shrubs to achieve the desired stocking of the best trees or to improve the reproduction, composition, structure, condition, and volume growth of a stand.

Timberland: Forest land capable of producing timber of a marketable size and volume at the normal harvest age for the cover type. It does not include lands withdrawn from timber utilization by statute (e.g., BWCAW) or administrative regulation such as designated old-growth forest and state parks. On state forest lands timberland includes stands that can produce at least three cords per acre of merchantable timber at the normal harvest age for the cover type. It does not include very low productivity sites such as those classified as stagnant spruce, tamarack, and cedar, off-site aspen, or nonforest land.

Tolerant: A plant cable of becoming established and growing beneath overtopping vegetation; a tree or seedling capable of growing in shaded conditions.

Two-aged stand: A stand with trees of two distinct age class separated in age by more than 20 percent of the rotation age.

Underplant: To plant seedlings under an existing canopy or overstory.

Understory: The vegetation (shrubs, seedlings, saplings, small trees) in a forest stand that forms a layer between the overstory and the herbaceous plants of the forest floor.

Uneven-aged management: Forest management that results in forest stands composed of intermingling trees or small groups having three or more distinct age classes. Uneven-aged management is best suited for shade-tolerant species.

Uneven-aged stand: A stand of trees of a variety of ages and sizes growing together on a uniform site; a stand of trees with three or more distinct age classes.

Vegetation growth stage: The vegetative condition of an ecosystem resulting from natural succession and natural disturbance, expressed as vegetative composition, structure, and years since disturbance. The vegetation growth stage describes both the successional changes (i.e., the change in the presence of different tree species over time) and developmental changes (i.e., the change in stand structure over time due to the regeneration, growth, and mortality of trees). Vegetation growth stages express themselves along the successional pathways for a particular ecosystem depending on the type and level of natural disturbance that has occurred. Forest tree and other vegetation composition, habitat features, and wildlife use change with the various growth stages.

Vegetation management plan: A management plant that includes many decisions and considerationsbeyond what timber will be cut (i.e., broader than timber management). This includes designation of old growth, ERFs, riparian areas, DFFC, and visually sensitive travel corridors, all of which are intended to address wildlife habitat, biodiversity, aesthetic, and other concerns. Prescriptions assigned to stands reflect decisions based on multiple considerations and are broader than decisions relative to final harvest (e.g., ERF designation, uneven-aged management, thinning, regeneration, underplanting, prescribed burning).

Viable population: The number of individuals of a species sufficient to ensure the long-term existence of the species in natural, self-sustaining populations that are adequately distributed throughout their range.

Volume: The amount of wood in a tree or stand according to some unit of measurement (board feet, cubic feet, cords), or some standard of use (pulpwood, sawtimber, etc.).

Well stocked: The situation in which a forest stand contains trees spaced widely enough to prevent competition, yet closely enough to use the entire site.

Wildlife management area (WMA): Areas established by the Department of Natural Resources, Division of Wildlife, to manage, preserve, and restore natural communities, perpetuate wildlife populations, and provide recreational and educational opportunities.

Windthrow: A tree pushed over by the wind. Windthrows are more common among shallow-rooted species.

Appendix D: Acronyms

Area Forest Resource Management Plan	(AFRMP)
Commissioner's Management Team	(CMT)
Cooperative Stand Assessment	(CSA)
Department of Natural Resources	(DNR)
Desired Future Forest Conditions	(DFFCs)
Director's Management Team	(DMT)
Ecological Classification System	(ECS)
Endangered, Threatened, or Special Concern	(ETS)
Extended Rotation Forestry	(ERF)
Forest Inventory Module	(FIM)
Forest Resource Issues Team	(FRIT)
Gap Analysis Program	(GAP)
Geological Information Systems	(GIS)
High Risk/Low Volume	(HRLV)
Land Type Association	(LTA)
Mean Annual Increment	(MAI)
Minnesota Association of County Land Commissioners	(MACLC)
Minnesota County Biological Survey	(MCBS)
Minnesota Forest Resource Council	(MFRC)
Minnesota Forest Resource Plan	(MFRP)
Off-Highway Vehicles	(OHV)
Range of Natural Variability	(RNV)
Regional Management Team	(RMT)
Research Natural Areas	(RNAs)
Scientific and Natural Areas	(SNAs)
Subsection Forest Resource Management Plan	(SFRMP)
Timber Management Plan	(TMP)
Timber Management Plan Information System	(TMPIS)
Wildlife Management Areas	(WMAs)

Appendix E. Responses to Public Comments on Issues/Assessment Document

The following lists all the issues identified during the public comment period during Step 2 of the planning process. Comments are grouped under the issue to which they relate.

Issue: How can DNR resource managers retain the ability to use a variety of forest management tools?

Comments:

- Too frequent and ill-advised prescribed burns result in loss of valued tree and herbaceous species on state land.
- Foresters lack skill in reforestation techniques. I know of a site where multiple reforestation efforts have been unsuccessful. I would like a cost/benefit analysis.

Response:

Increased use of native plant community classifications (eventually on all sites prior to management) will help foresters choose the most appropriate management strategy for a given site and will reduce the incidence of ineffective and costly management efforts. These classifications will provide guidance about communities that are fire dependent, or not, and their use will increase the likelihood of successful use of fire and other *regeneration* tools.

Issue: How can DNR resource managers ensure an appropriate distribution of forest types across the subsection?

Comments:

- Conversion of mixed hardwood stands to aspen is a concern; it is perceived as a concession to industry and a failure to invest in long term forest improvement.
- Overly aggressive thinning of hardwood stands results in poor form of residual trees and a loss of herbaceous vegetation from the understory.
- Site by site management decisions result in a lack of long term planning at the landscape scale.
- The plan should emphasize restoration of pine, especially white pine, to some reasonable fraction of the presettlement condition.
- Birch, basswood, and white cedar resources for the future, on a variety of sites, are a concern for Mille Lacs Band of Ojibwe resource managers.
- I am concerned about special concern species like butternut; would like to see specific management plans in place for these.

Response:

Desired future composition goals address each of the forest types of concern. Birch and butternut received special management recommendations due to these comments.

Issue: How can DNR resource managers plan for adequate distribution of age classes across the landscape?

Comments:

- The Department of Natural Resources (DNR) Division of Forestry has sold logging rights to almost our entire township. We are being left with almost nothing but dense, immature poplar where once great forests stood. Please do not allow indiscriminate logging of every piece of land the DNR controls. Can't you leave something?
- A distribution of forest ages is required for the variety of products traditionally made from birch and to provide various herbs and forbs for traditional use by the Mille Lacs Band of Ojibwe.
- Lands administered by the DNR should be managed with more attention to insect and disease problems (leaving old trees promotes these).Response:

Response:

The Minnesota DNR is committed to managing state forest land in ways that will achieve a balanced *age-class distribution* in forest types managed under *even-age* systems (e.g., aspen, jack pine, black spruce, birch) and to move the forest toward a desirable mix of forest types (e.g., decreasing aspen; increasing birch, northern hardwoods, and white cedar). Decisions related to these goals in the planning process include number of *acres* to maintain or convert to other forest types, appropriate ages of harvest, and identification of areas appropriately managed under *extended rotation forest* (ERF) *prescriptions*.

Old-growth forests are also identified and protected under these management scenarios, i.e., the Subsection Forest Resource Management Plans (SFRMPs). These subsections have approximately 2,000 *acres* of designated old-growth forest in protected status.

The models developed for species managed using even-age management prescriptions will help us predict future age-class distribution of these types across the landscape. This should help identify and mitigate current and future age-class imbalances.

Issue: How can DNR resource managers improve the productivity of DNR-administered timberlands?

Comments:

- Overly aggressive thinning of hardwood stands has been done to the detriment of residual trees.
- My goal is to see a healthy, diverse forest producing a sustainable timber yield and meeting the needs of recreational users in fifty years.
- I want to see productive sites identified (initially by site index) and intensively managed for timber production.
- DNR should consider agro-forestry (e.g., hybrid tree species) to improve production.

Response:

Improved productivity of DNR timberlands is included as a *desired future forest composition* (DFFC) goal. This is reflected in the management recommendations including thinning, *rotation age,* conversion of northern hardwood and aspen types where appropriate, and reconsidering and amending past management objectives for stands that have shown themselves to be relatively unproductive. Again,

identification of native plant community for managed sites will ensure better decisions and more informed goals.

Issue: How can DNR resource managers ensure the most appropriate locations are chosen for management as ERF?

Comments:

- ERF should be applied as modeled in the Generic Environmental Impact Statement on Forestry (GEIS).

Response:

Designation of DNR timberlands for ERF management is guided by the DNR *Extended Rotation Forest Guidelines*. The guidelines provide that a minimum of 10 percent of DNR timberlands will be assigned an ERF prescription (i.e., will be managed to an older age before final *regeneration harvest*). The guidelines also recommend potential locations where it would make sense to consider placing ERF on the landscape (e.g., adjacent to designated old-growth, along travel corridors and recreational facilities, in or adjacent to riparian areas). The GEIS model randomly assigned ERF prescriptions to 20 percent of DNR timberlands and did not attempt to place ERF in particular or appropriate locations. The 20 percent *prescribed ERF* used in the GEIS model was simply a modeling assumption, not a plan for what was most appropriate. DNR staff and subsection team members use the DNR ERF guidelines and their local knowledge and professional expertise to determine the appropriate amount and placement of ERF in the subsection. In addition, staff are using historical fire regime, *bearing tree*, and ecological system data to better identify appropriate locations for older forest. Nongame wildlife habitat data are also incorporated in the identification of ERF areas.

Issue: How are preservation and utilization balanced in the plan?

Comments:

- Economic contributions of the timber program should be fully disclosed e.g., jobs created and contributions to the trust fund.
- DNR should use forest models in the planning process to reduce the subjectivity inherent in the current method.

Response:

Economic analysis is beyond the scope of this plan, although such analyses are being conducted by the *Minnesota Forest Resources Council* landscape planning teams. Models are being used, and more sophisticated models will be used in the future, to achieve better management plans and decisions.

Issue: How can DNR resource managers maintain a desirable road density for a given area of the subsection?

Comments:

- The Nemadji State Forest, formerly a de facto roadless area, is becoming criss-crossed with roads and trails. The plan should specify no net increase in roads and trails in this state forest. Outside the Nemadji, we need more hunter-walker trails.
- Fragmentation of forests by roads and clear-cut openings is a concern. I am also concerned about ever-increasing off-highway vehicle (OHV) use promoted by

excessive logging-road building; I approve the recognition in SFRMP that planning for road access is important.

Response:

Comprehensive road/transportation system planning is currently beyond the scope of SFRMP. Phase IV of the SFRMP process (see Table 2 on page 3) will include the identification of road access needed to carry out management on stands identified in the *stand examination list*. The type and intended management of any new road access that is needed will be identified (e.g., gated, maintained open, closed/reseeded, etc.) Also, a desired future condition and strategies for minimizing future road building and undesirable road use were included in response to these questions.

Issue: How can we make the SFRMP useful for guiding *forest stewardship plans* on nonindustrial private forest lands? How can we make this plan applicable to forest stewardship planning?

Comments:

- I would like to see more emphasis on private forest management and coordination with private landowners to achieve landscape goals, avoid introduction of exotics, etc.

Response:

Private forest management is outside the scope of SFRMP, however we have attempted to keep the language in this document user-friendly, and to make the information relevant to forest management on all ownerships wherever possible. We continue to work with stewardship planners inside and outside the DNR, and will make our planning information available to them upon request. DFFCs are applicable across all ownerships, should private landowners wish to consider them.

General comments about the process:

- I approve the implementation of notice of intent to harvest enabling local people with knowledge about locations of unusual or valuable species to make that knowledge known to DNR.
- I am encouraged by this process, which I perceive to be a way that all stakeholders can work together to improve the forest resource.

Appendix F. Responses to Public Comments on Step 3 Strategic Direction Document

The public offered several hundred comments on the Step 3 plan document. The DNR is obligated to respond to these comments and make changes to the strategic directions document as appropriate.

The following narrative presents summarized versions of the comments by category. To each set of comments the agency provides a response including a statement of any action based upon that response. Unless otherwise noted, all page numbers refer to the "Issues, Strategies, Desired Future Forest Composition, and Stand-Selection Criteria" document (DNR, February 2003).

Harvest Levels/Fiber Production

Comments:

- ♦ The plan's proposed harvest levels are too low
  - Current (forest) conditions are hurting fiber production. The plan reduces available fiber and exemplifies indifference toward the forest products industry. Minnesota Forest Industries (MFI) estimates that more acres and cords could be harvested than what is proposed in the plan. Short-term plan goals tend to de-emphasize timber production for other values. Plan should accelerate harvests to capture mortality, and should evaluate and actively treat high-risk, low-volume (HRLV) stands over the next seven years.
- ♦ The plan's proposed harvest levels are too high
  - The plan is totally slanted toward timber production with little concern for the nontimber plant life, or for wildlife with the exception of those that eat tree seedlings. The plan is about trees, trees, and more trees with little regard for wildlife.

Responses:

- ♦ The plan does propose substantially increased harvest levels over the seven-year planning period compared to recent years (estimated at 94,000 cords per year compared to an estimated 66,000 cords per year average over the past five years) to address current aging stands of early successional species and begin improving the growth and quality of thousands of acres of northern hardwood stands.
- ♦ The plan does propose to accelerate harvest of old aspen and birch in particular over the seven-year planning period to reduce mortality losses and maintain the desired acres of aspen type in the subsection.
- ♦ The plan does propose to field visit and appropriately treat HRLV stands during the seven-year planning period.
- ♦ MFI and other estimates are likely to be different since they probably used different rotation ages, amounts of (extended rotation forest) ERF, and other assumptions.
- ♦ The harvest schedule being planned attempts to address the current undesirable age-class structure. It should be noted that the planning process involved collaboration among DNR Fish and Wildlife, Forestry, and Ecological Services

divisions, and considered the benefits to some wildlife species of older forest in addition to the economic benefits of timber production.

- A number of changes have been made in response to comments regarding the perceived lack of emphasis on wildlife concerns.

Extended Rotation Forests

Comments:

- The amount of prescribed ERF proposed in the plan is too high.
  - DNR should stick to 20 percent modeled in the Generic Environmental Impact Statement (GEIS). Rotation ages should be the same as those in the DNR's own ERF guidelines. Other forest lands should be considered in establishing the amount of prescribed ERF. Managing some types as 100 percent ERF does not show a good faith effort to address forest productivity and health. Focusing ERF in Wildlife Management Areas (WMAs) is not appropriate. Using historic conditions or the range of natural variation (RNV) as a goal is also not appropriate.
- The amount of prescribed ERF proposed in the plan is appropriate.
  - Support the plan's expansion of ERF acres especially in areas with historically low disturbance rates. Old forests are an essential component in the forested landscape and 10 percent of the forest as old growth (referring to the 10 percent effective ERF DFFC) is reasonable.

Responses:

- The GEIS assumed 20 percent of state and federal lands would be managed as ERF. This was simply a rough modeling assumption used to project changes in forest age-class distributions over the 50-year modeling horizon, and associated potential effects on numerous factors (including wildlife). It is not intended to be a guideline for forest management.
- The 1994 ERF guidelines present average recommended rotation ages for various forest types as general guidance. Since the adoption of the ERF guidelines, DNR has consistently directed staff to adjust rotation ages based on local conditions and data, and professional judgment. It should be noted that the normal rotation age for aspen used in the Mille Lacs Uplands plan is 40 years, the same as the recommended average rotation age referenced in the ERF guideline.
- In this planning process we used Mean Annual Increment to set the normal rotation age, after which the team considered setting the extended rotation age at 1.5 times the normal rotation age. In many cases, the ERF age was adjusted back to reflect inability to hold certain cover types in this landscape, where a number of forest types are at the edge of their ranges.
- The plan did consider old-forest values likely to be provided on other ownerships and other state lands (e.g., parks, old-growth forests, scientific and Natural Areas, etc.) in reaching agreement on the level ERF proposed in the plan for DNR timberlands.
- By policy, 100 percent of white pine types on DNR timberlands are to be managed as ERF. For other types, the amount of timberland given an ERF prescription (i.e., prescribed ERF) was based on a goal to have a certain amount

of the forest beyond the identified normal rotation age (i.e., effective ERF) at any point in time in the future (i.e., once the forest desired age-class distribution is achieved).

- ERF is intended to provide a suite of "old forest" characteristics on the landscape in the context of a productive, working forest. This is in contrast to old-growth forests, Scientific and Natural Areas (SNAs), and other reserved forest land areas where harvest is not an explicit part of the management plan. Final harvest is merely being delayed to provide more old forest "services" to the landscape. ERF that is designated in the Mille Lacs Uplands plan is not focused on WMAs.
- ERF is designed to provide old forest values, many of which are in fact wildlife values, including huntable populations of game species.
- ERF stands are highly productive for important game species such as wood ducks, hooded mergansers, pine marten, and squirrels. Older aspen in particular is heavily used as a cavity tree, a habitat element on which these species depend. ERF stands with a conifer component are also critical wintering areas for white-tailed deer. Without some older forest on WMAs, in addition to other state forest land, these important species cannot be "optimized."
- Historical conditions were not used as a management goal in the plan. Rather, this data helped the team locate ERF in parts of the subsection where soils, climate, and disturbance regimes have allowed old forest to develop in the past.

Aspen Management

Comments:

- **Against** the proposed long-term (50+ years) goal of a 5 percent reduction in the aspen cover type.
  - Assuming industry will shift to other species shows indifference to forest industry. Restrictions on the aspen resource will result in further job loss. Do not support conversion of older aspen stands through succession to other types (northern hardwoods, conifers). Early successional types are important to wildlife. Conversion of aspen will affect ruffed grouse and woodcock. Northern hardwood forests make poor deer habitat. DNR is treating aspen as a weed (undesirable) tree. Clear-cut harvesting of aspen is good for wildlife.
- **Supporting** the proposed long-term (50+ years) goal of a 5 percent reduction in the aspen cover type.
  - Approve plan to reduce aspen cover type and restore cover types that once were more prevalent by encouraging natural succession. Supports statement that industry will adapt to the available resource (shift in species).

Responses:

- Industry has shown the ability to adapt to other species in the past (SAPPI mill in Cloquet using greater mix of hardwoods to make paper). In addition, the GEIS assumed that industry would have to shift to other species (northern hardwoods in particular) to support current/increased harvest levels during the period of time when the aspen age-class imbalance reduces the amount of available mature aspen for harvest.

- Aspen is a species that is highly valued in Minnesota for a variety of reasons, and it will remain a large part of the forested landscape. Text has been added to plan emphasizing the value of aspen as a dominant forest type in this subsection and across the state.
- Aspen harvest during the current planning period is likely to be higher than it has been in recent years. There will be a decline in aspen harvest 10 to 20 years in the future due to the current age-class imbalance, but fiber will be available from other forest types. A small reduction in aspen acreage over the next 10 years will be offset by greater vigor in the remaining stands, improved timber quality in aspen and other forest types, and increased attention focused on currently under-utilized species.
- Many of the aspen stands to be converted currently have a low volume of aspen mixed with a number of other species and have the potential for management to produce quality hardwoods. If they are converted to a more valuable or higher quality forest, local business will benefit from the availability of more diverse wood resources.
- The Mille Lacs Uplands contains most of the high-quality northern hardwood sites in the state. Opportunities exist to harvest high-quality hardwood sawlogs in perpetuity if the stands are managed appropriately. The goal is to promote value-added opportunities for secondary manufacturers using high-quality local wood resources
- The high levels of aspen harvest over the next seven years are expected to provide an abundance of young aspen for grouse habitat. The vast majority of aspen harvests will continue to be clear-cut or modified clear-cut harvests conducted in accordance with the Minnesota Forest Resources Council Voluntary Site-Level Forest Management Guidelines.
- Northern hardwood forests with oak and aspen inclusions provide good deer habitat and hard mast for forage. Aspen clones will be harvested in northern hardwood forests that are otherwise managed on an all-age management regime; the harvest of these one- to three-acre clones will provide young aspen inclusions in small patches required by some life stages of wildlife.
- The SFRMP team is looking at an aspen resource that is in critical need of management and trying to address an age-class imbalance. We are trying to balance the aspen age-class structure over a period of 50 to 80 years. To do this, we plan to harvest some aspen acres at younger ages, i.e., in a few cases even younger than the normal rotation age. We anticipate that this will create early successional wildlife habitat sustainable for the future.

Open Landscape Management

Comments:

- Supporting reforestation of brushland acres capable of productively growing trees.
- Opposing the planting of trees in historically or sensitive open landscapes/ brushland complexes.

Responses:

- There is no plan to increase the number of forested acres on state land during the planning period. However, some brushlands that are not part of priority open landscapes will likely see continued in-growth of trees.
- Forest management will focus on improvement of quality in existing forests and on addressing a backlog of work in older forests. Reforestation is only one of many interests we are trying to balance through forest management. As the comments summarized here indicate, there is also a strong interest in the maintenance of open landscapes and early successional forests that must be considered.
- Priority open landscape complexes were identified in the plan and every attempt will be made to maintain these as habitat for open landscape-dependent species through management of public and private land. Additional open landscape complexes may be identified and developed during the planning period
- Discussions among DNR Forest and Wildlife managers occur when goals for areas that could be managed as either forest or brushland are developed.

Pine Management

Comments:

- Concern about the current lack of red and white pine in the subsection, and lack of adequate attention to pine restoration in the plan.
- Questioning the restoration of white pine as a means to enhance timber productivity, but still supporting and encouraging white pine management.

Responses:

- White pine is a species that has declined very significantly in the planning area during the past 100 years (10- to 15-fold declines are common in the Mille Lacs Uplands). In 1997 the Minnesota Legislature authorized the White Pine Initiative to increase the presence of white pine in Minnesota. In 1998, the DNR, county land departments, and USDA Forest Service began an accelerated program of white pine planting. Since the beginning of the initiative, many millions of white pine seedlings have been planted on forest lands in the state.
- Red and white pine are recognized as important forest types in the subsection. Apart from plantations, these species naturally occur as a component of other forest types and are therefore not accurately represented in charts and graphs in which forest types are named for the most dominant species in a stand. We will soon have a system to better capture the amount of pine that has been planted in existing stands, planted in small clusters, and protected where it occurs naturally in the understory.
- The Sandstone Forestry Area is probably the most appropriate part of the subsection for red and white pine enhancement. The forest supervisor there said that during the 1980s, an average of 40,000 pine seedlings were planted each year. A long-term average is about 20,000 per year. There has been less pine planting during recent years because the focus has been on thinning and protecting previously planted stands. Reestablishment of pine forests continues to be a high priority.
- When red and white pine are found as a component in a stand scheduled for harvest, they are often reserved from harvest.

- The current budget situation is demanding that we make every effort to focus our white pine restoration efforts on sites where the trees will have the greatest chance of survival and they are accessible for continuing care (i.e., protection).
- Forestry staffs in the planning area are routinely maintaining existing pine in mixed stands as a way of increasing within-stand diversity. The actual anticipated change in white pine cover type as a percentage of commercial forestlands in the subsection is from 0.5 percent to 0.9 percent. Chart formats have been changed to show actual percentages rather than rounded figures to address the perception that the goal was "zero percent."

Reintroduction of white pine was listed in the plan as one means of increasing forest productivity as a whole (timber productivity being one part). White pine has historically been a much sought-after species for sawtimber because of its wood characteristics. It also grows well on many sites in Minnesota. Timber productivity may be enhanced by reintroduction of white pine as part of an overall strategy to restore native plant communities.

Appendix G. Oak Regeneration Plan

Work group members

Project leader: Bill Foss, Sandstone Area Forestry Technician

Tim Quincer: Central Region Forestry-Wildlife Coordinator

Daren Wysocki: Aitkin Area Timber Program Forester

Peter Willis: Little Falls Area Timber Program Forester

Steve Lane: Aitkin Area Forest Supervisor

Bill Barnacle: Central Region Silviculturist

Advisory personnel:

Rich Staffon: Cloquet Area Wildlife Manager

Nick Reindl: Division of Wildlife Depredation Specialist

Lynn Sue Mizner: Subsection Plan Team Leader

Doug Tillma: Northeast Region Timber Program Leader

Analysis of the oak resource indicates that to prevent a future age-class imbalance, and provide a consistent supply of this valuable resource, approximately 1,120 acres will need to be regenerated during the seven-year planning period. The task of this group is to determine criteria for identifying appropriate stands in which to focus this work during the planning period and create a plan for protection and enhancement of the regenerating resource.

Oak management in the planning area will follow the management recommendations in the body of the plan (e.g., retention of mast, rotation ages, etc.). This work group's focus is on the correction of the perceived lack of recruitment in the oak cover type.

Criteria for selecting stands to be regenerated

As noted in the cover-type notes in the subsection plan, oak will be primarily managed using a shelterwood harvest. This entails thinning young stands for quality and vigor, and later a heavy thinning at rotation age to promote natural or artificial regeneration under the remaining canopy. These residuals are then removed at such time when they are no longer necessary to provide a microclimate for the regenerating stand. It is this regeneration that is the subject of current concern over depredation.

Initially, the following criteria will be used to identify oak stands that are good candidates for implementation of a shelterwood harvest.

- Site has a high incidence (50 percent+) of environmental damage (e.g., frost cracks, blowdown, high grading, poor form, animal damage)
- Site has greater than 20 percent affected by insect and disease problems
- Site has good accessibility for tending, fence maintenance, bud capping, etc.
- Site classification indicates appropriate quality and native plant community classification to support quality oak forest (e.g., MHc36)

A preliminary sort of the data indicated that 363 acres of oak type met the first criterion alone. Additional acres will no doubt be identified during field visits.

In addition to sites that meet the criteria above, sites where existing regeneration exists will be candidates for implementation of protective measures.

Exclosure costs

Deer exclosures are the most effective, and also the most costly, means of protecting regeneration. Fence materials may have potential for re-use when trees reach a height where they are safe from depredation. Exclosures have the added benefit of protecting herbaceous vegetation and other trees in addition to the target oak seedlings.

An eight foot fence with posts every twenty feet is required to exclude deer. Here is a picture of the standard deer fence with twelve foot treated wood posts, buried between three and four feet, with fence ready to be installed. Several fence manufacturers make appropriate high tensile fences in different heights and stay distances. This wire is eight foot high with 6-inch stays. The roll is approximately 330 feet long and weighs over 300 pounds. It can be unrolled on the ground and then tightened with fence stretchers; the fence will stand itself up as it is tightened. Special fencing tools are required to install this type of fence (high tensile).

Costs for fence construction vary, but estimates for materials for this kind of fence range from $1.25 to $2.00 per lineal foot, plus labor. Corners and gates are the most expensive part of fence construction. This, and the fact that fencing costs do not increase linearly with size of area enclosed, makes it advantageous to work with larger enclosures/exclosures wherever possible. We estimate a total cost for materials to be $2 per lineal foot, or about $582 per acre to enclose a 10-acre parcel and $374 per acre to enclose a 20-acre parcel. These figures include one eight-foot gate per enclosure. The estimates can be doubled if labor is included.

Alternatives to the standard twelve foot wood post and high tensile welded mesh pictured above include a high density polyethelene welded plastic 2-inch x 2-inch mesh fence that comes in a roll. This material, called Deer II Extra Strength Deer Fence, is 8 feet x 330 feet and has a breaking load of 685 lbs. The cost is about $249 per roll. Possible advantages include light weight for application on remote sites, cheaper installation cost, ease of repairing tears, lower cost, possible ability to attach to existing trees on some sites, and ability to use a lighter (steel “T”) post that can be pounded in. This mesh is very strong, but could be cut by a determined vandal more easily than could a high tensile fence. Gates may be optional with this type of fence, but should gates be needed, an access gate (4 feet x 7 feet) is $169 plus $70 for a frame.

Using this HDPE material, it would be possible to enclose ten acres for $4,050 or twenty acres for $4,648 (materials cost only). This is $232.40 per acre for a twenty-acre block or $405 per acre for a ten-acre block, excluding labor costs, site prep costs, and gates.

Other methods of protection

Current protection efforts include experimental contract bud-capping of oak seedlings using drywall tape. The efficacy of this method has yet to be determined.

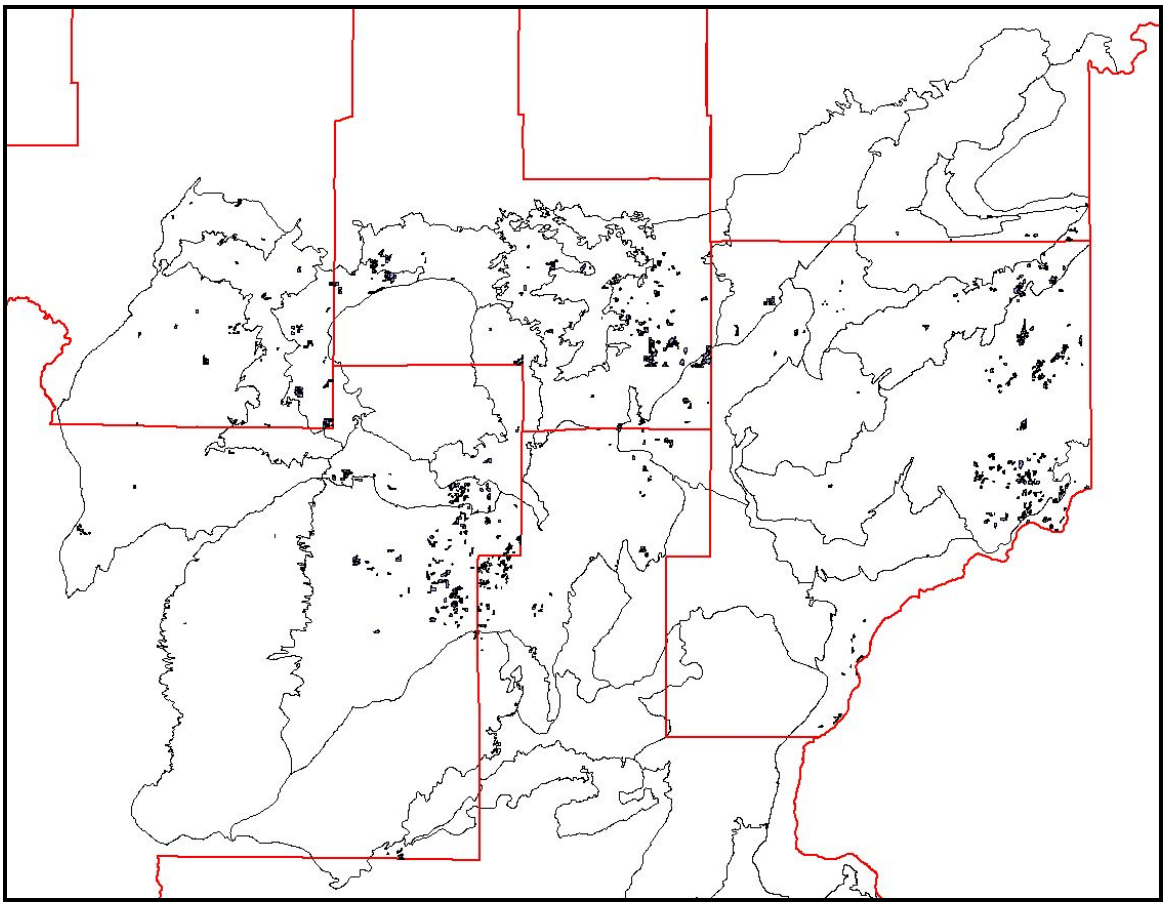
Contracting costs for bud-capping ranges from about $50-$60 per acre, and must be done annually for at least five years. This results in an estimated cost of $200 per acre to achieve protection. Itasca State Park has experimented with bud capping using volunteer labor and recycled paper; this has greatly reduced the annual cost of bud capping to a total of about $100 for 30,000 trees.

The use of deer repellents was discussed. This means of protecting seedlings has been used with varying levels of success. Weather and time investments make this a less certain method of protection, however, any means of protection that is appropriate for the site and conditions will be considered. Materials cost estimates for repellant use include the cost of a specialized sprayer ($85) and the repellant itself, which is fairly inexpensive.

Access

Both bud-capping and fencing require reasonable access, but to bud cap smaller acreages, access is less critical a factor than it is for fencing. Fences need monitoring and occasional maintenance.

Figure G.1. Location of Oak Forest in the Mille Lacs Uplands



2002 DNR Division of Forestry Area Boundaries

Conclusions:

The work group determined depredation to be a problem of such magnitude in the planning area that other management investments, e.g., planting, site preparation, weeding and tending, or herbicide treatments, should not be undertaken if resources are not available to protect regeneration. The group suggested that if fencing, bud-capping, or other appropriate protection methods are not possible, no final harvest should be considered for oak in vulnerable areas. Stand quality improvement thinnings would, of course, continue.

To this end, the work group will prepare a proposal in an attempt to obtain sufficient funding to protect approximately 1,200 acres of oak regeneration in the subsection. Other divisions in DNR and partners external to Minnesota DNR will be approached (e.g., nonprofit entities) to assist with funding for this effort.

Appendix H. Red Shouldered Hawk Habitat in the Planning Area

The Red-shouldered Hawk *(Buteo lineatus)* is distributed throughout much of eastern North America, with an isolated population in California. The range for this species apparently expanded into Minnesota during the early 1900s. Red-shouldered hawks require extensive, relatively mature, well-stocked lowland hardwood or upland hardwood stands in close proximity to wetlands or other water bodies. Surveys in central and north-central regions of Minnesota have shown that red-shouldered hawks are more commonly found in upland deciduous forests, particularly those found on moraine topography with rolling hills covered by mature forest interspersed with numerous small wetlands.

Nesting habitat primarily consists of well-stocked pole or sawtimber stands (stocking densities 30 to 45 cords per acre) with a closed canopy (80-100%) and basal area of at least 80 square feet per acre. An additional recommendation would be to retain and restore (R/R) all native species common to the Northern Hardwood type including some of moderate shade tolerance.

The Red-shouldered Hawk is listed as a species of Special Concern in Minnesota, but in adjacent states is listed as Endangered (Iowa and Illinois) and Threatened (Wisconsin and Michigan). Because forest management practices have the potential to significantly impact the species in much of the state, planning team members agreed to consider habitat requirements for Red-shouldered Hawk when planning forest management. Two ways these data were considered were in the identification of areas for management as “large patches”, and identification of areas for management as “Extended Rotation Forest”.

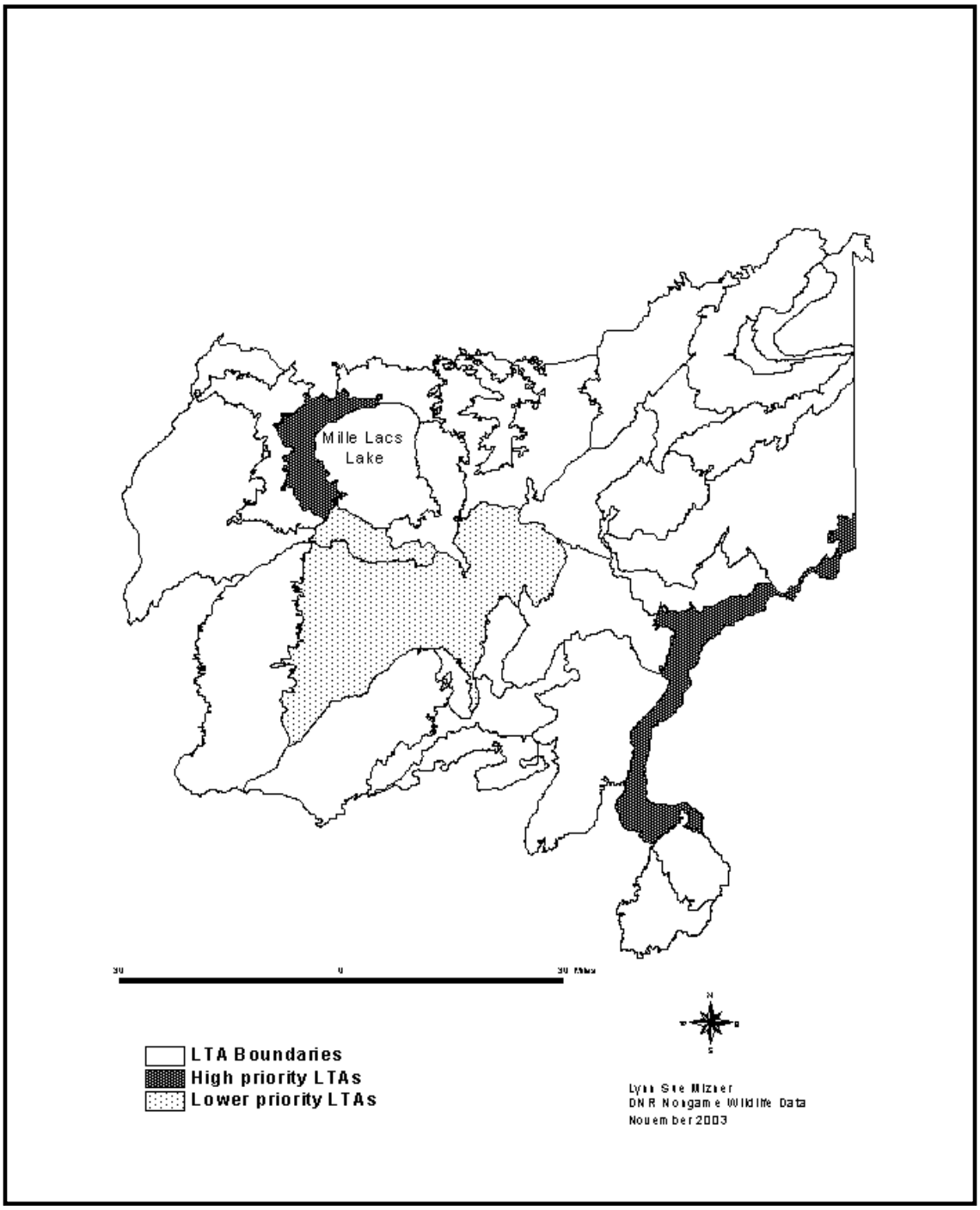
Figure H.1. Shows Landtype Associations (LTAs) in the planning area that have been assigned one of three levels of importance as Red-shouldered Hawk habitat:

High: These are LTAs where existing soils, topography, and habitat conditions (closed canopy forest) currently support the highest concentrations of Red-shouldered Hawks in the state.

Moderate: These are secondary areas where Red-shouldered hawks are regularly found, but numbers may be limited by forest age, fragmentation, or other factors.

Lower: Additional LTAs within the state where Red-shouldered Hawk breeding has been documented.

Figure H.1. High and lower-priority LTAs for RSH habitat in the planning area (there are no LTAs in the planning area with the Moderate ranking).



Appendix I. Patch Size Determination for the Planning Area

The following seven forest-type combinations were used to group stands into "patches":

1. Aspen, birch, and Balm of Gilead
2. Northern hardwoods, central hardwoods, and oak
3. Ash, lowland hardwoods, cottonwood, and willow
4. Red pine and jack pine
5. White pine
6. Tamarack, white cedar, lowland black spruce
7. White spruce, balsam fir, and upland black spruce

Two size class categories for each of the above groups were identified (class 1, 2, and 3; Class 4, 5, and 6), resulting in a total of 14 possible combinations.

No rivers large enough to break up patches occur on state land within the Mille Lacs Uplands. However, state, county, and township roads do break up a number of patches. Data on state forest roads were not available. The group determined that class 4, 5, and 6 forest roads were not significant in the fragmentation of patches, although class 1, 2, or 3 forest roads could be.

A map of the entire planning area was produced, showing patch sizes on state land.

Agreement was reached that the plan would use data in Table 8 as a long term goal for patch sizes; although these percentages were modified to accommodate the CSA data format, the starting point was data from Malcolm L. Hunter, Wildlife, Forests, and Forestry. There was some feeling in the group that definite numbers would be important for interim goals, but numbers associated with desired future forest conditions (DFFCs) could be a little more vague, due to uncertainty about the ideal patch size distribution and lack of data specific to Minnesota.

Agreement was reached that the interim goal will be to maintain the percentage of large patches (250 acres and larger), combine or conduct adjacent harvests in patches smaller than forty acres to create patches in the size class 100-249 acres. A 2 percent reduction in patches less than forty acres will be the seven-year goal. There was some question about how this would influence management in the woods; the group agreed that goals would alert foresters to look for opportunities to conduct adjacent cuts (creating a larger patch), or avoid fragmenting existing large patches with harvest activities.

It was agreed that data on all ownerships should be acquired at some time in the near future, to provide a more realistic picture of patch sizes on the landscape.

Table I.1 shows current patch size distribution, and possible goals, with percentages and numbers of acres. The numbers confirmed that Minnesota DNR resource managers have tended in the past to create smaller patches (Cloquet Area average harvest size is about 18 acres). Team members pointed out that harvest size and patch size were not the same thing; a large patch could contain a number of smaller adjacent harvests occurring over a period of time.

Table I.1. Current and Desired Patch Sizes in the Planning Area

Patch size Class	Goal % In class	Current % In class	No. of Patches In class	Acres in Class
640+	10%	18%	65	68,572
250-639	15%	20%	210	79,958
100-249	40%	20%	505	77,852
40-99	25%	20%	1,238	76,934
<40	10%	23%	6,634	88,226
	Totals		8,652	391,542

Appendix J. Early Successional Habitat in the Planning Area

Figure J.1. Percentages of Aspen-Birch Forest in LTAs in the Planning Area.

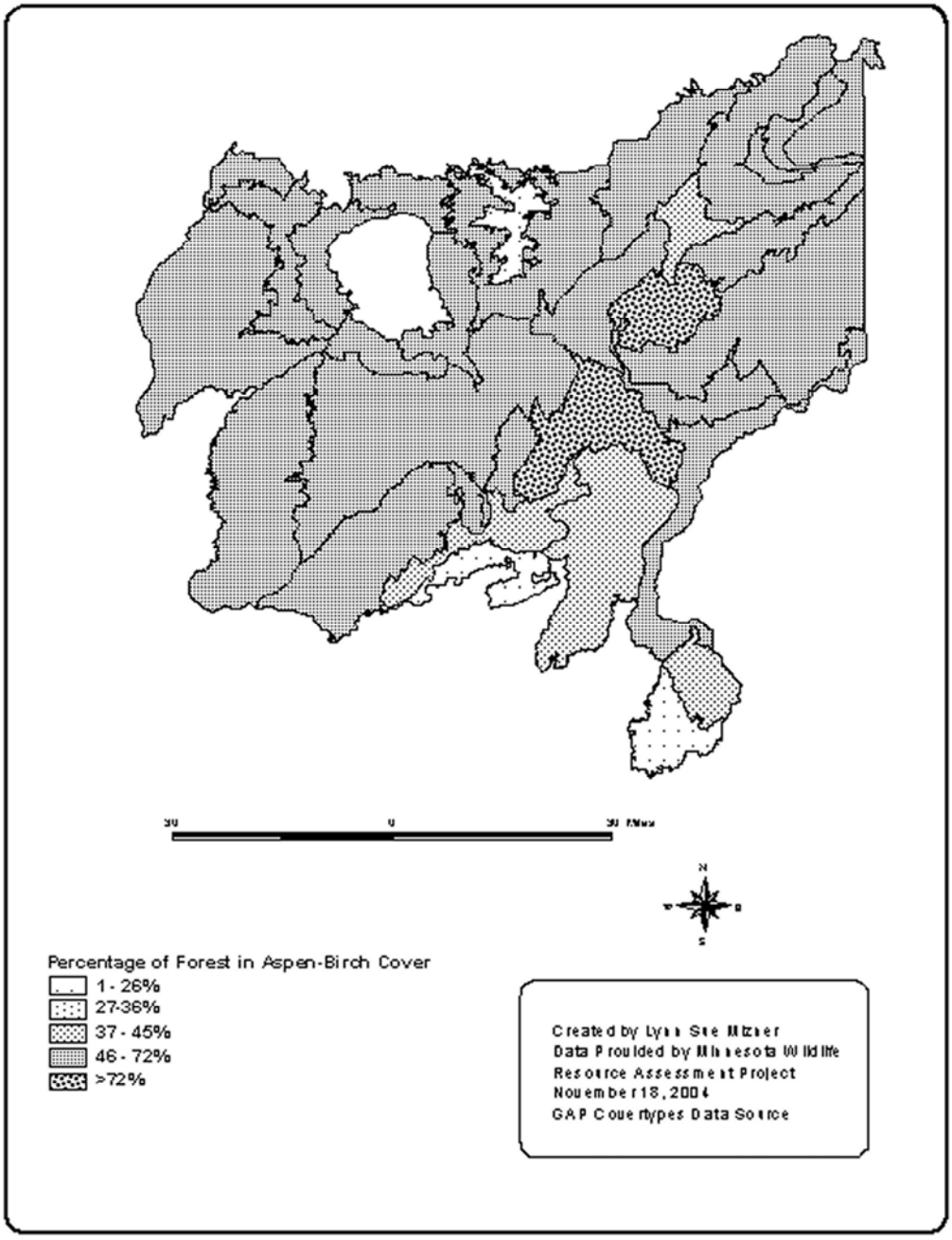


Table J.1. Percentage of Forested land in Aspen-Birch Forest Type by LTA

LTA Number	LTA Acres	LTA Forested Acres	Aspen/Birch Percentage of Forested Acres	Open Landscape Priority LTA
212Ja01	60,151	47,470	71.28%	No
212Ja09	33,401	18,290	63.59%	No
212Ja10	16,126	7,467	59.33%	No
212Kb01	76,800	48,448	66.75%	Yes
212Kb02	276,231	182,978	68.40%	Yes
212Kb03	46,716	17,826	45.61%	Yes
212Kb04	40,050	20,909	46.07%	Not proposed
212Kb05	68,586	30,458	45.93%	No
212Kb06	46,718	23,112	23.96%	Yes
212Kb07	177,366	122,479	48.55%	Not proposed
212Kb08	93,557	52,553	65.83%	Yes
212Kb09	376,361	180,883	62.64%	Not proposed
212Kb10	85,706	33,417	55.58%	Not proposed
212Kb11	267,623	74,458	46.34%	Not proposed
212Kb12	122,816	66,193	64.02%	Yes
212Kb13	41,449	17,498	43.01%	No
212Kb14	154,610	85,420	60.64%	Not proposed
212Kb15	76,162	32,056	79.44%	Yes
212Kb16	126,631	0	0.00%	Mille Lacs Lake
212Kb18	123,933	67,843	60.96%	Not proposed
212Kb19	63,396	27,967	69.78%	Yes
212Kb20	79,627	10,312	42.27%	Not proposed
212Kb21	52,251	8,817	21.91%	Not proposed
212Kb22	234,810	25,282	49.55%	Not proposed
212Kb23	48,598	10,204	67.60%	Not proposed
212Kb24	179,486	24,849	56.97%	Not proposed
212Kb25	132,591	34,907	72.59%	Yes
212Kb26	196,429	33,018	43.83%	Not proposed
212Kb27	30,565	16,381	69.16%	Not proposed
212Kb28	61,220	36,370	47.20%	Not proposed
212Kb31	58,697	10,293	11.32%	Not proposed
212Kb32	49,958	8,938	38.33%	Not proposed

Appendix K. The Two-Lined Chestnut Borer

In 2002 (time of writing of Strategic Direction document) it was fairly common to see oaks that are dying due to infestation by two-lined chestnut borers (TLCB) from Bemidji to Grand Rapids to Mora. TLCB have attacked oak trees stressed by the recent forest tent caterpillar outbreaks, local droughts and/ or construction damage.

The two-lined chestnut borer, Agrilus bilineatus, is an opportunistic insect that attacks weakened oak trees. It is a native beetle known to attack all oak species found in Minnesota, red oak being its preferred host. When trees and stands are healthy, TLCB confines its attack to low-vigor trees or broken branches. When drought stress, construction, and/or defoliation have reduced tree vigor, oaks are predisposed to TLCB attack. Under severe stress conditions, widespread outbreaks of TLCB can occur.

Adult beetles seek out and lay eggs on weakened oaks in late May and June. From June to August, larvae feed on the inner bark of live branches and stems, which destroys nutrient- and water-conducting tissues causing the foliage to turn brown and hang on the branches. Larvae create meandering galleries on the surface of the wood that are visible if patches of bark are cut off infested branches or stems. Larvae are white with an enlarged head and slender segmented body, are about 1.25 inches long when fully grown, and have two spines at the tip of their abdomens. Larvae pupate under the bark where they overwinter. They emerge as adults through D-shaped exit holes in the bark the next May and June

In mid-July, the first visible symptoms of TLCB infestation occur. Infested oaks may be recognized by sparse, small, and discolored foliage that is followed by the dieback of branches. Leaves of infested branches turn uniformly red-brown. The leaves on noninfested branches remain green. Infested oaks have a distinctive pattern of dead and live leaves on them. Branches in the upper crown are dead and leafless; branches in the middle crown are dying and have red-brown wilted leaves; branches in the lower crown are alive and have green leaves. In other words, TLCB-infested oaks have a “dead, red and green” pattern from the top of the tree down its branches.

By the time branch flagging becomes fully evident in August and September, the attack is finished for the year. The dead, brown leaves usually remain attached to the tree, even after normal leaf drop in the fall. When a tree is killed, surrounding oaks are often attacked by TLCB and Armillaria root disease and killed in the following year, which creates a pocket of dead trees.

Management Options

There is a big difference in how a TLCB infestation is handled, depending on whether the trees are in a wood lot or in a back yard. In either case, Minnesota DNR Forest Health Specialists recommend replanting oaks to replace the ones that were lost.

Forested Stands

Oak stands that have been stressed by drought and defoliation are vulnerable to damage and mortality caused by two-lined chestnut borers and Armillaria root disease. Management options for these stressed stands should be limited to (1) postponement of any activities in the stand, or (2) salvage harvest of high-value, damaged trees to reduce economic impact. The choice of option to use depends on the potential for continuation of stress due to drought, defoliation, or pest infestation and the volume and quality of wood in the stand.

Management activities should cease when oaks are under severe stress from drought and/ or defoliation since any stand disturbance will further open up the stand and cause additional stress on the trees. Management activities could begin during the winter after a growing season with more normal precipitation patterns. However, oaks would be vulnerable to TLCB for a few years after the drought and defoliation ended as the trees slowly regain their vigor.

Salvaging

Salvaging does not control borers in outbreak situations, but it does reduce the economic impact by recovering timber while it still has its greater value**.** Salvaging is an option if the dead oak and the oak with at least 50 percent dieback have a great enough volume to make a merchantable sale and the quality is high enough to produce veneer and grade lumber. Salvage the stand during the winter. Trees should be marked for salvaging during the leaf-on period since dead trees and trees with severe dieback will be impossible to identify during the dormant season. When salvaging, do not extend the harvest into areas of the stand untouched or lightly damaged by TLCB.

If the main product is firewood, delay any salvaging for at least a year after the oaks have died. Firewood quality will not deteriorate during this delayed period. This gives the borer larvae time to become adults and leave the tree and dead firewood will not be reinfested. If infested firewood is moved into back yards with oaks, the TLCB population will spread into the backyard oak trees.

Thinning

Thinning will not control TLCB during an outbreak situation. In fact, thinning should be avoided during a TLCB outbreak, particularly if the outbreak has been triggered by drought. Thinning will open up the stand to drying winds that will increase the drought stress on the residual oaks. Thinning can also mechanically wound trees and cause serious damage to the tree roots. Even if thinning reduces stocking to optimum levels, the trees will not benefit from the reduced competition for a number of years until the roots and crowns are able to occupy the spaces created during thinning.

Thinning will also produce additional food supply for the Armillaria root disease organism. Fresh stumps and roots of cut trees will provide an additional food base for this fungal pathogen. It would be best to delay thinning for a few years until the oaks are more vigorous. Even at that time, thinnings should be kept light; do not remove more than 30 percent of the basal area.

Sanitation

Sanitation will not be effective in controlling damage during an outbreak. A sanitation harvest simply cannot remove enough of the insect population to prevent future damage to the residual oak trees. During an outbreak, there are vast numbers of low-vigor, vulnerable oaks that will perpetuate the outbreak. The best practice is to postpone all management activities until the conditions that caused stress have ended.

Stump sprouting will be virtually nonexistent in borer-infested stands**.** In effect, the low vigor that created the TLCB problem will also decrease sprouting and enhance vulnerability to Armillaria root disease. To ensure future oak regeneration, count on advanced regeneration or oak planting stock, not stump sprouts.

Armillaria root disease, caused by an opportunistic soil-borne fungus, attacks the root systems of weakened trees and will often lead to tree mortality. If Armillaria root rot is involved in damaging the root system, a white mat of fungal tissue growing between the bark and wood of the roots and root collar can be found. These white mats, however, may not be found until after the tree is completely dead.

References

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Appendix L. Historical Disturbance Regimes

Historically, fire and wind were the most important stand-replacing disturbances in the planning area. The severity of these disturbances ranges from light surface fires and blowdown of individual trees to catastrophic crown fires and windthrow that kill most trees in a stand and allow regeneration of a new stand. Although fire was historically the most important catastrophic disturbance, its role has decreased within the last century due to fire exclusion resulting from human-caused changes in vegetation in combination with direct fire suppression. Historically, rotation periods for catastrophic fires were shortest (80 – 130 years) in the western portion of the planning area, near the St. Croix River, and in the pine-dominated Willow River Sandplain LTA. (Figure L-1). The central portion of the planning area experienced the longest rotations (800 – 1150 years), whereas the northwestern portion generally experienced intermediate disturbance regimes of 370 – 600 years. In general rotation periods for stand-replacing windstorms were longest in those areas with the shortest rotation period for catastrophic fires (compare Figures L-2 and L-1) because older and larger trees are more susceptible to windthrow than younger, smaller trees. Figure L-2 also show pattern of increasing blowdown rotation periods from southwest to northeast, reflecting an increasing rotation period for winds >112 m/h from southwest to northeast (Frelich, L.E., 2002. Forest dynamics and disturbance regimes: studies from temperate evergreen-deciduous forests. Cambridge University Press.)

Disturbance regimes provide a benchmark to compare with current and potential future ecosystem conditions, and can form part of a suite of tools useful for developing sustainable resource management strategies and evaluating trade-offs among management activities[5]

Even though it may not be practical or desirable to recreate historical conditions, examining options for managing ecosystems in the light of knowledge about those conditions can provide benefits for resource managers. Natural disturbance cycles influenced the adaptations of the native plants and animals, therefore, ecosystems operating nearer to the range of natural variation tend to be more diverse, resilient, and in some cases more productive than ecosystems that have significantly departed from those conditions.[6]

As Minnesota DNR works through its planning processes, its resource managers are attempting to understand how these newly available data can contribute to better management of Minnesota's natural resources. Historical disturbance regimes were considered during the development of this plan, and were used to help locate extended rotation forests; otherwise they did not significantly affect the selection of stands for examination or the development of management prescriptions in this planning area.

[5] Carlson, Daren. 2003. Range of Natural Variation: Information for Sustainable Forest Management. Minnesota DNR Office of Management and Budget Services Science Policy Section. St. Paul, Minnesota.

[6] Id.

Figure L.1. Historical Fire Disturbance Regimes in the Planning Area.

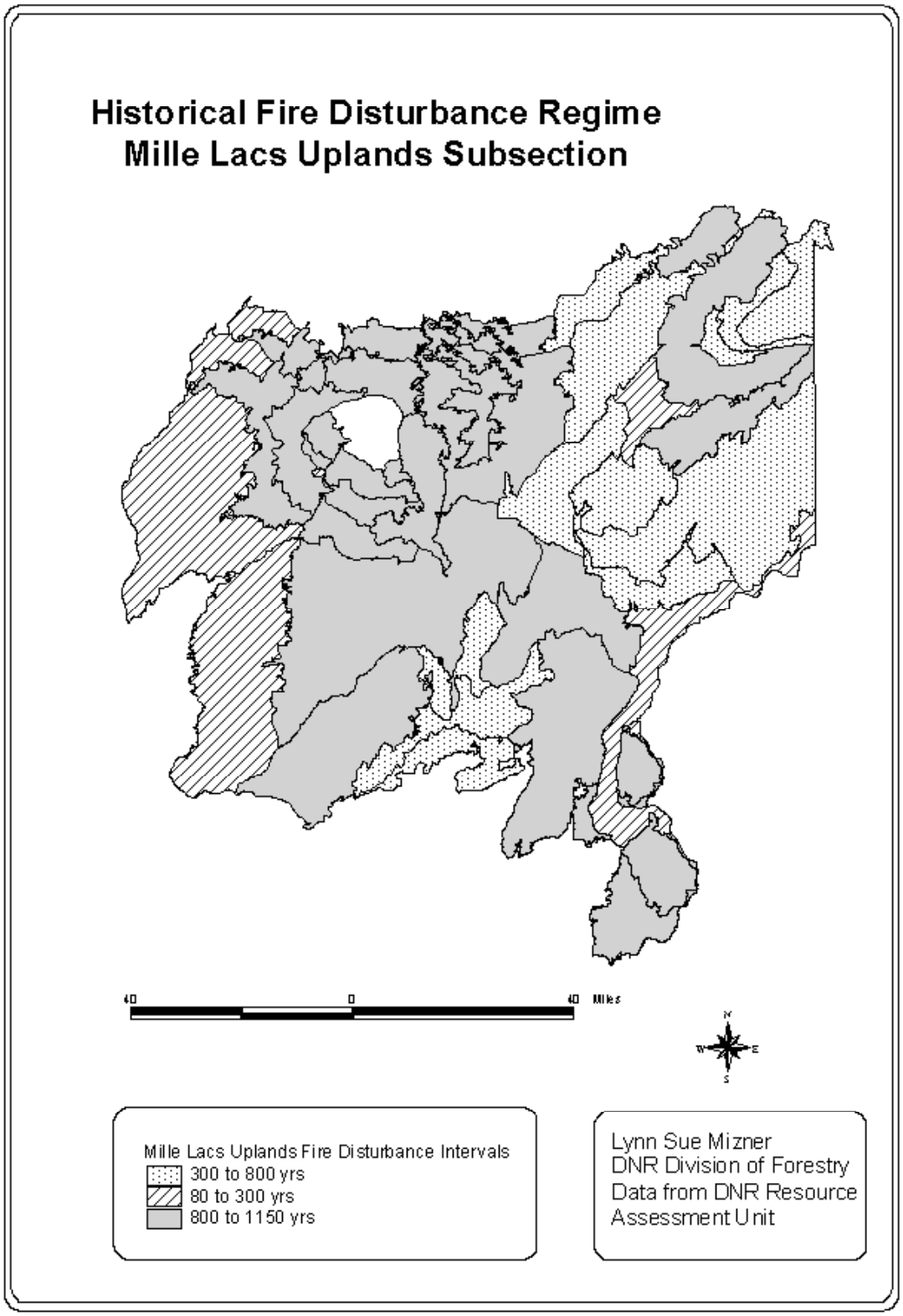
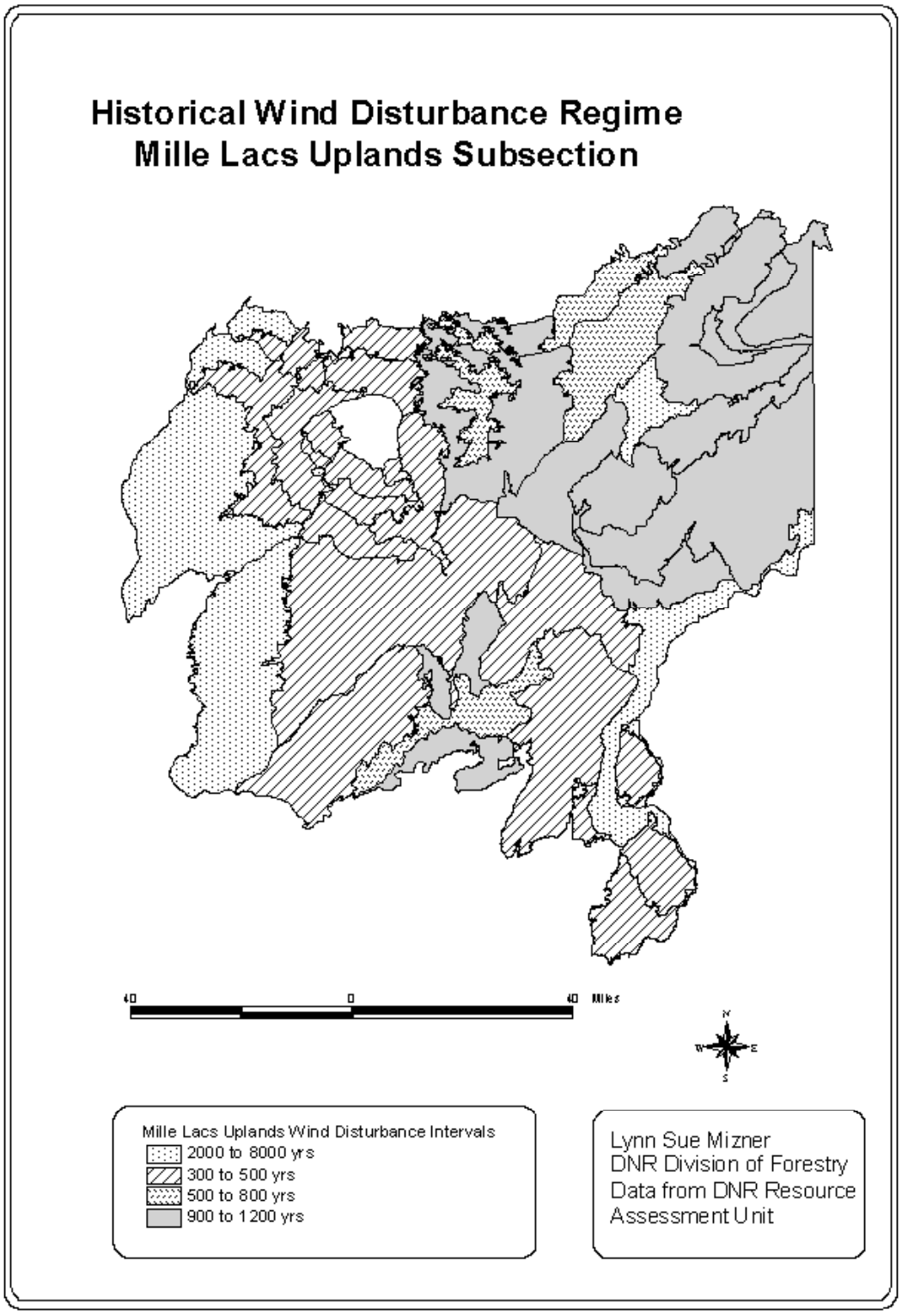


Figure L.2. Historical Wind Disturbance Regimes in the planning area.



Appendix M. Brief Descriptions of Landtype Associations (LTAs) in the Mille Lacs Uplands Subsection (212Kb) and Glacial Lake Superior Plain (212Ja)

(*Included in Open Landscape Assessment)

(‡Designated as priority open landscape LTA by SFRMP team)

Glacial Lake Superior Plain (212Ja)

*‡Douglas Lake-Modified Till Plain (212Ja01) 60,080 acres

General Description. This LTA is in the deep-water portion of a basin formed by Glacial Lake Duluth, that has been deeply eroded by post glacial lake streams. Uplands occupy 92 percent, wetlands occupy 7 percent, and lakes occupy 1 percent of the LTA (Minnesota DNR, 1998, Minnesota Wetlands GIS Cover.) Soil parent material is red clay with small scattered areas of silts and sand (Natural Resources Conservation Service (NRCS) 1994). The majority of the upland presettlement vegetation was lowland hardwood-conifer (white pine) with minor amounts of mesic northern hardwoods (Shadis, 1999; Heinselman,, 1974). Lowland presettlement vegetation was commonly conifer bog and swamp (Heinselman, 1974).

Open Landscape Assessment Summary. Based upon sharp-tailed grouse lek surveys and the Natural Heritage database of rare animal records, four sharp-tailed grouse leks and two open landscape-dependent wildlife species have been recorded in or within one mile of the LTA. Based upon 1990s land use and cover (Loesch and Orning, 1999), this LTA comprises 15 percent openland and 3 percent brushland habitat types, for a total open landscape composition of 18 percent. None of the 133 Public Land Survey (PLS) sections within the LTA has had brushland management activities. Based upon the Minnesota Gap Analysis Program (Minn-GAP) stewardship classified acres, landownership within the LTA consists of approximately 41 percent public lands and 59 percent private lands.

*‡Duesler Lake Plain (212Ja09) 33,366 acres

General Description. This LTA is in the shallow water portion of the Glacial Lake Duluth basin. Uplands occupy 79 percent, wetlands occupy 20 percent, and lakes occupy 1 percent of the LTA (Minnesota DNR, 1998, Minnesota Wetlands GIS Cover.) Soil parent material is a complex of fine sand, silt, and loams over sand (NRCS 1994). The majority of the upland presettlement vegetation was lowland hardwood-conifer (white pine) and with minor amounts of mesic northern hardwoods (Shadis, 1999; Heinselman, 1974). Lowland presettlement vegetation was commonly conifer bog and swamp (Heinselman, 1974).

Open Landscape Assessment Summary. Based upon sharp-tailed grouse lek surveys and the Natural Heritage database of rare animal records, four sharp-tailed grouse leks and two open landscape-dependent wildlife species have been recorded in or within one mile of the LTA. Based upon 1990s land use and cover (Loesch and Orning, 1999), this LTA comprises 47 percent openland and 2

percent brushland habitat types, for a total open landscape composition of 49 percent. None of the 92 PLS sections within the LTA has had brushland management activities. Based upon Minn-GAP stewardship classified acres, landownership within the LTA consists of approximately 15 percent public lands and 85 percent private lands.

***‡Nemadji Lake Plain (212Ja10) 16,103 acres**

General Description. The Nemadji Lake Plain is in the shallowest portion of the Glacial Lake Duluth basin. This is the transition between lake sediment and glacial till. Uplands occupy 68 percent, wetlands occupy 32 percent, and there are no lakes in this LTA (Minnesota DNR, 1998, Minnesota Wetlands GIS Cover.) Soil parent material is sand (fine and medium), sandy loam over sand, and silt over loamy till. The majority of the upland presettlement vegetation was lowland hardwood-conifer (white pine) with minor amounts of jack pine and mixed white pine-red pine (Shadis, 1999; Heinselman, 1974). Lowland presettlement vegetation was commonly conifer bog and swamp (Heinselman, 1974).

Open Landscape Assessment Summary. Based upon sharp-tailed grouse lek surveys and the Natural Heritage database of rare animal records, one sharp-tailed grouse lek and two open landscape-dependent wildlife species have been recorded in or within one mile of the LTA. Based upon 1990s land use and cover (Loesch and Orning 1999), this LTA comprises 50 percent openland and no brushland habitat types, for a total open landscape composition of 50 percent. None of the 47 PLS sections within the LTA has had brushland management activities. Based upon Minn-GAP stewardship classified acres, landownership within the LTA consists of approximately 14 percent public lands and 86 percent private lands.

Mille Lacs Uplands (212Kb)

***‡Bruno Moraine (212Kb01) 76,777 acres**

General Description. The Bruno Moraine is a hummocky end moraine formed by the Superior Lobe. Uplands occupy 65 percent, wetlands occupy 35 percent, and lakes occupy less than 1 percent of the LTA (Minnesota DNR, 1998, Minnesota Wetlands GIS Cover.) Soil parent material in the uplands is loamy. A hardpan commonly exists in the subsoil. The majority of the upland presettlement vegetation was mixed white pine-red pine, dry-mesic pine-hardwood, and lowland hardwood-conifer (white pine) (Shadis, 1999; Heinselman, 1974). Lowland presettlement vegetation was commonly conifer bog and swamp (Heinselman, 1974).

Open Landscape Assessment Summary. Based upon sharp-tailed grouse lek surveys and the Natural Heritage database of rare animal records, six sharp-tailed grouse leks and two open landscape-dependent wildlife species have been recorded in or within one mile of the LTA. Based upon 1990s land use and cover (Loesch and Orning, 1999), this LTA comprises 37 percent openland and 1 percent brushland habitat types, for a total open landscape composition of 38 percent. Brushland management activities have taken place on 2 percent (4 sections) of the 175 PLS sections in this LTA. Based upon Minn-GAP stewardship classified acres, landownership within the LTA consists of approximately 34 percent public lands and 66 percent private lands.

***Duxbury Moraine (212Kb02) 283,006 acres**

General Description. The Duxbury Moraine is a hummocky end moraine formed by the Superior Lobe. Patches of rolling outwash are common. Uplands occupy 66 percent, wetlands occupy 34 percent, and lakes occupy less than 1 percent of the LTA (Minnesota DNR, 1998, Minnesota Wetlands GIS Cover.) Soil parent material in the uplands is loamy over sandy loam (NRCS, 1994). A hardpan commonly exists in the subsoil. The majority of the upland presettlement vegetation was lowland hardwood-conifer (white pine), mixed white pine-red pine and dry-mesic pine-hardwood (Shadis, 1999; Heinselman, 1974). Lowland presettlement vegetation was commonly conifer bog and swamp (Heinselman, 1974).

Assessment Summary. Based upon sharp-tailed grouse lek surveys and the Natural Heritage database of rare animal records, 21 sharp-tailed grouse leks and 4 open landscape-dependent wildlife species have been recorded in or within one mile of the LTA. Based upon 1990s land use and cover (Loesch and Orning 1999), this LTA comprises 33 percent openland and 1 percent brushland habitat types, for a total open landscape composition of 34 percent. Brushland management activities have taken place on 1 percent (4 sections) of the 520 PLS sections within the LTA. Based upon Minn-GAP stewardship classified acres, landownership within the LTA consists of approximately 42 percent public lands and 58 percent private lands.

***Malmo Peatlands (212Kb03) 46,684 acres**

General Description. The Malmo Peatlands are a landscape characterized by peatlands interspersed with upland areas with level to gently rolling terrain. Uplands occupy 49 percent, wetlands occupy 46 percent, and lakes occupy 5 percent of the LTA (Minnesota DNR, 1998, Minnesota Wetlands GIS Cover.) Stream density is 0.63 miles per square mile (46 miles total). The majority of the upland soil materials are sand with scattered areas of loamy textures (NRCS 1994). The majority of the upland presettlement vegetation was l wet-mesic hardwood-conifer (white pine), mixed white pine-red pine, and mesic northern hardwoods (Shadis, 1999; Heinselman, 1974). Lowland presettlement vegetation was commonly conifer bog and swamp (Heinselman, 1974).

Open Landscape Assessment Summary. Based upon sharp-tailed grouse lek surveys and the Natural Heritage database of rare animal records, two sharp-tailed grouse leks and one open landscape-dependent wildlife species have been recorded in or within one mile of the LTA. Based upon 1990s land use and cover (Loesch and Orning; 1999), this LTA comprises 61 percent openland and 4 percent brushland habitat types, for a total open landscape composition of 65 percent. Brushland management activities have taken place on 5 percent (5 sections) of the108 PLS sections in this LTA. Based upon Minn-GAP stewardship classified acres, landownership within the LTA consists of approximately 22 percent public lands and 78 percent private lands.

Kathio Moraine (212Kb04) 40,052 acres

General Description. A rolling end moraine formed by the Superior lobe. Uplands occupy 54 percent, wetlands occupy 40 percent, and lakes occupy 6 percent of the LTA (Minnesota DNR, 1998, Minnesota Wetlands GIS Cover.)

Soil parent material in the uplands is stoney sandy loam. A hardpan commonly occurs in the subsoil. Wetlands are acid peat over sandy loam. The majority of the upland presettlement vegetation was wet-mesic hardwood-conifer (white pine), mixed white pine-red pine, and mesic northern hardwoods (Shadis, 1999; Heinselman, 1974). Lowland presettlement vegetation was commonly conifer bog and swamp (Heinselman, 1974).

***Eastside Till and Outwash Plain Complex (212Kb05) 68,578 acres**

General Description. This LTA is characterized by areas of rolling to hilly terrain (till plain) separated by areas of level to gently rolling terrain (outwash plain). Uplands occupy 64 percent, wetlands 34 percent, and lakes 2 percent of the LTA (Minnesota DNR, 1998, Minnesota Wetlands GIS Cover.) Stream density is 0.39 miles per square mile (total of 39 miles). Soil parent material in the uplands is commonly sandy loam in texture. A hardpan commonly occurs in the subsoil. Scattered areas of sand or sandy loam over sand also occur. The majority of the upland presettlement vegetation was wet-mesic hardwood-conifer (white pine) in the northern two thirds and dry-mesic pine-hardwood in the southern third (Shadis, 1999; Heinselman, 1974). Minor amounts of mixed white pine-red pine and mesic northern hardwoods also occurred. Lowland presettlement vegetation was commonly conifer bog and swamp (Heinselman, 1974).

Open LandscapeAssessment Summary. Based upon sharp-tailed grouse lek surveys and the Natural Heritage database of rare animal records, one sharp-tailed grouse lek and one open landscape-dependent wildlife species have been recorded in or within one mile of the LTA. Based upon 1990s land use and cover (Loesch and Orning 1999), this LTA comprises 53 percent openland and 2 percent brushland habitat types, for a total open landscape composition of 55 percent. None of the 153 PLS sections within the LTA has had brushland management activities. Based upon Minn-GAP stewardship classified acres, landownership within the LTA consists of approximately 12 percent public lands and 88 percent private lands.

***‡Three Rivers Peatlands (212Kb06) 46,705 acres**

General Description. This LTA is a landscape characterized by peatlands interspersed with upland areas of level to rolling terrain. Uplands occupy 25 percent, wetlands occupy 75 percent, and lakes occupy less than 1 percent of the LTA (Minnesota DNR, 1998, Minnesota Wetlands GIS Cover.) Stream density is 0.68 miles per square mile (50 miles total). The majority of the upland soil materials are sandy loam; small areas with sand and gravel also occur. A hardpan commonly occurs in the subsoil. The majority of the lowland presettlement vegetation was conifer bog and swamp with minor amounts of wet prairie (Heinselman, 1974). The majority of the upland presettlement vegetation was wet-mesic hardwood-conifer (white pine) with minor amounts of mixed white pine-red pine (Shadis, 1999; Heinselman, 1974).

Open Landscape Assessment Summary. Based upon sharp-tailed grouse lek surveys and the Natural Heritage database of rare animal records, two sharp-tailed grouse leks and two open landscape-dependent wildlife species have been recorded in or within one mile of the LTA. Based upon 1990s land use and cover (Loesch and Orning 1999), this LTA comprises 75 percent openland and 2 percent brushland habitat types, for a total open landscape composition of 77 percent. Brushland management activities have taken place on 4 percent (5 sections) of the143 PLS sections in this LTA. Based upon Minn-GAP stewardship classified acres, landownership within the LTA consists of approximately 81 percent public lands and 19 percent private lands.

***Solana Till Plain (212Kb07) 177,310 acres**

General Description. The Solana Till Plain is a landscape characterized by hilly terrain with steep slopes. Uplands occupy 60 percent, wetlands 40 percent, and lakes less than 1 percent of the LTA (Minnesota DNR, 1998, Minnesota Wetlands GIS Cover.) Stream density is 0.46 miles per square mile (128 miles total). The soil material is quite variable and ranges from loam to sand. A hardpan commonly occurs in the subsoil. The majority of the lowland presettlement vegetation was conifer bog and swamp (Heinselman, 1974). The majority of the upland presettlement vegetation was wet-mesic hardwood-conifer (white pine) or mixed white pine-red pine (Shadis, 1999; Heinselman, 1974).

Open Landscape Assessment Summary. Based upon sharp-tailed grouse lek surveys and the Natural Heritage database of rare animal records, two sharp-tailed grouse leks and two open landscape-dependent wildlife species have been recorded in or within one mile of the LTA. Based upon 1990s land use and cover (Loesch and Orning 1999), this LTA comprises 35 percent openland and 3 percent brushland habitat types, for a total open landscape component of 38 percent. Less than 1 percent of the 399 PLS sections within the LTA have had brushland management activities. Based upon Minn-GAP stewardship classified acres, landownership within the LTA consists of approximately 63 percent public lands and 37 percent private lands.

***Pine Lake Till Plain (212Kb08) 93,547 acres**

General Description. The Pine Lake Till Plain is a landscape characterized by rolling hills. Uplands occupy 69 percent, wetlands 28 percent, and lakes 3 percent of the LTA (Minnesota DNR, 1998, Minnesota Wetlands GIS Cover.) Stream density is 0.79 miles per square mile (115 miles total). Roughly half of the uplands have sandy loam texture. A hardpan is commonly found in the subsoil. The remaining areas contain a variety of soil textures ranging from sand to loam to loam over sand. The majority of the upland presettlement vegetation was wet-mesic hardwood-conifer (white pine) with minor amounts of mixed white pine-red pine and dry-mesic pine-hardwood (Shadis, 1999; Heinselman, 1974). The majority of the lowland presettlement vegetation was conifer bog and swamp (Heinselman, 1974).

Open Landscape Assessment Summary. Based upon sharp-tailed grouse lek surveys and the Natural Heritage database of rare animal records, six sharp-tailed grouse leks and two open landscape-dependent wildlife species have been recorded in or within one mile of the LTA. Based upon 1990s land use and cover

(Loesch and Orning 1999), this LTA comprises 38 percent openland and 3 percent brushland habitat types, for a total open landscape composition of 41 percent. None of the 194 PLS sections within the LTA has had brushland management activities. Based upon Minn-GAP stewardship classified acres, landownership within the LTA consists of approximately 16 percent public lands, 84 percent private lands, and less than 1 percent tribal lands.

Ann Lake Drumlin Plain (212Kb09) 376,352 acres

General Description. This landscape that is characterized by rolling hills formed by the Superior Lobe. Long cigar-shaped ridges called drumlins, oriented southwest-northeast, are common. Uplands occupy 71 percent, wetlands 28 percent, and lakes 1 percent of the LTA (Minnesota DNR, 1998, Minnesota Wetlands GIS Cover.) Wetlands are commonly long and narrow. Stream density is .85 miles per square mile (total of 476 miles). The majority of the upland land has sandy loam parent material. A hardpan in the subsoil is common. The remaining uplands contain a variety of soil textures ranging from sand, loam, to loam over sand. The majority of the upland presettlement vegetation was mesic northern hardwoods in the southern three quarters, dry-mesic pine-hardwood in the north central part, and wet-mesic hardwood-conifer (white pine) in the northeast portion (Shadis, 1999; Heinselman, 1974). Lowland presettlement vegetation was commonly conifer bog and swamp (Heinselman, 1974).

‡Nokay Sand Plain (212Kb10) 85,713 acres

General Description. This LTA is a nearly level outwash plain formed by the Rainy lobe. Uplands occupy 59 percent, wetlands occupy 29 percent, and lakes occupy 12 percent of the LTA (Minnesota DNR, 1998, Minnesota Wetlands GIS Cover.) Stream density is .36 miles per square mile (total of 47 miles). The majority of the uplands have sandy and gravelly soil parent material without hardpans in the subsoil. Scattered areas contain a variety of soil textures ranging from sandy loam with hardpans to silt over loam. The majority of the upland presettlement vegetation was dry-mesic pine-hardwood with minor amounts of mixed white pine-red pine and wet-mesic hardwood-conifer (white pine) (Shadis, 1999; Heinselman, 1974). Lowland presettlement vegetation was commonly conifer bog and swamp (Heinselman, 1974).

***Brainerd Drumlin Plain (212Kb11) 267,552 acres**

General Description. This LTA is a rolling till plain formed by the Rainy and Superior lobes. Long cigar-shaped ridges oriented southwest-northeast, called drumlins, occupy 79 percent of the landscape, wetlands occupy 20 percent, and lakes occupy 2 percent of the LTA (Minnesota DNR, 1998, Minnesota Wetlands GIS Cover.) Soil parent material is usually sandy loam, with subsoil hardpans, in the till plains. In the outwash channels, the soil parent material is sand, sand over gravel, or sand over sandy loam. The majority of the upland presettlement vegetation was dry-mesic pine-hardwood, mesic oak, and dry pine (red and jack pine) (Shadis, 1999). Lowland presettlement vegetation was commonly conifer bog and swamp (Heinselman, 1974).

Open Landscape Assessment Summary. Based upon sharp-tailed grouse lek surveys and the Natural Heritage database of rare animal records, zero sharp-

tailed grouse leks and nine open landscape-dependent wildlife species have been recorded in or within one mile of the LTA. Based upon 1990s land use and cover (Loesch and Orning, 1999), openland and brushland habitat types comprise 61 percent and 4 percent of this LTA respectively, for a total open landscape composition of 65 percent. None of the 498 PLS sections within the LTA has had brushland management activities. Based upon Minn-GAP stewardship classified acres, landownership within the LTA consists of approximately 4 percent public lands and 96 percent private lands.

***Kettle River Drumlin Plain (212Kb12) 122,784 acres**

General Description. This LTA is a landscape characterized by rolling hills formed by the Superior Lobe. Long, cigar-shaped ridges (drumlins) oriented southwest-northeast, are abundant. Wetlands are commonly found between the ridges. Uplands occupy 71 percent, wetlands occupy 28 percent, and lakes occupy less than 1 percent of the LTA (Minnesota DNR, 1998, Minnesota Wetlands GIS Cover.) The majority of the soil parent material is silt loam or loam over sandy loam in the till plains. Hardpans in the subsoil are common. The remaining uplands contain a variety of soil textures ranging from sandy loam over sand to silt over loam. The majority of the upland presettlement vegetation was wet-mesic hardwood-conifer (white pine) and mixed white pine-red pine (Shadis 1999; Heinselman, 1974). Lowland presettlement vegetation was commonly conifer bog and swamp (Heinselman, 1974).

Open Landscape Assessment Summary. Based upon sharp-tailed grouse lek surveys and the Natural Heritage database of rare animal records, 15 sharp-tailed grouse leks and 2 open landscape-dependent wildlife species have been recorded in or within one mile of the LTA. Based upon 1990s land use and cover (Loesch and Orning, 1999), openland and brushland habitat types comprise 46 percent and 1 percent of this LTA respectively, for a total open landscape composition of 47 percent. Less than 1 percent (1 section) of the 250 PLS sections within the LTA has had brushland management activities. Based upon Minn-GAP stewardship classified acres, landownership within the LTA consists of approximately 12 percent public lands and 88 percent private lands.

***Willow River Sand Plain (212Kb13) 41,449 acres**

General Description. The Willow River Sand Plain consists of rolling outwash plains and channels formed by the Superior Lobe. Uplands occupy 68 percent, wetlands occupy 24 percent, and lakes occupy 8 percent of the LTA (Minnesota DNR, 1998, Minnesota Wetlands GIS Cover.) Sandy soil is the parent material on 74 percent of the uplands. Hardpans in the subsoil are not common. The remaining uplands contain a variety of soil textures ranging from silt loams, loams, to sandy loam over sand. The majority of the upland presettlement vegetation was dry jack pine with minor amounts of wet-mesic hardwood-conifer (white pine) and mixed white pine-red pine (Shadis, 1999; Heinselman, 1974). Lowland presettlement vegetation was commonly conifer bog and swamp (Heinselman, 1974).

Open Landscape Assessment Summary. Based upon sharp-tailed grouse lek surveys and the Natural Heritage database, which contains rare animal records, one sharp-tailed grouse lek and two open landscape-dependent wildlife species

have been recorded in or within one mile of the LTA. Based upon 1990s land use and cover (Loesch and Orning; 1999), openland and brushland habitat types comprise 36 percent and 1 percent of this LTA respectively, for a total open landscape composition of 37 percent. None of the 94 PLS sections within the LTA has had brushland management activities. Based upon Minn-GAP stewardship classified acres, landownership within the LTA consists of approximately 20 percent public lands and 80 percent private lands.

***Nickerson Moraine (212Kb14) 154,525 acres**

General Description. The Nickerson Moraine is a complex of steep end moraines and outwash plains formed by the Superior Lobe. Uplands occupy 68 percent, wetlands occupy 29 percent, and lakes occupy 3 percent of the LTA (Minnesota DNR, 1998, Minnesota Wetlands GIS Cover.) The soil parent material in the uplands is quite variable. Roughly one-third is silt loam over loam with hardpans. Another third is sandy loam over sand. The remaining uplands contain a variety of soil textures ranging from silt loam over sandy loam to sand. The majority of the upland presettlement vegetation was mixed white pine-red pine with minor amounts of dry-mesic pine-hardwoods and wet-mesic hardwood-conifer (white pine) (Shadis, 1999; Heinselman, 1974). Lowland presettlement vegetation was commonly conifer bog and swamp (Heinselman, 1974).

Open Landscape Assessment Summary. Based upon sharp-tailed grouse lek surveys and the Natural Heritage database of rare animal records, five sharp-tailed grouse leks and two open landscape-dependent wildlife species have been recorded in or within one mile of the LTA. Based upon 1990s land use and cover (Loesch and Orning, 1999), openland and brushland habitat types comprise 41 percent and 1 percent of this LTA respectively, for a total open landscape composition of 42 percent. None of the 319 PLS sections within the LTA has had brushland management activities. Based upon Minn-GAP stewardship classified acres, landownership within the LTA consists of approximately 17 percent public lands, 83 percent private lands, and less than 1 percent tribal lands.

***Finlayson Till Plain (212Kb15) 76,160 acres**

General Description. The Finlayson Till Plain is a rolling till plain formed by the Superior Lobe. Uplands occupy 78 percent, wetlands occupy 21 percent, and lakes occupy 1 percent of the LTA (Minnesota DNR, 1998, Minnesota Wetlands GIS Cover.) Roughly 80 percent of the uplands have silt loam over loam or sandy loam soil material. Hardpans are common in the subsoil. The remaining uplands contain a variety of soil textures ranging from sandy loam to sand. The majority of the upland presettlement vegetation was mixed white pine-red pine and wet-mesic hardwood-conifer (white pine) (Shadis, 1999; Heinselman, 1974). Lowland presettlement vegetation was commonly conifer bog and swamp (Heinselman, 1974).

Open Landscape Assessment Summary. Based upon sharp-tailed grouse lek surveys and the Natural Heritage database of rare animal records, twelve sharp-tailed grouse leks and two open landscape-dependent wildlife species have been recorded in or within one mile of the LTA. Based upon 1990s land use and cover (Loesch and Orning, 1999), openland and brushland habitat types comprise 57 percent and 1 percent of this LTA respectively, for a total open landscape composition of 58 percent. Brushland management activities have taken place on

3 percent (4 sections) of the156 PLS sections in this. Based upon Minn-GAP stewardship classified acres, landownership within the LTA consists of approximately 10 percent public lands and 90 percent private lands.

Mille Lacs Lake (212Kb16) 126,632 acres

St. Croix Terraces (212Kb18) 123,921 acres

General Description. A landscape of rolling outwash terraces formed by the Superior lobe and modified by the St. Croix River. Uplands occupy 71 percent, wetlands occupy 29 percent, and lakes occupy less than 1 percent of the LTA (Minnesota DNR, 1998, Minnesota Wetlands GIS Cover.) Roughly one third of the LTA has soils that have sandy textures. The remaining upland areas contain a variety of textures ranging from sand over sandy loam (with hardpans), sandy loam (with hardpans), to silt over sandy loam (with hardpans). The majority of the upland presettlement vegetation was wet-mesic hardwood-conifer (white pine), mixed white pine-red pine and mesic northern hardwoods (Shadis, 1999; Heinselman, 1974). Lowland presettlement vegetation was commonly conifer bog and swamp (Heinselman, 1974).

***‡Cloverdale Sand Plain (212Kb19) 63,400 acres**

General Description. This LTA is a level to gently rolling landscape that is dominated by outwash plains formed by the Superior Lobe. Uplands occupy 73 percent, wetlands occupy 26 percent, and lakes occupy 1 percent of the LTA (Minnesota DNR, 1998, Minnesota Wetlands GIS Cover.) Sandy loam over sandy textured soil occurs on 40 percent of the uplands, ranging from silt over sandy loam to sandy loam. The majority of the upland presettlement vegetation was lowland hardwood-conifer (white pine), mixed white pine-red pine and dry-mesic pine-hardwoods (Shadis, 1999; Heinselman, 1974). Lowland presettlement vegetation was commonly conifer bog and swamp (Heinselman, 1974).

Open Landscape Assessment Summary. Based upon sharp-tailed grouse lek surveys and the Natural Heritage database of rare animal records, eight sharp-tailed grouse leks and three open landscape-dependent wildlife species have been recorded in or within one mile of the LTA. Based upon 1990s land use and cover (Loesch and Orning, 1999), openland and brushland habitat types comprise 50 percent and 1 percent of this LTA respectively, for a total open landscape composition of 51 percent. None of the 164 PLS sections within the LTA has had brushland management activities. Based upon Minn-GAP stewardship classified acres, landownership within the LTA consists of approximately 14 percent public lands and 86 percent private lands.

***Stanchfield Lake Plain (212Kb20) 79,625 acres**

General Description. This LTA is a gently rolling to level lake plain formed by Glacial Lake Hugo. Uplands occupy 71 percent, wetlands occupy 27 percent, and lakes occupy 2 percent of the LTA (Minnesota DNR, 1998, Minnesota Wetlands GIS Cover.) Clayey or silty soils occur on 60 percent of the uplands. The remaining areas contain a variety of textures ranging from sandy loam, sand, to silt over sand. The majority of the upland presettlement vegetation was mesic northern hardwoods with minor amounts of wet-mesic hardwood-conifer (white pine), dry-mesic pine-hardwood, and wet prairie (Shadis, 1999; Heinselman,

1974). Lowland presettlement vegetation was commonly conifer bog and swamp (Heinselman, 1974).

Open Landscape Assessment Summary. Based upon sharp-tailed grouse lek surveys and the Natural Heritage database of rare animal records, zero sharp-tailed grouse leks and two open landscape-dependent wildlife species have been recorded in or within one mile of the LTA. Based upon 1990s land use and cover (Loesch and Orning, 1999), this LTA comprises 73 percent openland and 7 percent brushland habitat types, for a total open landscape composition of 80 percent. None of the 196 PLS sections within the LTA has had brushland management activities. Based upon Minn-GAP stewardship classified acres, landownership within the LTA consists of approximately 4 percent public lands and 96 percent private lands.

Elm Park Till Plain (212Kb21) 52,252 acres

General Description. A rolling till plain formed by the Superior lobe. The LTA comprises 73 percent uplands, 25 percent wetlands, and 2 percent lakes by area (Minnesota DNR, 1998, Minnesota Wetlands GIS Cover.) Roughly three quarters of the LTA has soils with loamy textures. Hardpans are common in the subsoil. The remaining uplands contain a variety of soil textures ranging from sandy loam with hardpans to sand. The majority of the upland presettlement vegetation was mesic northern hardwoods with minor amounts of aspen-oak lands, oak openings-barrens, wet prairie, and wet-mesic hardwood-conifer (white pine) (Shadis, 1999; Heinselman, 1974). Lowland presettlement vegetation was commonly conifer bog and swamp (Heinselman, 1974).

***Pierz Drumlin Plain (212Kb22) 234,726 acres**

General Description. This LTA is a rolling drumlin field formed by the Superior Lobe. Uplands occupy 79 percent, wetlands occupy 21 percent, and lakes occupy less than 1 percent of the LTA (Minnesota DNR, 1998, Minnesota Wetlands GIS Cover.) Soils with sandy loam textures occur on 85 percent of the LTA. Hardpans are common in the subsoil. The remaining uplands contain a variety of soil textures ranging from sand to sand over gravel. The majority of the upland presettlement vegetation was mesic northern hardwoods, mesic oak, and oak openings-barrens with minor amounts of wet prairie and brush prairie (Shadis, 1999; Heinselman, 1974). Lowland presettlement vegetation was commonly conifer bog and swamp (Heinselman, 1974).

Open Landscape Assessment Summary. Based upon sharp-tailed grouse lek surveys and the Natural Heritage database of rare animal records, zero sharp-tailed grouse leks and five open landscape-dependent wildlife species have been recorded in or within one mile of the LTA. Based upon 1990s land use and cover (Loesch and Orning, 1999), this LTA comprises 79 percent openland 4 percent brushland habitat types, for a total open landscape composition of 83 percent. None of the 438 PLS sections within the LTA has had brushland management activities. Based upon Minn-GAP stewardship classified acres, landownership within the LTA consists of approximately less than1 percent public lands and 99 percent private lands.

Mora Sand Plain (212Kb23) 48,605 acres

General Description. This is a nearly level outwash plain formed by the Superior lobe. Uplands occupy 87 percent, wetlands occupy 11 percent, and lakes occupy 2 percent of the LTA (Minnesota DNR, 1998, Minnesota Wetlands GIS Cover.) Just over 75 percent of the LTA has mineral soils with sandy loam over sand textures. The remaining uplands are predominantly sandy loam soils with hardpans. The majority of the upland presettlement vegetation was mesic northern hardwoods and dry-mesic pine-hardwood with minor amounts of white pine, oak openings-barrens, and river bottom forests (Shadis, 1999; Heinselman, 1974). Lowland presettlement vegetation was commonly conifer bog and swamp (Heinselman, 1974).

Milaca Till Plain (212Kb24) 179,476 acres

General Description. This LTA is a rolling loess-covered till plain formed by the Superior Lobe. Drumlin features are present but not abundant. Uplands occupy 83 percent, wetlands occupy 17 percent, and lakes occupy less than 1 percent of the LTA (Minnesota DNR, 1998, Minnesota Wetlands GIS Cover.) Mineral soils with sandy loam textures occur on 85 percent of the LTA. Hardpans are common in the subsoil. The remaining uplands contain a variety of soil textures ranging from sand, to loam over sand. The majority of the upland presettlement vegetation was mesic northern hardwoods with minor amounts of wet prairie, wet-mesic hardwood-conifer (white pine), mesic oak, and oak openings-barrens (Shadis, 1999; Heinselman, 1974). Lowland presettlement vegetation was commonly conifer bog and swamp (Heinselman, 1974).

***‡Brook Park Till Plain (212Kb25) 132,590 acres**

General Description. This LTA is a rolling till plain formed by the Superior Lobe glacier. Uplands occupy 74 percent, wetlands occupy 25 percent, and lakes occupy 1 percent of the LTA (Minnesota DNR, 1998, Minnesota Wetlands GIS Cover.) Roughly two-thirds of the LTA has mineral soils with sandy loam textures. Hardpans are common in the subsoil. The remaining uplands are predominantly sand. The majority of the upland presettlement vegetation was lowland hardwood-conifer (white pine) in the northeast half and mesic northern hardwoods in the southwest half with minor amounts of oak openings-barrens (Shadis, 1999; Heinselman, 1974). Lowland presettlement vegetation was commonly conifer bog and swamp (Heinselman, 1974).

Open Landscape Assessment Summary. Based upon sharp-tailed grouse lek surveys and the Natural Heritage database of rare animal records, eight sharp-tailed grouse leks and two open landscape-dependent wildlife species have been recorded in or within one mile of the LTA. Based upon 1990s land use and cover (Loesch and Orning, 1999), the LTA comprises 64 percent openland and 4 percent brushland habitat types, for a total open landscape composition of 71 percent. Brushland management activities have taken place on 1 percent (4 sections) of the 280 PLS sections in this LTA. Based upon Minn-GAP stewardship classified acres, landownership within the LTA consists of approximately 2 percent public lands and 98 percent private lands.

***Rush City Moraine (212Kb26) 196,356 acres**

General Description. This LTA is a rolling to hummocky end moraine formed by the Superior Lobe glacier. Uplands occupy 75 percent, wetlands occupy 20 percent, and lakes occupy 5 percent of the LTA (Minnesota DNR, 1998, Minnesota Wetlands GIS Cover.) Mineral soils with loamy textures occur on 65 percent of the LTA. Hardpans are common in the subsoil. The remaining uplands contain a variety of soil textures ranging from sandy loam to sand to silt over loam. The majority of the upland presettlement vegetation was mesic northern hardwoods and oak openings-barrens with minor amounts of wet-mesic hardwood-conifer (white pine) and wet prairie (Shadis, 1999; Heinselman, 1974). Lowland presettlement vegetation was commonly conifer bog and swamp (Heinselman, 1974).

Open Landscape Assessment Summary. Based upon sharp-tailed grouse lek surveys and the Natural Heritage database of rare animal records, zero sharp-tailed grouse leks and three open landscape-dependent wildlife species have been recorded in or within one mile of the LTA. Based upon 1990s land use and cover (Loesch and Orning 1999), openland and brushland habitat types comprise 70 percent and 2 percent of this LTA respectively, for a total open landscape composition of 72 percent. None of the 378 PLS sections within the LTA has had brushland management activities. Based upon Minn-GAP stewardship classified acres, landownership within the LTA consists of approximately 1 percent public lands and 99 percent private lands.

Riverton Moraine (212Kb27) 30,562 acres

General Description. Rolling to steep end moraine formed by the Rainy Lobe. Uplands occupy 68 percent, wetlands occupy 19 percent, and lakes occupy 13 percent of the LTA (Minnesota DNR, 1998, Minnesota Wetlands GIS Cover.) Stream density is 0.93 miles per square mile (total of 45 miles). Small areas of outwash plains are common. Soil parent material is a mixture of sand, gravel, and sandy loam till in the moraine and sandy in the outwash plains. The majority of the upland presettlement vegetation was dry-mesic pine-hardwood and jack pine with minor amounts of wet prairie (Shadis, 1999; Heinselman, 1974). Lowland presettlement vegetation was commonly conifer bog and swamp (Heinselman, 1974).

Mille Lacs Moraine (212Kb28) 61,222 acres

General Description. A rolling to hummocky end moraine formed by the Rainy Lobe. Lakes occupy 13.3 percent (8143 acres) of the LTA. Stream density is 0.2 miles per square mile (total of 19 miles). Uplands occupy 61 percent, wetlands occupy 26 percent, and lakes occupy 13 percent of the LTA (Minnesota DNR, 1998, Minnesota Wetlands GIS Cover.) Mineral soils with silt over loam textures occur on 80 percent of the LTA. Hardpans are common in the subsoil. The remaining uplands contain a variety of soil textures ranging from stony sandy loam till with a hardpan, sand, or gravel. The majority of the upland presettlement vegetation was dry-mesic pine-hardwood with minor amounts of mesic northern hardwoods and mesic oak (Shadis, 1999; Heinselman, 1974). Lowland presettlement vegetation was commonly conifer bog and swamp (Heinselman, 1974).

Chisago Moraine (212Kb31) 58,697 acres

General Description. A gently rolling to steep end moraine formed by the Grantsburg Lobe. Lakes are abundant. Uplands occupy 71 percent, wetlands 14 percent, and lakes 15 percent of the LTA (Minnesota DNR, 1998, Minnesota Wetlands GIS Cover.) Mineral soils with sandy loam over clay loam textures occur on 87 percent of this LTA. Hardpans are not common in the subsoil. The remaining uplands contain a variety of soil textures ranging from sandy loam with hardpans to sand. The majority of the upland presettlement vegetation was mesic northern hardwoods, with minor amounts of oak openings-barrens (Heinselman, 1974). Lowland presettlement vegetation was commonly conifer bog and swamp (Heinselman, 1974).

Almelund Moraine (212Kb32) 49,941 acres

General Description. Almelund Moraine is a gently rolling to steep end moraine formed by the Grantsburg Lobe. Uplands occupy 87 percent, wetlands occupy 12 percent, and lakes occupy 1 percent of the LTA (Minnesota DNR, 1998, Minnesota Wetlands GIS Cover.) Mineral soils with sandy loam over clay loam textures occur on 96 percent of this LTA. Hardpans are not common in the subsoil. The remaining uplands are predominantly sandy. The majority of the upland presettlement vegetation was mesic northern hardwoods with minor amounts of wet prairie. Lowland presettlement vegetation was commonly conifer bog and swamp (Heinselman, 1974).

Open Landscape Assessment Summary. Based upon sharp-tailed grouse lek surveys and the Natural Heritage database of rare animal records, zero sharp-tailed grouse leks and three open landscape-dependent wildlife species have been recorded in or within one mile of the LTA. Based upon 1990s land use and cover (Loesch and Orning, 1999), this LTA comprises 73 percent openland and 2 percent brushland habitat types, for a total open landscape composition of 75 percent. None of the 105 PLS sections within the LTA has had brushland management activities. Based upon Minn-GAP stewardship classified acres, landownership within the LTA consists of approximately 1 percent public lands and 99 percent private lands.

Appendix N. *Directions 2000*—Forest Resources Section

The complete *Directions 2000, The Strategic Plan* document can be found at http://files.dnr.state.mn.us/aboutdnr/reports/directions2000.pdf

Forest Resources

Directions 1997 identified four forest management priorities. Those priorities are:

- Protecting riparian areas,
- Ensuring forest soils productivity,
- Maintaining wildlife diversity, and
- Managing for healthy and resilient forest ecosystems across landscape scales.

Working with partners, DNR has made considerable progress developing new approaches to address these priorities. The Sustainable Forest Resources Management Act established sustainable forest ecosystems as a priority goal for Minnesota. The act was based on recommendations of the Generic Environmental Impact Statement on Timber Harvesting and Forest Management in Minnesota (GEIS). The GEIS studied the potential impacts from current and increased levels of timber harvesting and recommended strategies for the sustainable management of the state's forest resources.

DNR has become increasingly concerned about problems posed by land use conversion throughout rural areas of the state. Land use conversion is the process of converting forest or other natural areas into housing and related uses (commercial development, parking lots, roads, etc.). At the same time, many larger blocks of land are being subdivided into smaller blocks. Increased fragmentation of the landscape is a critical threat to the state's natural resource base. Land conversion and fragmentation decrease the area in forest cover, destroy fish and wildlife habitat, degrade water quality, and reduce the large blocks of ownership best suited to managing land holistically. This concern is greatest when it occurs within significant blocks of public ownership as the character and ability to manage the surrounding land is changed dramatically. Over the long term, a continuation of these patterns poses significant concerns for the health of forest resources and viability of industry dependent on healthy forest ecosystems. These concerns form the basis for DNR's approach to developing Smart Growth and Conservation Connections strategies. They also are the basis for DNR's investment in Sustainable Forest initiatives.

Forest Ecosystem Goals and Objectives

Building on the GEIS, the Minnesota Forest Resources Council (MFRC) identified three priority forest management goals. DNR has developed a fourth goal to address mineral development in forest ecosystems.

GOAL 1. Minnesota's forestland base will be enlarged and protected. No net loss of forestland will occur and some previously forested areas will be returned to forest cover. The forest land base will be protected from decreases and fragmentation by land use changes.

Objective 1.1. **Landowners will have viable options for restoring former farmland to forest and other open land conditions**. As use of some lands changes from the production of agricultural commodities to other uses, opportunities arise to direct new uses to serve natural resource purposes, including forestry.

Objective 1.2. **Loss and fragmentation of private forestlands will be minimized.** Subdivision of forest lands or conversion of those lands to non-forest uses diminishes the

capacity of forests to provide healthy public benefits and results in a net loss of forest acreage. The objective is to maintain the productive capacity of forests by minimizing the loss and fragmentation of private forest lands.

GOAL 2. Forest ecosystems will be healthy, resilient, and functioning. Forests will be composed of appropriate mixes of vegetative types and age classes that maintain wildlife and biological diversity.

Objective 2.1. Forests will be managed for structural and plant species diversity. A forest with a variety of tree species, native plant communities and ages provides habitat suitable for more species and has greater potential to provide a sustainable yield of timber. A diverse forest generally is healthier and more resilient than a less diverse forest. Landscape metrics provide useful tools for measuring vegetative spatial patterns across landscapes. The objective is to establish and manage towards landscape goals that provide a diversity of age classes, habitats, patch sizes, and spatial configuration using the natural range of variation as a guide.

Objective 2.2. Forest practices will ensure healthy forest soils and water resources. The objective is to ensure that forestry practices minimize damage to soils and maintain healthy aquatic ecosystems.

Objective 2.3. **Forests will support self-sustaining fish and wildlife populations.** Self-sustaining fish and wildlife populations - game and non-game - are important to the recreating public and as components of healthy ecosystems. The objective is healthy, self-sustaining populations of all native and desirable introduced plant, fish, and wildlife species, especially those species listed as threatened and endangered.

Objective 2.4. Forest habitat areas will be connected by natural corridors. Where forests are fragmented by other land uses such as agriculture or urban areas, corridors of forest, often along streams or trails, may connect larger forest habitat areas serving both wildlife and recreation uses. Where older forest blocks are fragmented by younger forest in a primarily forested landscape, corridors composed primarily of older or uneven-aged forests and careful planning of timber harvest patterns can provide continuous forest cover. The objective is to identify and maintain natural areas representative of the variety of the forested landscape and connect those areas by natural corridors.

Objective 2.5. Exotic species will have a minimal impact on forests and other native plant and animal species. Minnesota's forests are susceptible to significant impacts from exotic species. Examples of exotics that adversely affect Minnesota forest resources include white pine blister rust, Gypsy moth, and buckthorn. Management will seek to minimize impacts from these species while also minimizing the impact of control measures on vulnerable native species.

Objective 2.6. Damage from native insects, diseases, and wildlife will be managed at acceptable levels. Native insects, diseases and wildlife have both positive and negative impacts on forests. On one hand, they are a major source of mortality and reduce resistance of forests to other stresses. On the other hand, they promote diversity of tree species and forest structure and generate dead wood, which provides important habitat and soil nutrients. Widespread pest outbreaks cause high levels of tree mortality and can have significant ecological and economic consequences. The objective is to reduce vulnerability of forests to the effects of significant outbreaks and to manage impacts of native pests, including wildlife, at levels consistent with forest ecosystem sustainability.

Objective 2.7. **The acreage of healthy brushland landscapes will increase**. Large, open brushlands are some of the state's most productive wildlife habitat and are essential to survival of several wildlife species, some of which are declining in Minnesota (e.g. sharptailed grouse, yellow rail, savanna sparrow, short-eared owl). Brushland acreage has declined due to conversion to agriculture and fire suppression.

GOAL 3. Forest-based economic and recreational opportunities will be numerous and wide-ranging. The contribution of forests to the state's economic and social well-being will be acknowledged. Economic opportunities for Minnesota's forest-based industries, including tourism and wood-based businesses, will be large, sustainable, and diverse.

Objective 3.1. Commercial timber supply will be abundant and sustainable. DNR will manage state lands and work with other forest landowners to help provide a predictable and sustainable amount of quality wood to meet the raw material needs of a growing population consistent with the sustainability of forest ecosystems. Predictable and sustainable harvests of quality wood from forests will support a strong state economy by helping maintain a viable forest products industry in the state.

Objective 3.2. Use of non-timber forest products will expand. Non-timber products, such as balsam boughs and birch bark, help diversify local economies. DNR will expand use of non-timber forest products consistent with sustainability of forest ecosystems.

Objective 3.3. Forest management will minimize impacts on visual quality. The visual quality of forest landscapes is especially important in areas of significant public use, such as roadsides, shorelands, and park areas. MFRC has incorporated "*Visual Sensitivity Categories*," developed by the Timber Tourism Visual Quality Committee, into site level forest management guidelines. DNR will apply the appropriate guidelines so that visual quality is not adversely impacted during forest management activities.

Objective 3.4. Forests will support diverse recreation opportunities. Forests provide opportunities for many outdoor recreation activities, which in turn provide economic benefits to local communities. The objective is to meet the demand for forest related outdoor recreation where and when these activities are consistent with the sustainability of forest ecosystems. See the Recreation Systems section for a more comprehensive development of recreation goals.

Objective 3.5. Private forest land owners will be able to manage their forests to provide public benefits. Public lands cannot provide all benefits demanded from forests. Private lands will play a key role. The objective is for private landowners to have sufficient access to the technical assistance and other services they need to satisfy their own management goals, while also maintaining healthy forest ecosystems, providing timber and serving recreation needs.

Objective 3.6. Cultural resources will be protected. Cultural resources are scarce, nonrenewable features that provide physical links to our past. MFRC voluntary site-level guidelines protect cultural resources during forest activities. The objective is to increase the awareness and use of the guidelines by forest landowners, loggers, and resource managers.

Objective 3.7. Trust fund revenues from mining and forest management will continue. Trust fund and other DNR-administered state land management will be proactive in the identification of surplus parcels for an annual sale and will initiate land exchanges with private landowners within established natural resource management areas to consolidate state ownership. The DNR also will identify and remove some trust fund lands from non-revenue producing natural resource management units on an annual basis.

GOAL 4. Mineral resources use will be economically viable and environmentally sound. Extraction of subsurface resources on all lands will continue to be a significant component of the state's economy. DNR will manage mineral development to protect public health and safety, reduce environmental impacts, and restore land for post-mining uses.

Objective 4.1. Opportunities for mineral exploration will continue. Minnesota has excellent potential for non-ferrous and industrial mineral deposits. These deposits are found throughout the state, though predominantly in the forested areas. Mineral exploration requires availability of land in areas of high mineral potential, preferably within regions with compatible

land uses. The objective is to provide improved data on the quality and quantity of mineral deposits including a consideration of the ecological impacts of minerals extraction.

Objective 4.2. The diversity of the minerals industry will continue to expand. Areas for mineral development include peat, clay, stone, non-ferrous minerals, and stockpiled material from existing or previous mining. Value-added processing of taconite or iron ore will further add stability and diversity to the minerals industry. The objective is to develop uses, marketing, and transportation strategies in cooperation with industry and other partners in order to expand the diversity of the mineral industry.

Objective 4.3. Mining and exploration will have minimal environmental impacts. The objective has three components: 1) restoring expired mine lands to productive uses including for recreation and fish and wildlife habitat, 2) minimizing the impact of new mining operations on areas with high biodiversity or where extractive operations will fragment significant native habitats, and 3) addressing the multiple concerns relating to how mining operations affect surface and subsurface water resource quality and flows.

Forest Ecosystem Management Strategies

DNR will employ the following management strategies to achieve forest lands resource goals and objectives.

Strategy 1. Develop landscape-scale management plans to guide timber harvest and biodiversity protection. DNR is developing ecosystem subsection plans for forest management. Plans will develop interdisciplinary approaches to meeting multiple forest objectives on state Forestry and Wildlife lands. Harvest, reforestation, and protection strategies will guide management in reaching a variety of objectives such as timber production, diversity of age classes, patch size distribution, native plant communities (forest land, wetland, and open brushland communities) and connectivity (to provide habitat corridors and wildlife habitat). DNR's Old Growth and Extended Rotation Forest Guidelines will focus on maintaining older forests. DNR will coordinate landscape plans and priorities with other owners when possible, including MFRC's landscape planning effort. (This strategy applies to objectives 1.1-3.7.)

Strategy 2. Apply MFRC Site-level Forest Management Guidelines. DNR will apply the MFRC guidelines on DNR-administered land and encourage widespread adoption and use of the guidelines on other public and private lands to protect wildlife habitat, historic and cultural resources, riparian areas, soils productivity, water quality, and visual quality of forest lands across the state. The DNR will assist with education and training for guideline implementation and coordinate efforts to monitor the application of these guidelines in forest management practices. DNR will encourage land managers to use the guidelines whenever appropriate (e.g. road construction, forest harvest, pesticide use, reforestation, thinning, fire management and recreation management). In some cases, land managers may choose to apply land treatments that are more restrictive than the guidelines; in other areas, less restrictive standards may be appropriate. Specifics of local conditions and management objectives will determine appropriate application of guidelines. (This strategy applies to Objectives 1.1-3.7.)

Strategy 3. Manage insect pests and forest diseases. Exotic insects such as the gypsy moth and native insects (such as the spruce budworm) as well as diseases (such as white pine blister rust and oak wilt) are major threats to forest resources. DNR will monitor exotic and native forest insects and diseases and seek to minimize damage on public and private lands. DNR will seek to minimize impacts of control efforts on non-target organisms. DNR will coordinate management efforts with the Minnesota Department of Agriculture, the U. S. Forest Service, and the U.S. Dept. of Agriculture. (This strategy applies to Objectives 2.1, 2.2, 2.3, 2.5-3.5, and 3.7.)

Strategy 4. Expand focus on corridor management and planning. Corridors provide opportunities to connect habitat, provide outdoor recreation, and protect scenic vistas. DNR,

through the Conservation Connections initiative, will work closely with private landowners, other land management agencies, and local communities to identify corridor opportunities and to implement corridor management concepts. (This strategy applies to Objectives 1.1-2.4, 2.7, and 3.3-3.5.)

Strategy 5. Provide habitat for rare and threatened species. Restoring populations of rare and threatened species requires information on the location and prevalence of suitable habitats and development of guidelines and plans to ensure that habitats are restored or maintained, such as DNR's Old Growth Forest guidelines. DNR will take a leadership role in advocating for maintaining habitat for rare and threatened species in all forests regardless of ownership. (This strategy applies to 1.1-2.7, and 3.5)

Strategy 6. Enhance opportunities to use state forests for outdoor recreation. DNR will continue to seek a balance between intensive recreation uses (off-highway vehicles - OHVs) and activities that require nature and solitude in forests. DNR will maintain forest campgrounds and will complete its recreation trail system planning for OHVs. Additional focus on recreation opportunities in forest ecosystems appears in the Recreation Systems section. (This strategy applies to Objectives 1.1-2.7, and 3.3-3.7)

Strategy 7. Incorporate wildlife population targets in all forest management efforts. DNR will consider fish and wildlife population targets in forest ecosystem management as part of an integrated strategy to maintain healthy forest ecosystems. Fish and wildlife population goals will continue to be an important consideration in planning timber harvests, old growth management, reforestation and forest recreation. (This strategy applies to Objectives 2.1-3.7)

Strategy 8. Provide appropriate access roads to forest lands. Access to forest lands is provided by an intermingled network of federal, state, county, and private forest access roads. Cooperation with other forest land owners will be critical in maintaining existing access to DNR forest lands and to coordinate future road access needs and road management direction. DNR balances a variety of considerations (e.g., biodiversity, wildlife management, fire suppression, timber harvest, and recreation) in developing access roads. DNR will continue providing access to forest lands consistent with management plans, MFRC site-level guidelines, and forest ecosystem sustainability. (This strategy applies to Objectives 1.1, and 2.1-3.7)

Strategy 9. Manage fire to protect public safety and foster healthy, diverse forest and brushland ecosystems. Wildfire prevention and suppression will continue to be guided by statutory directives to protect public safety, property, and natural resources. Prescribed (i.e. ignited and controlled) fire will be used to mimic natural processes, alter forest or brushland composition, encourage regeneration of certain species, eliminate exotic species, and reduce risk/potential of wildfire (i.e. fuels reduction). DNR will increasingly use prescribed burning to manage wildlife habitats, plant communities, brushlands, and timber lands. Fuels management (including prescribed fire, constructing fire breaks, and salvage harvesting), will be a growing need to help reduce the risk of dangerous wildfires in forested areas damaged by natural events (e.g. blowdowns, *insects, and diseases*) and where residential and commercial development has expanded into forested areas. (This strategy applies to Objectives 1.2-3.7)

Strategy 10. Accelerate management of brushland landscapes. Active management is required to maintain productive brushlands wildlife habitat. DNR will complete efforts to assess the extent and quality of large, open brushland landscapes. DNR will use the landscape planning process to identify priority brushland areas and will develop management plans across all ownerships for these areas. Management plans will specify appropriate use of controlled fire, mechanical disturbance, and herbicide treatments to maintain the health of the priority brushlands using the range of natural variation as a guide. (This strategy applies to Objectives 2.1, 2.2, 2.3, and 2.7)

Strategy 11. Increase focus on timber quality and productivity. Demand for more and higher quality timber will continue as society's need for forest products continues to grow and Minnesota's forest industry seeks to remain competitive in a world-wide market. Focusing attention on timber productivity and quality will help increase the quality and quantity of wood available for harvest in Minnesota and will enhance the protection of non-timber values in forested landscapes. For example, increasing the wood fiber productivity of a certain portion of the forest will help reduce the intensity of harvest pressures on other forest land. DNR will increase efforts in programs and initiatives that focus on increasing the amount and quality of timber produced from appropriate forest lands. (This strategy applies to Objectives 1.1, 1.2, 2.1, 2.5, 2.6, 3.1, 3.2, 3.5, and 3.7)

Strategy 12. Continue acquisition of critical land parcels. DNR will continue to acquire parcels of land that are adjacent to or within blocks of existing DNR lands. This strategy is especially important in areas of growing recreation or residential/commercial pressures. (This strategy applies to Objectives 1.2, 2.4, 3.1, 3.2, 3.4, and 3.7-4.2)

Strategy 13. Cooperate broadly with stakeholders and other agencies. Cooperative approaches to managing forest resources have expanded, especially with MFRC activities. DNR will continue to involve other agencies, stakeholders and the public in forest management decisions. The forest sub-section planning process provides opportunities to involve the public to provide input in developing management goals. (This strategy applies to all objectives.)

Strategy 14. Cooperate with other landowners in sale and exchange of DNR-administered land. DNR will be proactive in identifying surplus parcels for sale and will initiate land exchanges with public and private landowners within established natural resource management areas to consolidate state ownership. DNR will identify and remove trust fund lands from non-revenue producing natural resource management units on an annual basis. (This strategy applies to all objectives.)

Strategy 15. Cooperate with other agencies, local government, and stakeholders to help establish viable rural economies. DNR will work with other state agencies, especially the Minnesota Department of Agriculture and the Department of Trade and Economic Development, and with other stakeholders to strengthen the rural economy by minimizing the impact of land fragmentation and development on forest lands. (This strategy applies to all objectives.)

Strategy 16. Increase investments in information technology. Information technology includes data collection, research, ecosystem monitoring, inventory efforts, and acquisition of technology. The expansion of information management technology allows a better understanding of the relationships between management techniques and resource conditions.

Forest inventories, and related data gathering efforts provide information needed by all land owners to manage land in a sustainable manner. DNR will maintain and provide access to a wide range of databases (e.g., Forest Inventory and Analysis, Cooperative Stand Assessment, ECS, Forest Health Monitoring, County Biological Survey, Natural Heritage, mineral potential, etc.) and coordinate access to other databases that provide information on forest composition, wildlife habitat, rare species, cultural resources, etc. DNR will develop compatible forest information across all ownerships, focusing on spatial features of landscapes (habitat patch size, shape, connectivity) not addressed in previous inventories and assessments.

Data assessment and applications, such as those made possible by the Native Plant Community Classification effort and the interagency effort to develop a Range of Natural Variation for forest age classes, provide important opportunities to better use databases. Monitoring of impacts from roads, timber harvests and recreation use provide information needed to develop timber management plans and forest use policies. DNR will intensify data collection, database development, information sharing, data assessment and monitoring efforts so as to provide forest

managers with the information tools needed to manage forest ecosystems in a sustainable manner. DNR will improve the state land records system so that GIS technology can be better used to analyze land ownership records. (This strategy applies to all objectives.)

Strategy 17. Provide technical assistance and financial incentives to landowners. DNR will use private landowner assistance and easement programs (e.g. Private Forest Stewardship plans, Conservation Reserve Program and Forest Legacy Program) to help landowners manage their lands to meet personal and broader forest ecosystem objectives for timber production, maintaining forest ownership parcel size, recreation, wildlife habitat, and other forest resources. DNR will provide technical assistance to builders and developers to assist them in developing land in ways that are compatible with the limitations and opportunities provided by natural settings. DNR will coordinate stewardship programs with other entities, such as soil and water conservation districts.

DNR will provide technical assistance for mineral processing projects and for reclamation of mineral extractive sites. Long term management planning will provide communities with information and advice for mineral resources development and associated land use practices. DNR will assist private landowners in developing mineral product marketing efforts. (This strategy applies to all objectives.)

Strategy 18. Continue forest restoration and improvement. DNR will encourage restoration of non-forest land to forest cover where appropriate. DNR will assist private landowners in considering options for using land once in non-forest cover, for timber and other beneficial uses. DNR will restore the presence of some forest types such as Big Woods and white pine, which are less common than they once were. Other restoration strategies (removal of buckthorn and prescribed fire) will restore and maintain the ecological health of forest habitats. (This strategy applies to all objectives.)

Measuring Progress

Measuring progress toward forest management goals and objectives requires regular collection of forest resources information, including information on how those resources benefit society. In order to demonstrate forest resource accountability, DNR also must document how strategies have been implemented. Information (and specific indicators, where appropriate) will allow DNR to measure: 1) the ecological status of forests; 2) the economic status of forest-based industries; and 3) progress in implementing management strategies.

Goal One: Minnesota's forest land base will be enlarged and protected. Maintaining the state's forest land base is fundamental to achieving all of DNR's goals, including those associated with forests. To ensure that forestland is protected for the long term, DNR needs information on the extent of forest land, ownership and productive capacity. Examples of performance measures are:

- Acres of forestland categorized by ownership type (public, private industrial, private non-industrial) and productivity class (timber producing, non-timber producing).
- Average size of non-industrial private forest land ownership

Goal Two: Forest ecosystems will be healthy, resilient, and functioning. Forest ecosystem health and resilience insures that forests can respond to disturbances and the demands society place on them. Measures of forest composition and ecosystem functions are useful in documenting forest health. Examples of performance measures that focus on the distribution of forest plant communities, species, and ages are:

- Acres of old growth forest by type, or
- Acres of forest by community or forest type and age class.

Examples of performance measures that focus on forest health are:

- Number of species of plants and animals with significantly reduced geographic ranges or population sizes (compared to historic conditions),
- Tree growth rates.

Goal Three: Forest-based economic and recreational opportunities will be numerous and wide-ranging. Performance measures for this goal focus on uses of forests and the benefits of those uses for Minnesotans. Examples of performance measures are:

- Quantity of timber available,
- Quantity of timber harvested,
- Implementation of Visual Quality Guidelines
- Number of state forest campground user nights.