

Recreation and Aesthetic Resources

A Technical Paper for a Generic Environmental Impact Statement on Timber Harvesting and Forest Management in Minnesota

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SUMMARY

This technical paper focuses on the identification and evaluation of recreation and aesthetic impacts associated with timber harvesting and management in Minnesota over a 50-year planning horizon. Considering previously specified timber harvesting levels and looking at timber harvesting and forest management activities statewide, the objectives of this technical paper address the questions: (1) to what extent are forest recreation opportunities (both quantitatively and qualitatively) impacted by timber harvesting and forest management, and do such impacts vary by type of recreation (e.g., day use, overnight use, dispersed, nondispersed, onsite, consumptive, nonconsumptive); and (2) to what extent does timber harvesting and forest management impact the visual quality of Minnesota's forests?

The recreation opportunities and aesthetic features of forest lands in Minnesota are described in this paper, as are their distribution and the current use level of these resources. However, in developing these descriptions and assessing impacts, a number of data sources and constructs were used. Among these were (1) the statewide forest inventories and associated forest plot records, particularly those for 1990 and projected to 2040 by the study group that prepared the technical paper on Maintaining Productivity and the Forest Resource Base; (2) the Recreation Opportunity Spectrum (ROS) developed by the USDA Forest Service and available in the forest inventory data; (3) recreation activity data available from the Statewide Comprehensive Outdoor Recreation Planning (SCORP) data; (4) Recreation Value of forest plots as developed from their location and SCORP activity hour data; and (5) Attractiveness Value of plots as developed from the forest inventory data. Additionally, a Visual Sensitivity Rank was developed for each plot based on consideration of recreation and attractiveness values. These constructs (Recreation Value, Attractiveness Value and Visual Sensitivity Rank) provided a linkage between the forest setting, the recreation and aesthetic experience preferred by the public, and the recreation activities that take place on the site. Further, while subjective, the constructs provide a degree of consistency important to assessing impacts statewide. These constructs were developed following an extensive review of the literature on impacts of timber harvesting on recreation and aesthetics.

Study Approach

The GEIS relies on USDA Forest Service Forest Inventory and Analysis (FIA) plots as a major data source to characterize future forest resource conditions in response to timber harvesting. Consequently, the study approach first categorized FIA plots by their recreational value. The recreational value (1 to 5) was derived by assuming the managerial objectives of the ROS class to which the FIA plot has been assigned as well

as the extent of recreational activity (activity hours from SCORP data) occurring in the vicinity of the plot location. Subsequently the plot was categorized by a visual attractiveness value derived by consideration of plot (onsite) and regional (context) variables in the FIA data. The result was a landscape categorization of the forest environment by attractiveness values (1 to 5). Combining recreational and attractiveness values by ROS class then led to a ranking of plots by Visual Sensitivity (Rank I to V). A series of tabulations were then made to assess the extent to which harvesting impacted the FIA plots by ecoregion, ownership and Visual Sensitivity Rank. In doing so, emphasis was placed on the second model run output which incorporated a number of ownership constraints and mitigations (timberland availability, BMPs, extended rotation forests (ERF), wildlife buffers, old growth reservation).

Impact Analysis

The paper describes specific types of impacts and the likely results of these impacts on the recreational use and aesthetic experiences of forest visitors. Major findings and illustrations of them are given below.

The assessment indicates that timber harvesting and forest management activities have an impact on: (1) the quality of the recreational experience and on the number of hours of recreational activity at a given site; and (2) the visual perception and attractiveness of the forest setting. Some of the impacts are long-term while others are short-term and/or subject to change from forest growth and dynamics on that site or over a broader context or area. Table I.1 illustrates findings in terms of qualitative rankings for impacts on recreational opportunities. In several instances, while timber harvesting negatively impacts the quality of the recreational experience, improvements in access resulting from roads constructed in conjunction with timber harvesting may actually increase total recreational activity in the area. Tradeoffs like this are especially important when the lost opportunity (e.g., primitive area activity) is in short supply and cannot be replaced.

In terms of the potential extent of impacts, table I.2 describes the forest by the percent of plots (and in effect, acreage) by recreational opportunity (ROS) class.

Harvesting at the base scenario level (4.0 million cords per year) would subject approximately 50 percent of the timberland plots (45 percent of all plots) to harvesting over the 50-year study period. Harvesting at the medium (4.9 million cords per year) and high (7.0 million cords per year) scenarios would subject 59 and 70 percent of the timberland plots to harvesting. Harvesting beyond the year 2040 would tend to concentrate on the accessible and productive plots harvested in the first 50 years, i.e., additional harvesting is not likely to extend far beyond the set of plots harvested in the first 50-year period.

Table I.2 describes the overall rate of harvesting by visual sensitivity.

Table I.1. Qualitative impact of timber harvesting on forest recreation opportunities by setting (ROS class).

Activity	Recreation Opportunity Spectrum (ROS) Classes ^a									
	Primitive		Semiprimitive no motor		Semiprimitive motor		Roaded natural		Rural	
	A	B	A	B	A	B	A	B	A	B
Camping	-2	+1	-2	+1	-1	+1	-1	+1	0	0
Fishing	-2	+1	-2	+1	-1	+1	-1	0	0	0
Boating (motor)	na	na	na	na	-1	+1	-1	0	-1	0
Canoeing	-2	+1	-2	+1	-1	+1	-1	0	-1	0
Picnicking	na	na	na	na	-1	+1	-1	+1	0	0
Cross-country skiing	-2	+1	-2	+1	-2	+1	-1	+1	-1	0
Downhill skiing	na	na	na	na	na	na	-1	0	-1	0
Snowmobiling	na	na	na	na	-1	+2	-1	+2	0	+1
Walking/hiking	-2	+1	-2	+1	-2	+1	-2	+1	-1	0
Nature study	-2	+1	-2	+1	-1	+1	+1	+1	+1	0
Hunting	-2	+1	-2	+1	-1	+1	-1	+2	0	+1
Atv/orv	na	na	na	na	-1	+2	-1	+2	0	+2

^aColumn coding and values: A—this column represents the impact of timber harvesting on the quality of the recreation experience for an activity.

B—this column represents the impact of timber harvesting on the level of activity hours for an activity.

Cell values range from -2 large decrease, -1 decrease, 0 no change, +1 increase, +2 large increase.

na—not appropriate/not provided for.

Table I.2. Recreation opportunities on timberland and on all forest plots statewide.

Recreational Opportunity (ROS) Class	Percent of Plots	
	Timberland	All Forest
Primitive	0.4	3.1
Semiprimitive nonmotor	7.2	9.6
Semiprimitive motor	25.4	25.2
Roaded natural	41.7	38.7
Rural	25.0	23.0
Urban	0.3	0.4
Total	100.0	100.0

Table I.3. Distribution of timberland plots projected to be harvested for visual sensitivity ranks II through V (ROS classes semiprimitive motorized, roaded natural and rural).

Visual Sensitivity Rank	Percent of plots	Base Scenario		Medium Scenario		High Scenario	
		Percent of plots harvested	Percent of harvested plots	Percent of plots harvested	Percent of harvested plots	Percent of plots harvested	Percent of harvested plots
II (high)	14.8	60.1	17.3	67.4	16.6	80.9	17.1
III (moderate)	28.1	55.9	30.4	62.7	29.3	75.7	30.2
IV (low)	24.1	50.0	23.3	58.9	23.5	68.0	23.3
V (very low)	33.0	45.5	29.0	56.0	30.6	62.6	29.4
All ranks (II to V)	100.0	51.7	100.0	60.3	100.0	70.3	100.0

Given the constraints and mitigations assumed on state and federal lands, there appears to be a tendency to harvest areas of high visual sensitivity at a lower rate than areas of moderate to low sensitivity. The converse was found on private lands.

In terms of dynamics over time, the forests of Minnesota are aging and under the base and medium scenarios would continue to do so. For timberland, aging is also favored by ownership constraints and mitigations that preclude certain areas from clearcutting. Under the high scenario, the future forest would have an average age similar to that of today for most covertypes. However, the oldest ages, given 50 years of growth, would be greater than found today for many areas. It follows that average tree size, which is an important component of attractiveness, would be negatively impacted only in the high scenario and only for those covertypes subject to substantial harvesting (e.g., aspen, balsam poplar, maple basswood, etc.).

Recreation and aesthetic impacts were ultimately assessed against two significant criteria: (1) an impact is considered significant if there is projected to be development of permanent forest roads in areas meeting the criteria for either of the ROS categories of primitive areas and semiprimitive nonmotorized areas and (2) an impact is considered significant if visual management guidelines are not used in the planning and execution of timber sales in visually sensitive areas. The magnitude and distribution of significant impacts is presented in the context of ownership types and distribution across ecoregions.

Considering plots near the primitive end of the ROS, between 4 percent (base scenario) and 5 percent (high scenario) of the primitive plots on all forest lands (i.e., timberland, reserved and unproductive forest land), are projected to be harvested and thus significantly impacted. When only timberland is considered, this amounts to between 32 and 43 percent of all

ROS primitive

plots. Similarly, between 17 and 23 percent of the semiprimitive nonmotorized plots on all forest lands are projected to be harvested or between 26 and 35 percent of such plots on timberland. The significantly impacted plots are those which would require access by permanent roads. These plots are significantly impacted because such roads would by definition change the respective ROS class of the plots.

In assessing potential impacts of timber harvesting on forest aesthetics, timberland plots in national forest or state ownership were not thought to be significantly impacted because visual management guidelines are in place that effectively address impacts. Timberlands not in federal or state ownership have no visual management guidelines in place. In the base scenario 38 percent of nonfederal and nonstate owned timberland plots are projected to be significantly impacted. Under the medium and high scenarios 44 and 48 percent, respectively, are projected to be significantly impacted.

Mitigation strategies were developed to address the significant recreational and aesthetic impacts. The recommended mitigation strategies are a coordinated road trail plan, a prohibition of all forms of harvesting in the most recreationally sensitive timberland plots and a range of strategies for the remaining timberland plots, including: allowable harvest systems, allowable size of harvest area, allowable shape of harvest area, edge treatment, harvest area pattern requirements, residue management, planting specifications, restrictions on season of harvest, and information and interpretive programming.

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1 INTRODUCTION

The purpose of this technical paper is to assess the impact of timber harvesting and forest management activities on forest-based recreation and aesthetics. The specific objectives have been defined by the Minnesota Environmental Quality Board (MEQB) and reported in their Final Scoping Decision (FSD) (MEQB 1990).

1.1 Issues of Concern

The specific issues of concern identified in the FSD relative to recreation and aesthetics are expressed as the following questions:

Forest Recreation. Forests provide significant opportunity for a wide variety of outdoor recreational experiences. Considering previously specified timber harvesting levels and looking at timber harvesting and management activities statewide:

- 1. To what extent are forest recreation opportunities, both quantitatively and qualitatively, impacted by timber harvesting and management? Do such impacts vary by type of recreation (e.g., day use, overnight use, dispersed, nondispersed, onsite, consumptive, nonconsumptive)?*

Aesthetics. Forests provide a variety of scenic vistas. Considering previously specified timber harvesting levels and looking at timber harvesting and management levels statewide:

- 1. To what extent does timber harvesting and management impact the visual quality of Minnesota's forests?*

1.2 Report Structure

Study Tasks and Organization

Forest-based recreation and aesthetics are subjects with both quantifiable and subjective elements. Since a major intent of this study was statewide and long-term impact assessment, the methodology by necessity required the development of certain constructs to provide consistency in treatment of the subjective or qualitative aspects of the subject matter. These constructs are described below.

This study, like other technical papers in the GEIS, relied heavily on the statewide forest inventory data and modelling to describe the resource and extent of harvesting. However, this study also required information on

recreational activity, the value of certain resource characteristics for such activity, and how that activity might be impacted by timber harvesting and forest management. Additionally, the study required some quantification of the aesthetic value of the resource and how that might be affected by harvesting and management. These information needs meant that the study had to go beyond forest inventory data, bring in other data and develop linkages between these data. The schematic outline in figure 1.1 describes the data/information that ultimately was used, the constructs that were developed to link them, and the application to impact analysis.

DATA/INFORMATION/ANALYSIS	CONSTRUCTS
Forest inventory data: <ul style="list-style-type: none"> • Forest resource (plot) description including: <ul style="list-style-type: none"> - location, covertime, stand age, site conditions, etc. - Recreation Opportunity Spectrum (ROS) 	<ul style="list-style-type: none"> • Timberland recreation unit (TRU) (area around a plot)
Recreation activity data: <ul style="list-style-type: none"> • State Comprehensive Outdoor Recreation Planning (SCORP) data including activity hours • plot location x activity hours x ROS 	<ul style="list-style-type: none"> • Recreation value
Aesthetics data: <ul style="list-style-type: none"> • from forest plot/resource description • onsite + contextual attractiveness dimensions 	<ul style="list-style-type: none"> • Attractiveness dimensions • Attractiveness value
Additional combinations of data and constructs: <ul style="list-style-type: none"> • recreation x aesthetics constructs • ROS x recreation x aesthetics 	<ul style="list-style-type: none"> • Visual sensitivity rank • Primitive sensitivity rank
Forest change and harvest projections: <ul style="list-style-type: none"> • plots harvested by scenario 	<ul style="list-style-type: none"> • Plots (areas) impacted
Impact analysis/significance/mitigations <ul style="list-style-type: none"> • recreation • aesthetics 	<ul style="list-style-type: none"> • All of above • All of above

Figure 1.1. Schematic outline of stand approach involving data, constructs and analysis.

Note that the constructs describe the plot or forest resource in ways that allow linking of the resource with recreation and aesthetic issues and concepts. The basis for the constructs was developed from a review of literature on forest based recreation and aesthetics research. However, the broad application of these ideas as in this assessment required considerable adaptation. While the constructs are by nature somewhat subjective, they do provide the level of consistency important to statewide analyses. This report follows this schematic in the development of the constructs and analysis of their implications for impact assessment.

Background and Sources of Data Inputs Used in the Analysis

This study has been structured to complement work prepared for the other technical papers. Consistent formats were required to accept much of the input data and subsequently to present the results of the analysis.

The statewide scope of the study, as well as the need to be able to interpret the output of the forest change and scheduling model, necessitated use of the statewide U.S. Forest Service Forest Inventory and Analysis (FIA) database. The plots described in these data are the fundamental decision units used to create the three harvest scenarios analyzed in the GEIS.

Consistent presentation format across the study groups was achieved by mandating use of defined ecoregions (see section 1.4) as the minimum unit for presentation of output. The ecoregion format and requirements to use the FIA data defined the options available for this group to address the scoped issues.

Forests provide many opportunities for a wide variety of recreational experiences. The forest recreation experience is highly dependent upon visual and other sensory stimuli which contribute to the perceived aesthetic values of the forest. Research on recreation opportunities indicates that the quality of recreation experiences and the ability of a forest resource to attract visitors/tourists/recreationists to those experiences are closely related to the aesthetic values of the forest. This strong connection between recreation and forest aesthetics also works the other way. Aesthetics become more or less important to the way a forest is managed, depending on the types and amounts of recreational uses available, both now and in the future. As aesthetics become more important, management must become more sensitive to changes in aesthetic values. Therefore, the forest recreation and forest aesthetics issues from the FSD were brought together in a single technical paper. The recreation subgroup worked closely with the aesthetics subgroup to coordinate the literature review in common topic areas, to share literature reviews and data and to develop a common methodology for impact assessment.

As required by the FSD, the GEIS addresses impacts at three levels of harvest: the existing or base level of 4.0 million cords harvested per year, a medium level of 4.9 million cords per annum by 1995 if all planned and potential industry expansion were developed; and a high level of 7.0 million cords by the year 2000.

This paper describes the recreational usage of Minnesota's forests and associated waterbodies, and assesses changes to recreational usage that might occur under the three levels of harvest mentioned above. Aesthetic values of Minnesota's forests are also described. In addition, the various approaches to managing those values, as used by different ownerships, are

also discussed. This description includes techniques of visual management planning currently used by some ownerships to mitigate adverse visual impacts. Subsequently, the paper describes techniques that are used to identify visually sensitive timberlands. The analysis identifies timberlands which are likely to be harvested using visual management guidelines (VMG). Timberlands that are harvested without use of VMGs are assumed to cause at least a temporary adverse impact.

The impacts identified in the recreation and aesthetics analyses were then assessed against the approved significant impact criteria that were developed following input by the MEQB, the GEIS Advisory Committee and Core Group. Mitigation alternatives were developed to address impacts considered to be significant.

Recreation Opportunities

For the purpose of this study, the term *natural resource based outdoor recreation* was used to distinguish experiences that involve forests and associated water bodies from those that are merely outdoor recreation experiences, such as those that occur at playgrounds or when playing softball.

1.3 Factors Shaping the Study Approach

Much information is available on the impact that setting attributes, recreation activities and recreation-related values can have on user experiences and ultimately, recreation opportunities. In contrast, there is little information available that directly ties the impacts of specific timber harvest activities to recreational opportunities or visual characteristics of the landscape. Only limited research has been conducted to examine the relationship between timber harvesting and recreational use patterns in Minnesota. Some research has been conducted in the western U.S. that describes recreational use occurring on harvested lands. However, aside from these studies, changes in recreation opportunities that are likely to result from harvesting are not well-known.

Similarly, information about forest aesthetic values exists, but most of it applies to forested areas in mountainous regions of the country. Timber harvesting and forest management practices can change the visual resource. In certain cases, legislative mandate or public sentiment require consideration of these changes in resource management decisions. Despite this, in Minnesota, as in most states, little is known on a statewide basis about how or why different landscapes appeal to different kinds of recreationists and therefore how changes in aesthetic values will impact these users.

On some public lands within the state, the kinds of recreation opportunities managers provide are known and, in some cases, why visitors go to those places is also known. For example, the Minnesota Department of Natural Resources (MNDNR) has conducted surveys to find out where recreationists go, what activities they engage in, what their motives are, and what kinds of facilities/resource areas are needed to meet current and future recreation needs statewide (see section 2.2). Also, an extensive annotated bibliography exists of social science research conducted in the Boundary Waters Canoe Area Wilderness (BWCAW).

In contrast, little is known about the patterns of recreational use on private lands, or lands managed by some of the other major landowner groups such as Native American tribes and counties. Since the location, number, and type of recreation opportunities existing statewide has never been adequately recorded, it is unclear whether or how previous timber harvesting practices have diminished or enhanced these opportunities.

This lack of research was identified as a constraint to the study in the Feasibility Assessment (Jaakko Pöyry Consulting, Inc. 1991a), and the approved GEIS Workplan (Jaakko Pöyry Consulting, Inc. 1991b). As anticipated in these documents, the data available in these subject areas is highly qualitative as it is heavily dependent on individual preferences as well as other factors.

Therefore, to address the scoped issues the study group needed to rely extensively on their own professional judgement to interpret the literature. Due to the lack of uniform statewide data, the study group was required to develop methodologies to derive information from existing data sources. These methods are described in more detail in subsequent sections of this technical paper.

1.4 Spatial Resolution

During the ice age, glaciers covered all but the southeastern corner of the state. As they retreated northward and melted, these glaciers left behind a landscape riddled with lakes and streams, rugged terrain with exposed bedrock and ancient seabeds. As a result, Minnesota contains many distinct landscape regions, each defined by unique ecological and geological characteristics. There are many different classification schemes used to define ecoregions in the state. This technical paper uses seven of the ecoregions recommended by the Upper Great Lakes Biodiversity Committee (figure 1.2) as reported in the Maintaining Productivity and the Forest Resource Base technical paper (Jaakko Pöyry Consulting, Inc. 1992a).



Figure 1.2. Ecoregions of Minnesota.

Glacial Lake Plains

The glacial lake plains ecoregion is characterized by flat, extensive peatlands, with intermittent sandy soil. Stands of black spruce, tamarack and white cedar predominate, with aspen-birch and jack pine barrens also being prominent.

Border Lakes

The border lakes ecoregion includes the BWCAW which is characterized by bedrock outcroppings and clear, cold, rocky lakes. Pine, spruce and aspen-birch stands dominate the landscape.

Lake Superior Highlands

The Lake Superior highlands ecoregion is characterized by the rock cliffs along Lake Superior and the waterfalls and gorges of the myriad streams

that flow into the lake. The upland areas are covered by glacial moraines. Today, as a result of logging in the state, the landscape is dominated by stands of aspen and birch.

Central Pine-hardwoods

This is the largest ecoregion in the state. The central pine-hardwoods is geologically diverse. It is dotted by countless lakes and wetlands and deposits of coarse gravel left behind as glaciers receded. This ecoregion is defined by the iron ore mines of the Cuyahuna range, as well as the peatlands of glacial Lake Aitkin, outwash plains, terminal moraines and sandy plains. This ecoregion has the most diverse vegetative cover of all the ecoregions in the state.

Western Prairie/forest Transition

This ecoregion is characterized by rolling terrain and lakes, outwash plains deposited by glacial meltwater streams, wet marshy areas, and finer soil materials. Maple-basswood, aspen-oak and oak savanna remnants dominate the landscape. Much of this area is now agricultural land. In some tabulations this ecoregion was broken further into a south, southwest and northern component as appropriate (ecoregions 7, 8 and 9, respectively).

Eastern Prairie/forest Transition

Unlike most other ecoregions of the state, this area was not glaciated. Meltwater carved through the sedimentary rock forming rolling hills, steep valleys with exposed rock bluffs and flat floodplains. Much of the area is now agricultural, but hardwoods, primarily oak, are prominent in the wooded areas.

Western Prairie

The western prairie is a transition zone between the grasslands and coniferous forests. It has rich soils deposited from Lake Agassiz. Much of this area is now agricultural. This ecoregion (7) is sometimes broken down further to form ecoregions 8 and 9 which comprise the southwestern and northern parts, respectively, of what is normally considered ecoregion 7.

2

PRIMARY INFORMATION SOURCES

There was much information to work with, but key linkages among data sets were often absent.

2.1

Forest Inventory and Assessment (FIA) Data

The FIA data, specifically that from the 1990 Minnesota survey, was a

major input to the study. According to the survey, 43,959 ground verified FIA survey plots exist statewide, and 14,296 of these were classified as forested or as having trees on them. Technically, forest land in Minnesota is a complex of land and land use types with trees. The FIA survey refers to these lands by the ground land use (GLU) variable.

In general, there are three classes of forest land, *timberland* or commercial forest, reserved forest (such as the BWCAW) and unproductive forest (woodland). These are outlined in table 2.1 along with the various nonforest with trees and other classes that also contribute to the overall landscape. Note that the FIA plots are distributed systematically (with a random start) across the state, but given land use patterns, forested plots are concentrated in the northern and eastern parts of the state.

Table 2.1. Summary of 1990 FIA data.

Ground Land Use (grouping)	Number of plots	Thousand acres	Percent acreage
Timberland or commercial forest	12,118	14,773.4	83.6
Reserved forest	674	1,113.1	6.3
Other forest (unproductive)	744	828.3	4.7
Nonforest with trees*	760	953.6	5.4
Total	14,296	17,668.4	100.0

Source: Jaakko Pöyry Consulting, Inc. (1992a).

*Includes pasture with trees, wooded strips, marsh with trees, windbreaks, urban forest reserved, urban with trees, etc.

Note that *timberland* or commercial forest land was based on the FIA GLU variable and consists of plots coded as *timberland*, *pastured timberland* and *plantation*. The combination of these categories results in a total of 12,118 plots so classified. Subsequently, changes to timberlands are emphasized since timber harvesting and forest management activities are effectively confined to these areas. The other two categories of forest—reserved and unproductive lands, were also considered, but primarily in the interpretation of results.

The following data attributes were examined for each of the timberland plots: vegetation and site descriptors, the recreation opportunity spectrum (ROS) class (see section 3.1), the ownership classification and the dominant land use (GLU). A code assigning each plot to an ecoregion in the state was also added to the data set.

Vegetation and site descriptors from the plots were used to describe the localized setting and to develop a model of relative attractiveness as a surrogate for aesthetic values (see sections 3.21 and 3.22).

FIA ROS Attribute

The ROS attribute is used extensively in this study to suggest the setting or landscape context of recreational opportunity for the forested plots on a primitive to urban scale. The development and use of ROS is described in section 3.1. The criteria used by the FIA field crews to determine the ROS class of a plot can provide an indication of the distinguishing characteristics and meaning of these classes. The FIA field crews determine the setting of the immediate plot area in relation to the surrounding natural environment using the following criteria:

1. ***Primitive.*** An area three or more miles from all maintained roads or railroads and which has an unmodified natural environment. There can be evidence of foot trails, or recreational use. Structures in use are rare. Contact with humans is rare and chances of seeing wildlife are good. Example: BWCAW, Minnesota.
2. ***Semiprimitive Nonmotorized.*** An area one-half to three miles from all maintained roads or railroads, but which can be close to primitive roads or trails used only occasionally. Modifications to the environment are evident, such as old stumps from logging, but are not apparent to the casual observer. Structures in use are rare. Human contact is low and chances of seeing wildlife are good. Example: recently undisturbed state lands.
3. ***Semiprimitive Motorized.*** An area one-half to three miles from all maintained roads or railroads, but one-half mile or less from primitive roads or trails used by motorized vehicles. Modifications to the environment, human contact and chances of seeing wildlife are the same as semiprimitive nonmotorized. Example: state lands with snowmobile trails.
4. ***Roaded Natural.*** An area less than one-half mile from maintained roads or railroads. Modifications to the environment may be obvious, and buildings are occasionally seen. Chances of seeing wildlife are diminished by evidence of increased human contact. Example: private hunting lands.
5. ***Rural.*** An area close to maintained roads, but not limited by distance, and in a setting which has been substantially altered by humans. Structures and houses are obvious and/or visible, and human contact is frequent. Wildlife can be present, but sightings are rare. Example: farm woodlot.

6. **Urban.** An area close to maintained roads, but not limited by distance and surrounded by an urban-suburban setting. Substantial modifications to the environment may be apparent and buildings or structures can usually be seen. Human contact is quite frequent and wildlife sightings are rare. Example: home development areas.

In addition, the size of the immediate plot area is estimated by aerial photo interpreters and field checked by the field crews. In general, large areas tend to display more primitive characteristics. Small areas tend to display characteristics more likely to be found in roaded natural, rural or urban settings.

2.2

State Comprehensive Outdoor Recreation Plan (SCORP)

Background and Definition of Terms

Recreational use intensity is the amount of recreational activity an area sustains over a given period of time. The most common method to determine recreation use intensity is to count the number of recreational users on a given site engaging in a particular activity(s) for a specific length of time. Agencies such as the USDA Forest Service measure recreation use intensity in terms of visitor days. One visitor day is equal to one person recreating on a site for a period of up to twelve hours. Other federal and state agencies use similar measures.

The MNDNR Office of Planning uses *activity hours* to arrive at recreational use intensity (MNDNR 1990). An activity hour is more specific than most measures, measuring the length of time a recreation user engages in an activity such as camping, fishing, boating, sightseeing or birdwatching at a given site.

Use of SCORP Data in the Study

The number of activity hours by type of recreation associated with each plot was determined through the SCORP database. This database is the product of a statewide household survey conducted by the MNDNR during 1985. In the survey, participants were asked how many hours they had recreated, where their recreation activities took place, and the kinds of recreational activities they had engaged in over the past week. These data were then analyzed and entered into a geographic information system (GIS) database.

The SCORP data sample was designed to provide regional comparisons of outdoor recreation activity. As such, the SCORP data are particularly appropriate for use in an assessment undertaken at the statewide scale of resolution required for the GEIS. The MNDNR's office of planning is responsible for maintaining and overseeing use of the SCORP database.

This office indicated that the finest level of resolution at which the statistical validity of the data could be maintained was an area defined by a radius of 18 miles (see below). This is the level of resolution used to generate MNDNR regional recreation studies and other uses of the SCORP data. Use of the SCORP data in this study is consistent with the original purpose for which the database was developed.

Data for the SCORP study were recorded at a township level. A smoothing algorithm had to be applied to the data because people sampled in the study often had difficulty recalling the precise location of their recreational activities; and because the sample size in some townships was too small for statistical accuracy. The algorithm assigned the average numbers of activity hours reported within a three township (18-mile) radius of each township. This database provides the most comprehensive assessment of outdoor recreation activity available in Minnesota.

One of the consequences of the methodology used to develop SCORP is that where areas are reasonably homogeneous and use levels are consistent, the smoothing algorithm would have little effect. In contrast, data from areas that are heterogeneous may show some inconsistencies. For example, motorized activities may show up in wilderness adjacent to motorized areas. It is therefore necessary to scrutinize input data, and to use care when interpreting outputs from analyses which use the data.

For this study, the MNDNR office of planning used SCORP data for a selected range of activities to develop estimates of the number of activity hours.¹ Subsequently, the level of activity hours associated with the township within which an FIA plot was located were then attributed to that plot. Twelve recreational activities were selected as relevant to forest recreation: walking, hiking, camping, fishing, boating, canoeing, hunting, picnicking, cross-country skiing, downhill skiing, snowmobiling, nature study including birdwatching, and driving all-terrain and/or off-road vehicles.

The role of timberlands in providing these recreation opportunities varies considerably. For some activities, such as nature study and hiking, the forest setting is a key factor and therefore, these activities are closely linked to forests. In contrast, forests provide only a backdrop for other activities used in the analysis, such as lake-based boating and fishing activities.

¹MNDNR Office of Planning, 1991.

3

ISSUE DESCRIPTION

3.1

Forest Recreation

Recreation value is described as: (1) kinds of recreation experiences visitors have when engaging in selected activities in particular settings and (2) the intensity or amount of recreational use an area receives.

Recreation Opportunity Spectrum (ROS)

Public preferences for outdoor recreation vary among recreation users and, individual tastes for recreation experiences may change over time (Burch 1966, McCool et al. 1984, Williams 1984, Clark and Downing 1984, Downing and Clark 1984). A systems approach to outdoor recreation management, the ROS, was developed in the late 1970s and early 1980s to assist agencies to respond to the diversity of recreation experiences the public demanded (Bultena and Klessig 1969, Lloyd and Fischer 1972, Brown et al. 1978, Driver and Brown 1978, Brown et al. 1979). Currently, several state and federal agencies, such as the USDA Forest Service and the USDI Bureau of Land Management use ROS as a planning management tool.

Briefly, ROS describes six levels of recreation opportunities—primitive, semiprimitive nonmotorized, semiprimitive motorized, roaded natural, rural, and urban. Generally, opportunities described in the primitive range are less developed, less accessible, less abundant, and occur in more natural or less developed areas than nonprimitive opportunities. Additionally, recreation activities that take place on lands at the primitive end of the spectrum are activities that require a more dispersed setting and do not include the use of motorized transport (Brown et al. 1979). Conversely, activities that take place at the more developed end of the spectrum typically depend on better access and more developed facilities.

Recreation opportunities are characterized by three major components—activity, setting, and recreation experience.

Activity: table 3.1 shows the kinds of land based, water based and snow and ice based activities that are considered appropriate for each of the ROS classes. The list of activities presented is not exhaustive, but represents the types of activities users will most likely undertake while recreating in a given ROS class. Specific additions or deletions from the list will depend on local forest conditions.

Setting: the recreation setting component describes the physical, social and managerial attributes found within each ROS class (table

3.2). As the ROS class changes from primitive to urban the setting become less remote and perhaps smaller in size. In addition, there is greater evidence of humans, greater user density and more noticeable management and regimentation (Brown et al. 1979).

Experience: the experience component changes across ROS classes (table 3.3). At the primitive end of the spectrum the opportunities for solitude, closeness to nature, tranquility and self-reliance are at a maximum. In contrast, more opportunities to experience affiliation with other recreation user groups as well as convenient sites and more developed facilities are provided on lands at the nonprimitive end of the spectrum.

3.2 Forest Aesthetics

3.2.1 Aesthetic Values of the Forest: Transaction of People and Environment

Aesthetic values of the forest environment result from a transaction between people and a forest's physical characteristics in a specific context. Practically speaking, the term *transaction* implies an *experience*. Therefore, aesthetic value of a forest environment and the aesthetic impact of forest management vary, depending on the physical characteristics of the forest, the characteristics of the people experiencing the environment, and the psychological, social, physical, managerial and temporal context in which the experience takes place (Pitt 1989, 1990).

Multisensory Perception of Forest Environments

Much human perception of the forest involves visual cues, but nonvisual sensations also play a significant role in enriching forest images. For example, in addition to its strong visual appeal, the aesthetic value of a pine cathedral is also linked to the smell of pine resins, the sound of wind whispering through pine boughs and the bouncing movement of walking over a soft needle-covered floor. Over time, people learn from their own experiences or through social norms that a particular pattern of sound, sight, smell and touch is known as a *pine cathedral*. They also learn that this pattern is both attractive and pleasing and that it is associated with high aesthetic value. The definition of aesthetic value used here, termed the *transactional model*, can be defined as an experience resulting from an interaction between humans and their environment. The interaction can involve sights, sounds, smells, or touch. The interaction is further defined by the meanings that society or a particular social group assign over time to these experiences.

Table 3.1. ROS activity characterization.

Primitive/Semiprimitive nonmotor	Semiprimitive motor	Roaded natural/Rural	Urban
<p><u>Land Based:</u> Viewing scenery Hiking and walking Horseback riding Tent camping Hunting Nature study Mountain climbing</p> <p><u>Water Based:</u> Canoeing Other watercraft (nonmotorized) Swimming Fishing</p> <p><u>Snow and Ice Based:</u> Snowplay Cross-country skiing/snowshoeing</p>	<p><u>Land Based:</u> Viewing scenery Automobile (off road use) ORV/ATV use Aircraft use Hiking and walking Horseback riding Camping Hunting Nature study Mountain climbing</p> <p><u>Water Based:</u> Power boating Canoeing Sailing Other boating Swimming Diving (scuba/snorkel) Fishing</p> <p><u>Snow and Ice Based:</u> Snowmobiling Skiing, downhill Snowplay Cross-country skiing /snowshoeing</p>	<p><u>Land Based:</u> Viewing scenery Viewing activities Viewing works of humankind Automobile (on and off road use) ORV/ATV use Specialized landcraft use Aircraft use Aerial trams and lifts use Hiking and walking Bicycling Horseback riding Camping Picnicking Resort and commercial services use Resort lodging Recreation cabin use Hunting Nature studies Mountain climbing Gathering forest products Interpretive services</p> <p><u>Water Based:</u> Tour boat and ferry use Power boating Canoeing Sailing Other watercraft use Swimming and waterplay Diving (skin/snorkel/ scuba) Waterskiing Fishing</p> <p><u>Snow and Ice Based:</u> Snowmobiling Ice skating Sledding and tobogganing Downhill skiing Snowplay Cross-country skiing/ snowshoeing</p>	<p><u>Land Based:</u> Viewing scenery Viewing activities Viewing works of humankind Automobile (on and off road use) ORV/ATV use Train and bus touring Aircraft use Aerial trams and lifts use Hiking and walking Bicycling Horseback riding Camping Picnicking Resort and commercial services use Resort lodging Recreation cabin use Hunting Nature studies Gathering forest products Interpretive services Team sports participation Games and play participation</p> <p><u>Water Based:</u> Tour boat and ferry use Power boating Canoeing Sailing Other watercraft use Swimming and waterplay Diving (skin/snorkel/ scuba) Waterskiing and watersports Fishing</p> <p><u>Snow and Ice Based:</u> Snowmobiling Ice skating Sledding and tobogganing Downhill skiing Snowplay Cross-country skiing/snowshoeing</p>

Source: USDA Forest Service ROS user's guide.

Table 3.2. ROS setting characterization.

Primitive	Semiprimitive Nonmotorized	Semiprimitive Motorized	Roaded Natural	Rural	Urban
<p>Area is characterized by essentially unmodified natural environment of fairly large size. Interaction between users is very low and evidence of other users is minimal. The area is managed to be essentially free from evidence of human-induced restrictions and controls. Motorized use within the area is not permitted.</p>	<p>Area is characterized by a predominantly natural or natural-appearing environment of moderate-to-large size. Interaction between users is low, but there is often evidence of other users. The area is managed in such a way that minimum onsite controls and restrictions may be present, but are subtle. Motorized use is not permitted.</p>	<p>Area is characterized by a predominantly natural or natural-appearing environment of moderate-to-large size. Concentration of users is low, but there is often evidence of other users. The area is managed in such a way that minimum onsite controls and restrictions may be present, but are subtle. Motorized use is permitted.</p>	<p>Area is characterized by predominantly natural-appearing environments with moderate evidences of the sights and sounds of man. Such evidences usually harmonize with the natural environment. Interaction between users may be low to moderate, but with evidence of other users prevalent. Resource modification and utilization practices are evident, but harmonize with the natural environment. Conventional motorized use is provided for in construction standards and design of facilities.</p>	<p>Area is characterized by substantially modified natural environment. Resource modification and utilization practices are to enhance specific recreation activities and to maintain vegetative cover and soil. Sights and sounds of humans are readily evident, and the interaction between users is often moderate to high. A considerable number of facilities are designed for use by a large number of people. Facilities are often provided for special activities. Moderate densities are provided far away from developed sites. Facilities for intensified motorized use and parking are available.</p>	<p>Area is characterized by a substantially urbanized environment, although the background may have natural-appearing elements. Renewable resource modification and utilization practices are to enhance specific recreation activities. Vegetative cover is often exotic and manicured. Sights and sounds of humans, onsite, are predominant. Large numbers of users can be expected, both onsite and in nearby areas. Facilities for highly intensified motor use and parking are available with forms of mass transit often available to carry people throughout the site.</p>

Source: USDA Forest Service ROS User's Guide.

Table 3.3. ROS experience characterization.

Primitive	Semiprimitive Nonmotorized	Semiprimitive Motorized	Roaded Natural	Rural	Urban
Extremely high probability of experiencing isolation from the sights and sounds of humans, independence, closeness to nature, tranquility, and self-reliance through the application of woodsman and outdoor skills in an environment that offers a high degree of challenge and risk.	High, but not extremely high, probability of experiencing isolation from the sights and sounds of humans, independence, closeness to nature, tranquility, and self-reliance through the application of woodsman and outdoor skills in an environment that offers challenge and risk.	Moderate probability of experiencing isolation from the sights and sounds of humans, independence, closeness to nature, tranquility, and self-reliance through the application of woodsman and outdoor skills in an environment that offers challenge and risk. Opportunity to have a high degree of interaction with the natural environment. Opportunity to use motorized equipment while in the area.	About equal probability to experience affiliation with other user groups and for isolation from sights and sound of humans. Opportunity to have a high degree of interaction with the natural environment. Challenge and risk opportunities associated with more primitive type of recreation are not very important. Practice and testing of outdoor skills might be important. Opportunities for both motorized and nonmotorized forms of recreation are possible.	Probability for experiencing affiliation with individuals and groups is prevalent, as is the convenience of sites and opportunities. These factors are generally more important than the setting of the physical environment. Opportunities for wildland challenges, risk-taking, and testing of outdoor skills are generally unimportant except for specific activities like downhill skiing, for which challenge and risk-taking are important elements.	Probability for experiencing affiliation with individuals and groups is prevalent, as is the convenience of sites and opportunities. Experiencing natural environments, having challenges and risks afforded by the natural environment, and the use of outdoor skills are relatively unimportant. Opportunities for competitive and spectator sports and for passive uses of highly human-influenced parks and open spaces are common.

Source: USDA Forest Service ROS User's Guide.

Influence of Differences Among People

Aesthetic values perceived by people in the forest vary, depending on their backgrounds, life cycles or life styles, and physical, emotional or cognitive abilities and disabilities. That which is perceived as attractive to a 22-year old who grew up in the mountains of Colorado may invoke fear and distaste to an 80-year old lifelong resident of Manhattan Island.

Contextual Influences

The aesthetic values perceived by the same person visiting a specific forest environment on repeated occasions will vary with alternations in the psychological, social, physical, managerial and temporal context of the visit. For example:

- When seeking the experience of solitude, a person's aesthetic expectations of and sensitivities to a forest are likely to be different than when seeking a setting for a picnic with many members of an extended family. The ROS considers these expectations and is designed to ensure that a broad range of settings is available to meet them. The aesthetic value derived by a person within a given forest environment will likely change as they gain familiarity with the area, or as they develop expertise in forest recreation activities.
- Perceptions of a forest from the back seat of an automobile travelling at 55 miles per hour on a four-lane highway are different from those of walking on a forest trail parallel to the four-lane highway.
- The discovery that a favorite forest campground has been closed by forest managers to permit rehabilitation of degraded soil and groundcover vegetation may alter a person's perception of the entire forest unit.

Disciplinary Approaches to Landscape Perception

Knowledge about perception and management of aesthetic values in the forest environment has evolved from several perspectives (Zube 1984).

1) Professional Judgment. Landscape architects, geographers and foresters have developed a set of theories to explain the perception of forest environments in terms largely restricted to visual characteristics of the forest (e.g., Litton 1968; Simonds 1987). These professional judgment theories have served as the basis for a management approach that attempts to manipulate forest environments as visual resources (e.g., USDA Forest Service 1973). They form the basis for the visual resource management guidelines used by the USDA Forest Service and the MNDNR to manage the federal and state forest holdings in Minnesota.

2) Behavioral Approach. Geographers, psychologists, and other social

scientists have conducted experiments that try to understand how different people perceive various kinds of forest environments (e.g., Daniel and Boster 1976; Kaplan and Kaplan 1982). Most of the focus in this literature is on vision.

3) *Humanistic Approach*. The humanistic approach to understanding perception of forest environments is more holistic than either the professional judgment or the behavioral approaches. Humanists examine perception from philosophical, historical or experiential perspectives, and they attempt to describe and interpret the meaning of the interaction of people and environment in terms of all five senses. The humanist approach comes closest to considering the multisensory experience of environment. However, it has yet to be translated into a set of criteria and standards that can be applied to the management of forest environments (Daniel and Vining 1983; Zube et al. 1981).

Attractiveness as a Surrogate for Aesthetic Values

The state of the art in aesthetic resource management, especially as it relates to forest environments, is heavily focused on the visual aspects of perception, values, attractiveness, and impacts. Therefore, for the remainder of this report, the analysis assumes that visual values, especially those associated with *attractiveness*, can be considered as being surrogates for aesthetic values. The term *aesthetic value* is hereafter used in its more narrow meaning—relating to visual perception and attractiveness. Factors or *dimensions* that contribute to the relative attractiveness of forests are described in the following section.

Recreation Value as a Component of Aesthetic Value

Aesthetic values also need to be defined in terms of the characteristics of the people who are experiencing the environment and the context in which these experiences occur. Consequently, the following assumptions are made in this analysis:

- people are Minnesota residents and others who use Minnesota's forests;
- the context of experience is limited to recreational activity that is consistent with forest management objectives; and
- the definition of activities considered to be consistent with objectives is based on the spectrum of activities appropriate to a forest's recreation opportunity rating as set out in table 3.1 (Brown, Driver and McConnell 1977).

Data gathered in a statewide survey of Minnesota residents for the 1985 Minnesota SCORP provide detailed information on statewide recreational activity levels and patterns. Where they are explicitly stated, an owners'

managerial objectives for a given forest provide insight into the appropriateness of specific use types for a given forest. For example, forest areas managed for primitive opportunities typically forbid motorized use. Therefore, motorboating or snowmobiling are inappropriate uses. In contrast, a wider range of uses including motorboating and snowmobiling, may be very acceptable in a forest managed for more diverse use.

Only a minority of timberland ownerships develop specific forest management objectives and not all of these ownerships concern themselves with recreational uses (see section 5.1.2). Therefore, in the absence of articulated objectives for recreation use over a large proportion of the state's timberlands, it was necessary to develop an alternative approach that would allow a consistent, statewide analysis of recreation opportunities. This was developed by assuming that only uses consistent with a plot's ROS class occurred on the plot. These are termed "managerially appropriate uses." Thus, the amount of managerially appropriate use occurring in the vicinity of a FIA forest plot is used as a measure of the plot's *recreation value* as defined in section 3.1. Recreation value, therefore, serves as a surrogate for the activity of people in any particular context or setting. This assumption is developed further in section 4.1.

Collective Nature of Aesthetic Experiences

The experiences that people have with forest environments take place over time and space (Litton et al. 1974). Thus, visual response to any location undergoes comparison with responses to other locations. Also, the visual responses to different parts of a forest are integrated toward the creation of an overall impression or image of the forest. The sequential and integrative nature of visual response to environment has two implications: (1) response to any given location must be framed in the context of responses that could be elicited from other locations in nearby environments; and (2) responses to environments that are vastly different in character (e.g., Minnesota and Arizona) are not directly comparable.

Summary

- Forest aesthetic values emerge from the experience of people with forests in specific contexts;
- assessing aesthetic value of a forest environment involves an analysis of forest appearance as well as the recreational expectations placed on the environment;
- the aesthetic value of a specific tract of forest is affected by the visual character of surrounding areas, as well as its onsite appearance;
- recreation value is used as a surrogate for the activity of people in a context or setting; and
- recreation value is an important component of aesthetic value.

3.2.2

Factors Contributing to Relative Attractiveness of Forests

Definition of Attractiveness and the Picturesque Ideal

While the attractiveness of forests seems fundamentally simple and involves personal preference, there is much history to our understanding. Aesthetic interpretation of forest landscapes is driven largely by remnants of “the Beautiful, the Sublime and the Picturesque,” an 18th century English philosophy of aesthetics. The beautiful is epitomized by landscape scenes that are framed by trees and contain views of peaceful, gentle and pastoral valleys. *Beautiful* landscapes contain warm light, soft, rounded forms of tree masses and landforms, and fine textures created by pasture and open field vegetation.

The *sublime* landscape contains jagged cliffs, building ruins, and twisted and knurled trees. Whereas the beautiful landscape depicts the soft, warm, gentleness of nature, the sublime depicts the cruel, threatening, horrible and awesome qualities of nature.

The *picturesque* landscape contains elements of both the beautiful and the sublime. The picturesque philosophy of aesthetics found its way to the United States in the 19th century poetry and prose of Washington Irving, Henry Wadsworth Longfellow, Nathaniel Hawthorne and other authors. This

literature, along with the paintings of Turner, Constable, Sargent and other artists, became a mechanism through which a fledgling, impoverished country could boast of such natural treasures as Yosemite Valley, Niagara Falls and the giant sequoia trees. The picturesque philosophy captured the minds and hearts of wilderness conservationists who pushed for establishment

of the nation’s natural resource agencies. Starting with its earliest attempts to accommodate tourists and recreational visitors, the National Park Service and USDA Forest Service have designed their visitor services and interpretative facilities in the rustic idiom of the picturesque.

The picturesque presented a coherent philosophy that had strong appeal for a nation already charged with picturesque wonder. It provides a basis for evaluating the aesthetic properties of unaltered landscapes that have been embraced by most segments of American society. Most Americans attach high aesthetic appeal to such picturesque notions as large trees and old growth vegetation characterized by rough textures and brilliant fall color contrasts. Old growth specimens of bur oak, sugar maple, cotton wood and white pine epitomize the picturesque, particularly within settings such as meadows or winding rivers or streams. Such picturesque notions as steep changes in topography, exposed bedrock, and cascading and meandering water are frequent destinations of Sunday afternoon drives “to enjoy the

scenery.”

Contemporary Explanations of Forest Attractiveness

The behavioral and humanistic literature on perception of forest attractiveness includes many findings of empirical support for picturesque-like qualities of landscapes being strongly associated with the perception of attractiveness (see Ribe 1990, 1989; and Hull 1989 for recent reviews of this literature). Thus, it is understandable that the literature on the management of aesthetic resource values (USDA Forest Service 1974, 1975; USDI Bureau of Land Management 1980; U.S. Dept. of Transportation n.d.) and the literature on mitigating adverse aesthetic impacts of resource management practices (USDA Forest Service 1980, Ontario Ministry of Natural Resources 1987, Wisconsin Department of Natural Resources n.d., MNDNR 1991) advocate an aesthetic resource management strategy. Such strategies seek to blend the appearance of practices into the *natural* character of the landscape.

Like the landscape paintings from which the picturesque drew its inspiration, contemporary literature on aesthetic resource management implies that the attractiveness of the forest landscape can be attributed to variations of *landform* and *landcover* (Linton 1968, Zube 1973, Lewis 1968, Litton 1968, Litton et al. 1974). Fourteen factors that contribute to the relative attractiveness of forests were derived from the professional judgment, behavioral and humanistic literature. Collectively, these parameters are intended to represent the components of landform and landcover. These parameters, hereafter referred to as attractiveness dimensions, can be assessed using variables available in the FIA data set. They are defined for this study in section 4.2.

Landform Dimensions

1. *Slope steepness*. The forest aesthetics design literature (Litton 1968; Litton et al. 1974; Litton 1968; Lewis 1968; USDA Forest Service 1974; Zube 1973) and the behavioral literature on forest aesthetics (Zube 1973; Zube et al. 1974) suggest that as the slope of a forested site increases, so will the site's attractiveness.
2. *Regional slope diversity*. The literature on slope steepness also indicates that increasing attractiveness is associated with sites found in regions that are characterized by strong slope diversity.
3. *Landform enclosure of space*. A basic tenet of landscape architectural design is that people derive greater aesthetic enjoyment from landscapes that contain defined and well enclosed or bounded outdoor rooms (Symonds 1961; Condon 1987, 1988; Laurie 1975). In forested landscapes, spatial enclosure can be created by various combinations of landform and/or landcover that provide vertical walls and a ceiling to enclose outdoor space. The forest aesthetics literature suggests that as the definition of outdoor space becomes more apparent by the

enclosing properties of landform, attractiveness will also increase (Litton 1968).

4. *Water distinctiveness.* Investigators in the behavioral literature concur that the presence of water on a site or the ability to see water from a site almost always makes the site appear more attractive (Herzog 1986; Amedeo et al. 1988; Ulrich 1983; Zube et al. 1974). The contribution of water to aesthetic value is enhanced when this water presents a vivid or distinctive and memorable form such as a waterfall or rapids (Litton et al. 1974).
5. *Regional water diversity.* The literature also suggests that regional landscapes containing a larger abundance and greater diversity of surface waterbodies will also be perceived as being more attractive.
6. *Visual absorption capacity.* Forest landscapes vary in their ability to absorb visual changes associated with timber harvesting and management without experiencing dramatic change in visual character (USDA Forest Service 1972; Litton 1984). Visual changes in the forest environment become especially apparent when they occur on land planes that are perpendicular to the line of sight. As an example, changes are most visible when a site is on a relatively steep slope that is viewed from an adjacent and facing slope. As the angle of incidence between visitor sight line and viewed land plane becomes more acute (as when the viewer is in a valley looking up at a slope, at the top of a valley looking down a slope, or on a flat site) change becomes less apparent. Extreme homogeneity of landcover pattern also affects the perception of change. For example, openings introduced in a large stand of spruce-fir forest are much more noticeable than openings in an oak stand that exists in agricultural setting.

Landcover Dimensions

1. *Species diversity.* The professional judgment literature suggests that a greater diversity of species types on a site will be associated with higher attractiveness (Litton et al. 1974; USDI Bureau of Land Management 1980; USDA Forest Service 1973, 1974). The behavioral literature provides strong support for the attractiveness enhancing contribution of species diversity (Hull 1989; Cook 1972; Kellomaki 1975; Karhu and Kellomaki 1976; Schroeder and Daniel 1981; Kellomaki and Savolainen 1984; Daniel and Schroeder 1979; Brown and Daniel 1984).
2. *Regional vegetative diversity.* The species diversity literature also suggests that a greater diversity of vegetative communities within a regional landscape will enhance the attractiveness associated with sites in the region.

3. *Presence of large old trees.* Investigators report strong relationships between attractiveness and the presence of large old trees on a site (Brush 1979; Klukas and Dunkin 1967; Schroeder and Daniel 1981; Daniel and Schroeder 1979; Arthur 1977; Hull and Buhyoff 1986). The positive influence of large trees on attractiveness is stronger when the trees have a diameter-at-breast height (dbh) of 15 inches or more (Brown and Daniel 1984, 1986; Ribe 1989; Hull et al. 1987).
4. *Vegetative distinctiveness.* Many authors suggest the attractiveness of a landscape is associated with the vividness or distinctiveness of its components (Litton et al. 1974; U.S. Dept. of Transportation n.d.). Among forested sites, this distinctiveness often translates into vegetative color as it affects attractiveness. For example, species having vivid and distinctive bark or leaf color patterns (e.g., aspen, white birch, conifers) are perceived as enhancing attractiveness (Brush 1979; Karhu and Kellomaki 1980; Kellomaki 1975; Savolainen and Kellomaki 1981; Klukas and Duncan 1967; Ribe 1989). Similarly, the presence of vegetation that produces vivid fall color is also associated with high attractiveness value (Hull and McCarthy 1988).
5. *Ground plane conditions.* One of the most potent predictors of attractiveness in forest stands (revealed in statistical models that relate perceived attractiveness to various attributes of a forest stand) is the condition of the forest floor. For example, the presence of bare soil is perceived as detracting from the aesthetic value of a forest stand (Brush 1979; Echelberger 1979; Schroeder and Daniel 1981). Similarly, the presence of dead and downed wood or slash on a forest floor detracts from attractiveness (Arthur 1977; Daniel and Boster 1976; Schroeder and Daniel; Daniel and Schroeder 1979; Brown and Daniel 1984, 1986; Vodak et al. 1985; Ribe 1989). On the other hand, groundcover that provides a smooth and consistent texture for the forest floor strongly enhances attractiveness of the forest (Arthur 1977; Radar 1971; Brown and Daniel 1984, 1986; Kaplan and Kaplan 1982; Hull et al. 1987; Hull 1989; Schroeder, Daniel and Schroeder 1979; Ribe 1989; Schroeder and Brown 1983).
6. *Negative human scale effects of large stands on flat sites.* When harvested, these stands leave large openings in the forest cover. The size of these openings can readily reach levels beyond the scale of human comprehension. The result is a reduction in the attractiveness of the harvest site and adjacent areas (Litton 1968).
7. *Spatial definition and visual penetration.* The attractiveness of forest environments is associated with conditions that produce the sensation of strong spatial enclosure through the presence of walls and ceilings created by vegetation and/or landform (Symonds 1961; Condon 1987,

1988; Laurie 1975). Forests that have been thinned to open up understory vegetation provide a stronger sense of canopied space, and they are perceived as being more attractive than are unthinned stands (Brush 1979; Radar 1971; Kenner and McCool 1985). Similarly, stands that have been grazed and therefore have an open understory and shrub layer that enhances the sensation of canopied space are often perceived to have higher attractiveness (Daniel and Boster 1976; Patey and Evans 1979). The least preferred stands in terms of attractiveness are young stands of dense saplings (Brown and Daniel 1984, 1986; Schroeder and Daniel 1981; Hull et al. 1987). When the spaces that are created by thinning or when the spaces that naturally evolve in some forests are interconnected, visitors are able to see farther into the forest. The presence of long views, or distant sight lines that are interconnected inside the forest is associated positively with attractiveness (Arthur 1977; Buhyoff et al. 1982; Vining et al. 1984; Hull and Buhyoff 1983).

8. *Regional pattern of open space and forested mass.* The edges between masses of forest vegetation and open spaces of forest harvests or agricultural fields are important too in the perception of landscape (Gratzer and McDowell 1968). The density, character and distribution of these edges is a strong determinant of attractiveness (Brush and Shafer 1975). The presence of connected open spaces in a forest environment affords forest visitors the opportunity to gain a comprehensive understanding of landscape structure. This structural understanding provides a sense of orientation. Landscapes possessing a sense of orientation (i.e., knowledge of where a visitor has been, where a visitor is going) are also perceived as being attractive, especially when the texture of the groundcover provides little impediment for movement through the space (Kaplan and Kaplan 1982). The interconnection of openings in the forest also affords the opportunity for longer sight lines through the forest that are perceived as enhancing attractiveness (Arthur 1977; Buhyoff et al. 1982; Vining et al. 1984; Hull and Buhyoff 1983).

4

ASSESSMENT METHODOLOGY

The following sections describe the assessment methodology used in this report for both recreation and aesthetic considerations. These sections describe the available data, how it was assembled and analyzed to assess recreation and aesthetic values within an ecoregion, and how these values are impacted by timber harvesting and forest management.

4.1

Assessment of Recreation Value

As defined in section 3.1, recreation value is described as: (1) the kinds of recreation experiences visitors have when engaging in selected activities in particular settings and (2) the intensity or amount of recreational use an area receives. In this report the kinds of recreation experiences, as measured by ROS and recreational activity hours as measured by SCORP, are combined to arrive at measures of recreation value. These are not monetary values, rather they are levels developed to be helpful in understanding impacts that are assessed later in the paper.

4.1.1 Methodology for Assessing Recreation Value

Data Sources

Forest recreation values were developed using several variables from the FIA data (section 2.1) and others from SCORP (section 2.2).

According to the FIA data, 43,959 FIA ground verified plots exist statewide. Of these 14,296 are classified as having tree cover, including 12,118 designated as timberland plots. For purposes of this paper, the timberland plots are emphasized, as the remaining plots are within unharvested reserved and unproductive forest areas. However, these reserved and unproductive plots are extremely important to recreational activity within the state as they include park and other systems that accommodate substantial recreation usage, as well as some of the premier primitive and semiprimitive opportunities in the state.

Each of the timberland plots identified in the FIA data set was assigned a ROS class. In addition, the plots were classified by ownership, dominant land use and ecoregion. Subsequently, the number of activity hours by type of recreation associated with each plot was computed. Activity hour data was obtained through the SCORP database. As discussed in section 2.2, the SCORP data were linked with the FIA data by matching the SCORP location coordinates to the FIA plot coordinates.

Twelve recreational activities were selected from the range reported in the SCORP database as being relevant to forest recreation. For each timberland plot, estimates were made of the number of activity hours that would take place at the plot location, and within an 18-mile radius of the plot. Estimates were based on SCORP data, which gives the kinds of activities engaged in by location and number of hours. Matching UTM coordinates for these data and the FIA plots provided estimates of the kind and amount of activity occurring on and around each timberland plot. The resulting area around a plot is referred to as a *timberland recreation unit* or TRU. This linkage was developed for each activity and by ROS class, ecoregion, ownership class, and dominant land use. The activities considered were walking, hiking, camping, fishing, boating, hunting,

canoeing, picnicking, cross-country skiing, downhill skiing, snowmobiling, nature study including birdwatching, and driving all-terrain and/or off-road vehicles. These activities were used because they are often conducted in forested environments and therefore

assumed to be affected by timber harvesting. Also, they are considered the activities for which SCORP data are most reliable.

Estimating Recreation Value

Recreation value was developed to describe the distribution of activity hours within and across all TRUs. It is a measure of the intensity of recreational use of an area of timberland. Recreation values were derived for all TRUs statewide. These values were then aggregated to derive totals by ecoregion.

Estimates of the recreation value for a TRU were computed by plot. First, the plot's ROS class was determined. Next, based on the ROS class, activities appropriate for that class (see table 3.1) were selected. The activity hours for each of these activities were then determined from the SCORP data and added together for a total number of activity hours for the TRU.

For TRUs classed as primitive or semiprimitive nonmotor, only seven of the twelve activities examined are appropriate uses of these plots. Uses considered appropriate are: camping, fishing, canoeing, cross-country skiing, walking and hiking, nature study including birdwatching, and hunting. Other uses excluded involve the use of motorized equipment or are those generally associated with easily accessible lands (e.g., picnicking). These access-dependent activities would not be permitted or provided for in primitive and semiprimitive nonmotorized areas, and therefore were excluded in considering such areas.

This constitutes an implicit assumption that all ownerships manage *primitive* and *semiprimitive nonmotorized* areas according to the ROS. In applying this assumption it is recognized that only the USDA Forest Service manages these forest lands using the ROS; and therefore that some of these access dependent activities do occur on lands in the primitive and semiprimitive nonmotorized categories that are managed by other ownerships. However, the SCORP data indicate the amount of use in these primitive and semiprimitive nonmotorized areas is small, which is understandable given their remoteness (by definition). Therefore, there are only minor implications that arise from making this assumption. For all other plots, all twelve activities are considered appropriate uses.

After activity hours for all appropriate activities for each plot were added together, the TRUs were grouped by ROS class and then ranked from highest to lowest by number of activity hours. Within an ROS class, the plots were then grouped into five equal width intervals representing five different levels of intensity of use (activity hours), and assigned a value from 1 to 5. The 20 percent of TRUs with the greatest or most intense level of recreation use were assigned a recreation value level of 1. The 20

percent of TRUs that are the least heavily used were assigned a value level of 5.

Rational for Recreation Value

The FSD scoped issue required an assessment of the extent to which forest recreation opportunities were impacted quantitatively and qualitatively by timber harvesting and management. To do so, however, requires a consistent statewide means of describing opportunities. For reasons outlined below, *forest recreation opportunities* are defined in this paper in terms of the ROS which was discussed in section 3.1. Briefly, ROS provides the only criteria to distinguish forest recreation opportunities that can be applied uniformly statewide.

As discussed in section 1.2, there is some information on managing recreation opportunities for some of the public lands. However, with the exception of the USDA Forest Service and to a lesser degree the state and several other ownerships, there are no clearly articulated management objectives that specify how natural resource based recreational opportunities are to be managed in Minnesota's forests. In the absence of management objectives, the study group had to develop a surrogate that could be applied uniformly across all ownerships statewide.

In addition to providing criteria for distinguishing opportunities, ROS values in the FIA data are the only statewide data available that actually characterize potential natural resource based outdoor recreation opportunities. Therefore, the study methodology was developed to utilize these data. Whether the identified opportunities for a particular area are actually realized depends on the owner's management objectives. The objectives may explicitly recognize these opportunities and direct management to maintain them and encourage appropriate uses. The USDA Forest Service's management of the Chippewa and Superior national forests (which includes the BWCAW) is a good example of this. Opportunities may also be maintained by default, especially where recreational uses are not explicitly recognized or managed for by the owners. For example, opportunities that depend on a semiprimitive nonmotorized setting may continue to exist on a private property simply because the owner does not have the money to build an access road.

A strong distinction must be made between the existence of recreation opportunities and the realization of those opportunities. The difference lies with the owner's management objectives. In Minnesota, only the USDA Forest Service manages lands in accordance with ROS. The MNDNR does not manage lands based on ROS. Other ownerships also do not apply ROS in developing their management plans, where plans are developed at all. However, despite having limited management application in Minnesota, ROS can characterize the recreation opportunity settings across the state's

timberlands and therefore serve as a useful tool with which to address the scoped issue.

Regarding resolution, the SCORP database (see section 2.2) was used to estimate the levels of recreation activity, by use, occurring in the area surrounding each plot. The levels of activity, by use, are simply indicative of the degree to which the opportunities are being realized. By combining these data with the ROS classification, the methodology obtained resolution appropriate to provide insight on present and potential activity level in a context important to understanding impacts.

4.2

Assessment of Relative Forest Attractiveness

The visual quality, aesthetic or landscape values of forests include many factors—environmental, social, cultural and psychological. As previously discussed, there are few data available that document how or why certain landscapes appeal to different types of people.

The scoped issue required an assessment of the extent to which timber harvesting and management practices impacted the visual quality of Minnesota's forests. This required the development of a way to characterize current aesthetic values and also to characterize the changes likely under the three scenarios. The methodology described below was developed to assess the relative attractiveness of units of forest using the FIA data. The FIA was the only data set that could be used because of its uniform statewide coverage. Later this is augmented by the consideration of temporal changes in aggregate forest characteristics.

The methodology does not attempt to measure beauty. Instead it assesses certain attributes of each unit of forest to determine the likelihood that a particular area has a high probability of being attractive. Obviously this is a subjective area, as people have differing opinions on what constitutes beauty. However, the approach that has been developed attempts to remove this subjectivity and can be applied and analyzed uniformly statewide.

Visual management systems (VMS) or guidelines (VMGs) are used by the USDA Forest Service and, increasingly, by the MNDNR for managing aesthetic values of federally and state owned forests in the state. Section 5.2.3 traces development of these systems and their application in Minnesota. These systems assess the attractiveness and the sensitivity of a forest tract, and they assign a management objective to each tract based on its combined rating for attractiveness and sensitivity.

The methodology described in the following section employs the same principles contained in the VMS of the USDA Forest Service. The methodology was devised to define and assess aesthetic values (relative attractiveness) associated with the plots contained in the FIA data. The attractiveness value of each plot is compared with the plot's recreation

value (as described in section 4.1). The intersection of attractiveness value and recreation value was then used as a measure of visual sensitivity for each plot or TRU. This definition of visual sensitivity attempts to encompass sensory attributes of the forest, characteristics of the forest visitor, and the context in which the forest recreational experience occurs. Visual sensitivity is then aggregated into five levels. The five levels correspond directly to the visual management objectives of VMS.

It is important to emphasize that this approach to assessing attractiveness does not purport to *measure* beauty directly. Rather, the assessment scale defines factors associated with attractiveness and the probability that a plot containing specified levels of the factors will be considered attractive as defined here. The value of the approach for this study is its capability for examining regional trends in attractiveness, and to identify visually sensitive areas in conjunction with the recreation areas.

The methodology characterizes the forests statewide with a level of resolution that is able to detect trends in aesthetic values that are likely under the three harvesting scenarios. Specifically, the aesthetic values estimated by the methodology reflect a combination of 17 FIA variables. The following sections describe the components of the methodology and its application.

Attractiveness was postulated to have a number of dimensions. Subsequently, the attractiveness dimensions for each of the FIA timberland plots were developed by defining each dimension in terms of the FIA variables. The definitions identify the name of FIA variables that contribute to each attractiveness dimension, and they specify how the variables are to be combined. Specifically, a series of rules of combination (Nassauer 1980; Hopkins 1977) were used to assign numerical values to the dimensions. Relative attractiveness for each FIA plot was then calculated by adding the numerical values of the 14 attractiveness dimensions (see appendix 1). In the absence of empirical validation, variables were not weighted when they were added together. This approach may seem overly complicated, but there is a body of literature supporting it and it does provide a useful level of quantification and consistency.

Operational Definitions of 14 Attractiveness Dimensions

Table 4.1 identifies the FIA variables used in defining the 14 attractiveness dimensions. The attractiveness dimensions describe landscape characteristics at the FIA plot level, and they also describe the landscape conditions existing within an 18-mile radius of each plot (roughly equivalent to 3 townships). This radius was selected to correspond with the area sampled by the SCORP data and thus provides the same level of resolution for assessing both the visual and recreation context for each plot. The assessments consider the visual attributes of the forest found at the FIA

plots as well as the visual attributes of the surrounding areas of forest that provide the regional context.

Table 4.1 Operational definition of attractiveness dimensions within the FIA data set.

Landscape Characteristics Being Described	Attractiveness Dimension	FIA Variables Included in Dimension	
		Variable	Possible Points
A. Landform characteristics of FIA plot	1. Slope steepness	a. Percent slope	100
	2. Landform enclosure of space	a. Slope position (recoded to indicate presence of low position on slope)	25
		b. Slope shape (recoded to indicate presence of concave slope)	25
		c. Percent slope	25
		d. Slope length	25
	3. Water distinctiveness	a. Type of nearest waterbody	40
		b. Distance to nearest waterbody	60
B. Regional landform characteristics (within 18 miles of FIA plot)	1. Regional slope diversity	a. Number of plots within 18 miles having a slope greater than 8%	100
	2. Regional water diversity	a. Number of plots within 18 miles with ground land use equal to marsh or surface waterbody	50
		b. Distance to nearest waterbody	50
C. Landcover characteristics of FIA plots	1. Species diversity	a. Number of species groups present at site	67
		b. Mean Dbh of trees	33
	2. Presence of large old trees	a. Mean Dbh of trees greater than 5 inches in diameter	33
		b. Number of live trees present at the plot	33
		c. Age of the stand	34
	3. Vegetative distinctiveness	a. Forest types present at the plots (recoded to indicate presence of aspen, birch, maple and conifer, excluding jack pine and black spruce)	50
		b. Mean Dbh of trees present at the plot	50
	4. Ground plane conditions	a. Stand history (recoded to indicate presence of ground plane disturbance within most recent 5 and 10 year periods)	100
	5. Negative human scale effects of large stands on flat sites	a. Slope shape (recoded to indicate presence of level slope)	60
		b. Stand area	40

Table 4.1 continued.

Landscape Characteristic Being Described	Attractiveness Dimension	FIA Variables Included in Dimension	
		Variable	Possible Points
Landcover characteristics of FIA plots (continued)	6. Spatial definition and visual penetration	a. Mean Dbh of trees (recoded to give preference to larger trees)	40
		b. Number of live trees present (recoded to give preference to low numbers)	40
		c. Stand history (recoded to give preference to plots having disturbance regimes that favor visual penetration)	20
D. Regional landcover characteristics (within 18 miles of FIA plot)	1. Regional vegetative diversity	a. Number of forest types present within 18 miles	100
	2. Regional pattern of open space and forested mass	a. Number of ground land use types within 18 miles that are open field, wetland or water	50
		b. Distance to nearest agricultural field	50
E. Visual absorption capacity of FIA plot	1. Visual absorption capacity of plot based on landcover and landform	a. Number of ground land use types within 18 miles that are forested	50
		b. Percent slope	50

Note that calculations involving land area within 18 miles of a plot were derived from all of the 43,959 ground verified FIA plots in the state (i.e., the 12,118 timberland plots plus the 31,841 plots not considered timberland). The attractiveness dimensions include FIA variables that pertain to landform as well as land cover. A detailed description of definitions and assignment of ratings is given in appendix 1. A summary of how dimensions were developed is given below.

A. Landform Characteristics of Plots. Three attractiveness dimensions are derived from landform and physical landscape features as they exist at the FIA plots.

1. *Slope steepness* is measured by the percent slope variable contained in the FIA data.
2. *Landform enclosure of space* is defined by four FIA landform variables: (1) slope position; (2) slope shape; (3) percent slope; and (4) slope length. The spatial enclosure dimension rates landform on the extent to which it provides a sense of being in a bounded outdoor space. Plots located at the bottom of a concave slope that is both steep and long

receive the highest enclosure ratings, and plots located on a level slope receive lowest ratings.

3. The *water distinctiveness* measure of landscape attractiveness defines the proximity of a plot to surface waterbodies. Forest plots that contain or are next to streams and/or lakes are rated as more attractive than plots near farm ponds or marshes. As distance from a waterbody increases, water distinctiveness decreases.

B. Regional Landform Dimensions. Two attractiveness dimensions describe landform within 18 miles of an FIA plot.

1. *Regional slope diversity* identifies the number of FIA plots within 18 miles of a subject plot that have slopes greater than eight percent.
2. *Regional water diversity* adds an adjustment to the distance to water measurement that is based on the number of FIA plot locations within 18 miles of each plot that contain water (i.e., ground land use is water).

C. Landcover Characteristics. A total of nine FIA variables are used to define six dimensions of attractiveness at each of the FIA plots.

1. *Species diversity* is calculated using the FIA variables that describe the number of species groups present at a plot and the mean dbh.
2. *Presence of large old trees* is calculated on the basis of mean Dbh of trees exceeding five inches, number of live trees present at a plot, and the stand age. Higher values are given to plots in older age classes that have comparatively few trees with larger mean Dbh.
3. *Vegetative distinctiveness* is assessed based on the presence of vegetation with distinctive color or texture. The species include white birch, pole sized aspen, maple and conifers.
4. The *ground plane conditions* attractiveness dimension is assessed on the basis of a stand history report that indicates human or natural disturbance at the plot in the most recent five- and ten-year periods. Plots with a stand history of no disturbance are given high ratings on the ground plane conditions dimensions compared with plots experiencing recent disturbance.
5. High ratings on the *human scale* attractiveness dimension are awarded to FIA plots with large stand areas on a level slope.
6. Finally, high ratings on the *spatial definition and visual penetration* dimension are assigned to plots having a large mean Dbh for trees greater than 5 inches, a low number of live trees, and a stand history that indicates presence of a disturbance that would increase visual penetrability of the stand (e.g., thinning).

D. Regional Landcover Characteristics. Two attractiveness dimensions describe landcover conditions existent within 18 miles of a plot.

1. *Regional vegetative diversity* is calculated by counting the number of different forest types that occur within 18 miles of a plot.
2. *Regional patterns of open space and forested mass* is calculated by counting the number of FIA plots within 18 miles of a subject plot that contain vegetation other than forest. This count is weighted by the distance to the nearest agricultural field. High vegetative pattern diversity ratings are assigned to plots containing many nearby nonforested plots.

E. Visual Absorption Capacity. The attractiveness dimension *visual absorption capacity* is calculated from the FIA variable describing ground land use within 18 miles of a plot and the variable describing percent slope. Plots located on flat sites that exist within a greater diversity of forest and nonforest land uses are rated as having higher visual absorption capacity than steeply sloped sites located in an area containing monotonic forest land use patterns.

Assignment of Numerical Attractiveness Ratings to Each FIA Plot
Transformation and Coding of FIA data

To make full use of the information available in the FIA database, it was necessary to use both continuous and categorical variables. Percent slope is an example of a variable using continuous data. Each FIA plot is assigned a value which represents the percent of slope present at the plot. Values range from zero percent to 20 percent or higher.

Categorical variables in the FIA database are those which describe unique aspects of the plot. For example, slope shape is defined for each FIA plot by one of four possible categories: (1) level; (2) concave; (3) uniform; and (4) convex.

To facilitate analysis, the continuous variable values were transformed into categorical values. The transformation involved dividing the distribution of a variable's values across the state's timberland plots into between two and four equally sized categories. For example, slope length was divided into two categories represented by a 1 for those plots falling below the median and a 2 for those plots falling above the median.

For coding of data, values were assigned to categories in a manner consistent with the way in which the variables would be used to define attractiveness dimensions. For example, the distance to water variable was divided into three categories, each containing the same number of plots. One-third of the timberland plots are within 6 chains from water. Plots within 6 chains of water were assigned a water distinctiveness value of 3. Another one-third of the plots are between 6 and 15 chains from water, and these received a distinctiveness value of 2. The final one-third of the plots are further than 15 chains from water and received a 1. When using the

recoded variable to describe the attractiveness dimension of water distinctiveness, the highest recoded values identify those plots with the most potential for water distinctiveness, and the lowest recoded values identify the plots with the least potential.

Distribution of Attractiveness Values

The previous section described how the FIA variables were recoded to allow their complementary use in defining attractiveness dimensions. Columns 2 and 3 of table 4.1 identify the FIA variables that were used to define each attractiveness dimension. The fourth column in table 4.1 describes the possible number of points assigned to each variable when it is used to define a dimension. A total of 100 points were distributed across the categorical values of the variable(s) that define each attractiveness dimension. For those dimensions that are composed of a single variable (e.g., slope steepness), all 100 points are evenly distributed across its categories.

Since there are four categories of slope steepness, plots falling into the lower one-fourth of the distribution (categorized to a value of 1) would receive 25 points and plots falling into the steepest one-fourth of the timberland distribution (recoded as a 4) would be allotted 100 points. For dimensions defined by more than one FIA variable (e.g., water distinctiveness), the 100 points are distributed among the variables. Decisions concerning the allocation of points among variables comprising an attractiveness dimension were based on professional judgment of the relative contribution of each variable to defining the dimension. For example, a belief that the four variables comprising the landform enclosure of space are of equal importance to the dimension resulted in the four variables each receiving 25 points. In the water distinctiveness dimension, however, the two variables are not believed to contribute equally. In this case, the proximity to the waterbody variable is considered to be slightly more important than whether the waterbody is a lake or stream. Thus, 60 points were assigned to the distance to water variable and 40 points to the type of waterbody variable. For analysis, the consistency provided by this approach was more important than the actual point levels.

Calculation of a Relative Attractiveness Value for Each Plot

Since the recoding of the FIA variables was based on their distributions across all Minnesota timberlands, TRUs can be characterized in relative terms using the categorical values to reflect variations of the attractiveness dimensions.

Based on onsite and regional plot attributes, a value ranging from zero to 100 can be assigned to a plot for each of the 14 dimensions. A total of these values across the dimensions yields a comprehensive assessment of relative attractiveness that has a theoretical upper limit of 1,400 (14

dimensions x 100 points on each dimension). This assessment scale represents an interval level measurement of relative attractiveness. In the absence of empirical validation, variables were not weighted when they were added together.

Defining Relative Forest Attractiveness Levels

Onsite Dimensions of Relative Forest Attractiveness

Six dimensions of relative attractiveness can be directly impacted by timber harvesting and management activities. These dimensions were included in the list of *landcover dimensions* described in section 3.2.2. The six onsite dimensions of forest attractiveness include:

1. species diversity;
2. presence of large old trees;
3. vegetative distinctiveness;
4. ground plane conditions;
5. negative human scale effects; and
6. spatial definition and visual penetration.

The following summarizes the literature and depicts how timber harvesting and forest management activities can change these dimensions, therefore changing the aesthetic values of affected forests. Changes to these dimensions can have positive as well as negative impacts on aesthetic values. The emphasis is on Minnesota conditions and practices specific to this region.

Species diversity. There is a link between species diversity within a stand and its aesthetic values. Stands with greater diversity typically have higher aesthetic values. Timber harvesting and forest management activities can affect the species diversity at a stand level. In areas of low diversity, forest management is likely to increase species diversity and thereby improve the stand's aesthetic value. In contrast, intensive management such as development of plantations can reduce diversity. Since aesthetic values are more closely associated with stands having a high diversity of species, a reduction of species diversity will diminish aesthetic value (Litton et al. 1974; Leopold 1969; USDI-Bureau of Land Management 1980; USDA Forest Service 1974; U.S. Department of Transportation n.d.; Hull 1989; Louk 1972; Kellomaki 1975; Karhu and Kellomaki 1976; Schroeder and Daniel 1981; Kellomaki and Savoläine 1984; Daniel and Schroeder 1979; Brown and Daniel 1984).

Presence of large old trees. Old stands of long-lived species that develop the high canopy and sense of spaciousness provided by large old trees make a substantial contribution to the determination of aesthetic value (Brush 1979; Klukas and Dunkin 1967; Schroeder and Daniel 1981; Daniel and Schroeder 1979; Arthur 1977; Hull and Buhyoff 1986; Brown and Daniel

1984; Ribe 1979; Hull et al. 1987). Stands of relatively long-lived species, such as red

and white pine and northern hardwoods, that are managed as old growth or on longer rotations can develop these attributes.

Aesthetic values diminish as the size of trees decreases. Therefore, a mature stand has greater aesthetic appeal than an immature stand of the same species. Mature stands of shorter-lived species such as aspen and jack pine can develop these values. However, increased mortality in older stands can reduce aesthetic values to the degree that values can be improved by harvesting and regenerating the stand. Alternatively, in some circumstances these stands will be naturally succeeded by stands of more tolerant species.

Vegetative distinctiveness. Forest aesthetic values of stands larger than poletimber size trees are enhanced by the presence of species having vivid or distinctive bark or leaf color patterns (Litton et al. 1974; U.S. Department of Transportation n.d.; Brush 1979; Karhu and Kellomaki 1980; Kellomaki 1975; Savolainen and Kellomaki 1981; Klukas and Duncan 1967; Ribe 1989; Hull and McCarthy 1988). The Minnesota species that exhibit high distinctiveness include: aspen, white birch, sugar maple and conifers. Harvesting can reduce that distinctiveness. Conversely, regeneration can be managed to enhance distinctiveness in the subsequent stand.

Ground plane conditions. The appearance of forest ground cover vegetation, the amount of dead and downed wood and postlogging slash, and the ground plane condition all contribute to the aesthetic value of a stand. Undisturbed stands with intact ground cover and no evidence of slash, debris and ground plane disturbance are the most attractive. Conversely, disturbed stands have a lower rating until they regenerate and evidence of the disturbance is lost (Brush 1979; Echelberger 1979; Schroeder and Daniel 1981; Arthur 1977; Benson 1982; Daniela and Bosta 1976; Daniel and Schroeder 1979; Brown and Daniel 1984, 1986; Ribe 1989). However, the effect at any one site is generally short-lived except in sites where revegetation is slow. Also, ground plane conditions are less evident in winter, depending upon snow depth.

Negative human scale. When people are near trees, they are able to understand tree size and the size of spaces between trees relative to their own body size. This recognition of the size of elements in the environment relative to the size of the people perceiving these elements is called *human scale*. Generally, the presence of human scale relationships in the forest enhances aesthetic value (Litton 1968). Thus, the aesthetic difference between a 100-year old stand and a 20-year old stand of the same species is perceived only if someone is close enough to the forest to compare tree size and human size. The harvesting of stands that cover large areas on flat sites can create openings with boundaries that are not evident to

recreationists. With increased distance between an observer and the trees in a forest, as with

some types of harvesting patterns, human scale relationships are lost and aesthetic value can be diminished.

Spatial definition and visual penetration. Forests that contain well-defined three-dimensional volumes of space that can best be described as *outdoor rooms* are perceived as having high aesthetic appeal (Litton 1968; Brush 1979; Rider 1971; Kenner and McCool 1985). Stands having strong spatial qualities enable long sight distances into the forest that add aesthetic appeal (Vining et al. 1984; Hull and Buhyoff 1983). Aesthetic appeal can also vary by season. Northern hardwood stands appear impenetrable in summer offer long clear views from fall to spring. Likewise, snow cover can enhance visual penetration for otherwise obscure situations. Thinning can enhance visual penetration, however, clearcutting disturbs perceptions of spatial definition.

The sum of these six dimensions provides a measure of the onsite forest attractiveness of a plot or TRU.

Contextual Dimensions of Relative Forest Attractiveness

The changes to aesthetic values caused by timber harvesting and forest management activities are directly related to the naturally and culturally induced variability in onsite landcover patterns that can occur at a stand or timber sale level. Regional vegetation patterns provide an additional and more stable context within which the changes to stand structure and species diversity at a stand level occur. This is because the topographic, physiographic and hydrographic characteristics of landform at a regional scale change little over time, especially when compared with the dynamic biological attributes of a specific forest site.

This stability means that these *contextual dimensions* are much less likely to be impacted by timber harvesting and forest management than the onsite landcover dimensions described above. However, their contribution toward defining the attractiveness of a specific area of forest must still be considered in assessing the magnitude of aesthetic impact associated with timber harvesting and forest management.

There are two regional landcover dimensions and six landform dimensions that are classified as contextual dimensions. These are described in section 3.2.2 and are listed below:

Regional landcover dimensions

1. regional vegetative diversity; and
2. regional pattern of open space and forested mass

Landform dimensions

1. slope steepness;
2. landform enclosure of space;
3. regional slope diversity;
4. water distinctiveness;
5. regional water diversity; and
6. visual absorption capacity.

The sum of these eight dimensions provides both a measure of forest attractiveness and the regional context within which change at a stand or forest level takes place.

Integration of Onsite and Contextual Dimensions

To arrive at an overall relative attractiveness value, the ratings of the onsite attractiveness were added to the ratings for contextual attractiveness. The resulting values from this summation were grouped into five levels of *relative forest attractiveness*. The number of timberland plots contained in each level is shown in table 4.2.

It is important to emphasize that this approach does not purport to *measure* beauty directly. Rather, the assessment identifies variables associated with attractiveness, and it suggests the probability that a plot containing specified levels of the parameters will be considered attractive. Further, it does so in a consistent manner for the purposes of this study.

Table 4.2. Timberland plots in each level of relative forest attractiveness.

Level	Number of FIA plots
I (most attractive)	2,679
II	2,449
III	2,108
IV	2,602
V	2,280
Total	12,118

The timberland plots were subsequently divided into two categories based on their ROS class. Those that were within the primitive and semiprimitive nonmotorized classes were separated from the remainder and were analyzed using a different methodology than that applied to the bulk of the plots. This was done to reflect the inherent differences between these classes of lands in terms of access and recreational usage.

4.3

Visual Sensitivity

4.3.1

Definition of Visual Sensitivity

Given the above constructs, the *visual sensitivity* of a plot can now be assessed by crosstabulating the plot's recreation value with its relative attractiveness value. Conceptually, the methods used here to assess visual sensitivity are similar to those used by the National Forest System. The ROS, a key component of recreation value, is used as a recreation planning and management tool in national forest units. The visual management objectives that serve as the core of the USDA Forest Service VMS are analogous to the visual sensitivity levels used here. The data needs and assessment procedures used in setting visual management objectives are also similar to those used in assessing sensitivity level.

Two elements, the five levels of relative forest attractiveness value and the five levels of recreation value, combine to define the visual sensitivity of the timberland plots. With this scheme, an area of high visual sensitivity would possess a high level of relative forest attractiveness, and it would also be a place where many people pursue a variety of outdoor recreational activities. In contrast, an area of low visual sensitivity would have a comparatively low level of relative forest attractiveness, and few people would use the area as a recreational activity setting.

Therefore, highly sensitive areas can be characterized as those where more stringent visual management prescriptions, such as those described in appendix 4, would be applied by agencies that plan and manage their timberlands using VMGs. Failure to implement such prescriptions would produce substantial adverse impacts on the recreational and aesthetic values of the harvested forest and of surrounding areas. In contrast, timber harvesting and forest management activities occurring on less sensitive plots need to conform to only the most basic visual management prescriptions. These less sensitive areas are not particularly attractive nor do they sustain the recreational use levels that will bring a large volume of recreationists to the area.

4.3.2

Special Categories of Visual Sensitive Areas

Four out of a total of five visual sensitivity ranks were defined by cross-tabulating recreational values with relative forest attractiveness values. However, there are some categories of visually sensitive land that cannot be detected using this analysis. This is because these lands are either too small to be detected at the level of resolution used for assessing the above

values; or the attribute data needed to identify them are not contained within the FIA database. These lands include unique recreation and aesthetic resource areas that can be highly sensitive to visual impacts. Examples are:

- buffer strips (e.g., one-fourth mile) around county parks, state parks, national parks, the BWCAW, and state scientific and natural areas; and
- buffer strips (e.g., 200 feet) along the edges of wild and scenic rivers, canoe and boating routes, primary state trails and resorts; and
- visual buffer strips (e.g., 100 feet) along lakes and streams.

4.3.3

Visual Sensitivity Ranks

Five ranks of visual sensitivity have been identified. The first includes the special categories of lands listed in section 4.3.2; the remaining four include areas (plots) sorted by using combinations of recreational value and relative attractiveness value. These rankings are described below and illustrated in figure 4.1.

Visual Sensitivity Rank I.—This is a special case that refers to lands adjacent to designated recreational areas such as state parks, national parks, wilderness areas, wild and scenic rivers and long distance trails. These adjacent lands can fall into any ROS class. They can also have any recreational or attractiveness value. They are highly sensitive lands because of their proximity to designated recreational areas.

Visual Sensitivity Rank II.—Plots with this rank include those in semiprimitive motorized, roaded natural, rural and urban ROS classes that have: (1) a very high attractiveness level rating and high to very high recreation value; and (2) very high recreation value and high to very high attractiveness rating.

Visual Sensitivity Rank III.—Plots in this rank include all those in the motorized semiprimitive, roaded natural, and rural ROS classes that have: (1) very high recreation values and low or moderate attractiveness ratings; high recreation value and moderate to high attractiveness ratings; and (2) low recreation value and very high attractiveness ratings.

Visual Sensitivity Rank IV.—Plots in this rank include all those in the motorized semiprimitive, roaded natural and rural ROS classes that have: (1) very high recreation values but a very low attractiveness rating; (2) high recreation value but low or very low attractiveness ratings; (3) moderate recreation value and a moderate attractiveness rating; (4) low recreation value but a high attractiveness rating; and (5) very low recreation value but high to very high attractiveness ratings.

Visual Sensitivity Rank V.—Plots with this rank include all those in the motorized semiprimitive, roaded natural and rural ROS classes that have: (1) moderate recreation value and low to very low attractiveness ratings; and (2) low or very low recreation value and moderate to very low attractiveness ratings.

These rankings, while arbitrary in terms of definition, do follow logical consideration of ROS recreation value and relative attractiveness constructs. Thus, they are germane to and important in understanding impacts as per the scoped issues of concern.

Recreation Value	Attractiveness Value					total plots
	very high 1	high 2	moderate 3	low 4	very low 5	
very high 1	II 581	II 519	III 382	III 443	IV 299	2,224
high 2	II 554	III 445	III 362	IV 475	IV 397	2,228
moderate 3	III 580	III 440	IV 352	V 479	V 385	2,235
low 4	III 480	IV 468	V 383	V 474	V 421	2,226
very low 5	IV 317	IV 382	V 403	V 546	V 589	2,237
total plots	2,512	2,254	1,882	2,417	2,086	11,151

Figure 4.1 Attractiveness values, recreational values and *visual sensitivity ranks (II to V)* of timberland plots for ROS classes: semiprimitive motorized, roaded natural and rural.

5 DESCRIPTION OF EXISTING ENVIRONMENT

5.1 Minnesota's Recreation Resources

Minnesota is endowed with an abundance of natural resources and a wealth of outdoor recreation opportunities. One-third of the state, nearly 17 million acres, is forested, and this area forms the backdrop for much of the natural resource based recreational activity that takes place in the state. The forest resource is primarily located in the north central and northeastern area of the state.

Over half of the state's forest land is in public ownership, and nearly all of this is open to dispersed recreational use. However, agencies at all levels of government and the private sector form a partnership in providing recreation opportunities for Minnesotans. Each partner has its own goals and policies for the lands they own or manage, and some partners manage or provide recreation opportunities more actively than do others. Some of the key providers of recreation opportunities in Minnesota are: the private resort industry; the USDA Forest Service; the USDI National Park Service; Army Corps of Engineers; U.S. Fish and Wildlife Service; the MNDNR divisions of forestry, parks and recreation, trails and waterways, and fish and wildlife; and numerous counties.

Minnesota's recreation resources are both water and land based. There are over 193,000 miles of shoreland on over 12,000 lakes and 92,000 miles of rivers and streams. More than 3,500 miles of this water resource are accessible by canoe, and of this total, there are 2,850 miles of designated canoe routes. Also, 2,600,000 acres of water are used by motorboaters, sailing enthusiasts and other watercraft users. In all, about 715,000 watercraft are registered in the state (MNDNR 1989). Probably the state's premier water resource is the BWCAW. This area alone has nearly 1 million acres of interconnected lakes and streams and is the most heavily used wilderness area in the United States.

Among the states, Minnesota has the highest proportion (49 percent) of people that fish (MNDNR 1989). About 144 fish species are found in 3,800,000 acres of fishing waters and 1,900 miles of trout streams. Over 2.3 million Minnesotans fish for pleasure, catching more than 35 million pounds of fish annually. Yearly, sport fishing generates over one billion dollars for the state. (See section 4 of the Economics and Management Issues technical paper for additional information on fishing.)

Hunting of large and small mammals is a popular recreational activity in Minnesota. In 1985 there were 544,900 resident and nonresident hunters 16 years of age and older who hunted in Minnesota (U.S. Fish and Wildlife Service 1989). State residents accounted for 96 percent of hunters. (See section 4 of the Economics and Management Issues technical paper for additional information on hunting activity in Minnesota.)

Bird watching/nature study is another recreational activity that is very popular in Minnesota. Over the next five to ten years the highest projected increases in participation are expected in this activity (MNDNR 1989). Much of the increase is attributed to the aging of Minnesota's population.

Sixty-six state parks, one national park, two national monuments, 57 state forests, two national forests plus numerous county lands are distributed

across the state. These areas alone account for more than 10 million visits a year (MNDNR 1989).

There also are more than 15,000 miles of designated recreational trail systems throughout the state. Just over 10,200 miles are grant-in-aid snowmobile trails, 2,000 miles are state snowmobile trails and the remainder serve a mix of trail users' needs, including bicycling, hiking, horseback riding, and cross-country skiing (MNDNR 1991).

5.1.1

Statewide Distribution of Recreation Activity

According to the most recent recreation participation survey conducted by MNDNR, Minnesotans spend a total of 847 million hours per year participating in outdoor recreation activities. This is an average of 225 hours per person per year (MNDNR 1990). Results of the survey show that walking and hiking, bicycling, fishing and driving for pleasure account for half of the annual outdoor recreation activity hours expended by Minnesotans.

In Minnesota, the summer is only 17 weeks long but it is the season when over half of all outdoor recreation occurs. Conversely, winter, which is 21 weeks long, accounts for only 19 percent of the activity hours.

Most natural resource based recreational activity takes place in the northern half of the state. Most state and federal forested lands and resorts are located in this region. The BWCAW and many of the heavily used state parks, such as Jay Cooke, St. Croix, Itasca, Cascade and Gooseberry Falls, are all located in the northeastern, north central and arrowhead regions of Minnesota. Estimates from the MNDNR show that of the 10 million recreational visits made yearly to natural resource areas in Minnesota, approximately 8 million of them are made to Minnesota state parks (MNDNR 1990). State parks serve as both destination sites—people travel to them to recreate solely in them—and as staging sites for recreational activities in the surrounding region.

Table 5.1 provides data comparing the relative levels of recreational usage and the number of timberland plots (which is a surrogate for area). The central pine hardwoods and border lakes ecoregions sustain higher levels of activity relative to the other ecoregions. In contrast, the glacial lakes plains ecoregion sustains levels of activity that are significantly lower relative to the other ecoregions.

The importance of the central pine hardwood ecoregion as a major focus for natural resource based outdoor recreation is underscored by data presented in table 5.2, which shows the distribution of selected activities

across ecoregions. The central-pine hardwoods ecoregion accounts for at least half and up to nearly 80 percent of the total statewide activity hours for all but one (canoeing) of the activities sampled.

Table 5.1. Percent of activity hours for selected activities for all FIA timberland plots by ecoregion.

Ecoregion	Number of FIA Plots*	Percent of FIA Plots	Percent of Activity Hours
1 Glacial lake plains	2,446	20	6
2 Border lakes	793	7	10
3 Lake Superior highlands	744	6	5
4 Central pine-hardwoods	6,460	53	65
5 Western prairie/forest transition	675	6	7
6 Eastern prairie/forest transition	468	4	4
7 Western prairie	116	1	1
8 and 9	415	4	2
Total	12,117	100	100

* Number of plots may differ from the total number of timberland plots (12,118) due to varying levels of completeness for certain variables in the FIA test data available for this study.

The distributions for individual activities by ecoregion show some predictable patterns. A high proportion of canoeing and camping activity hours occur in the border lakes and Lake Superior highlands ecoregions, both of which are located adjacent to the BWCAW. The Lake Superior highlands ecoregion, with its steeper terrain and established facilities, also provides opportunities for 20 percent of the state's downhill skiing activity hours.

The western prairie forest transition ecoregion supports significant levels of day use activities such as picnicking, hunting, hiking/walking and cross-country skiing. This usage can be explained by the proximity of much of this ecoregion to the main population centers and the provision of suitable facilities. The glacial lake plains ecoregion provides a significant (15 percent) share of the hunting activity hours.

Table 5.3 shows the relative percent of activity hours for selected activities within each ecoregion, and added across ecoregions. The data show that water related activities (fishing, boating and canoeing) account for nearly half of all activity hours. At an ecoregion level, the relative percentages of water related activities follow predictable patterns. At the upper end of the scale, these activities account for 71 percent of all activity hours in the border lakes ecoregion. In contrast, these activities account for little over one percent of hours in the western plains ecoregion.

Table 5.2. Percent of activity hours occurring **across** ecoregions for selected activities.

Activity	Ecoregion							Total*
	Glacial Lake Plains	Border Lakes	Superior Highlands	Central Pine Hardwood Forest	Western Prairie Forest Transition	Eastern Prairie Forest Transition	Western Prairie	
Camping	5	14	7	62	8	3	1	100
Fishing	9	12	4	67	6	1	1	100
Boating	4	7	1	73	9	4	<1	98
Canoeing	3	40	19	33	4	1	<1	100
Picnicking	3	3	6	50	23	12	1	98
Cross-country skiing	4	4	8	61	15	5	<1	97
Downhill skiing	0	7	23	52	9	8	1	100
Snowmobiling	2	2	<1	79	8	7	1	99
Walking/hiking	2	4	5	58	18	9	1	97
Nature study	4	4	8	66	9	7	1	99
Hunting	15	<1	<1	61	12	8	1	97
Off-road vehicle	5	1	<1	79	7	4	1	97

Source: MNDNR SCORP.

*May not total 100 percent in some cases because ecoregions 8 and 9 are not included in this analysis. There is relatively little recreation activity in these ecoregions and few timberland plots.

Table 5.3. Percent of activity hours occurring within each ecoregion for selected activities.

Activity	Ecoregion							
	Glacial Lake Plains	Border Lakes	Superior Highlands	Central Pine Hardwood Forest	Western Prairie Forest Transition	Eastern Prairie Forest Transition	Western Prairie	All Ecoregions
Camping	8	16	15	10	8	7	10	10
Fishing	49	45	25	36	21	9	32	34
Boating	7	9	3	12	10	9	8	11
Canoeing	2	17	14	2	1	1	1	4
Picnicking	1	1	3	2	6	7	3	3
Cross-country skiing	1	<1	2	1	2	2	<1	1
Downhill skiing	0	1	6	1	1	2	1	1
Snowmobiling	1	1	<1	4	3	5	3	3
Walking/hiking	6	7	19	15	31	33	23	17
Nature study	5	3	11	7	6	10	6	7
Hunting	17	<1	<1	6	8	12	6	7
Off-road vehicles	2	<1	<1	3	2	3	5	3
All activities	100	100	100	100	100	100	100	100

Source: MNDNR SCORP.

Walking/hiking and nature study activities account for between 30 and 40 percent of hours in the Lake Superior highlands, Western Prairie forest transition and eastern prairie forest transition ecoregions. These three ecoregions contain some of the state's premier long distance hiking trails.

Camping is the only activity to show a fairly consistent proportion of total hours across all ecoregions, and this is at least partly due to the widespread distribution of public and private camping facilities.

**5.1.2
Recreation Opportunities**

Timberlands

The proportion of timberland plots within the six ROS classes are weighted towards opportunities at the nonprimitive end of the ROS. More than 40 percent of the timberlands are designated as offering roaded natural types of recreation opportunities (table 5.4). Another 25 percent offer rural types of opportunities.

Recreation opportunities in the primitive and semiprimitive nonmotorized end of the spectrum comprise less than nine percent of timberland plots and less than 13 percent of all forested land in the state.

Table 5.4. Recreation opportunities statewide on FIA timberland plots and on all forest plots statewide.

Opportunity Class	Timberland Plots		All Forest Plots	
	Number of plots	Percent of plots	Number of plots	Percent of plots
Primitive	53	0.4	425	3.1
Semiprimitive nonmotor	876	7.2	1,306	9.6
Semiprimitive motor	3,074	25.4	3,409	25.2
Roaded natural	5,049	41.7	5,232	38.7
Rural	3,030	25.0	3,107	23.0
Urban	36	0.3	57	0.4
Total	12,118	100	13,536	100

Recreation Opportunities Within Ecoregions

As with the distribution of opportunities statewide, recreation opportunities are unevenly distributed within ecoregions (table 5.5). For example, the glacial lake plains and border lakes ecoregions offer many opportunities for primitive and semiprimitive nonmotorized experiences while offering few opportunities at the more developed end of the spectrum. Other ecoregions,

such as the prairie and forest transition zones, offer no opportunities at the primitive end of the spectrum as all the recreation opportunities in these ecoregions are at the developed end of the spectrum.

Table 5.5. Distribution of recreation opportunities on FIA timberland plots **within** each ecoregion (percent of plots^a).

ROS Class	Glacial Lake Plains n=2446	Border Lakes n=793	Lake Superior Highlands n=744	Central Pine Hardwoods n=6460	Western Prairie Forest Transition n=675	Eastern Prairie Forest Transition n=468	Western Prairie n=116
Primitive	1	1	0	<1	0	0	0
Semiprimitive Nonmotor	18	17	4	4	0	0	1
Semiprimitive Motor	40	47	46	21	0	0	0
Roaded Natural	37	33	43	51	15	9	10
Rural	5	3	7	24	84	90	89
Urban	0	0	0	0	1	0	0
All Classes ^b	100	100	100	100	100	100	100

^a n = number of timberland plots in each region.

^b May not total 100 percent in some cases because ecoregions 8 and 9 are not included in western prairie ecoregion.

The central pine hardwoods ecoregion is the largest and has the most (53 percent) timberland plots. The majority of recreation opportunity settings in this ecoregion are in the middle of the spectrum. Roaded natural opportunities make up 51 percent, semiprimitive motorized make up 21 percent and rural account for 24 percent. There are none at the urban end of the spectrum and a little over 4 percent in the nonmotorized classes.

Recreation Opportunities Across Ecoregions

Compared to the other ecoregions, the glacial lake plains has the largest area of primitive and semiprimitive lands (table 5.6). However, the recreation value calculated for this ecoregion is very low. This low value suggests that although primitive opportunities are available in this region, recreation users do not seek them out. This likely occurs because many of the plots within the primitive ROS class are in hydric (wet) physiographic classes and spruce covertypes, areas of marginal interest for most recreators. Another factor is that these uses may not be encouraged by the owners.

The glacial lake plains, border lakes and central pine hardwood ecoregions together provide 97 percent of all nonmotorized recreation opportunities. The central pine-hardwood and glacial lake plains are the primary setting for semiprimitive motor opportunities. The central pine-hardwood region provides more than half of the opportunities falling in the roaded natural to rural classes. The prairie/forest transition regions and glacial lake plains also provide opportunities in these classes.

Table 5.6. Distribution of recreation opportunities on FIA timberland plots **across** ecoregions (percent of plots^a).

ROS Class	Glacial Lake Plains n=2,446	Border Lakes n=793	Lake Superior Highlands n=744	Central Pine Hardwoods n=6,460	Western Prairie Forest Transition n=675	Eastern Prairie Forest Transition n=468	Western Prairie n=116	All Classes ^b
Primitive	47	17	0	11	0	0	0	86
Semiprimitive Nonmotor	49	16	3	28	0	0	0	96
Semiprimitive Motor	32	12	11	44	0	0	0	99
Roaded Natural	18	5	6	66	2	1	0	98
Rural	4	1	2	50	19	14	3	93
Urban	3	0	6	78	11	3	0	100

^a n = number of timberland plots in each ecoregion.

Recreation Opportunities Across Ownerships

As previously stated, the ROS class assigned to an FIA plot is not necessarily indicative of active recreation management practices in place for the area. It simply means that the area associated with the plot met the criteria set out in section 2.1. In Minnesota, only the USDA Forest Service manages its lands according to ROS guidelines.

Although the MNDNR does not manage its lands based on ROS, providing opportunities for natural resource based outdoor recreation is an important part of its programs. The MNDNR recognizes the need to identify and provide recreation opportunities across a range of settings and it does this through a variety of programs. These programs are carried out by the various divisions within the MNDNR that have responsibility for recreational activity occurring on their lands. However, there are differences between divisions in how they manage their lands for recreational uses. Each division has a separate mission, which differs from those assigned to the other divisions. For example, the MNDNR Division of Parks and Recreation and Division of Trails and Waterways have primary missions to provide and manage for recreational use occurring on state park land, state trails and waterways respectively. In contrast, managing for recreational uses is a secondary mission for the Division of Forestry in its management of state forests. Recreation use occurring on lands administered by the other MNDNR divisions is likewise ancillary to the managing division's mission.

In general, counties manage some of their lands (eg. county parks) for a variety of recreational *activities*. The settings where these activities occur may represent a diverse set of recreation *opportunities*. The Hennepin County regional park system is the best example of a Minnesota county managing for a diversity of recreational opportunities rather than only recreational activities.

For all other ownership classes, the ROS designation is more a reflection of site conditions, rather than an indication of actual recreation opportunities. That is, private individuals, corporations, counties, industry, and farmers who own timberlands are not likely to manage those lands for recreational use as defined by ROS. Therefore, lands managed by state and federal forestry agencies take on additional significance as providers of forest based recreational opportunities.

Recreation Opportunities Within Landownership Classes

There are distinct differences in the distributions of ROS classes within the various ownerships that are set out in table 5.7. The majority of timberlands owned by private interests (farmers, corporations and individuals) and other federal ownerships are in the roaded natural to urban end of the ROS.

In contrast, the majority of timberlands owned by the USDA Forest Service, state, BLM and Native Americans are in the semiprimitive motorized to primitive end of the spectrum.

Recreation Opportunities Across Landownership Classes

Table 5.8 describes the distribution of ROS opportunities across ownerships (table 5.8). The majority of timberlands classified as primitive are on Native American (53 percent) and state (21 percent) lands. Almost half (46 percent) the land in the semiprimitive nonmotorized class is owned by the state, with most of the remainder owned by the counties, USDA Forest Service and Native American ownerships.

Most of the land at the urban end of the spectrum is owned by private individuals and corporations. Most timberlands in the rural category are owned by farmers, private individuals and corporations.

Resorts

Minnesota has over 1,300 privately owned resorts. The majority are located in the central pine hardwood forest ecoregion and nearly all of them include lake, stream or riverfront property (MN Office of Tourism 1991).

In 1991 a survey of these 1,300 resort owners was conducted by the Office of Tourism. Eight-two percent of these providers responded. Their responses indicate that over 12,000 privately owned campsites affiliated with resorts exist within the state and over 14,000 lodging units exist. (See appendix 4 for a breakdown of survey results for resort location by county and number of lodging and campsite units in each county.)

The variety of recreation activities that occur in these areas includes all of the major outdoor recreation activities associated with Minnesota (e.g., camping, canoeing, fishing, boating and hiking) and other activities which do not require a natural setting (e.g., golfing, volleyball, baseball and tennis). The recreational experiences provided by these areas fall largely in the roaded natural and rural ends of the ROS.

Resorts often depend on lands owned by others for their setting. In addition, many resorts are adjacent to public lands such as state parks, state and federal forests, and county lands. The opportunities available on these public lands serve as part of a resort's attraction. Owners typically advertise using these public lands as an important backdrop or attraction for their resorts. Programs such as the Resort Naturalist Program enable resort owners to provide recreation opportunities for resort visitors by forming partnerships with public land managers. Opportunities provided through these partnerships include campfire talks, nature hikes, birdwatching, and nature study (see tourism report for additional information on Minnesota's resort industry).

Table 5.7. Distribution of ROS recreation opportunities on FIA timberland plots statewide **within** an ownership class (percent of plots*).

ROS Class	Forest Service n=1,251	BLM n=25	Native American n=398	Other Federal n=128	State n=2,617	County/ Municipal n=2,184	Forest Industry n=647	Farmers n=1,775	Private Corporation n=533	Private Individual n=2,559
Primitive	<1	0	7	1	<1	<1	0	0	0	<1
Semiprimitive Nonmotor	10	8	24	10	15	7	5	1	3	1
Semiprimitive Motor	45	80	36	18	36	36	42	3	20	7
Roaded Natural	43	12	28	33	39	46	47	30	49	49
Rural	2	0	5	38	10	12	6	67	27	42
Urban	0	0	1	0	0	0	0	0	2	1
All Classes	100	100	100	100	100	100	100	100	100	100

* n = number of timberland plots by ownership class (12,117 total).

Table 5.8. Distribution of ROS recreation opportunities on FIA timberland plots statewide **across** ownership classes (percent of plots*).

ROS Class	Forest Service n=1,251	BLM n=25	Native American n=398	Other Federal n=128	State n=2,617	County/ Municipal n=2,184	Forest Industry n=647	Farmers n=1,775	Private Corporation n=533	Private Individual n=2,559	All Classes
Primitive	9	0	53	2	21	9	4	0	0	2	100
Semiprimitive Nonmotor	15	0	11	2	46	18	3	1	2	4	100
Semiprimitive Motor	18	1	5	1	31	25	9	1	3	6	100
Roaded Natural	11	0	2	1	20	20	6	11	5	25	100
Rural	1	0	1	2	8	9	1	39	5	35	100
Urban	0	0	6	0	8	6	0	6	25	50	100

* n = number of timberland plots by ownership class (12,117 total).

Summary of Natural Resource Based Outdoor Recreation in Minnesota

Analysis of the data in this section shows patterns in the statewide distribution of recreation activities on timberlands. Natural resource based outdoor recreation use is concentrated in the northern half of the state; the central pine hardwood ecoregion alone accounts for 65 percent of total activity hours. This ecoregion contains most of the state's resorts. Most resorts are situated in close proximity to water. Recreation activities related to water (fishing, boating and canoeing) account for around half the total activity hours. This underscores the importance of riparian lands in the context of maintaining the backdrop, and in some cases, settings, for a major portion of natural resource based outdoor recreational activities in the state.

Timberlands classified under the various ROS classes are unevenly distributed spatially and across ownerships. Opportunities towards the primitive end of the spectrum are located in the north central and northwestern parts of the state. Timberlands at the more primitive end of the spectrum are mainly owned by Native American tribes and the state. Timberlands in these ROS classes characteristically show low levels of use. The USDA Forest Service and counties own some timberlands at this end of the spectrum; however, the majority of their lands are in the semiprimitive motorized and roaded natural classes.

The majority of the more developed and accessible timberlands are owned by private interests. These areas are concentrated at the prairie margins and in the central and southern parts of the state. Timberlands in the central part of the state typically fall in these more developed categories. Their relative proximity to major population centers, coupled with accessible water bodies and developed recreation oriented infrastructure (the resorts) mean these areas experience the high levels of use referred to above.

5.1.3 Recreation Value

Recreation Value by Ecoregion

Based on the procedure discussed in section 4.1.1, each TRU, regardless of ROS class, had an associated recreation value. Table 5.9 shows the percentage of TRUs by recreation value for each ecoregion.

Glacial Lake Plains ecoregion timberlands have 2,446 TRUs or 20 percent of the total. Nearly 50 percent of those have a low recreation value, while less than one percent have a very high recreation value. Overall, the recreational value or intensity of recreational use in this ecoregion is low. Practically speaking, the area has limited access, little topography and bog or lowland vegetation is a predominate feature.

Table 5.9. Distribution of recreation value on TRUs on FIA timberland within ecoregions (percent of total plots or TRUs*).

Recreation Value	Forested Ecoregions						
	Glacial Lake Plains (n=2,446)	Border Lakes (n=793)	Lake Superior Highlands (n=744)	Central Pine Hardwoods (n=6,460)	Western Prairie Forest Transition (n=675)	Eastern Prairie Forest Transition (n=468)	Western Prairie (n=116)
Very high (1)	1	47	16	27	27	7	3
High (2)	4	31	18	25	28	14	19
Moderate (3)	18	19	14	21	21	41	16
Low (4)	28	3	32	18	11	22	26
Very low (5)	49	1	20	9	13	17	36
Total	100	100	100	100	100	100	100

* n = number of timberland plots (TRUs) in each ecoregion (12,117 total).

Border Lakes ecoregion timberlands contain 793 (about seven percent) of the TRUs. Nearly half have a recreation value of 1 (very high), another 30 percent have a value of 2 (high), and about 20 percent have a value of 3 (moderate). The border lakes ecoregion is characterized by a high recreational value. Given that (1) this area includes the BWCAW, and (2) the 18-mile radius of activity considered in developing the SCORP data, the recreation value is clearly influenced by the proximity to the BWCAW.

Lake Superior Highlands ecoregion timberlands have 744 (about six percent) of the state's TRUs within its boundaries. A little more than 50 percent of them have low or very low recreation values of 4 or 5. The remaining 50 percent are evenly distributed among the high to moderate levels (1 to 3) of recreational use. The high values are related in part to the North Shore travel corridor.

Central Pine-hardwood ecoregion timberlands contain more than half (6,460) of the TRUs are found within the central pine-hardwoods ecoregion. Nearly three-fourths of these have recreation values ranging from 1 to 3 (very high to moderate). This ecoregion has many lakes and supports high levels of recreational activities. Most of Minnesota's resorts and private campgrounds are located within this ecoregion.

Western Prairie/Forest Transition ecoregion timberlands contain 675 (less than six percent) of the TRUs. Most of these experience very high to moderate levels of recreation use (recreation values of 1 to 3).

Eastern Prairie/Forest Transition ecoregion timberlands have 468 (about four percent) of the TRUs. For the most part, these were assigned recreation values in the range of 3 to 5, corresponding to moderate to low levels of recreation use.

Western Prairie ecoregion timberlands include 116 (one percent) of the TRUs. These are not considered prime forest recreation sites and the intensity of use or recreation values tends to be low.

Overall, the TRUs with the highest levels of use or recreation values are those found in the border lakes and central pine-hardwoods ecoregions of the state. The TRUs with the lowest levels of recreation use or values tend to be found in the glacial lake plains and prairie ecoregions.

In addition to being highly valued for recreational uses, the timberlands in the central pine-hardwoods ecoregion supply most of Minnesota's commercial timber. The probability of conflicts occurring between recreational and timber harvesting interests is perhaps greatest in this area of the state.

Recreation Value by Ownership

Statewide, more than one-quarter of the most highly valued TRUs are owned by private individuals (see table 3.2). The next largest group of landowners of TRUs with high recreation value are counties and municipalities. The USDA Forest Service owns and manages about 17 percent of the TRUs with a recreation value of 1, and the MNDNR is responsible for managing about 12 percent of these highly valued recreation lands.

By individual ownership class, the national forests have about ten percent of the statewide total of TRUs (see table 5.11). Over 85 percent of these are moderately to very highly valued recreation lands. The MNDNR is the largest owner and manager of timberland in the state. Nearly 60 percent of the TRUs it manages have low recreational values. The next largest group of owners, private individuals (nonfarmers), own and manage about one-fifth of the state's timberlands. Recreational value on these TRUs is fairly evenly spread across the range of values. Counties and municipalities own and manage another 18 percent of the timberlands. As with the private landowners, recreational values are fairly evenly spread across the range. Farmers own and manage 15 percent of timberlands. The recreation values also seem to be equally distributed across the range. Native American owned TRUs have mainly a low or very low recreational value due to their placement at the primitive end of the ROS and because they are relatively inaccessible.

Table 5.10. Distribution of recreation value on FIA timberland plots across ownership classes (percent of total).*

Recreation Value	Ownership Class										
	Forest Service n=1251	BLM n=25	Native American n=398	Other Federal n=128	State n=2617	County/ Municipal n=2184	Forest Industry n=647	Farmers n=1775	Private Corporations n=533	Private Individuals n=2559	All Ownerships
Very High (1)	17	0	1	0	13	22	3	10	6	27	100
High (2)	17	0	1	1	13	18	5	15	7	24	100
Moderate (3)	10	0	2	2	18	22	7	16	4	20	100
Low (4)	5	0	5	1	26	19	7	14	3	19	100
Very Low (5)	2	1	8	1	38	10	5	19	2	15	100

* n = number of timberland plots (12,117 total).

Table 5.11. Distribution of recreation value on FIA timberland plots within each ownership class (percent of total).*

Recreation Value	Ownership Class									
	Forest Service n=1251	BLM n=25	Native American n=398	Other Federal n=128	State n=2617	County/ Municipal n=2184	Forest Industry n=647	Farmers n=1775	Private Corporations n=533	Private Individuals n=2559
Very High (1)	34	0	5	7	12	26	13	14	28	27
High (2)	32	0	8	17	12	19	17	20	30	23
Moderate (3)	19	0	12	27	17	24	26	22	18	19
Low (4)	10	20	30	23	24	21	25	20	14	18
Very Low (5)	4	80	45	25	35	11	19	25	9	14
All Values	100	100	100	100	100	100	100	100	100	100

* n = number of timberland plots (12,117 total).

5.1.4 Relative Forest Attractiveness Values

Table 5.12 describes the relative importance of each landform and landcover dimension to the ecoregions and to the state as a whole. This table only reflects landform and land cover dimensions for *timberland* plots in the state. It does *not* assess landform and land cover dimensions for reserved and unproductive forest plots or plots under other land use variables. Because of the location of timberland plots within ecoregions, the values derived for some of the dimensions may not correspond with values that may be intuitively derived. For example, the Lake Superior highland ecoregion lies along the North Shore of Lake Superior. Intuitively, one would expect that the water distinctiveness dimension would be relatively high, perhaps higher, than that found in other ecoregions. However, it is not. The reason is that very few timberland plots in the Lake Superior highlands are close to Lake Superior. Much of the land close to Lake Superior is developed private land or reserved forest land (e.g., parks) with few or no timberland plots on it. In contrast, the glacial lake plains ecoregion has many timberland plots that are in close proximity to a waterbody, resulting in a comparatively high value for this attractiveness dimension.

Landform Dimension Values by Ecoregions

Glacial lake plains ecoregion timberlands have a landform value that is less than the state average. The relatively high value in water distinctiveness and regional water diversity are offset by having the lowest statewide value in slope steepness, landform enclosure of space and visual absorption capacity.

Border lakes ecoregion timberlands have a landform value that is slightly above average. The dominant landform features are regional slope and water diversity, absorption capacity and water distinctiveness. The values for landform enclosure of space and slope steepness dimensions are both slightly above the statewide average.

Lake Superior highlands ecoregion timberlands have the highest landform value of Minnesota's ecoregions. This value results from very high regional slope diversity and above average slope steepness, landform enclosure and absorption capacity. The value for regional water diversity is below average as is the water distinctiveness value.

Central pine-hardwood ecoregion timberlands have a landform value closest to the state's average. This pattern holds true in all of the landform dimensions except landform enclosure of space and regional water diversity.

Western prairie/western prairie forest transition zone ecoregions

timberlands have below average measures of water distinctiveness and regional water diversity, and they have a relatively low regional slope diversity. However, the values for steepness and enclosure of the timberland sites are above average. This suggests that the timberlands are on the hilliest parts of the ecoregion. A high degree of vegetative pattern diversity suggests a strong agricultural land use influence which may explain why the forested plots are on the steepest sites.

Table 5.12. Distribution of mean landform and mean landcover values within ecoregions for timberland.*

Attractiveness Dimensions (means)	Ecoregions							
	Glacial Lake Plains	Border Lakes	Lake Superior Highlands	Central Pine Hardwoods	Western Prairie Forest Transition	Eastern Prairie Forest Transition	Western Prairie	State Average
Landform								
Slope steepness	29.80	51.42	49.29	42.34	48.15	78.47	43.93	42.62
Landform enclosure of space	18.51	31.78	32.84	33.85	41.35	59.83	26.31	31.65
Water distinctiveness	88.63	70.10	74.19	76.11	63.14	79.04	65.50	77.05
Absorption capacity	56.63	72.78	71.27	67.72	72.34	88.30	70.08	67.19
Regional slope diversity	67.55	76.90	95.36	67.30	37.27	61.28	35.31	66.39
Regional water diversity	74.89	76.12	56.76	76.19	71.48	58.72	68.32	73.45
Mean landform value	56.00	63.10	75.83	60.59	55.62	70.94	51.59	59.73
Landcover								
Species diversity	59.79	72.47	70.70	66.46	61.85	64.40	49.44	64.68
Presence of large old trees	64.84	69.98	72.59	67.77	72.58	75.49	67.62	68.18
Vegetative distinctiveness	31.45	35.28	43.44	35.61	37.24	31.48	40.39	35.37
Ground plain conditions	87.71	88.02	85.21	84.43	74.30	74.89	76.17	84.08
Negative human scale effects	29.88	11.02	16.59	13.94	9.61	5.70	18.71	16.78
Spatial definition and visual penetration	53.49	59.94	57.76	60.66	71.88	76.28	60.95	59.90
Regional vegetative diversity	61.50	76.40	65.20	65.30	35.5	33.00	33.00	60.90
Regional pattern diversity of open space and forested mass	52.61	37.41	38.23	71.71	97.73	98.82	91.91	66.94
Mean landcover value	55.15	55.69	56.22	58.24	57.58	57.50	54.77	57.10
Number of FIA ground plots	2,446	793	744	6,460	674	468	531	12,119

* Maximum (high) value for any cell is 100.

Eastern prairie/forest transition ecoregion timberlands have comparatively high landform value. The value for mean slope steepness is the highest in the state, and the values for landform enclosure of space, water distinctiveness and visual absorption capacity are above the statewide average. The value for regional water diversity in this ecoregion is below average and the water distinctiveness of the sites is above average.

Western prairies ecoregion timberlands have very low values in regional slope diversity and landform enclosure of space. Regional water diversity and water distinctiveness values are also relatively low. The slightly above average value for visual absorption capacity suggest that the sites in this ecoregion are also relatively visible.

Landcover Dimensions

Overall, mean landcover values are lower than mean landform values on both statewide and ecoregion levels. This is due partly to low values for the human-scale effects dimension of attractiveness. In the glacial lake plains region, the large stand sizes and flat terrain cause the negative human-scale dimension to be especially important to defining attractiveness.

Table 5.12 also suggests that there is less variation in the landcover dimensions than in the landform dimensions. This is likely the result of at least two factors. Past land use and wildfire have had profound effects on the age class distribution and species composition throughout the state.

The FIA data used in these analyses also limits the potential for landcover variability by excluding agricultural land. There are, however, some prevalent landcover patterns. Species diversity and regional vegetative diversity values are slightly higher in the northern ecoregions than the southern ecoregions. Large trees are prevalent throughout the state. Vegetative distinctiveness is relatively low statewide. Current ground plane conditions throughout the state are relatively free from management caused disturbance. Regional vegetative diversity is higher in the northern ecoregions. Conversely, regional pattern diversity of open space and forested land is much higher in the southern ecoregions than in the northern ecoregions. This pattern reflects the predominance of agricultural uses in the southern and western ecoregions.

5.2 Visual Management

5.2.1 Visual Vulnerability in Forest Environments

Landscapes vary in the extent to which environmental disturbance will

affect their appearance. Some landscapes can accommodate a variety of forest management activities without noticeable changes in visual character. Management practices such as thinning can also enhance visual aspects of a landscape. Other landscapes are more vulnerable, and any form of land cover modification produces a very noticeable alteration of visual character. Still other forest landscapes are located at or in close proximity to sensitive recreation areas such as national, state and county parks; wild and scenic rivers; state trail systems; major resort areas; and heavily visited lake areas. Forest ownerships that practice visual management planning identify sensitive areas as the first step in a process to mitigate the adverse visual impact of timber harvesting and forest management activities. Understanding visual sensitivity provides a context that helps to identify areas that should be excluded from harvesting. It also helps to identify areas where other mitigation measures need to be exercised in harvest planning and forest management. A more complete discussion of visual sensitivity assessment can be found in appendix 3.

Visual sensitivity is determined by the proximity of an ownership to major recreational facilities, resources and travel routes (USDA Forest Service 1974) as well as by a number of landform and landcover characteristics (USDA Forest Service 1972; Litton 1984; Wisconsin Department of Natural Resources n.d.; MNDNR 1991), described below:

1. Ridgelines are especially sensitive. The breaks between a near ridge silhouetted against a distant ridge or where land meets sky establish strong color value and texture contrasts.
2. Changes occurring on a land surface that is perpendicular to a visual sightline tend to be more noticeable than when the angle between viewed land plane and the sightline is acute or obtuse. That is, changes in hilly or mountainous areas are more noticeable than changes in flat terrain.
3. Sites that are visible from many locations are more sensitive than sites seen from fewer locations.
4. Areas within the first one-quarter mile of an observation point, and especially within the first 300 feet, are more sensitive than areas in the middleground or background of a view.
5. Visual screening, provided by either intervening landform or vegetation, reduces sensitivity.
6. Landscapes containing homogeneous stand types and a monotone stand density are more sensitive than those characterized by greater stand diversity and varied density.
7. Along travel corridors, landscapes located on the outside arc of curves are viewed by travelers for a longer duration and are consequently more sensitive than landscapes located along the sides of road tangents.
8. Landscapes located along pronounced edges between various landcover types (e.g., water and land edge, forest and field edge, forest and

wetland edge) are more sensitive than landscapes *inside* a landcover type.

9. Areas contained in or within one-fourth mile of national, state and county parks and areas within 200 feet of a resort, wild and scenic river, recreational lake or river, and a state canoe, boating or recreational trail have high sensitivity.

5.2.2

Mitigating Adverse Visual Impacts

A number of techniques are applied as an important part of VMS to mitigate the adverse aesthetic impacts associated with timber harvesting and forest management. The techniques provide guidance in assessing where harvesting should occur, as well as assessing how harvesting should be conducted to minimize the adverse aesthetic impacts of timber harvesting and forest management. These techniques range from prohibition of harvesting to specific manipulations of the harvest area to management of information flow to recreational visitors in forests being harvested. These are briefly described below with a more detailed discussion in appendix 6.

Harvesting Prohibition

Prohibiting all forms of harvesting in a given locale represents one measure that will mitigate the adverse visual impacts of forest harvesting. Harvesting prohibition is generally reserved for use in mitigating adverse visual impacts only in stands having exceptionally high visual sensitivity by virtue of the high volume of recreation use or the special nature of recreation use these stands receive.

Several examples of harvesting prohibition to mitigate adverse visual impacts of harvesting exist in Minnesota. Harvesting is prohibited, for example, in the BWCAW. Commercial harvesting is generally prohibited within state parks and within 200 feet of a state designated wild river. Harvesting is also prohibited within 200 feet to as much as one-quarter of a mile on either side of federally designated wild and scenic rivers, such as the St. Croix National Scenic Riverway. Primarily, the designation of the river or segments of the river determines the width of the harvesting prohibition buffer. Rivers designated as recreational, scenic and wild have buffer widths of 200 feet to a quarter of a mile on either side of the river or river segment depending on their designation. These buffers are routinely applied by the USDA Forest Service, the MNDNR, some counties and private ownerships and are mandated under the legislation and rules outlined in section 7.3 of this report.

Use of Selective Harvesting Systems

In areas where forest harvesting occurs, there are several silvicultural systems that mitigate adverse visual impacts by retaining a proportion of the existing canopy. These include uneven-aged silvicultural systems such as single tree or group selection systems as well as modified even-aged or two-aged silvicultural systems such as shelterwood and reserved shelterwood. Thinning can also be used as an interim harvest technique to maintain a continuous canopy.

Manipulating the Size of the Harvest Area

The decision to clearcut a stand has obvious implications pertaining to the retention of large trees, vegetative distinctiveness, complementary human scale relationships and spatial definition. Values associated with these qualities of forest attractiveness are foregone until such time as the stand is regenerated. However, the loss of some of these values can be mitigated by manipulating the size of the area to be clearcut.

A distinction exists between the absolute size of the area to be clearcut and the apparent size of the harvest area (USDA Forest Service 1980). A clearcut of 40 acres may be experienced by passers-by from a road or by recreationists from an adjacent recreational use area in increments whose apparent size is 10 acres or less. In other words, intervening landform or retained vegetation may divide the 40-acre clearcut into a series of smaller spaces created through the clearcutting process, meaning that all 40 acres are never evident from any viewing point within the harvested area. By reducing the apparent size of the clearcut from 40 acres to 10 acres, some mitigation of the adverse effects of a 40-acre clearcut on human scale relationships and spatial definition is realized. Similarly, by carefully manipulating the size of a clearcut, a closer proximity can be established between people experiencing the clearcut and adjacent undisturbed forest. Studies of clearcut size in red pine stands on the Huron-Manistee National Forest report highest preference among forest visitors for harvest areas in which between 4 and 10 acres of harvest operation are evident. Openings of less than 4 acres or more than 10 acres are perceived as less attractive than openings between 4 and 10 acres (Schroeder, Gobster and Frid n.d.).

There are various techniques that can be used to manipulate the apparent size of a clearcut (USDA Forest Service 1980; Wisconsin Department of Natural Resources n.d.; MNDNR 1991; Ontario Ministry of Natural Resource 1989):

1. Leave strips or elongated patches of timber may be retained to serve as a foil between one *apparent space* and another. Leave strips may separate roads from harvest areas as well as separating one clearcut from another.
2. Groups of existing trees can be retained as inclusions within the clearcut area.

3. Retention of fingers of existing vegetation serve the same purpose as leave strips and inclusions. However, by retaining an explicit connection to existing forest vegetation, these peninsulas provide a stronger linkage between the visual qualities of the clearcut and the visual qualities of the adjacent uncut forest.
4. Apparent size can also be manipulated by carefully delineating the size and spacing of openings in a clearcut as viewed from adjacent roads and recreational areas.

Manipulating the Shape of the Harvest Area

Retention of leave strips, inclusions and peninsulas of existing vegetation to mitigate adverse visual impacts of clearcutting also influence the shape of a clearcut. The shape of a clearcut mainly determines the character of the harvesting area relative to the rest of the landscape (USDA Forest Service 1980; Wisconsin Department of Natural Resources n.d.; MNDNR 1991; Ontario Ministry of Natural Resources 1987). In many instances, shapes already present in a landscape can be used as a basis for establishing shapes of areas to be clearcut. Therefore, in undeveloped areas clearcuts can be made less obtrusive by designing boundaries that avoid long straight lines and sharp angles. The resulting clearcut shapes are more natural in appearance. In contrast, clearcuts with straight boundaries may be less obtrusive in agricultural areas, where the landscape character is dominated by the grid structure of field boundaries.

Manipulating the Edge of Clearcut Areas

An underlying principle in mitigating the adverse visual impacts of clearcutting is to create openings that maximize the ratio of length of clearcut edge to size of clearcut area. When combined with the techniques described above, promotion of large edge to area ratios can effectively mitigate visual impacts associated with scale relationship, spatial definition and visual penetration. These mitigation measures will maintain a closer proximity of harvested area to unharvested area. Visitors will be assured greater proximity to the visual amenities associated with adjacent uncut forest that may include all or some of the dimensions of aesthetic value described previously, such as large old trees, species diversity and vegetative distinctiveness.

Clearcut edges create linear patterns of strong contrast between the height of retained forest vegetation and the height of vegetation in the clearcut. By developing a gradient of vegetative density and stand age across the edge of clearcut, the contrast between vegetation of varying height, color and texture can be softened.

Manipulating the Pattern of Clearcutting Practices

As discussed in section 3.2.1, a recreationist's visual image of the forest environment is a product of impressions obtained across time and space.

Thus, mitigating the adverse visual impacts of forest harvesting and management also requires consideration of how harvesting affects the spatial patterns of visual character in the landscape. In this sense, mitigation measures used at a given clearcut must be integrated into the larger landscape pattern. Integration of a specific clearcut into the overall pattern involves several considerations (USDA Forest Service 1980; Wisconsin Department of Natural Resources n.d.; MNDNR 1991; Ontario Ministry of Forestry 1987):

1. To the extent possible, the long axis of clearcuts should be oriented perpendicular to or on a diagonal to the sight line.
2. To the extent possible, the patterns of forest openings size and shape should be varied.
3. Where possible, the edge of one apparent clearcut opening should overlap with the edge of an adjacent clearcut opening.
4. Within the size and shape parameters discussed earlier, openings of one clearcut should connect with the openings of an adjacent clearcut.
5. The time interval between harvesting of adjacent stands should be scheduled in a manner that establishes a landscape character that can be sustained over time.

Managing Harvesting Residue

One of the more noticeable visual impact of forest harvesting pertains to the slash or residue that litters the floor of many clearcut areas (Arthur 1977; Benson 1982; Daniel and Boster 1976; Daniel and Schroeder 1979; Schroeder and Daniel 1981; Brown and Daniel 1984, 1986; Vodak et al. 1985; Ribe 1989). Management of slash and harvest residues has considerable potential for mitigating the effects of harvesting on ground plane conditions.

Management of Regeneration Patterns

A considerable amount of future mitigation of the adverse impacts of forest harvesting can be realized through the proper layout of regeneration plantings (Wisconsin Department of Natural Resources n.d.; Ontario Ministry of Forestry 1987). Alignments of planting rows in a pattern that parallels topographic contours will produce stands with a more natural appearance. There will be benefits in the future as a consequence of visual planning for current harvests. Stands resulting from operations set out using the design principles described above will be able to be harvested with minimal impacts on visual quality.

Management of Road and Landing Design

Care in the location of forest roads and landings can minimize forest road density as well as reduce the visual impacts of roads. Both factors can substantially mitigate visual impacts of forest harvesting.

Management of Season of Harvest

Rutting, compaction and other disturbances caused by operation of harvesting equipment is an important factor contributing to adverse visual impacts on the ground plane (section 3.2.2). Other things being equal, harvest operations conducted on most soil types during the spring, and to a lesser extent the fall, will produce greater visual impacts than operations conducted during the summer. This is because most soils are more susceptible to rutting during periods when soil strength is reduced due to higher moisture content. Operations conducted during winter, when the ground is frozen, result in the least disturbance.

Management Over Long Time Periods

Since large tree sizes are an important aspect of forest attractiveness, choosing long rotation ages can be an important visual management decision. Extended Rotation Forests (ERF) can increase the length of time, say over a 50-year period, that the forest is most attractive. Such practice may be especially helpful for species and conditions where uneven-aged silvicultural systems are difficult to implement successfully. Likewise, thinning and/or forest weed control (reduction of shrub cover) that encourages the rapid buildup of individual tree size and opens up the forest to longer views can be important management tools.

Management of Information and Interpretation

Careful management of information flow may be an effective means of improving public attitudes about harvesting. Public information might include:

1. Onsite signs explaining how a tract of land is being managed and how its appearance will ultimately be affected by various management practices. In practice, signs could be developed for each harvest site along heavily trafficked routes.
2. Interpretive programs at visitor centers and public relations programs in popular resort communities to explain how the forests' appearance and how stewardship of the forest's resources are being considered in management planning and practice.

5.2.3

Application of Visual Management Planning

Beginning in the late 1960s, a concerted effort to improve the management of the visual resources of the National Forest System was begun by USDA Forest Service landscape architects and recreation resource managers. Much of this activity followed the federal Multiple Use and Sustained Yield (MUSY) Act of 1960 and the Outdoor Recreation Resource Review Commission (ORRRC). MUSY and ORRRC established recreation as an

important use of the nation's forests, and they identified pleasure drives to enjoy the scenery as a primary forest recreational activity. The National Environmental Policy Act (NEPA) of 1969 required that before any federal agency could take action that would significantly affect environmental quality, the action's environmental impacts must be assessed. NEPA specifically identifies aesthetic values as being among the range of values that must be considered in making an impact assessment. Finally, the Federal Land Policy Planning and Management Act (FLPPMA) of 1974 and the National Forest Management Act (NFMA) of 1976 specifically mandate the consideration of aesthetic values in the management of all federally held forest land.

These varied policy mandates produced a flurry of activity in the 1970s and 1980s aimed at developing principles and processes to consider aesthetic values in the management of forest environments. The USDA Forest Service responded to the MUSY, ORRRC, NEPA and NFMA mandates by developing a VMS. This system allows the consideration of aesthetic values in overall management planning for each national forest unit (USDA Forest Service 1974). A visual management objective is assigned to every tract within a national forest unit, based on an assessment of the tract's visual quality and its visual sensitivity. It also provides guidance for mitigating onsite aesthetic impacts of forest harvesting and management activities. Separate components of the VMS have been developed to guide consideration of aesthetic values in managing timber, utilities, ski areas, recreation and grazing. The VMS has been integrated into overall management planning, as well as project planning on both the Chippewa and Superior national forests.

During the 1980s, the concept of considering and deliberately managing aesthetic values of the forest environment emerged as an important policy mandate for managing forest land owned by the state of Minnesota. The MNDNR has recently drafted guidelines that consider aesthetic values in state owned forests (MNDNR 1991). These guidelines largely reflect concepts developed by the USDA Forest Service and implemented through the VMS.

On forest ownerships other than federal or state forest lands, the consideration of aesthetic value in forest management is sporadic. There is no statewide mandate that requires county, municipal or privately owned forests to consider aesthetic values in forest management. While incentives exist through the Forestry Incentives Program (FIP) for considering aesthetics, the inclusion of aesthetic values in forest management rests with the landowner.

An Aesthetic Best Management Practices (BMPs) Task Force has been convened by the MNDNR to develop visual management guidelines that

will be available for all ownership categories. Draft aesthetic BMPs are expected to be available in the near future. Availability of these guidelines should increase awareness of the need to include aesthetic values in forest management planning.

5.3 Roading Standards

The type of road constructed and how it is managed during and after harvesting are important determinants of impacts on recreational opportunities. This particularly applies to ROS classes 1 and 2, opportunities which are dependent on maintenance of nonmotorized opportunities.

Table 5.13 sets out the range of impacts likely to occur given a range of road construction standards. In the table permanent roads are classed as those that are constructed and maintained. Nonpermanent roads are either temporary roads built for nonwinter access or ice roads built for winter access.

Table 5.13. Impacts on primitive and semiprimitive nonmotorized opportunities due to road construction.

Original ROS class	New (Changed) ROS Class by Road Type by Period			
	Medium-term (10 to 50 years)		Long-term (50+ years)	
	Permanent Road ^a	Nonpermanent Road ^b	Permanent Road ^a	Nonpermanent Road ^b
Primitive	Roaded natural	Semiprimitive nonmotorized	Roaded natural	primitive to semiprimitive nonmotorized
Semiprimitive nonmotorized	Roaded natural	Semiprimitive nonmotorized	Roaded natural	Semiprimitive nonmotorized

^aAssumes road is maintained.

^bAssumes road is closed to motorized uses and is allowed to regenerate.

The USDA Forest Service has developed comprehensive guidelines that prescribe roading standards by ROS class. These standards, called *ROS Access Coordinator; Eastern Region Supplement* (USDA Forest Service 1986), are used on national forests in Minnesota (see appendix 7).

Application of these guidelines varies depending on the primary management objectives for an area. Where an area is primarily intended for timber production, with maintenance of recreation opportunities as a secondary objective, the techniques in these guidelines can be used to reduce impacts and the period over which impacts persist.

Where an area is designated primarily for recreation uses, roading and harvesting cannot take place while at the same time maintaining primitive and semiprimitive nonmotorized recreation values.

6

IMPACTS FROM TIMBER HARVESTING AND FOREST MANAGEMENT ACTIVITIES

Most timber harvesting and management activities will have direct and indirect impacts on the recreation opportunities and visual quality of Minnesota's forests. Direct impacts are those that affect the landscape as an immediate result of the harvesting or other practice. Indirect impacts are those that are implied over long time periods as the species composition and stand age class structure of the stands comprising the landscape change and become more or less valuable from a recreational and aesthetic standpoint. This section characterizes these impacts and assesses their extent under the three harvesting scenarios. The significance of these impacts, as measured by the approved GEIS significant impact criteria, is assessed in section 7.

6.1

Recreation

The following assesses impacts on recreational values likely to occur as a consequence of timber harvesting and forest management activities.

6.1.1

Recreation Opportunities

Timber harvesting and forest management activities can impact recreation opportunities in a variety of ways with widely varying consequences. The following aspects of recreation opportunities can be affected; recreation quality, the recreational experience of the user, the opportunity class designation of an area and/or the recreational value associated with an area. Furthermore, these activities can result in effectively irreversible impacts to some recreational areas (Clark and Stankey 1985, Clark and Downing 1985, Clark et al. 1984).

This section describes the general impacts of timber harvesting and forest management activities on recreation opportunities and on the activities of users within each ROS class. From the array of possible impacts identified, the ROS classes are then grouped into those that will experience long-term or irreversible impacts if harvesting occurs and those that will be impacted but where the impacts can be lessened or avoided with appropriate management intervention. Plots in this latter category are then sorted into those on ownerships which *do* manage using VMGs, and would therefore implement the necessary management intervention (see section 5.2); and those on ownerships which *do not* employ VMGs and therefore are unlikely to implement these actions.

Effects of Timber Harvesting and Forest Management Activities on Recreation

A summary of potential impacts of timber harvesting and forest management on forest recreation opportunities is provided in table 6.1. Impacts 1 through 5 are impacts on recreation opportunities and impacts 6 through 11 are impacts on aesthetic characteristics that affect the recreation opportunities. There is a close relationship between recreational value and aesthetic value.

Table 6.1. Potential impacts of timber harvesting and forest management on forest recreation opportunities.

Impacts
<ol style="list-style-type: none"> 1. Change, and in some cases eliminate, primitive recreation opportunities in primitive and semiprimitive nonmotorized ROS classes. 2. Harvest operations can create travel barriers and create negative recreation use impacts along improved and unimproved roads in the forest areas (e.g., slash on roadsides, trails, landing and staging areas, ruts in roadways) in ROS classes 3, 4 and 5. 3. Harvest operations can result in the creation of more improved forest roads (graveled, maintained roads) and the improvement (paving) of existing gravel roads. This improved system of roads can result in a change in the nature of the recreational opportunity and subsequent change in the recreational use of the area. 4. Increased harvest operations have the potential to increase offroad vehicle use in forest areas due to increased access provided by unimproved and improved logging roads. Increased ORV use has the potential to cause recreational user conflicts, stream and trail damage (soil erosion where logging roads cross watercourses), and impacts on sensitive wildlife (wolves, eagles). 5. Traffic conflicts can occur between logging vehicles and recreational drivers (vehicles competing for use of roadways, increased dust from logging traffic). 6. The aesthetic and natural experience of many outdoor recreation users can be reduced by large clearcut areas. Research shows that many outdoor recreation users (e.g., hunters, hikers, skiers, snowmobilers, berry pickers) seek an aesthetic experience directed towards the importance of viewing the landscape and the opportunity to be in a natural or relatively unmodified setting. Clearcutting may well produce more resources for consumptive recreational use (game, berries) in some areas, but it also will reduce the aesthetic/natural experience opportunities sought by many of these recreational users. 7. Visual and noise impacts of timber harvest operations can change recreational opportunities for persons in adjacent parks and other recreation areas designated to provide aesthetic and primitive recreation experiences (e.g., state parks, BWCAW, National Park Service units, county parks outside metropolitan areas, state and federal wildlife management areas, state scientific and natural areas). 8. Visual and noise impacts of timber harvest operations can change recreational opportunities for persons in adjacent linear recreation spaces including state and federal wild and scenic rivers, state canoe and boating routes, and state recreational trails. 9. Visual and noise impacts of timber harvest operations can change recreational opportunities for persons on adjacent riparian resources including lakes and streams. 10. Noise of harvesting operations may reduce opportunities for some recreational users to have a quality natural experience. 11. Visual impacts of timber harvesting operations on adjacent properties can adversely affect the visual setting of resorts. Noise impacts can also cause nuisance.

Characterization of Impacts

Based on the range of possible impacts identified above, timber harvesting and forest management activities were assessed (by ROS class) to determine if recreational opportunities within each class were affected positively or negatively. Changes were expressed in terms of both the quality of the recreational experience and potential change in the number of hours of recreational activity at a given site. This information is summarized as a matrix in table 6.2.

Table 6.2. Qualitative impact of timber harvesting on forest recreation opportunities.

Activity	Recreation Opportunity Spectrum (ROS) Classes ^a											
	Primitive n=53 0.4% ^b		Semiprimitive no motor n=876 7%		Semiprimitive motor n=3,074 25%		Roaded natural n=5,047 42%		Rural n=3,031 25%		Urban n=36 0.3%	
	A	B	A	B	A	B	A	B	A	B	A	B
Camping	-2	+1	-2	+1	-1	+1	-1	+1	0	0	-1	-1
Fishing	-2	+1	-2	+1	-1	+1	-1	0	0	0	-1	+1
Boating (motor)	na	na	na	na	-1	+1	-1	0	-1	0	-1	0
Canoeing	-2	+1	-2	+1	-1	+1	-1	0	-1	0	-2	0
Picnicking	na	na	na	na	-1	+1	-1	+1	0	0	-1	-1
Cross-country skiing	-2	+1	-2	+1	-2	+1	-1	+1	-1	0	-2	-1
Downhill skiing	na	na	na	na	na	na	-1	0	-1	0	0	0
Snowmobiling	na	na	na	na	-1	+2	-1	+2	0	+1	0	+1
Walking/hiking	-2	+1	-2	+1	-2	+1	-2	+1	-1	0	-2	-1
Nature study	-2	+1	-2	+1	-1	+1	+1	+1	+1	0	-1	-1
Hunting	-2	+1	-2	+1	-1	+1	-1	+2	0	+1	-1	-1
Atv/orv	na	na	na	na	-1	+2	-1	+2	0	+2	-1	+1

^aColumn coding and values: A—this column represents the impact of timber harvesting on the quality of the recreation experience of current users who engage in a selected activity.

B—this column represents the impact of timber harvesting on the level of activity hours engaged in by recreationists for a selected activity.

Cell values range from -2 to +2: (-2 large decrease, -1 decrease, 0 no change, +1 increase, +2 large increase).

na—not appropriate/not provided for.

^bn = Number of FIA timberland plots in each ROS class (12,117 plots total). % = Percent of total FIA plots in each ROS class.

This impact matrix is independent of harvesting levels and reflects the direct impacts on changes anticipated if timber harvesting and forest management activities are undertaken at a particular location in each ROS class where a given activity occurs. The six ROS classes are arrayed across the top of the matrix; and the twelve recreational activities used in the

recreation value assessments (section 4.1) are listed down the left hand side of the matrix. Changes in some of the activities listed in the impact matrix are omitted for the primitive and semiprimitive nonmotorized classes because they are considered inappropriate to the management implied by the ROS class. For example, motorboating, snowmobiling and driving motorized all terrain vehicles or off-road vehicles are not provided for within a primitive or semiprimitive nonmotorized ROS classes. Downhill skiing and picnicking are also either considered inappropriate or unlikely to occur as they require better access and more developed facilities than are generally available in areas meeting primitive and semiprimitive nonmotorized classifications.

Two columns of values (A and B) are given under each ROS class. Column A is a general qualitative assessment of the impact of timber harvesting and forest management activities on the quality of the recreation experience of *current* users engaging in a selected recreational activity within a given ROS class. A value of -2 represents a substantial decrease in the quality of the recreation experience when harvesting or associated activities such as roading occurs in that ROS class. A value of -1 represents a decrease, a value of 0 represents no change in the quality of the recreation experience, a value of +1 represents an increase and a +2 a substantial increase in quality.

For the primitive and semiprimitive nonmotor classes the value in column A, regardless of activity, is always a -2. That is, the quality of the recreation experience is substantially decreased if timber harvesting or roading occurs. This is because, by definition, any modification to primitive or semiprimitive classes means that the area no longer provides the setting within which these opportunities can be undertaken (see below).

Column B is a qualitative measure of the likelihood that timber harvesting will result in an increase or decrease in the number of activity hours engaged in by recreationists for a selected activity within an ROS class area. A value of -2 represents a substantial decrease in the number of activity hours for a given activity that would occur if timber harvesting took place in that ROS class. A value of -1 represents a decrease in activity hours, a 0 represents no change, a value of +1 represents an increase and a value of +2 represents a substantial increase in activity hours.

The values assigned to each cell of the matrix were developed using the following procedures. First, the literature on recreational choice, recreation preferences, visitor attitudes, and impacts of management activities on recreation experiences was reviewed. Appendix 5 lists the references consulted for each activity. Since the impacts of timber harvesting have not been documented in the literature for all of the recreation activities considered. Many of the cells could not be filled in using this procedure.

Therefore, a second procedure was devised to develop values that were based on the professional judgement of the study group.

Two workshop sessions were convened (see appendix 6 for a list of participants). At each session participants were given instructions on how to read the matrix and asked to assign the missing values for the relevant activities in each ROS class for columns A and B. At the end of each session a discussion followed in which the participants shared their assigned values with the group. Where values differed, discussion to arrive at an agreed cell value followed. Once agreement was reached, the workshop was concluded. About one week after the first workshop was held, the exercise was repeated with the same participants. Again discussion followed and consensus was reached on all cell values. Comparisons between the values assigned at the first and second workshops were made. Where differences existed discussion followed until there was agreement on the final values to be used.

This impact assessment clearly indicates that timber harvesting and forest management activities have direct effects on the recreational use of forests. In some cases the harvesting results in a decrease in the quality of the recreation experience and an increase in the amount and kind of recreational activity at a site. In other cases the opposite might occur. And, in still other instances no change might be expected.

6.1.2 Impacts on Recreation Value

In nearly all cases where quality decreases, activity hours increase. The reason for this apparent contradiction is that roads constructed for harvesting operations can provide access into previously inaccessible areas. Improved accessibility enables more people to use the area. In formerly unroaded areas, provision of motorized access can increase the diversity of recreational uses that are possible in such an area. However, increased numbers of users may not be desirable for the opportunity currently provided at the site, and may displace existing users. The implications from a management perspective largely depend on the owner's management objectives. Those ownerships who recognize and manage for recreation may take steps to control access, and therefore limit the range of uses, by closing off roads as harvesting is completed. Other ownerships may elect to do nothing and to accept whatever uses occur. The following discusses the impacts by categories of ROS class and ownership.

Primitive and Semiprimitive Nonmotorized

The management guidelines definition of ROS primitive and semiprimitive areas used by the USDA Forest Service are set out below (USDA Forest Service 1989):

- Primitive areas are three or more miles from all maintained roads or railroads. Primitive areas are unmodified natural environments. Evidence of trails or recreational use can exist. Structures in use are rare. Contact with humans is rare and chances of seeing wildlife are good.
- Semiprimitive nonmotor areas are one-half to three miles from all maintained roads or railroads. They may be close to primitive roads or trails used only occasionally. Modifications to the natural environment are evident, such as old stumps from prior logging operations, but they are not apparent to the casual observer. Structures in use are rare. Human contact is low and chances of seeing wildlife are good.

Given these specifications, it is clear that primitive ROS opportunities are by definition destroyed when such areas are permanently roaded and motorized uses are introduced. Under these circumstances, the opportunities available would shift to those more suited to sites at the less primitive end of the ROS. When this occurs the primitive recreation value of the site is lost and a new recreation value, for example roaded natural, would be assigned to reflect the opportunity the area would now provide.

In the medium-term at least, roading will also destroy semiprimitive nonmotorized ROS opportunities. The consequences of harvesting in semiprimitive nonmotorized areas are reversible but this process requires medium- to long-term time periods (10 to 50+ years).

As described in section 5.1.2 (table 5.4), of all forested plots (timberland, reserved and unproductive) in Minnesota, only three percent of the total are in the ROS primitive class and nine percent of plots are in the semiprimitive nonmotorized class. Of these statewide totals, less than one percent and seven percent, respectively, occur on timberland plots.

Timber harvesting and associated roading on any of these plots not only has an impact on the plot itself but also on the number and distribution of areas in the state where opportunities for primitive and semiprimitive nonmotorized recreation opportunities will be available in the future.

Motorized ROS Classes

Semiprimitive Motorized and Roded Natural

Timber harvesting and forest management activities in these ROS classes causes changes that are reversible over time. The types of impacts that could be expected include those associated with an increase in the accessibility of an area, and impacts to the setting caused by changes to the vegetation. The consequences of these changes are twofold. For existing users who appreciate comparatively natural surroundings and lower levels of contact with other groups (see tables 2.2 and 2.3), the quality of the recreation experience diminishes. However, the improved access increases

the opportunities for people who were previously constrained by a lack of access. Therefore, the amount of activity increases as a consequence of the increase in the levels of use as these opportunities are realized. The persistence of these changes depends to a large degree on how the area, and particularly the roads, are planned and managed before, during and after harvesting is completed.

Some ownerships, notably the USDA Forest Service and MNDNR employ (or are in the process of introducing) VMGs in the planning and execution of timber harvesting and the subsequent management and regeneration of harvested areas. Under these circumstances, impacts on users are minimized. Also, where appropriate, these ownerships restrict access by closing logging roads where they are not required for other management purposes. Therefore, the recreation values for users seeking relative isolation will be restored over time as the forest regenerates and usage levels drop. Use of VMGs will likely lessen the time taken to restore the setting sought by this category of user.

However, where ownerships do not manage using VMGs and apply ad hoc management to access, it is likely that these changes will persist. Use of unmaintained logging roads by ATV and offroad drivers will continue to diminish recreation values for users seeking relative isolation.

Where new or reopened roads are maintained, the recreation values for these users will not be restored and the areas affected are likely to move to a higher ROS class. However, new users who are able to accept increased levels of contact with other groups will use the improved access to make use of areas that were formerly not readily available to them. Therefore, the levels of use on these areas will likely increase.

Rural and Urban

Timber harvesting and forest management activities are less likely to create access related changes in these classes. However, visual impacts are more likely to occur as these areas are very accessible to large numbers of users. Among these lands, those harvested and managed using VMGs will likely have recreation values restored more quickly than in areas where VMGs are not used.

6.1.3 Second Model Runs and Analysis

Analysis of the results of the first runs helped the study group appreciate the potentially broad spatial and temporal impacts of timber harvesting on recreation and aesthetic values. Those runs led to modelling refinements and the incorporation of ownership constraints and possible mitigations.

Consequently, the second runs represent a more detailed and realistic look at the specified harvest levels and how they might be achieved given various mitigations. Those second run procedures and results for the basis for the impact analysis discussed in the rest of this paper.

Among the existing and perspective agency policies and procedures and mitigations, accepted and/or modified by the Advisory Committee, those that were amenable to implementation in the second runs were:

- ERF, i.e., lengthened (usually by 50 percent) minimum rotation ages for approximately 20 percent of the timberland on state and USDA Forest Service ownerships;
- increased use of uneven-aged management (approximated by thinning practices);
- designation and reservation of old growth and acreage that might replace that;
- BMPs, i.e., thinning or ERF within 100 feet of water; and
- wildlife buffers (thinning only within 200 feet of water) on the national forests and in the southeastern part of the state.

In addition, estimates of the actual availability of timberlands for harvest or management, developed separately by ownership, were used to set aside a portion of the timberland as *not available* for various economic, environmental and social concerns. Table 6.2 summarizes this acreage.

Table 6.3. Second run acreage availability by use and treatment category for FIA timberland, statewide, 1990.

Use and treatment category	Acres	Percent
1. Normal harvest	11,289,200	76.4
2. BMP and wildlife buffers	742,900	5.0
3. Extended rotation forest	899,400	6.1
4. Old growth and replacement	57,500	0.4
5. Not available	1,784,400	12.1
Total 1 to 3 (available)	12,931,500	87.5
Total 4 to 5 (not available)	1,841,900	12.5
Total	14,773,400	100

Source: Jaakko Pöyry Consulting, Inc. (1992a).

Other model changes for the second runs included refinement of the silvicultural decision trees used in the first runs to lengthen minimum rotation ages. Thinning options were also refined, notably to reflect desired practice within buffers and for approximating and encouraging uneven-aged management. Forest and timberland area change from 1990 to 2040

was also implemented gradually throughout the 50-year period using estimates of annual change rates. Covertypes areas were further subjected to change occurring at the time of harvest and later via stand dynamics or succession (see Jaakko Pöyry Consulting, Inc. 1992a for details).

The net effect of these constraints and mitigations was to incorporate some of the visual management practices and constraints discussed earlier in this paper. However, there was no explicit set of practices or constraints placed on plots due to their ROS class. Thus some but not all of those plots are included in BMP, buffer, extended rotation forest, or not available categories in table 6.3. These categories describe the acreage involved and to some extent the location (e.g. buffers along waterways. The not available category is also important as it related to ownership. Consequently, the availability of timberland for harvesting by ownership is developed further in table 6.4.

Table 6.4. Availability of FIA timberland by ownership assumed for second runs.

Ownership	Percent Available
National Forests	
Chippewa	87
Superior	53
State	95
County	95
Other public	64
Forest Industry	98
Other Private	90

Source: Jaakko Pöyry Consulting, Inc. (1992a).

6.1.4 Area Harvested by ROS Class

Table 6.5 shows the number, percent and distribution of plots projected to be harvested by ownership and ROS class for the base, medium and high harvesting scenarios in the second runs. For the base scenario 43.4 percent of all primitive plots on timberlands would be harvested. Fifteen percent of those harvested would be timberland plots on state and/or federal lands and the remainder on timberlands on other ownerships. For semiprimitive nonmotorized plots 36.8 percent would be harvested on timberlands with 17 percent on state and/or federal timberlands and 19.7 percent on other timberlands. Nearly half of all semiprimitive motorized plots, 55 percent of roaded natural plots and over 50 percent of rural plots would be harvested. Most of these plots are on ownerships other than state and federal.

Table 6.5. Distribution of FIA timberland plots and plots projected to be harvested, by ownership and ROS class.

ROS Class	Total number of plots	Percent of plots by ROS class	Number and (percent) of plots harvested by ROS class					
			Base Scenario		Medium Scenario		High Scenario	
			State/federal lands	Other lands	State/federal lands	Other lands	State/federal lands	Other lands
Primitive	53	.4	8 (15.1)	15 (28.3)	10 (18.7)	15 (28.3)	12 (22.6)	23 (43.4)
Semiprimitive nonmotorized	876	7.2	150 (17.1)	173 (19.7)	211 (24.1)	201 (22.9)	316 (36.1)	217 (24.8)
Semiprimitive motorized	3,074	25.4	529 (17.2)	925 (30.1)	691 (22.5)	1,119 (36.4)	1,003 (32.6)	1,185 (38.5)
Roaded natural	5,049	41.7	662 (13.1)	2,121 (42.0)	777 (15.4)	2,428 (48.1)	1,081 (21.4)	2,611 (51.7)
Rural	3,030	25.0	140 (4.6)	1,366 (45.1)	158 (5.2)	1,548 (51.1)	179 (5.9)	1,779 (58.7)
Urban	36	.3	1 (2.8)	18 (50.0)	1 (2.8)	19 (52.8)	2 (5.6)	20 (55.6)
All classes	12,118	100.0	1,490 (12.3)	4,618 (38.1)	1,848 (15.2)	5,330 (44.0)	2,593 (21.4)	5,835 (48.1)

For the medium scenario 47 percent of the primitive plots on timberlands would be harvested. All of the increase in harvesting over the base level that occurs on timberlands in this ROS class would come from plots in state and/or federal ownership. The percent of semiprimitive nonmotorized plots harvested would increase to 47 percent on timberlands. The percent of semiprimitive motorized plots harvested would increase to over half of all timberland plots. Nearly two-thirds of the roaded natural plots and slightly more than half of the rural plots would also be harvested. As in the base scenario, the bulk of this harvesting would be on ownerships other than state and federal.

Under the high scenario 66 percent of the primitive plots and 60.9 percent of the semiprimitive nonmotorized plots on timberlands would be harvested. In addition, over 70 percent of the semiprimitive motorized plots would be harvested. For roaded natural and rural plots, over two-thirds would be harvested.

The percent of all forested plots (timberland, reserved and unproductive) can be determined using the tabulation of plots by ROS class in table 5.4. Given the plots indicated as harvested in table 6.5, the base, medium and high scenarios impacted 5.3, 5.7 and 8.0 percent of all the primitive forested plots statewide. The base, medium and high scenarios would further impact 24.7, 30.7 and 39.8 percent of all the semiprimitive nonmotorized forested plots statewide.

With respect to semiprimitive nonmotorized and less primitive ROS classes of plots, impacts would likely be reduced somewhat from that in table 6.5 by the fact that the harvesting scenarios employed thinning or uneven-aged management rather than clearcutting on approximately 3 to 5 percent of the acres harvested (see Jaakko Pöyry Consulting, Inc. 1992a). Further, the background paper on Silvicultural Systems (Jaakko Pöyry Consulting, Inc. 1992c) indicated that 10 to 15 percent of the harvesting conducted recently has been thinning, selection or other than clearcutting. If clearcutting with residuals left standing is included, the percent of such *softer* harvesting rises to over 50 percent.

The overall harvesting rate of timberland plots was 50.4, 59.2 and 69.5 percent for the base, medium and high scenarios, respectively. Conversely, the respective harvesting rates for primitive plots was lower, i.e., 43.4, 47 and 66 percent on timberland. Apparent reasons for the fact that primitive and semiprimitive nonmotorized plots are not harvested at as high a rate as less primitive plots are related to plot location. Some of these plots fell into some of the more restrictive availability and treatment classes of table 6.3 and were, therefore, not subject to harvesting. The inherent lack of access to these plots is also a factor limiting their harvest relative to the other ROS classes.

It is also possible that a more detailed and site-specific description of the not available category would have recognized and therefore protected the primitive and semiprimitive nonmotorized plots.

Another nagging question is whether or not continued harvesting beyond the 50 year study period would eventually lead to disturbance of all primitive and semiprimitive nonmotor plots. Table 6.6 below describes the area impacted in 50 years by scenario.

Table 6.6. Original acres cut one or more times and never cut in the second runs, 1990–2040.

Forest land use and harvest status	Second model runs Total (acres)
Total forest land acres	16,714,800
Reserved/unproductive	1,941,400
Timberland	14,773,400
Base Scenario	
Acres never cut	7,600,000
Acres cut	7,173,400
Medium Scenario	
Acres never cut	6,156,400
Acres cut	8,617,000
High Scenario	
Acres never cut	4,308,200
Acres cut	10,465,200

Source: Jaakko Pöyry Consulting, Inc. (1992a).

This table indicates that while much acreage would be harvested, 4.3 to 7.6 million acres of timberland are not harvested. Further, economic analyses that consider site productivity, access and transportation costs suggest that most of the acres harvested would be cut again beyond 50 years before harvesting of less productive or less accessible areas would be justified. This implies that under these scenarios, the rate of harvesting of the more primitive ROS classes of plots would likely be reduced in subsequent 50-year periods.

6.2 Aesthetic Impacts

6.2.1 Impacts on Timberland Plots in Visual Sensitivity Rank I

The characteristics used to describe visual sensitivity rank I lands are not part of the FIA database and there was no way to link these areas with the harvesting scenario output. Because these data were not modelled it is not

possible to quantitatively assess impacts to visual sensitivity rank I lands. Impacts will occur where harvesting takes place in proximity to the categories of lands used to define visual sensitivity rank I such as state parks, wild and scenic rivers, and hiking trails (see section 4.3.2).

As discussed in section 5.2, the extent and degree of impact to the aesthetic values of these areas likely to be caused by timber harvesting and forest management activities is highly site dependent. Because of this it is not possible to estimate the areas potentially affected and therefore to quantify the impact likely under each scenario. Under some circumstances harvesting can be undertaken in close proximity to sensitive areas with no adverse impacts. For example, harvesting above a trail at the base of a steep slope. In contrast, inappropriate harvesting may cause impacts where it is visible from high use areas on these lands. In many cases impacts result from the way harvesting takes place or the method (e.g., thinning versus clearcutting) rather than harvesting *per se*.

6.2.2 Impacts on Timberland Plots in Visual Sensitivity Ranks II Through V

The characteristics used to define these ranks of visual sensitivity were drawn from the FIA database and therefore it is possible to quantitatively assess impacts. Table 6.7 shows the distribution of timberland plots in visual sensitivity ranks II through V by ownership class and those projected to be harvested under the three harvesting scenarios. Considering all ownership classes, the proportion projected to be harvested ranges from just over half under the base scenario up to over 70 percent under the high scenario.

Table 6.7. Distribution of FIA timberland plots in visual sensitivity ranks II through V (high to very low) and plots projected to be harvested by scenario (for ROS classes semiprimitive motorized, roaded natural and rural only).

Total Ownership	Number of plots	Percent of plots	Number and (percent) of plots harvested		
			Base Scenario	Medium Scenario	High Scenario
National Forest	1,119	10.0	315 (28.2)	326 (29.1)	841 (75.2)
State Forest	2,201	19.7	1,016 (46.2)	1,300 (59.1)	1,420 (64.5)
Other Public	2,159	19.4	1,349 (62.5)	1,569 (72.7)	1,675 (77.6)
Private	5,672	50.9	3,063 (54.0)	3,526 (62.2)	3,901 (68.8)
Total	11,151	100.0	5,743 (51.5)	6,721 (60.3)	7,838 (70.3)

When harvested timberland plots of visual sensitivity ranks II to V are considered (see table 6.8), it is evident that, for state and federal lands, the percentage of plots projected to be harvested decreases as visual sensitivity increases. This suggests a linkage to the constraints and mitigations

assumed

Table 6.8. Distribution of FIA timberland plots for visual sensitivity ranks II through V and plots projected to be harvested by ownership (for ROS classes semiprimitive motorized, roaded natural and rural only).

Visual Sensitivity Rank	Total number of plots	Percent of plots	Number and (percent) of plots harvested by visual sensitivity rank					
			Base Scenario		Medium Scenario		High Scenario	
			State/federal lands	Other lands	State/federal lands	Other lands	State/federal lands	Other lands
II (high)	1,654	14.8	172 (10.4)	821 (49.6)	187 (11.3)	927 (56.0)	312 (18.9)	1,026 (62.0)
III (moderate)	3,135	28.1	359 (11.4)	1,394 (44.5)	387 (12.3)	1,580 (50.4)	616 (19.6)	1,756 (56.0)
IV (low)	2,684	24.1	342 (12.7)	1,001 (37.3)	408 (15.2)	1,172 (43.7)	547 (20.4)	1,277 (47.6)
V (very low)	3,678	33.0	477 (13.0)	1,196 (32.5)	644 (17.5)	1,416 (38.5)	788 (21.4)	1,516 (41.2)
All ranks (II to V)	11,151	100.0	1,351 (12.1)	4,412 (39.6)	1,626 (14.6)	5,095 (45.7)	2,263 (20.3)	5,575 (50.0)

for these lands. Conversely, on other ownerships the percentage of plots that are projected to be harvested increases as visual sensitivity. Overall, 60.1, 67.4 and 80.9 percent of the visual sensitivity rank II plots are projected to be harvested for the base, medium and high scenarios, respectively. These are higher rates of harvest by scenario than for all plots combined as shown in table 6.7. However, the bulk of the harvest is projected to come from the plots of moderate, low and very low sensitivity ranks (ranks III to V).

6.2.3 Frequency of Impacts

Assuming the size and spatial distribution of harvested stands is consistent over the 50-year study period, the relative frequency of forest visitors encountering active harvesting can also be estimated. Using ratios of acres cut from table 6.6, the medium and high scenarios would show 20 and 46 percent more harvesting, respectively, than the base scenario. This calculation is interesting because a simple projection based on scenario harvest levels (4, 4.9 and 7 million cords) would show 22.5 and 75 percent increases in harvest acreage and frequency. Clearly, timber harvesting and forest management tend to be concentrated on the most productive portions of the forest. Further, such harvesting concentration reduces the overall area that is visually impacted.

6.3 Changes in Aesthetic Character of the Forest Due to Vegetation Dynamics

A summary of stand age by covertime for 1977, 1990 and projected to 2040 in table 6.9 indicates that, despite harvesting, the overall age for most covertypes will increase. An important factor in that is the designation in the second runs of significant areas as not available, old growth, ERF or otherwise constrained with respect to harvesting. In effect, harvesting in the base scenario for many covertypes will convert mature stands to younger age classes, but the aging of those young stands, plus those with harvesting constraints or not available, will cause the overall age of the forest to advance. The same is expected for the medium scenario. The high scenario would retain an average age similar to that of the forest today.

Given the role of tree age and associated size to forest attractiveness level, these changes should be considered as an important index of future forest attractiveness.

Like average age, the average and proportion of the forest in various stand size classes (seedling/sapling, pole and sawtimber) can also be helpful in appreciating tree size and vegetation diversity. Table 6.10 describes the acreage by stand size class for past inventories and projections.

Table 6.9. Average stand age by covertime and harvest scenario for timberland, 1977-2040.

Forest Type	Average Age of FIA Plots				
	1977	1990	2040		
			Base	Medium	High
Jack pine	42	48	77	69	42
Red pine	43	44	54	54	41
White pine	73	80	104	102	87
Black spruce	46	59	89	61	50
Balsam fir	42	46	82	71	58
Northern white cedar	82	97	116	106	94
Tamarack	52	57	99	85	55
White spruce	33	42	90	82	76
Oak-Hickory	63	69	78	71	63
Elm-Ash-Soft maple	56	56	86	75	60
Maple-Basswood	61	58	90	80	58
Aspen	38	41	34	33	28
Paper birch	49	58	92	81	61
Balsam poplar	39	41	33	31	31

Source: Jaakko Pöyry Consulting, Inc. (1992a).

Table 6.10. Percent of forest area by stand size class, 1957-90 and projections to 2040 by scenario.*

Year	Sawtimber	Poletimber	Seedlings/saplings
Timberland			
1977	22.9	50.8	25.1
1990	33.1	35.6	30.1
2040 base	40.3	26.7	33.0
2040 medium	33.9	25.9	40.2
2040 high	23.9	22.0	54.1
Reserved Forest			
2040	83.6	15.7	0.7
Unproductive Forest			
2040	13.1	67.4	19.5

*Values for projections in 2040 based on GEIS covertime and size class algorithms. See Jaakko Pöyry Consulting, Inc. (1992a) for details of those algorithms and definitions.

The table suggests that the acreage of stands classified as predominantly sawtimber (sawtimber trees are ≥ 9.0 inches Dbh for softwood species and ≥ 11.0 inches Dbh for hardwoods) will decline under the high scenario

compared to 1990. Additionally, reserved forest acreage will be predominately in large tree cover. However, as table 6.8 suggests, much of the younger stand acreage would be in but a few species, for example, aspen and balsam poplar on timberlands.

7 SIGNIFICANT IMPACTS

7.1 Overview of Significant Impact Assessment Process and Criteria

Impacts identified in this report vary in their significance and therefore in the need to develop a specific mitigation response. This is a critical stage of the study process, as these tests of significance will ultimately define the scope of policy recommendations developed by the GEIS.

Identification of an impact as being significant does not automatically prescribe a specific mitigation response. The significance criteria have been developed to be inclusive rather than exclusive. Their purpose is to identify the issues and circumstances where policy initiatives are required. The range of possible policy responses, the factors used to choose between them, and the implications of selecting a particular response are all evaluated by subsequent criteria.

For each significance criterion developed, several background factors were used to determine levels or thresholds when impacts are likely to be considered significant. They include:

- severity and spatial extent of impact;
- certainty of impacts;
- duration of impact (irreversibility);
- consideration of existing guidelines and standards; and
- biological and economic implications.

The first factor identifies the likely extent and severity of an impact. Impact extent varies considerably ranging from very localized site specific impacts to those impacting a watershed, physiographic region, soil type, covertype, ecoregion or the entire state. The second factor identifies the degree of certainty that a predicted impact will occur. The third factor incorporates the anticipated duration of the impact, and whether or not it is reversible. Duration is defined as very short-term—less than 2 years; short-term—2 to 10 years; medium-term—10 to 50 years; long-term—greater than 50 years; and irreversible. The fourth factor incorporates those existing standards and guidelines that are applicable to recreation. The fifth factor identifies the key biological and economic implications of the impact.

Applicable Significant Impact Criteria

Two significance criteria apply to recreation and aesthetic issues considered in this report. These are (1) changes to Minnesota's forests—patterns of forest cover in predominantly forested areas; and (2) forest recreation and aesthetics. The first criterion considers currently roadless areas (ROS 1 and 2) which are subject to the development of permanent forest roads and hence significantly impacted. The second criterion considers the significant adverse impacts projected to occur when visual management guidelines are not used in harvesting timber.

Advisory Committee and EQB Input

The criteria developed for application in this technical paper reflect very extensive input from the GEIS Advisory Committee and the EQB as part of their ongoing roles in the study process (Jaakko Pöyry Consulting, Inc. 1992a). Their contributions to the development, structure and scope of the criteria reflect social considerations that were added to the technical oriented inputs provided by the Recreation and Aesthetics study group.

7.2

Application of Criteria to Recreation Impacts

Changes to Minnesota forests - Patterns of forest cover in predominately forested areas.

An impact is considered significant if there is projected to be development of permanent forest roads in areas meeting the criteria for either of the following ROS (Recreation Opportunity Spectrum) categories:

- unroaded primitive areas.
- semiprimitive nonmotorized areas.

Severity and/or extent. The two ROS classes used in the criterion are defined as:

Primitive.—An area three or more miles from all maintained roads or railroads and which has an unmodified natural environment. There can be evidence of foot trails, or recreational use. Structures in use are rare. Contact with humans is rare and chances of seeing wildlife are good. Example: BWCAW. Approximately 3 percent of total forest land and 0.4 percent of timberland in Minnesota meet these criteria.

Semiprimitive nonmotorized.—An area one-half to three miles from all maintained roads or railroads, but which can be close to primitive roads or trails used only occasionally. Modifications to the environment are evident, such as old stumps from logging, but are not apparent to the

casual observer. Structures in use are rare. Human contact is low and chances of seeing wildlife are good. Example: Recently undisturbed state lands. Approximately 9 percent of total forest land and 7.2 percent of timberland meet these criteria.

A permanent forest road is defined as a formed road that is graveled or paved and is maintained in a trafficable condition (as distinct from being allowed to revegetate).

The criterion is intended to identify changes in the pattern of disturbance to the least disturbed areas of the unreserved forest lands. The ROS criteria assess levels of disturbance, particularly roads. The absence of permanent roads is a key indicator of patterns in forest cover at the broadest level. The criterion will be applied to northern counties that are predominantly forested. These are counties where nonforest land uses (as defined in the FIA data) account for less than one-third of the total land area. Figure 7.1 shows the approximate location of lands meeting these criteria based on FIA data.

Figure 7.1. Location of FIA plots classified as primitive and semiprimitive nonmotorized use (1,731 plots) across commercial and reserved forest acreage.

Harvesting and development of roads needed to access timber from forests within these categories of lands is indicative of an increased level of disturbance. Improved access will provide opportunities for additional human use for users who depend on motorized access. This will likely displace a proportion of existing users and will impact those animals, such as wolves and pine marten, that are adversely affected when the level of human contact increases.

Certainty of impact. The certainty of impact is dependent upon management objectives of different ownerships. The state and federal ownerships and to some extent counties identify and manage land in these categories. However, many lands held in private ownership and some counties do not specifically recognize or value primitiveness and do not manage lands to maintain tracts in this condition.

Duration of impact (irreversibility). Long-term disturbance is associated with harvesting, particularly where roads are built and maintained. Where temporary roads are built disturbance will be medium term as forest cover is restored.

Existing guidelines and standards. Not applicable.

Biological implications. Roads and other disturbance corridors are possible vectors for parasitism and spread of exotic species. Improved access has the potential to increase human use of formerly largely undisturbed areas. This will increase human contact. Increased human contact may disadvantage those animal species that are wary of humans. Game species should benefit from increased habitat availability that typically follows harvesting activities, particularly on those ownerships that actively manage for game production. Some species can benefit by using roads to increase predation success.

Poorly planned and executed roading and harvesting has the potential to reduce water quality by increasing erosion and sedimentation.

Economic implications. Roads can provide access to timber resources thereby sustaining the timber based industries. Permanent access facilitates other management functions including fire control activities. Roads also create additional recreation/tourism opportunities by allowing motorized access to hitherto less accessible areas. New hunting and fishing areas will be made accessible to more users thereby supporting the recreation/tourism sectors.

7.2.1

Assumptions Required to Apply the Significant Impact Criterion

According to the criterion developed and approved by the Advisory Committee and the EQB, only plots harvested on dry sites constitute significant impacts to primitive and semiprimitive nonmotorized recreation opportunities.

The criterion specified for use in assessing impacts on primitive lands further requires identification of those areas designated ROS class 1 or 2, which include unroaded *primitive* lands and *semiprimitive nonmotorized* lands, where it is projected that permanent forest roads are to be constructed.

Additionally, certain assumptions are required before the data can be analyzed to allow application of the criterion. The assumptions are:

- areas in either ROS class 1 or 2 that are harvested require construction of either winter roads or formed roads;
- winter roads are not formed roads as defined in the criterion and therefore do not trigger the criterion;
- formed roads are assumed to be constructed on lands that occur on dry sites, i.e., the following FIA physiographic classes: *xeric*, *xeromesic* and *mesic*; and
- formed roads are assumed to be graveled and maintained.

7.2.2

Extent of Significant Impacts on Primitive and Semiprimitive Nonmotorized Timberlands

Table 6.5 summarized the number of plots and extent of harvesting by ROS class. Based on the above additional assumptions, the numbers of timberland plots projected to be significantly impacted under the three scenarios are set out in table 7.1 by physiographic class.

Table 7.1. Distribution of FIA timberland plots and percent of plots projected to be harvested in primitive and semiprimitive nonmotorized ROS classes, by ownership, physiographic class and scenario.

ROS Class	Total number of plots	Percent of plots harvested by scenario and ownership*											
		Base Scenario				Medium Scenario				High Scenario			
		State/federal lands		Other lands		State/federal lands		Other lands		State/federal lands		Other lands	
		dry	wet	dry	wet	dry	wet	dry	wet	dry	wet	dry	wet
Primitive	53	11.3	3.8	20.7	7.6	13.2	5.6	21.5	6.8	17.0	5.6	26.4	17.0
Semiprimitive nonmotorized	876	10.8	6.3	15.3	3.9	12.1	12.0	17.3	5.6	17.4	18.7	17.8	7.0

* See table 6.5 for number of plots harvested by scenario.

Primitive. Under the base scenario 31.9 percent of the 53 timberland plots designated as primitive and dry are projected to be harvested and therefore significantly impacted (table 7.1). Under the medium scenario, 34 percent are dry and thus projected to be significantly impacted. This is approximately 4 percent of all primitive plots on all forest lands statewide. Under the high scenario, 43.4 percent of primitive and dry plots on timberland are projected to be significantly impacted. Of those plots harvested, most are on other than state and federal lands. Considering all forest lands, the base, medium and high scenarios show that 4, 4 and 5.3 percent of primitive plots would be harvested, respectively.

Semiprimitive nonmotorized. Under the base scenario, 26.7 percent of the 876 timberland plots designated as semiprimitive nonmotorized are projected to be significantly impacted. Under the medium scenario, 29.5 percent of the timberland plots are projected to be significantly impacted. Under the high scenario, 35.2 percent of the timberland plots are projected to be significantly impacted. Again, most are on other ownerships. These equate to 17, 19.2 and 23 percent of plots designated as semiprimitive nonmotorized on all forest land for the base, medium and high scenarios, respectively.

In summary, between 32 percent (base scenario) and 43 percent (high scenario) of primitive plots on timberlands, or 4 to 5 percent of such plots on all forest land, are projected to be significantly impacted. Similarly, between 26 percent (base scenario) and 35 percent (high scenario) of semiprimitive nonmotorized timberland plots are projected to be significantly impacted, or 17 to 23 percent of these plots when all forest land is considered. Based on the criterion, no significant impacts occur when plots in the "wet" physiographic classes are projected to be harvested. These plots would be accessed when the ground is frozen and therefore are assumed not to require permanent roads. Plots in these classes that are projected to be harvested ranged from 11 percent (base scenario) to 23 percent (high scenario). Mitigation alternatives aimed at the significant impacts are discussed in section 8.1. Table 7.2 summarizes the percent of primitive and semiprimitive nonmotorized plots projected to be significantly impacted over the 50-year study period, by scenario, on both all forest land and timberland.

Table 7.2. Distribution of timberland and all forest land plots projected to be significantly impacted over the 50-year study period, by scenario.

	Percent of plots harvested and significantly impacted by scenario		
	Base Scenario	Medium Scenario	High Scenario

ROS Class	All Forest Land	Timberland	All Forest Land	Timberland	All Forest Land	Timberland
Primitive	4.0	31.9	4.0	34.0	5.3	43.4
Seimprimitive nonmotorized	17.0	26.7	19.2	29.5	23.0	35.2

7.3

Application of Criteria to Aesthetic Impacts

7.3.1

Significant Impact Criterion for Forest Recreation and Aesthetics

An impact is considered significant if visual management guidelines are not used in the planning and execution of projected timber sales for visually sensitive areas.

Severity and/or extent. This criterion seeks to identify significant impacts affecting the aesthetic values of Minnesota's forests. The criterion refers to visual management guidelines which are planning tools used by the federal and state ownerships to reduce visual impacts. Significant impacts can be avoided where visual planning is used to identify *where* and *how* harvesting and associated forest operations should take place, i.e., road location and design, use of buffers, size and shape of cut, and slash and debris disposal practices.

Harvesting can reduce the aesthetic experience for subsequent users, therefore limiting the recreation value of both harvested areas and adjacent unharvested areas. However, harvest operations and associated roading can also create additional recreation opportunities in ROS classes 3, 4, and 5. Planning is required to fully realize these opportunities and to minimize impacts on some existing users such as snowmobilers, canoeists, cross-country skiers and hikers. As well as providing new access, harvest operations can also create travel barriers and negative visual impacts along improved and unimproved roads in the forest areas (slash on roadsides, trails, landings and staging areas, ruts in roadways, etc.) in ROS classes 3, 4, and 5.

The aesthetic and natural experience of many outdoor recreation users is reduced where inappropriate harvesting activities have been used. Research shows that many outdoor recreation users (such as hunters, hikers, skiers, snowmobilers, berry pickers) see an aesthetic experience as dependent upon views of the landscape and the opportunity to be in a natural or relatively unmodified setting. Consumptive users like deer hunters, grouse hunters, anglers and berry pickers seek the aesthetic experience as well as the harvesting of game or other resources. Clearcutting may well produce more harvestable resources (game, berries)

in some areas, but research has shown that this type of timber harvesting will also reduce the aesthetic/natural experience opportunities sought by many of these recreational users.

Visually sensitive forested areas recognized in this criterion can include such areas as those adjacent (within one-fourth mile) to water (lakes and rivers), important tourist and recreation areas, and along recognized tourist access routes. The criterion assumes that significant impacts occur where harvesting operations take place in visually sensitive areas on lands where owners do not practice formalized visual management planning. For example, the USDA Forest Service has had formalized visual management systems in place for a comparatively long time. Other ownerships, including MNDNR Management Region 2 and Beltrami County, are in the process of developing and applying guidelines.

Typically, other ownerships do not have formalized systems in place. Hence, while in some cases efforts are made to reduce visual impacts on a site by site basis, impacts can still occur when viewed from a wider context.

Controls over harvesting have been developed to incorporate visual concerns in shoreland areas. These rules apply irrespective of ownership, however, local zoning enforcement is necessary for the rules to be enforced. Noise is another important impact that can cause short-term impacts for recreators and residents within hearing distance of harvesting operations. Noise impacts occur for a very short period over the term of a typical rotation. Because it is short-lived and so variable in its extent and impact no significance criterion can be developed specifically to address noise. Mitigations to address noise impacts will be developed in the context of visual planning as the objectives of both are to maintain an aesthetically pleasing environment.

Certainty of impact. Certainty is dependent on the degree to which visual planning is used in timber sale layout and BMPs are adhered to in the execution of the harvesting and postharvest closure of the site.

Duration of impact (irreversibility). Impacts can extend into the medium-term depending on the circumstances.

Existing guidelines and standards.

- USDA Forest Service Visual Management System;
- DNR - Draft Visual Management Guidelines;
- Wisconsin DNR - Silvicultural and Forest Aesthetics Handbook;
- Shipstead-Newton-Nolan Act;
- Statewide Shoreline Rules (p. 31 subpart 8) prescribes use of BMPs within

- 1000' of lakes, ponds, flowages
- 300' of rivers and streams
- floodplains;
- Upper Mississippi Headwaters Ordinances seeks to preserve the scenic and aesthetic character of the shoreland along the river;
- DNR operational order (95) establishes a ¼-mile buffer around BWCAW for leasing minerals;
- Federal Wild and Scenic Rivers Act (1968) established a 200-foot buffer; and
- State Wild and Scenic Rivers Act.

Biological implications. There are no direct biological implications associated with use of visual planning to plan harvesting activities. There are some side effects that may occur under certain circumstances for example, retention of riparian vegetation as visual buffers along major waterbodies will likely be of benefit to those plant and animal species that live in this habitat. Also, visual planning may increase the amount of older forest and forest managed with selective harvests. If the latter occurs, it will have biological implications for those species of plants and animals that are found in older stands.

Economic implications. Timber harvesting can significantly impact outdoor recreational use of the forest by changing the aesthetic values of the forest and hence its value as a setting for many activities. Changes in recreational use will likely impact the recreation/tourism industries that have been developed to support such uses.

7.3.2

Assessment of Impacts on Visually Sensitive Areas

Application of this criterion requires that two tests be applied to determine if a plot projected to be harvested is significantly impacted. The first test is to ascertain whether the plot is *visually sensitive*. This requires an assumption as what constitutes visually sensitive. It was assumed that, based on practices employed by the USDA Forest Service and the MNDNR, areas considered to be visually sensitive are those where timber harvesting and forest management activities are constrained in order to avoid adverse visual impacts. Applying this test to the visual sensitivity rankings developed earlier equates visual sensitivity to ranks I to IV. Rank V, the lowest rank, is therefore comprised of plots that are not visually sensitive.

The second test requires knowledge of the ownership as a proxy for an assessment of whether VMGs are used, and therefore whether significant impacts are assumed to be avoided. Those plots on state and federal lands that are projected to be harvested are assumed to be planned and executed

using VMGs and therefore not significantly impacted. The converse is true for plots on other ownerships. While those VMGs being developed for state lands are not formal policy as yet, the study assumes they will be early in the 50-year study period.

The following analyses apply these tests to identify significant impacts under this criterion.

Visual Sensitivity Rank I

As discussed in section 6.2.1, it is not possible to quantitatively assess visual impacts on visual sensitivity rank I plots. Significant impacts are likely, particularly on ownerships other than state and federal. Mitigations to avoid these impacts are discussed in section 8.2.

Visual Sensitivity Ranks II to IV

Each of the plots ranked as being visually sensitive and projected to be harvested were assessed to determine ownership. Those harvested on lands managed by the USDA Forest Service and MNDNR, and therefore with use of VMGs in the planning and execution of timber sales and forest management activities, are assumed to have no significant impacts.

Those ranked as visually sensitive and projected to be harvested on the remaining ownerships are assumed to result in a significant impact.

Significant Impacts on Visually Sensitive Timberlands

Based on the interpretation of the significant impact criterion set out previously, significant visual impacts occur when timber harvesting and forest management activities do not follow VMGs.

The importance of the timberland plots that are not in national or state forest ownership and that are in visual sensitivity ranks II through IV are shown in table 7.3. Harvesting of these plots is considered to have a significant impact as assessed against the significant impact criterion.

Table 7.3. Distribution of significant impacts for FIA timberland plots of visual sensitivity ranks II to IV that are not under VMGs by ecoregion.

Ecoregion	Total number of plots*	Total number of plots and (percent) harvested that are not under VMGs		
		Base	Medium	High
Glacial lake plains	447	299 (66.9)	325 (72.7)	342 (76.5)
Border lakes	228	153 (67.1)	174 (76.3)	176 (77.2)
Lake Superior highlands	253	116 (45.8)	170 (67.2)	195 (77.1)
Central pine-hardwood	3,655	2,317 (63.4)	2,629 (71.9)	2,869 (78.5)

Western prairie/forest transition	508	164 (32.3)	193 (38.0)	267 (52.6)
Eastern prairie/forest transition	334	157 (47.0)	179 (53.6)	194 (58.1)
Western prairie	134	59 (44.0)	63 (47.0)	74 (55.2)
Statewide	5,559	3,265 (58.7)	3,733 (67.1)	4,117 (74.1)

* Number of plots not subject to VMGs. Only the USDA Forest Service and the MNDNR are assumed to use VMGs. Thus, this column describes numbers of plots in other ownerships.

The highest level of impact in absolute terms occurs in the central pine hardwood ecoregion where 78 percent of the region's visually sensitive plots are projected to be harvested in a manner assumed to cause significant impacts. Lowest absolute levels of impact occur in the western prairie/forest transition ecoregion where between 32 and 53 percent of the plots are projected to be harvested without consideration of VMGs, and thereby causing significant impacts.

The table 7.3 also provides information on patterns and trends of aesthetic impact among the ecoregions and across the three harvesting scenarios. Although the central pine hardwoods region contains the largest number of plots projected to be harvested with significant visual impact, all northern ecoregions contain similar percentages of plots projected to be significantly impacted.

Statewide, 59 percent of the plots ranked as sensitivity II to IV and projected to be harvested under the base scenario without visual management considerations. Consequently, these plots are expected to show significant visual impacts. Further, this percentage climbs to 74 percent under the high scenario. Mitigation alternatives to address these impacts are discussed in section 8.3.

8 MITIGATION ALTERNATIVES

The significant impacts identified in the previous section are those likely to occur at the three levels of harvest if existing management practices are applied. This section identifies the range of possible mitigations that could be applied to address these significant impacts. In addition, significant impacts which cannot be mitigated are also identified.

The significance criteria applied in the previous section identify those impacts that exceed threshold levels and therefore require a mitigative policy response. The significance criteria are thresholds which only have to be exceeded to *trigger* the criterion and, therefore, the assessment that the impact is significant. Further, a range of mitigation responses may be required that recognize differing degrees of exceedence. The mitigation

alternatives criterion will be used to identify possible responses.

Major considerations used in the development of the criterion to identify mitigation alternatives include:

- financial considerations;
- administrative considerations;
- certainty of effectiveness; and
- social implications.

The mitigation alternatives criterion is:

A mitigation alternative to address identified significant impacts will be considered if the mitigation is physically and biologically *feasible to implement*² in Minnesota taking into account the:

- administrative requirements to implement and oversee policy changes;
- the financial requirements to undertake the action; and
- social considerations (ability to organize support and effect implementation).

The mitigation action must also be supported by some degree of certainty regarding its effectiveness, both in terms of the relative extent of mitigating the impact and its duration at maintaining the mitigative effectiveness.

8.1

Mitigations for Recreation Uses: Primitive and Semiprimitive Nonmotorized Recreation Opportunities

As discussed in section 7.2.1, the criterion developed and approved by the Advisory Committee and the EQB identifies significant impacts only in primitive and semiprimitive nonmotorized areas where permanent roads are likely to be built. The following mitigations have been developed to mitigate the identified significant impacts. They do not mitigate all impacts identified in section 6.

8.1.1

Landscape Based Road and Trail Plan

Develop and implement a landscape based cooperative road and trail plan

²*Feasible* implies that the mitigation action can realistically be implemented and addresses the impact being considered.

among all land management and transportation agencies to ensure that a variety of recreational opportunities are maintained in appropriate ROS classes. This should include a comprehensive road and trail inventory across all ownerships and should identify management objectives for existing and potential recreation opportunities.

Effectiveness

This plan would provide the overview needed to develop a statewide understanding of where primitive and semiprimitive nonmotorized recreation opportunities exist and might exist in the future. This inventory and planning step will assist management agencies to more precisely identify critical recreational resources that are sensitive to the impacts of timber harvest operations. Identification of areas with varying degrees of accessibility and owners' management objectives would allow better coordination of road and trail developments that cross ownership boundaries. This level of coordination would provide the opportunity to plan mitigations to minimize adverse impacts.

Workability

This alternative is potentially feasible subject to cooperation of the major timberland ownerships. This will require a leadership role by the MNDNR as the most appropriate agency to initiate and oversee the project. Being a state initiative, the MNDNR would be responsible for the administration and staffing costs which would be approximately 1.5 to 2 full-time equivalents (FTE) to compile the information. Subsequent maintenance of the database and its use for planning purposes could be handled by existing staff. Other agencies and ownerships would also have to contribute some resources to compile information for inclusion in the inventory and subsequently to participate in the access planning and coordination process. This is a long-range planning step.

8.1.2

Nonpermanent Road Construction in Areas Managed Primarily for Timber Production

Develop guidelines for nonpermanent road construction for use in primitive and semiprimitive nonmotorized areas which are to be managed for timber harvest but also have recreational value.

The basis for these guidelines can be found in the USDA Forest Service ROS Access Coordinator; Eastern Region Supplement (USDA Forest Service 1986) and is also discussed in section 5.3 (appendix 7).

Effectiveness

As discussed in section 5.3 these guidelines can be effective in reducing the negative impacts on timberlands classified as ROS classes 1 and 2 caused by road construction. Use of nonpermanent roads coupled with use of

VMGs can reduce the degree and the period over which impacts persist (see table 5.3).

Workability

The MNDNR should insure that these guidelines on nonpermanent road construction techniques should be incorporated into the aesthetic BMPs under preparation. Implementation of these guidelines can be achieved if an owner wishes to maintain recreation value as a secondary management objective. Typically, the public ownerships will have these objectives to varying degrees. Private owners may or may not have an explicit recreational use objective. Under these circumstances these guidelines may not be implemented. In areas where roading is not required for ongoing management purposes the low development costs and lack of ongoing maintenance requirements may make nonpermanent roads cost effective when compared with more conventional techniques. This rationale could be used to promote use of nonpermanent roads. Development and application of these guidelines would provide long-term benefits.

8.1.3

Develop VMGs for Timberlands Managed Primarily to Provide Primitive and Semiprimitive Recreation Opportunities

The state should develop VMGs in conjunction with other public and private ownerships to be used by owners to specifically maintain or enhance primitive recreation opportunities.

The primitive lands identified as being significantly impacted in the previous section vary in their potential value for recreational use and hence in the type of mitigation that is needed. Therefore, two levels of primitive sensitivity have been identified using combinations of recreational value and attractiveness value of timberland plots. The primitive sensitivity levels refer only to plots in the primitive and semiprimitive nonmotorized ROS classes that have been projected to be harvested. Recreational use, whether in primitive areas or nonprimitive areas is partially dependent on the visual appeal of an area (Brunson and Shelby 1992). Thus, this analysis is directed at identifying those areas in these primitive classes that exhibit certain characteristics likely to make these areas more attractive to users seeking this type of recreational experience.

Primitive Sensitivity Group I.—This group includes *all* timberland plots having an ROS class description as primitive. Group I also includes the following categories of plots in the semiprimitive nonmotorized ROS class (1) those with a very high attractiveness value regardless of their recreation value; (2) those that have very high recreation value regardless of their attractiveness level; and (3) those that have low to high attractiveness value *and* low to high recreation value. These areas are likely to have some

recreation value and therefore would benefit from mitigations designed to minimize impacts on existing or potential uses.

Primitive Sensitivity Group II.—This group includes all plots assigned to the semiprimitive nonmotorized ROS class that have: (1) very low recreation value *and* high to very low attractiveness; and (2) a very low attractiveness level rating *and* very low to high recreation value.

Table 8.1 shows the split between primitive sensitivity group I timberlands and primitive sensitivity group II timberlands that are projected to be significantly impacted under the three scenarios.

Table 8.1. Distribution of plots significantly impacted for ROS primitive and semiprimitive nonmotorized classes by primitive sensitivity mitigation group.

ROS Class	Primitive Sensitivity Group	Number of plots projected to be impacted by scenario		
		Base	Medium	High
Primitive	I	17	18	23
Semiprimitive nonmotorized	I	166	187	227
Semiprimitive nonmotorized	II	51	53	58

Effectiveness

In order for these guidelines to be effective, they should include the following guidelines.

Primitive Sensitivity Mitigation Group I.—All plots falling into this group are classified as primitive or semiprimitive nonmotorized. In these recreational settings where recreation is the dominant management activity, *all* forms of harvesting are antithetical to maintenance of primitive and semiprimitive nonmotorized recreational opportunities and therefore impacts from harvesting cannot be mitigated.

Primitive Sensitivity Mitigation Group II.—The applicability of various mitigation measures are shown in table 8.2.

Workability

This alternative is potentially feasible subject to cooperation of the major ownerships that manage some timberland areas primarily for recreation uses. The USDA Forest Service currently operates in this way using existing ROS management and access development guidelines.

The MNDNR should insure that VMGs to address the management requirements of this category of timberlands are included in the aesthetic BMPs currently under development.

Table 8.2. Applicability of mitigation measures for primitive sensitivity mitigation group II timberlands managed primarily for recreation uses.

Mitigation Measure	Applicability
1. Recommended Harvest Systems	
uneven aged management	yes
shelterwood management	yes
thinning	yes
seed tree cuts	no
clearcutting	no
2. Recommended size of Harvest Area	
Maximum recommended harvest size	5 acres with inclusions
Percent of stand recommended to be in harvest openings at one point in time	20%
Maximum size of roadside openings	200 feet
Minimum distance between roadside openings	1000 feet
3. Recommended Shape of Harvest Area	
Irregular	yes
Regular	no
Other that conform to character of edges in the landscape pattern	yes
4. Harvest Area Edge Treatment	
Feathering of edges	yes
Curvilinear alignments	yes
Rectilinear alignments	no
Other alignments that conform to the character of edges in the landscape pattern	yes
5. Harvest Area Pattern Requirements	
Edge overlap	when feasible
Connections among openings	when feasible
Time interval required before adjacent trees can be harvested	10 year minimum
6. Harvest Residue Management	
Removal in conifer stands within 300 feet of road	required
Cut back to within one foot of ground in hardwood stands within 300 feet of road	required
Cut back to within three feet of ground in hardwood stands	required
Cut back to within one foot of ground in conifer stands	required
7. Regeneration Planting Specifications	
Parallel to contour	yes

Table 8.2. continued.

Mitigation Measure	Applicability
8. Road and Landing Design Specifications	
Curvilinear road alignment	required
Inclusions or leave strips at landing entrance	required
Landing setback from major travel corridors	400 feet
9. Restrictions on Season of Harvest	
Winter only	yes
10. Information and Interpretive Programming	
Onsite interpretation	required
Information programs in general vicinity	required

8.2

Mitigations for Aesthetic Resources: Visual Management of Forest Lands

The following mitigations are organized and discussed according to two ranks of visual sensitivity: visual sensitivity rank I and visual sensitivity ranks II to IV that have been previously defined in section 4.3. Section 5.2 describes the principles of visual management guidelines that are used by some land management organizations. These provide a useful background as to the planning, management and application of VMGs in a forestry context. These principles have been adopted in some of the mitigations that follow.

8.2.1

Mitigations for Visual Sensitivity Rank I Timberlands

Inventory of Visual Sensitivity Rank I Timberlands

The state should undertake an inventory of the visual sensitivity rank I timberlands across all ownerships. This should include timberlands adjacent to all state parks, the BWCAW, national parks, county parks, and lineal recreation resources including federal and state wild and scenic rivers, designated canoe and boating routes, and primary state hiking trails. Where these lands fall within state, federal or county ownerships the inventory should be used to identify those parts of these zones that are adjacent to sites used for recreation or that provide a visual setting for the recreation and aesthetic resource area. Public ownerships should be surveyed to identify current management practices applicable to these lands.

Effectiveness

Identification of timberlands that play an important role in providing a

setting for the state's premier recreation areas will provide the data necessary to insure that impacts on these important resources caused by timber harvesting and forest management activities can be avoided by appropriate planning. The MNDNR would be the most appropriate state agency to undertake the inventory and to survey management objectives and practices relative to these areas.

Workability

The inventory and survey would require specialist staff. The project would require funding at a level of 2 FTE for 1 year. Subsequent maintenance of the database could be undertaken by existing staff. The project would require the cooperation of other ownerships, particularly other public owners.

Develop VMGs for Use in Visual Sensitivity Rank I Timberlands

The state should develop VMGs for use within visual sensitivity Rank I timberlands. These should be developed in consultation with other public ownerships. The objective should be to insure more consistency in the management of these important resources. This will require that assistance be given to smaller ownerships, including some counties, to apply these guidelines. The state should encourage counties to incorporate these guidelines into county planning and extend their application to private lands.

Effectiveness

Development of VMGs that specifically apply to these lands would assist those ownerships that currently do not have the resources to develop or apply their own guidelines. This particularly applies to counties. The guidelines that are developed should replace those parts of existing shoreland regulations that prescribe permitted activities on private property within visual sensitivity rank I timberlands that are in riparian areas. Development of a more consistent, statewide standard of management for these lands would reduce the likelihood of significant visual impacts on these important recreation resources. This particularly applies to linear recreation resources such as rivers and trails that can pass through lands under many ownerships.

Workability

This mitigation is feasible as the guidelines could be developed by extending the work of the existing Aesthetic BMPs Task Force. This would require a leadership role for the MNDNR to oversee development of the guidelines and to promote their wider application via county land management and through regulations applying to private lands. This would require additional funding to hire staff with landscape management and planning skills. Statewide, this would require a five-year program with 1 FTE at the professional level. If applied, these guidelines would be

effective in reducing the levels of aesthetic impacts likely as a consequence of timber harvesting and forest management activities as well as other forms of development.

Options for Management Within Visual Sensitivity Rank I Timberlands

The state and other public land management agencies should consider the following management principles to apply within these timberlands. These principles should apply within a special management zone identified as part of the inventory described in 8.1.1. The width of the zone should vary according to the resource being buffered and site related factors; however the zone typically should extend a minimum of 200 feet either side of wild and scenic rivers, primary state hiking trails and boating and canoe routes; lakes; and >third order streams; and one-fourth mile around all state parks, the BWCAW, national parks and county parks. The following options for management principles to apply within these visual sensitivity rank I timberlands should be considered when preparing the special VMGs for use in these areas.

***Alternative 1:** The state should liaise with other public land management agencies to prohibit timber harvesting within the special management zone.*

***Alternative 2:** The state should liaise with other public land management agencies to restrict timber harvesting within these special management zones through the use of the following principles:*

- *restrict the size and shape of clearcuts;*
- *where possible use silvicultural techniques that maintain forest canopy cover such as selective harvesting and thinning;*
- *keep forest roads out of view of parks and linear recreation resources;*
and
- *restrict harvesting in these zones to weekdays and nonholiday periods during winter.*

Effectiveness

Retaining a visual buffer between these categories of recreation areas and adjacent timberlands would assist in mitigating negative visual impacts caused by timber harvesting. Given the generally flat to undulating terrain in Minnesota, under most circumstances the provision of a buffer of this width would completely remove visual impacts. In circumstances where a recreation area is higher in the landscape, the buffer would put disturbance caused by harvesting in the mid-distance, thereby reducing the severity of impact. Adoption of alternative 1 would insure that no impacts from harvesting and forest management activities were visible in the foreground. Adoption of alternative 2 may result in some evidence of disturbance in the foreground. However, application of specific VMGs would minimize adverse visual impacts. Therefore, this mitigation would be effective in most circumstances, with a higher level of certainty attached to the likelihood of success if alternative 1 is adopted.

Workability

Assessment of the workability of this mitigation requires evaluation at two levels. The first is at the administrative level, that is whether the ownerships currently recognize such special areas and apply different management to these zones. The second aspect of workability that must be assessed is the feasibility of the mitigation in terms of its application in the field.

Administrative feasibility. Adoption of this alternative would necessitate some changes in the management objectives for timberlands under state, federal and county ownership. The state has identified similar zones or buffer areas on certain categories of state land for similar reasons. For example, the MNDNR has identified a 200-foot *leave strip*, where clearcutting is prohibited along state wild rivers; and MNDNR Operational Order 95 establishes a one-fourth mile buffer around the BWCAW and the principal recreational entrances and travel corridors (roadways) entering the BWCAW. Exploration and development of mineral resources (mining) is prohibited in these areas. This suggests that this is a workable option for state lands. Adoption of alternative 1, no harvesting, would remove additional, but unquantifiable, areas from timber production uses. Alternative 2 would maintain some timber production from these lands, however the management objectives would shift from timber production to recreation.

It is also possible that some of these lands could be included under other programs such as those aimed at increasing the area of extended rotation forests and other biodiversity oriented objectives. Combining these buffers with other management objectives can satisfy several needs.

The USDA Forest Service recognizes special management zones surrounding riparian resources. For example, the Superior National Forest designates a 200- to 300-foot buffer, which is managed to optimize riparian resource values. The USDA Forest Service also recognizes recreational use patterns and visually sensitive areas as part of visual management planning undertaken on national forests.

Riparian lands under county ownership will increasingly be managed under provisions of the shoreland regulations. These regulations identify a buffer zone parallel to the stream bank where management is directed at avoiding impacts on the adjacent stream. Thus, county and management agencies have precedents with respect to identifying these special areas.

All categories of public ownerships recognize various special categories of lands and have developed mechanisms to identify these lands and to manage them differently from remaining lands. Therefore, this mitigation is workable if these ownerships agree to include the areas identified as

visual sensitivity level I timberlands as requiring special management.

Field application. Alternative I would be the simplest alternative to implement as a zone could be demarcated and no further planning would be required to give effect to the mitigation. In contrast, alternative 2 would require application of VMGs which would carry a comparatively heavy ongoing planning and supervision component.

Development of this mitigation would require the MNDNR to adopt a leadership role in the identification of these areas. It should also coordinate the development of management guidelines for use within these zones. Developing these guidelines will insure greater consistency in the management applied in these key boundary zones.

Visual Management of Resort Settings

The state should continue to encourage and assist resort owners to identify adjacent forest lands that are held by other ownerships and which provide a setting for their resorts. The state should facilitate development and application of VMGs for use where harvesting occurs under these circumstances.

Effectiveness

Application of VMGs to these operations, coupled with sensitivity in the timing of operations, can reduce the level of impact on the resort's setting. This long-range cooperative planning approach will assist in mitigating the negative visual impacts of timber harvest operations especially where these operations could adversely affect the visual setting of resorts.

Workability

This is a long-term strategy that will require the state to become more involved in working directly with resort owners to identify critical forest land near resorts. It will require administrative effort to work cooperatively with a number of stakeholders in the public and private sectors to manage lands so that visual quality and the "resort image of Minnesota" is maintained in such a way that resort customers will be attracted to visit and return.

8.3

Mitigations for Visual Sensitivity Ranks II through IV Timberlands

The state should prioritize development of VMGs or aesthetic BMPs that can be applied to all forest lands across all ownerships. In addition, the state should allocate additional resources to increase existing education programs to include training in aesthetic management.

These guidelines would include the principles as set out for each visual

sensitivity rank (II to IV) in table 8.3.

Table 8.3. Principles/applicability of mitigation measures for visual sensitivity levels II to IV.

Mitigation Measure	Applicability:		
	Visual Sensitivity Rank		
	II	III	IV
1. Recommended Harvest Systems			
uneven aged management	yes	yes	yes
shelterwood management	yes	yes	yes
thinning	yes	yes	yes
seed tree cuts	no	yes	yes
clearcutting	no	yes	yes
2. Recommended size of Harvest Area			
Maximum recommended harvest size	5 acres with inclusions	10 acres with inclusions	25 acres with inclusions
Percent of stand recommended to be in harvest openings at one point in time	20%	50%	75%
Maximum size of roadside openings	200 feet	400 feet	600 feet
Minimum distance between roadside openings	1000 feet	1000 feet	1000 feet
3. Recommended Shape of Harvest Area			
Irregular	yes	yes	yes
Regular	no	no	no
Other that conform to character of edges in the landscape pattern	yes	yes	yes
4. Harvest Area Edge Treatment			
Feathering of edges	yes	yes	not required
Curvilinear alignments	yes	yes	yes
Rectilinear alignments	no	no	no
Other alignments that conform to the character of edges in the landscape pattern	yes	yes	yes
5. Harvest Area Pattern Requirements			
Edge overlap	when feasible	when feasible	when feasible
Connections among openings	when feasible	when feasible	when feasible
Time interval required before adjacent trees can be harvested	10 year minimum	20 year minimum	10 year minimum
6. Harvest Residue Management			
Removal in conifer stands within 300 feet of road	required	not required	not required
Cut back to within 1-foot of ground in hardwood stands within 300 feet of road	required	not required	not required
Cut back to within three feet of ground in hardwood stands	required	required	not required
Cut back to within one foot of ground in conifer stands	required	required	not required
7. Regeneration Planting Specifications			
Parallel to contour	yes	yes	no

Table 8.3. continued.

Mitigation Measure	Applicability		
	Visual Sensitivity Rank		
	II	III	IV
8. Road and Landing Design Specifications			
Curvilinear road alignment	required	required	not required
Inclusions or leave strips at landing entrance	required	required	not required
Landing setback from major travel corridors	400 feet	400 feet	not required
9. Restrictions on Season of Harvest			
Winter only	yes	yes	no
10. Information and Interpretive Programming			
Onsite interpretation	required	desired	not required
Information programs in general vicinity	required	desired	not required

Effectiveness

Application of aesthetic BMPs or VMGs in the planning and execution of timber harvesting operations will mitigate visual impacts on timberlands in visual sensitivity ranks II to IV.

Workability

The guidelines have been adapted from those recommended for mitigating adverse recreation opportunity and aesthetic impacts by Minnesota and Wisconsin (MNDNR 1991; Wisconsin DNR n.d.), Ontario, Canada (Ontario Ministry of Natural Resources 1987), and the USDA Forest Service Eastern Region (USDA Forest Service 1980, 1985, 1986). The principles set out in table 8.3 have been field tested and are known to be workable. Therefore, at a technical level the mitigation is very feasible. Application of these guidelines across all ownerships, particularly on private lands, will likely present some problems. A major problem will be the additional costs to plan and set out timber sales in accordance with these guidelines. It is unlikely that many private owners will have the skills to implement these guidelines, therefore the state should provide additional funding to develop educational programs (via extension) to train landowners and loggers in the application of these guidelines. This could be done in conjunction with the program identified under section 8.2.2. Despite these problems, implementation of these guidelines is likely to be workable and the level of compliance can be expected to be reasonable if the level of compliance with water quality BMPs are any guide (Jaakko Pöyry Consulting, Inc. 1992d).

9

PREFERRED MITIGATION STRATEGIES

A variety of strategies can mitigate against adverse impacts of timber harvesting and forest management activities. The final criteria document (Jaakko Pöyry Consulting, Inc. 1991c) describes how such strategies would be identified and selected. The identification and analysis of preferred strategies is described below.

Framework for analyzing mitigations and selecting preferred mitigation strategies

Criteria for selecting strategies are drawn from the final criteria document noted above and reproduced below:

Based on an analysis of mitigation alternatives identified, preferred mitigation strategies will be selected by considering in relative terms:

1. the effectiveness at mitigating the identified significant impacts;
2. the beneficial effects on other resource values;
3. the adverse effects on other resource values;
4. the physical, biological, administrative (implementation and oversight), financial (costs, public and private, direct and indirect), and social (ability to organize, support and effect implementation) feasibility; and
5. the probability of success and duration of success.

In practice, the verbal and written input from the Advisory Committee on the potential mitigation strategies led to acceptance, rejection and/or refinement of the potential strategies. These results were then approved by the EQB and comprise the strategies considered and evaluated in detail. Additionally, for this analysis the above criteria were grouped as follows:

1) *Effectiveness* addresses a mitigation strategy in terms of its ability to either avoid or reduce the identified impacts.

2) *Feasibility* addresses the likelihood that the mitigation strategy can be implemented, based on existing or future economic, social, biophysical, or administrative constraints.

3) *Duration* of mitigation can best be scored into four classes: 1=long-term—greater than 50 years and irreversible; 2=medium-term—10 to 50 years; 3=short-term—2 to ten years; 4=very short-term—less than 2 years.

4) *Concomitant effects* refers to those strategies that have the potential to

significantly affect other resources. It is clearly fallacious to consider that

any forest management practice will only affect a single resource; forests are intricately interacting ecosystems, and each practice affects many resources.

5) *Probability of success*, though not tabulated explicitly in the following tables, is a combination of effectiveness, feasibility and duration with minimal negative concomitant effects. The strategies identified as highly effective, highly feasible, of long duration and with minimal negative concomitant effects are assumed to have the greatest chance of success in the long run.

These criteria were then applied to the various mitigation strategies for the purpose of comparison among them and to help determine preferred mitigation strategies.

Evaluation of Mitigations for Recreation Uses: Primitive and Semiprimitive Nonmotorized Recreation Opportunities

Three strategies have been put forward to mitigate potential adverse impacts of timber harvesting on primitive types of recreation opportunities. A comparison of these strategies is summarized in table 9.1

Table 9.1. Evaluation of mitigation strategies for minimizing significant negative impacts of timber harvesting and forest management activities on recreation opportunities. Rankings for effectiveness and feasibility from 1=high to 3=low, and for duration from 1=long to 4=very short-term. Concomitant effects refers to potential positive (+) or negative (-) effects on issues of concern from the FSD.

Mitigation Strategy	Effectiveness	Feasibility	Duration ^a	Concomitant Effects (±) ^b
Landscape-based road and trail plan	1	1	2	Biodiversity(±) Tourism (+) Water quality (+)
Nonpermanent road construction	2	2	1	Biodiversity (+) Water quality (+) Soils (-)
VMGs for primitive types of recreation opportunities	1	2	1	Biodiversity (+) Tourism (+) Water quality (+) Soils (-)

^a1=long-term—greater than 50 years; 2=medium-term—10 to 50 years; 3=short-term—2 to 10 years; 4=very short-term—less than 2 years.

^bEffects that are noted are those with potential to *significantly* affect another resource.

Explanations of the ranks for these mitigations are as follows:

Landscape-based road and trail plan.—This alternative would be very

effective. It would provide a fundamental planning tool that would allow coordination between ownerships to insure that primitive and semiprimitive nonmotorized recreation opportunities are adequately provided for. The alternative has high feasibility assuming the MNDNR fulfills the leadership role. It would provide benefits over the medium- and long-term.

Nonpermanent road construction.—An effective way to maintain primitive kinds of recreation opportunities on primitive and semiprimitive nonmotorized timberland plots that are primarily managed for timber harvesting. This option may not be feasible because use of nonpermanent roads may not be readily accepted as an alternative to conventional techniques to put in permanent roads. Disturbance to soils may also be greater where nonpermanent roads are used in dry physiographic areas. Long-term benefits could accrue.

Developing VMGs for primitive and semiprimitive recreation opportunities.—A highly effective way of retaining primitive kinds of opportunities in areas that will be harvested. VMGs, especially if used in conjunction with nonpermanent roads, give attention to the important social attributes and long-term benefits associated with primitive recreation opportunities. However, VMGs prescribed in the technical report (e.g., removal of slash) may run counter to prescriptions found in the Forest Soils technical report (Jaakko Pöyry Consulting, Inc. 1992e). The latter could limit the feasibility of some of the VMGs. Benefits would be short- to medium-term.

Preferred Mitigation(s)

The mitigations are not mutually exclusive and if used in combination would mitigate the identified significant impacts and would therefore retain primitive opportunities in the long-term.

Evaluation of Mitigations for Aesthetic Resources

Several strategies have been developed to mitigate the potential adverse impacts of timber harvesting on forest aesthetics. A comparison of these strategies is presented in table 9.2.

Explanations of the ranks for these mitigations are as follows:

Visual Sensitivity Rank I Timberlands

Develop a buffer zone where harvesting is prohibited in visual sensitivity rank I timberlands.—While a desirable alternative for its effectiveness as a way to maintain recreation opportunities currently existing within the zone, may not be as feasible nor of as long-lasting a duration as might be desired. In the long-run, prohibiting any kind of forest management may diminish existing recreation opportunities found in semiprimitive motorized, roaded natural, and rural ROS classes.

Develop a buffer zone where special harvest practices are permitted on visual sensitivity rank I timberlands.—A desirable alternative, especially for semiprimitive motorized, roaded natural and rural ROS classes. Timber harvesting practices that would be allowed would be those designed to enhance existing recreation opportunities managed for within these zones. Maintaining these types of opportunities should be possible in the short-, medium- and long-terms.

Develop VMGs for resort areas.—While somewhat effective and feasible for resorts, it would do nothing to maintain recreation opportunities outside these areas. It would maintain recreation opportunities in the short-, medium- and long-terms for areas adjacent to resorts.

Table 9.2. Evaluation of mitigation strategies for minimizing significant negative impacts of timber harvesting and forest management activities on forest aesthetics. Rankings for effectiveness and feasibility from 1=high to 3=low, and for duration from 1=long to 4=very short-term. Concomitant effects refers to potential positive (+) or negative (-) effects on issues of concern from the FSD.

Mitigation Strategy	Effectiveness	Feasibility	Duration ^a	Concomitant Effect (+) ^b
Visual Sensitivity Rank I Timberlands				
Inventory visual sensitivity rank I timberlands	1	2	1	Soils (+) Tourism (+) Economics (-) Water quality (+)
VMGs for use in visual sensitivity rank I timberlands	1	2	1	Soils (+) Tourism (+) Economics (-) Water quality (+)
Alternative 1 guidelines	1	3	1	Tourism (+)
Alternative 2 guidelines	2	1	1	Biodiversity (+) Soils (+)/(-) Tourism (+) Forest health (-)
Visual Sensitivity Ranks II to IV				
Develop VMGs for resort areas	2	2	1	Tourism (+)
Develop VMGs for all forest lands under all ownerships	1	2	1	Biodiversity (+) Soils (+)/(-) Tourism (+) Forest health (-)

^a1=long-term—greater than 50 years; 2=medium-term—10 to 50 years; 3=short-term—2 to 10 years; 4=very short-term—less than 2 years.

^bEffects that are noted are those with potential to *significantly* affect another resource.

Visual Sensitivity Ranks II to IV

Develop VMGs for all timberlands in visual sensitivity ranks II to IV under all ownerships.—This alternative would address maintaining visual quality and recreation opportunities for all ownerships on all forest lands. It would be effective, would address needs in the short-, medium- and long-terms and, although it would probably be expensive to implement, the costs are not expected to be prohibitive. The state is already moving in this direction so the feasibility of this alternative is, to some extent, validated. This approach would also ensure that resort interests were addressed.

Preferred Mitigation(s)

The preferred mitigations would be a combination of developing VMGs for all forest lands under all ownerships for visual sensitivity ranks II through IV and developing a buffer zone where special harvest practices would be permitted on visual sensitivity rank I timberlands. Guidelines have been outlined in table 8.2 for implementing VMGs for visual sensitivity ranks II through IV. Both mitigations have the potential to maintain visual quality and recreation opportunities on and around the timberlands impacted by harvesting.

**10
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APPENDIX 1

Nonlinear Rules of Combination Used in Developing Attractiveness Dimensions

I. Measurement Rules of Combination

- A. Each dimension was awarded a total of 100 points.
- B. For each dimension, divide 100 points by the number of variables comprising the dimensions to ascertain points per variable.
- C. For each variable in a given dimension, distribute points per variable across variable classes. As general rule, distribute points awarded for each variable evenly across variable classes unless compelling reason exists for alternative distribution of points per class.
- D. Assign points to each class for each variable in a dimension and add across variables to determine total dimension value for each plot. In the absence of empirical validation variables were not weighted when they were added together.
- E. Example:
 - 1. Construct X has 4 variables (V_1, V_2, V_3, V_4)
 - 2. V_1 and V_2 each have 4 classes (C_1 through C_4); V_3 has 3 classes; V_4 has 2 classes.
 - 3. Logic tree:

V_1 (25 pts)	V_2 (25 pts)	V_3 (25 pts)	V_4 (25 pts)
C_1 6	C_1 6	C_1 8	C_1 12
C_2 12	C_2 12	C_2 16	C_2 25
C_3 18	C_3 18	C_3 25	
C_4 25	C_4 25		

- 4. Points per variable equals $100/4 = 25$.
- 5. Points per class for $V_1, V_2 = 6, 12, 18, 25$.
- 6. Points per class for $V_3 = 8, 16, 25$.
- 7. Points per class for $V_4 = 12, 25$.
- 8. Examples of three ratings obtained from class ratings for each variable:
 - $V_{11} V_{21} V_{31} V_{41} = 6 + 6 + 8 + 12 = 32$ pts
 - $V_{14} V_{24} V_{31} V_{41} = 25 + 25 + 8 + 12 = 70$ pts
 - $V_{14} V_{24} V_{33} V_{42} = 25 + 25 + 25 + 25 = 100$ pts
- F. Special exceptions may be developed to better describe reality.
- G. Special exceptions that result in a dimension value of zero should start the first variable class with the next category.

II. Application of Measurement Rules to Attractiveness Dimensions

A. Landform characteristics of FIA plot.

1. Slope steepness

a. percent slope (100 points)

Categories		Values
1: 0		8
2: ≤ 3.45		25
3: 3.46 - 8.54		50
4: 8.55 - 15.45	75	
5: ≥ 15.46		100

2. Landform enclosure of space (100 points)

a. slope position (25 points)

1: top $\frac{1}{4}$ (1)		8
2: upper $\frac{1}{4}$ (2) and lower $\frac{1}{4}$ (3)	16	
3: lowest $\frac{1}{4}$ or level (4)		25

b. slope shape (25 points)

1: level (1) (if shape = 1, enclosure = 0)		0
2: convex (4)		8
3: uniform (3)	16	
4: concave (2)	25	

c. percent slope (25 points)

1: 0 (if slope = 0, enclosures = 0)		0
2: ≤ 8.54		8
3: 8.55 - 15.45	16	
4: ≥ 15.46		25

d. slope length (25 points)

1: 0 (if length = 1, enclosure = 0)		0
2: 1 - 70		12
3: ≥ 71	25	

3. Water distinctiveness (100 points)

a. type of nearest waterbody (40 points) (DWT)

1: Farm pond (4) and swamp (3)		20
--------------------------------	--	----

- 2: Stream (1), lake (2) and reservoir (5) 40

- b. Distance to nearest waterbody (60 points) (DWV)
 - 1: >15 chains (if DWV = 1, DWT = 0) 0
 - 2: 6 - 15 chains 30
 - 3: ≤5 chains 60

- B. Landform characteristics within 18 miles of plot
 - 1. Regional slope diversity
 - a. number of plots within 18 miles having a slope greater than 8 percent (100 points)
 - 1: ≤30 33
 - 2: 31 - 43 66
 - 3: >43 100

 - 2. Regional water diversity (100 points)
 - a. number of plots within 18 miles having a ground land use (GLU) that is water or marsh (50 points)
 - 1: 16
 - 2: 32
 - 3: 50

 - b. distance to nearest waterbody (50 points)
 - 1: >66 chains (>1 mile) 16
 - 2: 17 - 66 chains (¼ mile to 1 mile) 32
 - 3: <17 chains (within ¼mile) 50

 - C. Landcover characteristics of FIA plots
 - 1. Species diversity (100 points)
 - a. number of species groups present at plot (67 points)
 - 1: <3 22
 - 2: 4 44
 - 3: >4 67

 - b. mean DBH of trees at plot (33 points)
 - 1: 11
 - 2: 22
 - 3: 33

2. Presence of large old trees (100 points)
 - a. mean DBH of trees greater than 5 inches in diameter (33 points)

1: <7.3	11
2: 7.3 - 8.9	22
3: >8.9	33

 - b. number of live trees present at the plot (33 points)

1: > 566	11
2: 236 - 566	22
3: <236	33

 - c. age of the stand (34 points)

1: < 11 years	11	
2: 11 - 54 years		22
3: > 54 years	34	

3. Vegetative distinctiveness (100 points)
 - a. forest types present at plot (60 points)

1: jack pine (1), black spruce (12), oak (50), elm/ash/cottonwood (70)	0
2: red pine (2), white pine (12), balsam fir (13), N. white cedar (14), tamarack (15), white spruce (16)	30
3: aspen (91), balsam poplar (94)	60
4: paper birch (92), maple-basswood (80)	60

 - b. mean DBH of trees at plot (40 points)

1:	13
2:	26
3:	39

4. Spatial definition and visual penetration (100 points)
 - a. mean DBH of trees greater than 5 inches in diameter (40 points)

1: ≤7.3	0
2: 7.3 - 8.9	20
3: >8.9	40

b. stand history (20 points)

- | | |
|--|----|
| 1: clearcut more than 5 years ago (32,33,34);
partial harvest more than 5 years ago
(42,43,44);
grazing more than 5 years ago (12,13,14);
natural disturbance more than 5 years ago
(52,53,54);
human caused disturbance more than 5 years
age (62,63,64);
planting of forest land within last 20 years
(71,72,73,74);
planting of nonforest land within last
20 years (81,82,83,84);
natural regeneration within last 20 years
(91,92,93,94) | 0 |
| 2: partial harvest within last 5 years (41) | 10 |
| 3: grazing within last 5 years (11);
TSI within last 20 years (21,22,23,24)
clearcut within last 5 years (31) | 20 |

c. number of live trees present at plot (40 points)

- | | |
|--------------|----|
| 1: >566 | 13 |
| 2: 236 - 566 | 26 |
| 3: <236 | 40 |

5. Ground plane conditions (100 points)

a. stand history (100 points)

- | | |
|---|-----|
| 1: clearcut within last 4 years (31); partial
cut within 4 years (41);
TSI within 4 years (21); natural disaster
within 4 years (51); human caused
disaster within 4 years (61) | 0 |
| 2: clearcut 5-10 years (32); partial cut
5-10 years (42); TSI 5-10 years (22);
natural disaster 5-10 years (52);
human caused disaster 5-10 years (62) | 50 |
| 3: all else (11,12,13,14,23,24,33,34,43,44
53,54,63,64,71,72,73,74,81,82,84,
91,92,93,94) | 100 |

6. Negative human scale effects of large stands on flat sites (100 points)

a. stand area (60 points)

1: ≤10 acres	0
2: 10 - 20 acres	30
3: >20 acres	60

b. slope shape (40 points)

1: concave (2); convex (4); uniform (4) 0 (if shape = 1, scale = 0)	
2: level (1)	40

D. Landcover characteristics within 18 miles of FIA plot

1. Regional vegetative diversity (100 points)

a. number of forest types present within 18 miles of plot (100 points)

1: ≤9	33	
2: 10-11		66
3: >11	100	

2. Regional pattern of open space and forested mass (100 points)

a. number of ground land use types within 18 miles that are open field wetland or water (50 points)

1:	16
2:	32
3:	50

b. Distance to nearest agricultural field (50 points)

1: >66 chains (>1 mile)	16
2: 17-66 chains (¼ mile to 1 mile)	32
3: <17 chains (within ¼ mile)	50

E. Visual absorption capacity (100 points)

1. Number of ground land use types within 18 miles of plot that are forested (50 points)

1:	0
2:	25
3:	50

2. Percent slope (50 points)

1: 0 percent		0
2: ≤ 3.45 percent		12
3: 3.46 - 8.54 percent		24
4: 8.55 - 15.45 percent	36	
5: ≥ 15.46 percent		50

APPENDIX 2
Minnesota Resort Locations by County and Number of Lodging and Private Campsite Units in Each County

County	Number of resorts	Number of lodging units	Number of campsites
Aitkin	27	884	287
Anoka	0	0	0
Becker	65	651	773
Beltrami	63	594	473
Benton	0	0	0
Big Stone	0	0	0
Blue Earth	0	0	0
Brown	1	1	0
Carlton	3	32	82
Carver	0	0	0
Cass	197	2,419	1,645
Chippewa	0	0	0
Chisago	2	8	0
Clay	0	0	0
Clearwater	3	20	15
Cook	55	811	301
Cottonwood	0	0	0
Crow Wing	114	1,662	772
Dakota	0	0	0
Dodge	0	0	0
Douglas	67	667	837
Faribault	0	0	0
Fillmore	1	56	100
Freeborn	0	0	0
Goodhue	2	47	0
Grant	5	33	146
Hennepin	0	0	0
Houston	2	12	40
Hubbard	103	949	431
Isanti	3	20	52
Itasca	107	763	817
Jackson	0	0	0
Kanabec	0	0	0
Kandiyohi	17	177	131
Kittson	1	4	25

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Resources Technical Paper

County	Number of resorts	Number of lodging units	Number of campsites
Koochiching	10	119	190
Lac Qui Parle	0	0	0
Lake	49	513	181
Lake of the Woods	31	315	286
Le Sueur	8	78	396
Lincoln	1	24	10
Lyon	0	0	0
McLeod	0	0	0
Mahnomen	8	46	119
Marshall	0	0	0
Martin	2	11	22
Meeker	3	18	18
Mille Lacs	22	195	236
Morrison	8	44	130
Mower	1	2	200
Murray	1	12	12
Nicollet	0	0	0
Nobles	0	0	0
Norman	0	0	0
Olmsted	1	100	40
Otter Tail	122	1,097	818
Pennington	0	0	0
Pine	4	26	22
Pipestone	0	0	0
Polk	0	0	0
Popo	13	141	262
Ramsey	0	0	0
Red Lake	0	0	0
Redwood	0	0	0
Renville	0	0	0
Rice	5	41	166
Rock	0	0	0
Roseau	2	47	42
St. Louis	129	1,257	651
Scott	1	55	130
Sherburne	0	0	0
Sibley	0	0	0
Stearns	16	136	250

County	Number of resorts	Number of lodging units	Number of campsites
Steele	0	0	0
Stevens	0	0	0
Swift	0	0	0
Todd	23	199	230
Traverse	0	5	10
Wabasha	1	8	25
Wadena	2	17	5
Waseca	1	1	40
Washington	2	17	78
Watonwan	0	0	0
Wilkin	0	0	0
Winona	1	3	109
Wright	10	58	331
Yellow Medicine	0	0	0
STATEWIDE	1,315	14,395	11,936

Source: Minnesota Office of Tourism, resort database, 1991.

APPENDIX 3

Assessing Visual Sensitivity

Landscapes vary in the extent to which any form of environmental disturbance will affect their appearance. Some landscapes can accommodate a variety of forest management activities without noticeable changes in visual character. Other landscapes are more vulnerable, and any form of landcover modification produces a very noticeable alteration of visual character. Still other forest landscapes are located at or in close proximity to sensitive recreation areas such as national, state and county parks, wild and scenic rivers, state trail systems, major resort areas, and heavily visited lake areas. Forest ownerships that practice visual management planning seek to identify sensitive areas as the first step in a process to mitigate the adverse visual impact of timber harvesting and forest management activities. Understanding visual sensitivity provides a context that helps identify areas that should be excluded from harvesting as well as those where other mitigation measures need to be exercised in forest planning and management.

Visual sensitivity is determined by the proximity of an ownership to major recreational facilities and resources (USDA Forest Service 1974) as well as by a number of landform and land cover characteristics (USDA Forest Service 1972; Litton 1984; Wisconsin Department of Natural Resources n.d.; MNDNR 1991), including:

1. Ridgelines are especially sensitive. These breaks between a near ridge silhouetted against a distant ridge or where land meets sky establish strong color value and texture contrasts. Ridgelines and the horizon are important cues that receive strong visual attention a people view landscape (Gratzer and McDowell 1968). They are also important dimensions used in perceiving attractiveness of the landscape (Shafer and Brush 1975) (see figure A.3.1).
2. Changes occurring on a land surface that is perpendicular to a visual sightline tend to be more noticeable than when the angle between viewed land plane and the sightline is acute (see figure A.3.2).
3. Sites that are visible from many locations (i.e. have high intervisibility) are more sensitive than sites seen from fewer locations.
4. Areas within the first one-quarter mile of an observation point, and especially within the first 300 feet, are more sensitive than areas in the middleground or background of a view.
5. Visual screening, provided by either intervening landform or vegetation, reduces sensitivity.

Figure A.3.1. Ridgelines and the horizon represent visually sensitive components of the landscape. Sensitivity is also higher in foreground conditions (Source: USDA Forest Service 1975).

Figure A.3.2. Sensitivity increases as the angle between the line of sight and the viewed land plane becomes more nearly perpendicular (Source: USDA Forest Service 1975).

6. Landscapes containing homogenous stand types and a monotone stand density are more sensitive than those characterized by greater stand diversity and varied density (see figure A.3.3).

Figure A.3.3. Landscape changes occurring in homogeneous landcover are more evident than are changes occurring in diverse landcover (Source: USDA Forest Service 1975).

7. Along travel corridors, landscapes located on the outside arc of curves are viewed by travelers for a longer duration and are consequently more sensitive than landscapes located along the sides of road tangents (see figure A.3.4).
8. Landscapes located along pronounced edges between various landcover types (e.g. water and land edge, forest and field edge, forest and wetland edge) are more sensitive than landscapes having a location that is internal to a landcover type. The height, color and texture contrast evident at these edges are important cues in perceiving the structure of the landscape (Gratzer and McDowell 1968). These edges are also important determinants

of perceived attractiveness (Shafer and Brush 1975).

Figure A.3.4. Sensitivity is high for landscapes on the outside arc of travel corridors (Source: Wisconsin DNR n.d.).

9. Areas contained in or within one-fourth mile of national, state and county parks and areas within 200 feet of a resort; wild and scenic river; recreational lake or river; and a state canoe, boating or recreational trail have high sensitivity.

APPENDIX 4

Techniques for Mitigating Adverse Aesthetic Impacts of Timber Harvesting and Forest Management

A number of techniques can be used to mitigate the adverse aesthetic impacts of timber harvesting and forest management. This appendix describes eleven techniques of aesthetic impact mitigation.

Harvesting Prohibition

Effects of Mitigating Adverse Visual Impacts. Prohibition of all forms of harvesting in a given locale represents one measure that will mitigate many of the adverse visual impacts of forest harvesting. The extent to which prohibition will mitigate the effects of species diversity and the effects of vegetative distinctiveness depends largely on existing characteristics of the stand. Prohibition of harvesting in pure species stands (e.g. red pine, aspen) will affect species diversity only to the extent that understory and groundcover vegetation normally associated with the monoculture is retained. Depending on soil and environmental conditions in a stand, prohibition may enhance species diversity overtime if the stand would normally experience a succession from the monoculture toward richer species diversity. The vegetative distinctiveness of pure aspen monocultures is likely to be adversely affected by harvesting prohibition. For aspen, vegetative distinctiveness obtains its maximum effect when the stand reaches pole timber size. Maturation of pole timber aspen will eliminate the smooth textured, olive bark that enhances distinctiveness. In most other stand types, however, harvesting prohibition will facilitate maturation of the vegetation. This will enable stands of pine and other conifers as well as hardwood stands containing maple and birch to reach a growth stage where their visual distinctiveness reaches its maximum effect.

Harvesting prohibition can also mitigate adverse impacts associated with elimination of large old trees. It maintains and promotes development of complementary human scale relationships in the forest. Prohibition eliminates the unsightly ground plane conditions often associated with harvest activity. The effect of prohibition on promoting spatial definition and visual penetration depends on the structure and density of the stand. Stands having dense understory and shrub layers are likely to experience a reduction of spatial definition and visual penetration as the stand matures. At the same time, however, harvesting prohibition retains a continuous forest canopy that is important to maintaining spatial definition.

Typical Use in Forest Management Harvesting prohibition is generally reserved for use in mitigating adverse visual impacts only in stands having exceptionally high visual sensitivity. By virtue of the high volume of recreation use or the special nature of recreation use these stands receive, management

policies are established to prohibit harvesting activity. Prohibition is deemed necessary in these situations to preserve attributes of the forest setting that are critical determinants of the recreational experience.

Several examples of harvesting prohibition to mitigate adverse visual impacts of harvesting exist in Minnesota. Harvesting is prohibited, for example, in the BWCAW. Commercial harvesting is prohibited within state parks and within 200 feet of a state designated wild river. Harvesting is also prohibited within both the Upper and the Lower St. Croix National Scenic Riverways.

Use of Selective Harvesting Systems

In areas where timber harvesting occurs, there are several silvicultural systems that mitigate adverse visual impacts by retaining a proportion of the existing canopy. These include uneven-aged silvicultural systems such as tree or group selection systems as well as modified even-aged or two-aged silvicultural systems such as shelterwood and reserved shelterwood. Thinning can also be used as an interim harvesting technique.

Uneven Aged Management Strategies. Single tree or group selection harvesting systems allow a stand to be managed in a manner that favors trees meeting a prescribed set of criteria. Thus, single tree and group selection harvesting can be effectively used to promote species diversity and vegetative distinctiveness as well to retain a proportion of large old trees. Uneven-aged management also allows retention of complementary human scale relationships. Since harvesting under uneven-aged management occurs in a more diffused pattern throughout the landscape, single tree and group selection harvests generally do not produce extensive areas of disrupted ground plane conditions. Rather, forest floor disturbance is diffused throughout the stand. When dealing with tolerant forest types, single tree and group selection cutting offer the option to maintain a continuous forest canopy that promotes retention of spatial definition in the stand. Uneven-aged management can also be used as a technique to enhance spatial definition and visual penetration by removing selected understory vegetation.

Even-Aged Management Strategies. Silvicultural systems that retain a proportion of the original stand for part of the new rotation include seed tree retention and shelterwood cutting. Seed tree retention leaves 10 to 20 dominant, good quality trees per acre. The retained trees are usually evenly distributed across the harvest area. They represent trees whose form and branching habit evolved when the tree was a part of the forest canopy. When these trees are exposed by harvesting trees around them, they often present an unattractive appearance. Therefore, seed tree cuttings are generally not used to mitigate adverse visual impacts.

Shelterwood cuts are able to mitigate many adverse visual impacts. When the interval between harvesting entries is extended, a new canopy can develop under the taller retained trees; shelterwood cutting can also be used to retain a nearly continuous canopy. Extending the interval between harvest entries in a shelterwood cutting assures regeneration of a new stand while partially maintaining continuity in canopy closure, human scale relationships, spatial definition, species diversity and vegetative distinctiveness from one harvest cycle to the next. Two-age or reserve shelterwood strategies allow retention of large old trees until such point as a new set of large trees can effectively replace those removed in the second entry.

Thinnings are intermediate cuts in even-aged stands that remove a proportion of the trees. Thinning retains a nearly continuous canopy and, therefore, maintains the overhead enclosure that provides a sense of spatial definition. Both thinning and shelterwood systems enable the enhancement of visual penetration into and through the forest stand.

Manipulating the Size of the Harvested Area

The decision to clearcut a stand has obvious implications pertaining to the retention of large old trees, vegetative distinctness, complementary human scale relationships and spatial definition. Values associated with these qualities of forest attractiveness are foregone until such time as the stand is regenerated. However, the loss of some of these values can be mitigated by manipulating the size or the area to be clearcut.

Apparent Size Versus Absolute Size. A distinction exists between the absolute size of the area to be clearcut and the apparent size of the harvest area (USDA Forest Service 1980). A clearcut of 40 acres may be experienced in total or in increments whose apparent size is 10 acres or less. In other words, intervening landform or retained vegetation may divide the 40 acre clearcut into a series of smaller rooms created through the clearcutting process. From no single point in the harvest are all 40 acres evident. By reducing the apparent size of the clearcut from 40 acres to 10 acres, some mitigation of the adverse effects of a 40-acre clearcut on human scale relationships and spatial definition is realized. Similarly, by carefully manipulating the size of a clearcut, a closer proximity can be established between people experiencing the clearcut and highly distinctive forest vegetation containing large old trees.

Manipulating Apparent Size. Several aspects of land management enter into the manipulation of apparent size (USDA Forest Service 1980; Wisconsin Department of Natural Resources n.d.; MNDNR 1991; Ontario Ministry of Natural Resource 1989):

1. Leave strips or elongated patches of timber may be retained to serve as a foil between one apparent space and another. Leave strips may separate roads from harvest areas as well as separating one clearcut from another. Some forest managers argue for the retention of leave strips along all major travel corridors. Extensive leave strips along roads are generally unneeded assuming adoption of suitable visual management guidelines in the design and execution of the harvest. Extensive leave strips along roads inevitably fail to accomplish their purpose since the practices can never be hidden from all visitors. Leave strips have been proposed and implemented by recreation management agencies and advocacy groups to buffer sensitive recreation and scenic areas from the impacts of adjacent management activities including timber harvesting (Davis 1986; Kenny 1991; MNDNR 1974, 1991; NPCA 1979; Sawhill 1991; Sax 1976).
2. Groups of existing trees can be retained as inclusions within the clearcut area. Inclusions limit sight distances, especially when they are located with consideration for how people will experience the harvest area. In this way, the inclusions promote retention of complementary scale relationships, and they establish a new system of spatial definition.
3. Retention of fingers of existing vegetation serve the same purpose as leave strips and inclusions. However, by retaining an explicit connection to existing forest vegetation, these peninsulas provide a stronger linkage between the visual qualities of the clearcut and the visual qualities of the forest in which it occurs (figure A.4.1).
4. Apparent size can also be manipulated by carefully delineating the size and spacing of openings in a clearcut from adjacent roads and recreational areas. Passersby who view a clearcut through a long opening or through smaller openings spaced closely together derive an impression that the clearcut is large. This perception of apparent size can be altered by regulating the length and frequency of these windows into the harvest area.

Guidelines on Defining Appropriate Apparent Size. Relatively little has been written about how people respond to the apparent size of clearcuts. Studies of clearcut size in red pine stands on the Huron-Manistee National Forest report highest preference among forest visitors for harvest areas in which between 4 and 10 acres of harvest operation are evident. Openings of less than 4 acres or more than 10 acres are perceived as less attractive than openings between 4 and 10 acres (Schroeder, Gobster and Frid n.d.).

Figure A.4.1. Retention of islands of trees, leave strips and fingers of vegetation reduces the apparent size of a clearcut (Source: Wisconsin DNR n.d.).

In creating outdoor space, landscape architects use a rule-of-thumb that strongest spatial enclosure occurs when spaces are half as high as they are wide. A sense of enclosure is retained up to the point where spatial height is one-fourth that of spatial width (Lynch 1980). Assuming a tree height of 70 feet, this design guideline would suggest that forest openings created through harvesting should have an apparent width of not more than 280 feet.

The USDA Forest Service (1980) recommends that the absolute size of northern hardwood forest openings created by harvesting vary with management objective. Table A.4.1 specifies that size of harvest openings can vary from 2 to 40 acres. The size of roadside openings into a harvest opening should vary by management objective from 200 feet to an unspecified length. In highly sensitive areas, a minimum of 1000 feet is needed between roadside openings.

Table A4.1 Parameters of forest harvesting opening size appropriate for visual management objectives.

Management Objective	Absolute Clearcut Size (acreage)	Roadside Openings	
		Length	Width
Permit only ecological changes	0	0	0
Management practices are not visually evident	2 acres limited to roadsides	200 feet	1000 feet
Management activities remain visually subordinate to naturally occurring landscape character	5 acres with inclusions, leave strips, etc.	200 feet	1000 feet
Management activities in the foreground and middleground of view are dominant but have appearance of blending in with naturally occurring landscape character	25 acres with inclusions, leave strips, etc.	400 feet	1000 feet
Management activities are dominant but when seen as background of a view they have an appearance of blending in with naturally occurring landscape character	40 acres	unspecified	unspecified

Source: USDA Forest Service 1974, 1980.

Manipulating the Shape of the Harvested Area

Retention of leave strips, inclusions and peninsulas of existing vegetation to mitigate adverse visual impacts of clearcutting are considerations that influence the shape of a clearcut. The shape given to a clearcut opening is a major determinant of the character the harvesting practice imposes on the landscape (USDA Forest Service 1980; Wisconsin Department of Natural Resources n.d.; MNDNR 1991; Ontario Ministry of Natural Resources 1987).

Clearcuts given rectilinear shape by the harvesting process inscribe a strong presence of humans on the landscape. The Cartesian geometry of block and rectangular openings establishes a human-oriented sense of order in the landscape. For tourists and recreationists seeking the experience of a natural landscape, the occurrence of rectilinear forest openings (e.g., square or rectangular blocks) may be inappropriate to their experience expectations. Thus, the use of rectangular shapes in clearcutting practices, regardless of the size of these openings, can lower the perceived attractiveness of the forest environment. Except in instances where there already exists a strong

presence of rectilinear geometry (as in agricultural areas where visual character is dominated by the grid structure of field boundaries), clearcutting practices that assume a curvilinear shape will be more favorably received than practices possessing rectilinear shape (figure A.4.2).

Figure A.4.2. Curvilinear clearcut shapes and edge alignments are generally more consistent with the character of forest landscapes (Source: USDA Forest Service 1980).

In many instances, shapes already present in a landscape can be borrowed to serve as a basis for establishing shapes of areas to be clearcut. For example, undulations of landform might be used as a basis for establishing clearcut shape (figure A.4.3). As a general rule, the long axis of a clearcut area should parallel the topographic contours of land (figure A.4.4). Existing drainage networks in the landscape can be used as a guide for locating leave strips, inclusions and vegetative fingers within the clearcut area (figure A.4.5). The shape of openings created by wetland areas can be used as a model for determining the shape of clearcuts occurring in nearby landscapes.

Figure A.4.3. Landform can serve as a guide for planning clearcut shape (Source: Ontario Ministry of Natural Resources 1987).

Figure A.4.4. The long axis of this clearcut is parallel to topographic contours (Source: Ontario Ministry of Natural Resources 1987).

Figure A.4.5. Existing drainage network can be used as a guide for planning clearcut shape (Source: Wisconsin DNR n.d.).

Manipulating the Edge of Clearcut Areas

An underlying principle in mitigating the adverse visual impacts of clearcutting practices is to create openings that maximize the ratio of length of clearcut edge to size of clearcut area. The more irregular and curvilinear lines found in topography and drainage networks approximate the line character that promotes greater edge development. Combined with the retention of leave strips,

inclusions and vegetation peninsulas and combined with the use of curvilinear clearcut shapes, the promotion of large edge to area ratios can effectively mitigate visual impacts associated with scale relationship, spatial definition and visual penetration. These mitigation measures will maintain a closer proximity of harvested area to unharvested area. Regardless of how a visitor experiences a clearcut, they will also assure greater proximity between visitors and the visual amenities associated with large old trees, species diversity and vegetative distinctiveness (figure A.4.6).

Figure A.4.6. Clearcuts with high edge to area relationships that retain island inclusions, leave strips and peninsulas of vegetation have stronger human scale relationships and enhances spatial definition and visual definition (Source: Wisconsin DNR n.d.).

Clearcut edges present patterns of strong contrast between the height of retained forest vegetation and the height of vegetation in the clearcut. This height contrast is often accompanied by equally strong contrasts of the darker colors

and courser textures of the retained vegetation and the lighter colored and finer texture of the harvested areas (USDA Forest Service 1980). These strong contrasts focus an inordinate amount of attention on the edge of the clearcut. By establishing a gradient of vegetative density across the edge of clearcut (figure A.4.7), the contrast between vegetation of varying height, color and texture can be softened. In addition, a gradient of stand age can be manipulated across the edge of the clearcut to reduce height contrast between harvested and unharvested areas (figure A.4.8). Finally, location of clearcut edges should avoid topographic positions that will accentuate height, color and texture contrasts (figure A.4.9).

Figure A.4.7. A gradient in stand density across the edge of a clearcut softens the contrast between existing vegetation and the cut area (Source: Ontario Ministry of Natural Resources 1987).

Figure A.4.8. Softening the edge can be accomplished with careful scheduling of harvest dates (Source: Ontario Ministry of Natural Resources 1987).

Figure A.4.9. Careful location of clearcut edges with respect to topography reduces height contrast (Source: USDA Forest Service 1980).

Manipulating the Pattern of Clearcutting Practices

The visual image that recreationists form of the forest environment is a product of impressions obtained across time and space (Litton et al. 1974). Thus, mitigating the adverse visual impacts of forest harvesting and management also requires consideration of how harvesting affects the spatial patterns of visual character in the landscape. In this sense, mitigation measures used at a given clearcut must be integrated into the larger landscape pattern. Integration of a specific clearcut into the overall pattern involves several considerations (USDA Forest Service 1980; Wisconsin Department of Natural Resources n.d.; MNDNR 1991; Ontario Ministry of Forestry 1987):

1. To the extent possible, the long axis of clearcuts should be oriented perpendicular to or on a diagonal to the sight line (figure A.4.10). This pattern generates an undulating flow from one clearcut to another, and it avoids calling extensive attention to any single clearcut area.
2. To the extent possible, exactly the same pattern of forest openings size and shape should not be repeated endlessly throughout the landscape (figure

A.4.11). Repetition of the same pattern generates monotony. The landscape character can be vivified by creating undulations in the pattern of openings that typifies the pattern variation found, for example, in forest openings associated with lakes or wetland areas.

Figure A.4.10. Orienting the large axis of a clearcut perpendicular to or on a diagonal to the sight line reduces apparent size of a clearcut (Source: Ontario Ministry of Natural Resources 1987).

Figure A.4.11. Repetition of a clearcut pattern ad infinitum increases visual monotony (Source: USDA Forest Service 1975).

3. Where possible, the edge of one apparent clearcut opening should overlap with the edge of an adjacent clearcut opening. This overlap might occur across a road (figure A.4.12) or at varying distances within the sightline of a clearcut (figure A.4.13).

Figure A.4.12. Allowing clearcut edges to overlap across a road reduces apparent size of the opening and promotes stronger human scale relationships (Source: Ontario Ministry of Natural

Resources 1987).

Figure A.4.13. Overlapping edges at varying distances from a road reduces apparent size and improves human scale (Source: Ontario Ministry of Natural Resources 1987).

4. Within the size and shape parameters discussed earlier, openings of one clearcut should connect with the openings of an adjacent clearcut (figure A.4.14).

Figure A.4.14. Connecting the openings created by adjacent clearcuts increases spatial definition and visual penetration (Source: Ontario Ministry of Natural Resources 1987).

5. The time interval between harvesting of adjacent stands should be scheduled in a manner that establishes a landscape character that can be sustained over time (figure A.4.15). The objective of this time schedule would be to establish a spatial pattern such that regenerated vegetation

exists in a spatial pattern and matures at a point in time where it replaces the visual role of vegetation to be harvested in subsequent time intervals. In this manner, the specific location of elements creating the forest's visual character may change over time, but the overall pattern remains the same.

Figure A.4.15. Careful scheduling of harvest frequency can create a visual pattern that sustains itself (Source: Wisconsin DNR n.d.).

Managing Harvesting Residue

One of the more noticeable visual impact of forest harvesting pertains to the slash residue that litters the floor of many clearcut areas (Arthur 1977; Benson 1982; Daniel and Boster 1976; Daniel and Schroeder 1979; Schroeder and Daniel 1981; Brown and Daniel 1984, 1986; Vodak et al. 1985; Ribe 1989). For example, in a study of northern hardwood forests in Wisconsin, each

thousand cubic feet per acre of down wood (i.e. slash from harvesting and naturally occurring woody debris) reduces scenic beauty measurements by approximately 10 percent (Ribe 1989). Slash whose diameter exceeds three inches is particularly detrimental to the perception of scenic beauty in hardwood stands (Ribe 1990). Visitors to the Huron-Manistee National Forest in Michigan systematically rated clearcut harvest areas containing slash in the immediate foreground as less attractive than clearcuts not containing slash. The inverse relation between attractiveness and presence of slash is consistent across clearcuts ranging in size from one acre to 15 acres (Schroeder et al. n.d.).

It is evident that proper management of slash and harvest residues has considerable potential for mitigating the effects of harvesting on ground plane conditions, but it can be expensive. In the Chippewa National Forest in Minnesota, two measures are currently being used to mitigate the visual impacts of slash and harvesting residue (Parker 1992). In the immediate foreground of aspen and birch stands that have high visual sensitivity, slash is cut back to within one foot of the ground surface. In the immediate foreground of visually sensitive conifer stands, slash is completely removed from the site. These measures for mitigating the visual effects of residue in the immediate foreground (within 300 feet of observer) require expenditure of approximately \$75 per acre. In the remaining portions of visually sensitive aspen stands, slash is cut back to within three feet of the ground surface at an average per acre cost of \$40. In visually sensitive conifer stands beyond 300 feet of an observation point, slash is cut back to within one foot of the ground at an average cost of \$55 per acre.

Management of Regeneration Patterns

A considerable amount of future mitigation of the adverse impacts of forest harvesting can be realized through the proper layout of regeneration plantings (Wisconsin Department of Natural Resources n.d.; Ontario Ministry of Forestry 1987). Alignments of planting rows in a pattern that parallels topographic contours will produce more naturally appearing future stands of vegetation. Similarly, design of regeneration patch size, shape, and pattern according to parameters discussed earlier in this section will create stands which, when harvested, will have minimal impacts on visual quality.

Management of Road and Landing Design

Design of logging roads and harvest landings can substantially mitigate adverse visual impacts of forest harvesting (USDA Forest Service 1980; Wisconsin Department of Natural Resource n.d.; MNDNR 1991; and Ontario Ministry of Natural Resource 1987). Mitigation guidelines include:

1. Selecting a logging system that minimizes road density in the forest.

2. Selecting road alignments that minimize the distance that can be seen down the logging road from major travel corridors and recreational areas.
3. Designing road alignments that retain an inclusion of existing vegetation at the terminals of the road or other wise minimize visibility of landings from the logging road (figure A.4.16).

Figure C.16. Careful alignment of roads or retention of inclusions can screen landings (Source: USDA Forest Service 1980).

4. Locating roads and landings in areas where vegetation or topography provides a maximum amount of screening to reduce visibility from sensitive recreation areas (figure A.4.17).
5. Locating landings a minimum of 400 feet from major travel corridors or recreation areas.
6. Removal of stumps and boulders unearthed in the landing construction process.
7. Replanting of roads and landing immediately after their use has ended.

Figure A.4.17. Landings and roads can be screened by existing vegetation and topography (Source: USDA Forest Service 1980).

Management of Season of Harvest

Other things being equal, harvest operations conducted on most soil types during the spring, and to a lesser extent the fall will produce greater visual impact than operations conducted during the summer. This is attributable largely to the additional disruption of ground plane conditions associated with harvesting when soil strength is reduced due to higher moisture content. Harvesting under these conditions can create ruts caused by machinery operation. Operations conducted during winter when the ground is frozen results in the least disturbance. Thus, additional mitigation of visual impacts can be realized in visually sensitive areas by restricting all harvesting

operations to the winter months.

Management of Information and Interpretation

Forest harvesting operations create forest environments that are radically transformed from the picturesque ideal of the forest that people carry in their heads. The general public sometime associates these transformations with an attitude that the forest is being pillaged and plundered—that nobody really cares about what happens to Minnesota's forest resources.

In many situations, attitudes and beliefs about visual quality are closely aligned with attitudes about land stewardship (Nassauer 1989). If the public perceives forest harvesting as necessarily despoiling the forest's bounteous treasures, then all forms of harvesting will be deemed ugly. On the other hand, through careful interpretation of the ultimate benefits associated with scientific forest management, negative attitudes toward harvesting can be assessed and reversed. Careful management of information flow may be an effective means of improving public attitudes about harvesting. Measures that would address constructive flow of information to the public might include:

1. Onsite signage explaining how a tract of land is being managed and how its ultimate appearance will be affected by various management practices. In practice such signage might be developed for each harvest site.
2. Interpretive programming at visitor centers and public relations programs in popular resort communities to explain how the forests' appearance and how stewardship of the forest's resources are being considered in management planning and practice.
3. An attitude shift among forest managers that it is time to bring forest harvesting out of the closet. Instead of seeking practices that hide the effects of forest management from the public's view, maybe it is time to explore and implement management practices that will celebrate rather denigrate forestry with the public (Woods 1989).

APPENDIX 5

Selected Literature Documenting the Positive and Negative Impacts of Timber Harvesting on Recreation Activities Within an Outdoor Recreation Opportunity Class (ROS)

Author	Year	Title
GENERAL - NOT ACTIVITY SPECIFIC		
Anderson et al.	1983	Effects of sounds on preferences for outdoor settings
Anderson et al.	1984	Effects of vegetation on human response to sound
Arthur	1977	Predicting scenic beauty of forest environments: some empirical tests
Benson and Ullrich	1981	Visual impacts of forest management activities: findings on public preferences
Borset	1967	Interactions between silviculture and recreation
Clark	1986	Onsite interactions of recreation and other resource uses
Clark and Downing	1985	Why here and not there: the conditional nature of recreation choice
Clark and Stankey	1979	The recreation opportunity spectrum: a framework for planning, management, and research
Downing and Moutsinas	1978	Managers' views of dispersed recreation along forest roads
Gundermann	1981	The impact of forest-road construction in high mountains on forest recreation and landscape scenery
Harrison et al.	1980	Predicting impact of noise on recreationists
Langenau et al.	1977	The stability of attitudes toward clearcutting among landowners in Roscommon County, Michigan
Lime et al.	1990	Wildland recreation research in the western Lake Superior basin: an annotated bibliography
McCool et al.	1986	How the public perceives the visual effects of timber harvesting: an evaluation of interest group preferences
Manning	1986	Studies in outdoor recreation: a review and synthesis of the social science literature in outdoor recreation
MN Dept of Natural Resources & Dept of Trade and Economic Development	1990	Minnesota's outdoor legacy--strategies for the 90's: statewide comprehensive outdoor recreation for 1990-1994
Palmer	1990	Aesthetics of the northeastern forest: the influence of season and time since harvest
Rose et al.	1991	Impacts of present and potential forest road systems on timber, tourism, wildlife and aesthetic resources
USDA, Forest Service	n.d.	ROS users guide
Vesikallio	1980	Determining timber harvesting costs consistent with forest utilization limitations in forests used for recreation
CAMPING		
Anderson and Brown	1984	The displacement process in recreation
Burde and Lenzi	1980	Timber harvest and aesthetic quality: can they coexist?
Brunson and Shelby	1990	A hierarchy of campsite attributes in dispersed recreation settings
Clark et al.	1971	Values, behavior, and conflicts in modern camping culture
Clark et al.	1984	The value of roaded, multiple-use areas as recreation sites in three national forests of the Pacific Northwest

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Author	Year	Title
Downing and Clark	1979	Users' and managers' perceptions of dispersed recreation impacts: a focus on roaded forest lands
Echelberger and Moeller	1977	Use and users of the Cranberry Backcountry in West Virginia: insights for eastern backcountry management
Kariel	1980	Mountaineers and the general public: a comparison of their evaluation of sounds in a recreational environment
Lime	1971	Factors influencing campground use in the Superior National Forest of Minnesota
Lime and Cushwa	1969	Wildlife aesthetics and auto campers in the Superior National Forest
Lucas	1963	Visitor reaction to timber harvesting in the Boundary Waters Canoe Area
Lucas	1963	User concepts of wilderness and their implications for resource management
Nelso et al.	1989	Beliefs, attitude and political behavior of forest recreationists toward timber management in Michigan
Peterson	1974	A comparison of the sentiments and perceptions of wilderness managers and canoeists in the Boundary Waters Canoe Area
FISHING		
Bryan	1977	Leisure value systems and recreational specialization: the case of trout fishermen
Graefe	1981	Understanding diverse fishing groups: the case of drum fishermen
Cramann and Burdge	1981	The effects of recreation goals on conflict perception: the case of water skiers and fishermen
Manfredo and Anderson	1982	Recreation preferences of Oregon trout fishermen
West	1982	Effects of user behavior on the perception of crowding in backcountry forest recreation
MOTOR BOATING		
Adelman et al.	1982	Social psychological explanations for the persistence of a conflict between paddling canoeists and motorcraft users in the Boundary Waters Canoe Area
Donnelly et al.	1986	Degree and range of specialization: toward a typology of boating specialization
Graefe	1986	Recreational boating
CANOEING		
Adelman et al.	1982	Social psychological explanations for the persistence of a conflict between paddling canoeists and motorcraft users in the Boundary Waters Canoe Area
Anderson and Brown	1984	The displacement process in recreation
Kauffman and Graefe	1984	Canoeing specialization, expected rewards and resource related attitudes
Lucas	1963	Visitor reaction to timber harvesting in the Boundary Waters Canoe Area
Lucas	1963	User concepts of wilderness and their implications for resource management
Peterson	1974	A comparison of the sentiments and perceptions of wilderness managers and canoeists in the Boundary Waters Canoe Area
Wellman et al.	1982	Recreation specialization and norms of depreciative behavior among canoeists
PICNICKING		
Burde and Lenzini	1980	Timber harvest and aesthetic quality: can they coexist?

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Author	Year	Title
CROSS-COUNTRY SKIING		
Ballman	1980	Operationalizing the cross-country skiing opportunity spectrum
Ballman et al.	1981	Managing the environment for diverse recreation: cross-country skiing in Minnesota
Knopp and Tyger	1973	A study of conflict in recreational land use: snowmobiling versus ski-touring
McCool and Curtis	1980	Sources of conflict among winter recreationists
McLaughlin and Herrington	1971	The skier: his characteristics and preferences
SNOWMOBILING		
Knopp and Tyger	1973	A study of conflict in recreational land use: snowmobiling versus ski-touring
Knopp and Wieland	1983	Demand and response: the case of snowmobiling in Minnesota
WALKING/HIKING		
Anderson et al.	1991	Long-distance trails in Minnesota: planning and management concerns
Clark et al.	1984	The value of roaded, multiple-use areas as recreation sites in three national forests of the Pacific Northwest
Davis	1986	The National Trail System Act and the use of protective zoning.
Echelberger and Moeller	1977	Use and users of the Cranberry Backcountry in West Virginia: insights for eastern backcountry management
Hammitt et al.	1986	Experience level and participation motives of winter wilderness users
Lucas	1980	Use patterns and visitor characteristics, attitudes and preferences in nine wilderness and other roadless areas
McCay and Moeller	1976	Compatibility of Ohio trail users
Murran	1974	Appalachian trail users in the southern national forests: their characteristics, attitudes and management preferences
Pitt et al.	1991	Social impact assessment of Beaver Basin Rim Road in Pictured Rocks National Lakeshore
Pitt et al.	1991	Visual impact assessment of Beaver Basin Rim Road in Pictured Rocks National Lakeshore
Schroeder and Daniel	1980	Predicting the scenic quality of forest road corridors
Spring	1985	National forest trails on the wrong path
Taylor and Mackoy	1978	Backcountry information and education recommendations
Viriden	1988	Hiker diversity in backcountry areas: implications for planning and management
Williams and Huffman	1986	Recreation specialization as a factor in backcountry trail choice
NATURE STUDY		
Clark et al.	1984	The value of roaded, multiple-use areas as recreation sites in three national forest of the Pacific Northwest
Downing and Clark	1979	Users' and managers' perceptions of dispersed recreation impacts: a focus on roaded forest lands
Echelberger and Moeller	1977	Use and users of the Cranberry Backcountry in West Virginia: insights for eastern backcountry management

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Author	Year	Title
HUNTING		
Allen	1985	Predicting the impacts of high-voltage transmission lines on big game hunting opportunities in western Montana.
Burde and Lenzini	1980	Timber harvest and aesthetic quality: can they coexist?
Feltus and Langenau Jr.	1984	Optimization of firearm deer hunting and timber values in northern lower Michigan
Hautoluoma and Brown	1979	Attributes of the deer hunting experience: a cluster-analytic study
Jackson and Norton	1980	Phases: the personal evolution of the sport hunter
Kennedy	1974	Attitudes and behavior of deer hunters in a Maryland forest
Randall	1984	A multitrait-multimethod matrix comparative approach to recreational specialization
Wilman	1984	Benefits to deer hunters from forest management practices which provide deer habitat
ATV/ORV RIDING		
Andrews and Nowak	1980	Off-road vehicle use: a management challenge
Badaracco	1976	Conflicts between off-road vehicle enthusiasts and other outdoor recreationists--the ISD syndrome
Burde and Lenzini	1980	Timber harvest and aesthetic quality: can they coexist?
Massachusetts Dept. of Environ. Mgt.	1990	Draft GEIR Forest Management Practices
Nicholes	1980	Off-road vehicle trends
Noe et al.	1982	Normative response and norm activation among ORV users within a seashore environment

APPENDIX 6

List of Study Group Members Participating in Recreation Impact Matrix Workshops

Dorothy Anderson
Wayne Freimund
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APPENDIX 7

Management and Design Objectives for Harvesting in Semiprimitive Nonmotor Areas and Primitive Sensitivity Group II Areas

The following is excerpted from the USDA Forest Service Eastern Region ROS Access Coordinator: Eastern Region Supplement.

"Roads within semiprimitive nonmotor areas are designed for light administrative use. Road design is oriented toward attaining the recreational setting objectives of the forest management area while providing a facility which benefits the management of other resources. Roads are not open to public motor vehicle use.

Light administrative use includes activities such as servicing remote forest service recreation sites or harvesting timber to achieve stated management area recreational and resource objectives. Timber operators in these areas must use equipment compatible with setting oriented road design standards. Road designs maintain setting and experience characteristics of a semiprimitive recreation environment.

To provide a local, short-term road for light administrative or logging uses that will also accommodate hiking and horseback riding, the following design standards must be adhered to:

- mostly primitive surfacing with a minor amount of native material (crushed gravel) where needed.
- surface supports horses, emergency, administrative or light single axle logging vehicles.
- clearing width of 12 to 16 feet.
- occasional cuts and fills below 30 inches.
- gradient occasionally reaches 20 percent.
- curve radius is generally 75-150 feet and variable.
- design speed is 10 miles per hour.
- minor ditching is allowed where no alternative exists. Ditches may be no more than 6 inches deep. Outslopes and dips must provide drainage.
- tangent distances of 500 feet or less are desirable.

To provide a local, intermittent road for administrative or light logging only, the following design standards must be adhered to:

- mostly native surfacing (crushed gravel) and some primitive surfacing is required.
- surface may support horses and motor vehicles up to small dual axle trucks.

- a 16 to 20 foot clearing width and a road surface maximum of 12 feet is allowed.
- cut and fill where necessary but cuts and fills can be no greater than 30 inches.
- a gradient maximum of 15 percent is allowed.
- curve radius is generally 150 to 300 feet.
- design speed is 10 to 15 miles per hour.
- ditching is allowed only where conditions warrant and ditches must be as shallow as possible.
- tangent distances of 500 feet or less are desirable.

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