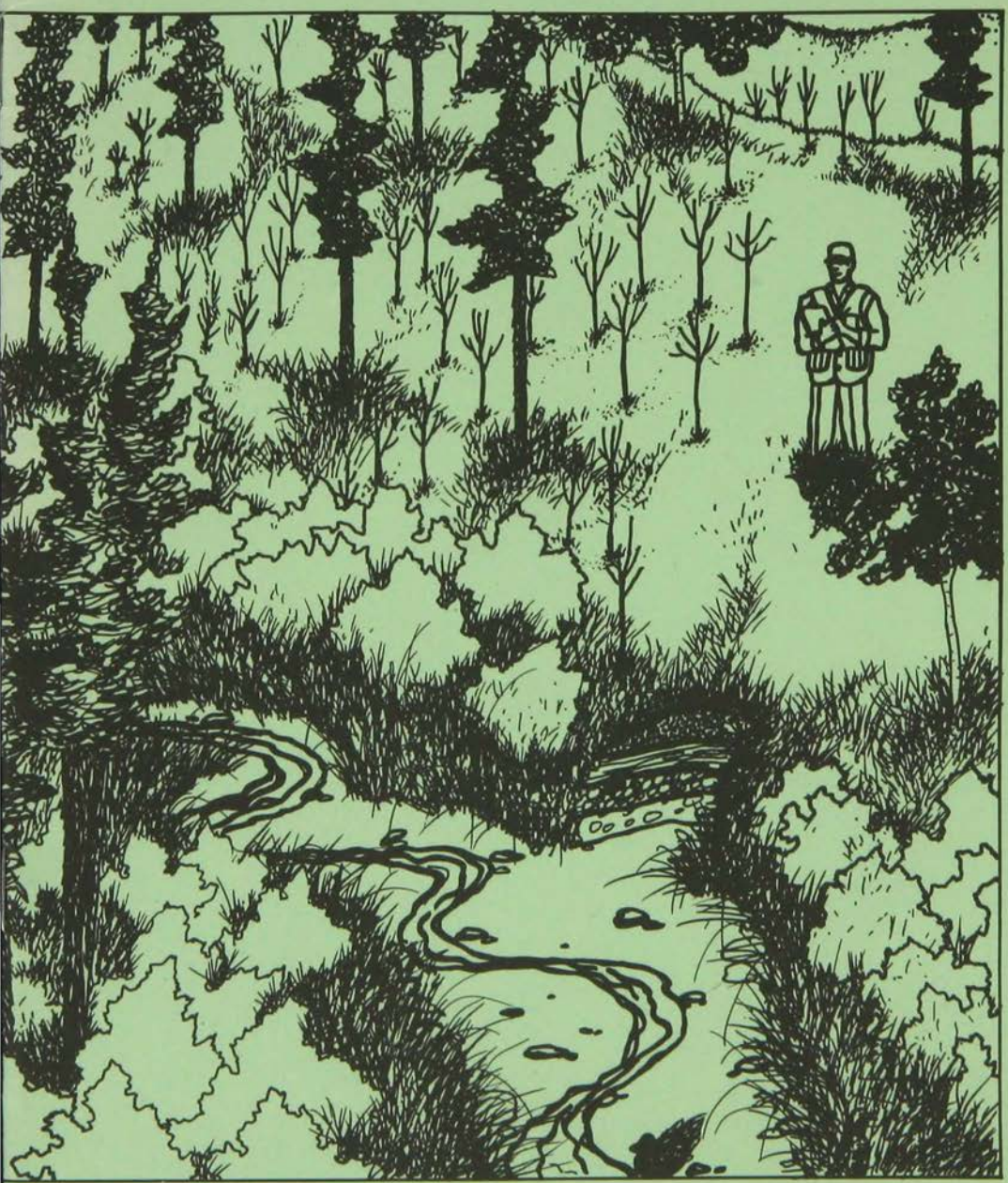
CD-BU-3288
1987

FIELD GUIDE:
Evaluating Land Conditions for Site Preparation

Donald H. Prettyman



Minnesota Extension Service • University of Minnesota

TABLE OF CONTENTS Page

Donald H. Prettyman is forest soil scientist with the Minnesota Agricultural Experiment Station at Cloquet Forestry Center, 175 University Road, Cloquet, MN 55720.

Acknowledgment

A special thanks is extended to the following individuals for their review of the guide and helpful comments:

William Barnacle, Dan Hanson, and George Miller, Minnesota Department of Natural Resources

David Grigal and Richard Rust, Department of Soil Science, University of Minnesota

James Anderson, Minnesota Extension Service, University of Minnesota

Stephen Shetron and Carl Trettin, Michigan Technological University

Richard Schantz-Hansen, Potlatch Corporation

Willard Carmean, School of Forestry, Lakehead University, Thunder Bay, Ontario.

Additional suggestions were received from representatives of the Bureau of Indian Affairs, U.S Forest Service, Soil Conservation Service, Itasca Tax Forfeited Land Department, and College of Forestry-Cloquet Forestry Center.

Project funds were provided by the Legislative Commission on Minnesota Resources, the Minnesota Agricultural Experiment Station, and the Minnesota Extension Service.

INTRODUCTION

This guide is designed for the land manager and resource specialist involved in reforestation projects in the northern half of Minnesota and similar forested areas. It will aid resource personnel in the systematic evaluation of field conditions for site preparation projects. A user of the guide is encouraged to use published information in conjunction with field investigations. Emphasis is placed on integrated resource information and prescriptive management. For the purpose of this guide, site preparation is associated with the conversion from one species to another, such as aspen to red pine or jack pine to white spruce. Some areas will have a complexity of conditions that are beyond the scope of this guide. Such areas will require a site investigation by resource specialists. Also, this is a dynamic guide and will change with new information. Users are encouraged to submit their ideas and suggestions to the author (Cloquet Forestry Center, 175 University Road, Cloquet, Minnesota 55720).

Soil and vegetation information combined with the results of actual site preparation projects form the basis for the guide. The effects of site preparation on competing vegetation, the survival and growth of seedlings, and productivity were correlated to those units of land. Comparisons between those units and the results of varied site preparation methods produced information that was used to develop prescriptions with predictable results.

OBJECTIVE

Developing a systematic approach for evaluating land conditions for site preparation is the main objective of this guide. Such an approach will provide information for comparing areas of land, minimizing adverse impacts, and prioritizing activities. This evaluation includes identifying the need for site preparation, matching methods of site preparation to site conditions, and evaluating the potential impacts on the land.

SITE PREPARATION

An objective of site preparation is to increase the use of soil moisture, soil nutrients, heat, and sunlight by the tree seedlings. Site preparation is done to change the conditions of an area to favor the survival and growth of tree seedlings. It includes the alteration of the effective root zone and a reduction in the amount of vegetation that will compete with the seedlings. This is accomplished by a range of activities including logging, dozing, disking, burning, and chemical applications.

All site preparation prescriptions should include provisions for the conservation of moisture, nutrients, and soil within the root zone. This can be accomplished by incorporating the duff with the topsoil or maintaining the native duff and topsoil in place. Thus, the thickness of the root zone is protected and biological activity is encouraged. **For example**, high nutrient and organic levels will encourage earthworm activity which helps to incorporate organic and mineral material which further improves root zone fertility. Some mechanical site preparation methods remove the duff plus six or more inches of the topsoil which results in a significant loss to the seedling of nitrogen, phosphorus, potassium, and water-holding capacity. A key point is to encourage the use of integrated resource information and prescriptive management.

Well-planned site preparation enhances the survival and growth of seedlings. This results from improvements in the root zone and the control of competing plants. The duration of the effects of site preparation is related to the

timing and matching of the method to site conditions. **For example**, the double disking of mountain maple and hazel on a dry loamy site during **the peak growing season (for the area covered by this guide, use June 15 to August 15 during normal weather conditions)** can retard its growth so that little or no release will be required for the seedlings. In contrast, site preparation that is not matched with site conditions can result in long-term adverse impacts that decrease the survival and growth of seedlings and enhance the growth of competing plants. Those impacts are associated with removal of topsoil, soil compaction, rutting of the soil, soil erosion, increased frost action, and treating the competing plants during the wrong season.

SITE PROPERTIES AND CLASSES

There are numerous soil, topographic, and competition properties to consider in determining need for appropriate site preparation. Data for these properties will be recorded on the FIELD DATA FORM (see page 5) and include existing vegetation (pre- and post-harvest), soil texture, soil compactability, soil moisture, thickness of the root zone, slope gradient, and the amount of boulders and stones on the ground. Each of these properties has a numerical value that reflects its importance to site preparation and resource management. A value was assigned following numerous observations of site preparation projects. These observations were used for determining the importance of each property. As new information becomes available, the values will be tested and changed if necessary.

All vegetation data will be collected from a 1/50 acre plot (radius of 16.7 feet) and an imaginary cylinder extending upward from the plot perimeter through the tallest vegetation. Collect the data during the growing season and when the leaves are fully developed. The vegetation is divided into structure, density, and indicator species.

The structure is the layers of vegetation in a plant community and consists of the overstory(Os), shrubs(Sh), and forbs(Fo). The density refers to the percent of the ground surface that is shaded by each layer and is an ocular estimate. Within the cylinder the density of the shrubs will be determined under the shade of a tree canopy and the density of the forbs will be determined under the canopy of shrubs. For sites lacking trees the shrub density will be determined in full light conditions. Where shrubs are absent the forb density will be determined under the canopy of a tree or in full light.

An indicator species is a plant that individually or in a group of plants indicates certain site conditions associated with synecological requirements (moisture, nutrients, heat, and light). In practice the dominant shrub species should be recorded along with its synecological values (see appendix A for the values). **Dominance is based on the amount of ground surface that is shaded by the canopy of a given species**. This is especially helpful in estimating the moisture and nutrient levels of the site. **For example**, if red osier-dogwood (values of 4, 2, 2, and 3) is the dominant shrub, this often indicates a rich moist site. In contrast, beaked hazel (values 2, 1, 2, and 3) typically indicates a dry site with a low to high level of fertility.

FIELD DATA FORM

Date _____ Name _____ Management Unit _____

Aerial Photo# _____ Access _____ Township _____ Range _____

Section _____ Acres _____ Landform _____ Landscape Position _____

Cover Type _____ Density Class _____Basal Area _____ Site Index _____

ITEM	NUMERICAL VALUE				
	Need		Operability		Impact
Overstory					
Shrubs					
Forbs					
Soil texture					
Compactability					
Soil moisture					
Saturation					
Root zone					
Slope gradient					
Boulders & stones					
TOTAL					
CLASS					

This data form may be added to an existing form. The management unit is the field level unit in an organization and is commonly the district. The aerial photo number is the standard flight, roll, and exposure number that appears on each print. Access is reported as "A" for all season and "S" for seasonal. The landform will be recorded according to "The Geologic Map of Minnesota" by H. C. Hobbs and J. E. Goebel, 1982. The landscape position will be recorded according to figure 1, this page. The cover type, density class, basal area, and site index will be recorded from a report or determined on site. The values for the individual items will be taken from the information beginning on page 7.

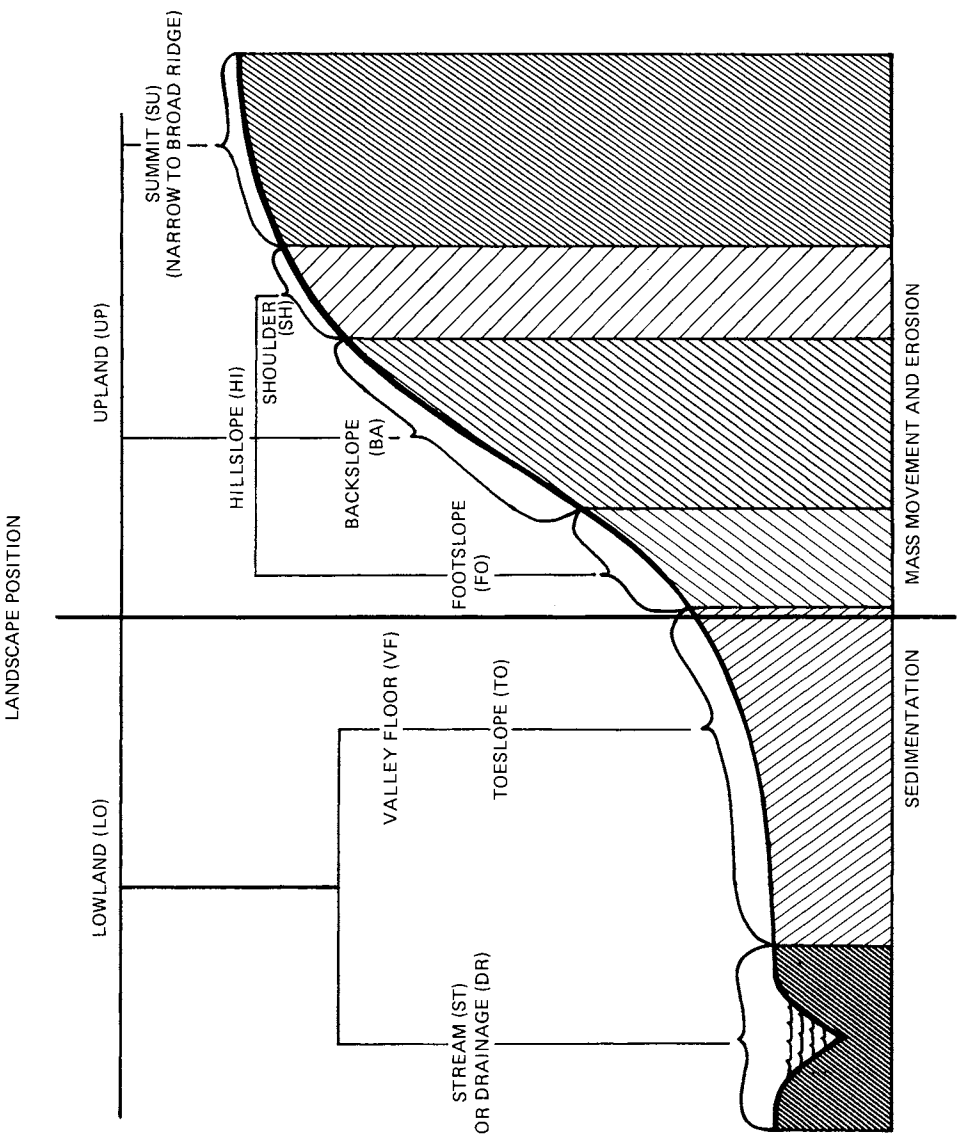


FIGURE 1, LANDSCAPE POSITION

The properties and the numerical values in table 1 are for use by the land manager while evaluating the conditions of a specific area for site preparation. This evaluation is made in the field with the support of published resource information. The field examination should be preceded with a review of general information for the area such as the history of cultural activities, fire, insects, diseases, and related topics.

Table 1. Site properties and numerical values

Property	Values		
	NEED	*OPERABILITY*	*IMPACTS*
Vegetation			
overstory shades 0% of the ground surface	0	0	0
overstory shades <10% of the ground surface	1	0	0
overstory shades 10 to 40% of the ground surface	3	0	0
overstory shades 41 to 70% of the ground surface	10	0	0
overstory shades >70% of the ground surface	15	0	0
NOTE: For post-harvest disregard the overstory. Seedlings of tolerant trees are considered shrubs.			
shrubs shade 0% of the ground surface	0	0	0
shrubs shade <10% of the ground surface	1	0	0
shrubs shade 10 to 40% of the ground surface	5	0	0
shrubs shade 41 to 70% of the ground surface	10	0	0
shrubs shade >70% of the ground surface	20	0	0
forbs shade 0% of the ground surface	0	0	0
forbs shade <10% of the ground surface	1	0	0
forbs shade 10 to 40% of the ground surface	2	0	0
forbs shade 41 to 70% of the ground surface	3	0	0
forbs shade >70% of the ground surface	5	0	0
sod, well established	10	0	0
Soil texture			
sandy (sands and loamy sands)	1	1	1
loamy coarse (sandy loams)	3	3	3
loamy medium (loams and silt loams)	5	8	5
loamy fine (clay loams and silty clay loams)	7	10	10
clayey (silty clay and clay)	10	15	15
organic (peat and muck)	3	25	10
Soil compactability			
sandy	0	1	1
loamy coarse	0	3	3
loamy medium	0	10	10
loamy fine	0	15	15
Soil moisture			
droughty (xeric or excessively well drained)	1	0	15
dry (well and moderately well drained)	5	1	3
moist (fresh or somewhat poorly drained)	3	5	12
wet (hydric or poorly drained)	2	10	8
saturated for 10 to 30 days above 40 inches add	0	5	5
clayey	0	20	20

Table 1 (continued). Site properties and numerical values

Property	Values		
	NEED	*OPERABILITY*	*IMPACTS*
Root zone-thickness			
<8 inches	1	10	15
8 to 20 inches	2	8	10
21 to 40 inches	5	5	3
>40 inches	10	1	1
Slope gradient			
<6%	0	1	1
6 to 18%	0	3	2
19 to 25%	0	5	5
26 to 35%	0	10	10
>35%	0	15	15
Boulders and stones (percent of ground covered)			
<5%	0	1	0
5 to 15%	0	2	0
16 to 30%	0	5	0
31 to 45%	0	10	5
46 to 75%	0	15	15
>75%	0	25	25

The classes in table 2 are based on the sum of the individual property values. For the NEED, two categories are used and one is for pre-harvest(PH) and the other is for post-harvest(PSH). The OPERABILITY and IMPACT categories are intended for evaluating or predicting the appropriateness and results of site preparation activities. See appendix B for definitions of the categories and classes.

Table 2. Need, operability, impact, and class values

Category	Class and value					
NEED						
Pre-harvest	I<15	II 15-27	III 28-40	IV 41-48	V 49-58	VI 59-70
Post-harvest	I<18	II 18-25	III 26-33	IV 34-43	V 44-50	
OPERABILITY	I<10	II 10-15	III 16-20	IV 21-30	V 31-50	VI>50
IMPACT	I<10	II 10-19	III 20-29	IV 30-39	V>40	

A NEED Class I means that considerable site preparation is necessary for most reforestation projects. However, a Class VI implies that site preparation can be accomplished through the harvest activities or with a minimum of additional effort. An OPERABILITY Class I means that the movement of heavy equipment on the ground surface is not limited by physical resource properties. There may be periods of restrictions due to saturation soil or wet weather conditions. But a Class VI implies that track and wheel equipment can be operated only during periods of frozen ground or not at all on very steep slopes. An IMPACT Class I suggests that there is a low potential for adverse alterations of the land due to site preparation activities. A Class V indicates that the potential for adverse impacts on the land is very high and an integrated prescription must be used to direct all site preparation activities.

CORRECTIONS

FIELD GUIDE: Evaluating Land Conditions for Site Preparation
CD-BU-3288/1987

Page eight, Last paragraph sentences one and two should read:

> A NEED Class VI means that considerable site preparation is necessary for most reforestation projects.
>
> However, a Class I implies that site preparation can be accomplished through the harvest activities or with a minimum of additional effort.

Table 3 depicts the relationship between NEED classes and effective site preparation methods. The methods have demonstrated effectiveness in controlling competition with minimal effects of site productivity. An "X" in the block indicates that the method may be considered for site conditions associated with the NEED class. The second letter indicates a companion treatment that may increase control of the competition. A "C" is chemical and an "M" is mechanical. An example is the spot scarification NEED class IV "XC" suggesting that coupling a chemical treatment with the scarification will increase control of the competition and may be more cost effective.

Table 3. Need and site preparation methods

Class	Spot scarification	Roller chopper	Disk	Shear	Burn	Chemical	Harvest	Planter & vee plow
I	X				X		X	X
II	X	X	X	X	X	X	X	X
III	X	X	X	X	X	X	X	X
IV	XC	XC	X	XC	X	X		XC
V	XC	XC	XC	XC		XM		XC
VI	XC	XC	XC	XC		XM		XC

As the control of the woody plants is improved on the medium to highly productive sites, grass tends to become a major competitor of tree seedlings. In some sites broadleaf forbs have become the main competitor. Some sites require a release within three growing seasons. Quality site preparation, quality stock, quality stock handling, and quality planting will enhance seedling survival.

SITE PREPARATION METHODS

Spot scarification is the local scalping of the ground surface to remove competition from the immediate area of the seedling. This scarification is also used for controlling the spacing of the seedlings. New equipment provides for some variation in the spacing, size, and depth of the scalps and these should be tailored to match site conditions. Spot scarification has demonstrated effectiveness on sites with good internal moisture drainage. On sites with slow internal drainage the scalps commonly collect water, causing mortality of seedlings planted in the scalps. On those same sites the bare soil will significantly increase frost heaving which causes mortality or reduced growth. Spot scarification is an effective method for sloping broken land and land with stones and boulders scattered on the surface.

A roller chopper (a drum with fins) may be used in a variety of sites. When used during the peak growing season it will control some woody plants. It does not control forbs or grasses. Five-to ten-year-old aspen seedlings have been effectively controlled with this method when treated during the peak growing season. For adequate traction the sites must be dry and this is especially true for sites with clayey soils. This method can be used on moderately steep land. Stones and boulders on the surface reduce its effectiveness.

Double disking during the peak growing season has effectively controlled woody competition. The second pass is delayed about one hour to maximize the control on the woody competition. Select a size of disk that incorporates the duff with topsoil. Refrain from using a disk that tends to plow rather than incorpo-

rate. On moderately sloping and broken land, disk on the contour. Surface stones, boulders, and high stumps will reduce the effectiveness of the disk.

Shearing is an effective method for moving large woody debris into piles or windrows. This method is not to be confused with rock raking or tractor scarifying. It can be used in moist and wet areas during the winter. Standing residual trees can be effectively removed with this method which has also been used in moderately sloping land.

Burning is an effective method of reducing the concentration of woody material on a site. Prescribed burning during the growing season has effectively controlled selected woody competition on some sites. Fuel loading, timing of the burn, fuel moisture, and site productivity are important factors to consider in prescribed burning. A summer burn in well-distributed conifer slash is a demonstrated effective control for hazel. A prescription for burning must include provisions for maintaining the moisture and nutrient levels and the respective holding capacities in the root zone.

Chemicals coupled with a mechanical method for site preparation have been used for controlling competition. This can be a cost effective treatment. Chemical treatment may be an effective method for broken and steep land and areas with limited access for mechanical methods. Spot application is becoming a common practice for controlling selected plants in areas where broadcast application is not necessary. New application equipment for chemicals has increased their use and effectiveness.

Timber harvest activities are used for site preparation on certain lands of moderate to low productivity. Harvest activities can distribute slash to meet the needs of a prescribed burn or mechanical site preparation. Total tree removal on certain sites may suffice for site preparation. Summer harvest has also been used for a partial control of selected woody plants.

A tractor equipped with a vee plow and pulling a tree planting machine has demonstrated success on a variety of sites. The woody competition is usually chemically treated prior to this operation. The plow is used for removing obstacles in the way of the planting machine and for knocking down the woody plants. This is a single pass operation and several thousand trees can be planted each day. On the low and some moderately productive sites the control of the competition may eliminate the need for release.

APPLICATION OF THE GUIDE

Users of this guide ought to keep in mind the importance of knowing the history of a project area. Such information will help for there will be situations that do not seem to fit the system. When this occurs, apply the guide and record additional supportive information and then contact an individual who is knowledgeable in soils and plants. **For example**, a highly productive trembling aspen stand (>75 Site Index) that has been grazed will frequently lack a dense shrub layer. If the user is unaware that the stand was grazed, then the results of the guide may be confusing. Thus it is important to seek help from a natural resource staff and to review the history of the area prior to conducting the field work. This is especially important in areas having a farm-forest mix of land uses.

As an example of how this guide can be used, consider what information a manager needs to prescribe a stand conversion of a site index of 60 trembling aspen stand to red pine. The aspen crown shades more than 70 percent of the ground surface, the beaked hazel 10 to 40 percent, and the forbs 10 to 40 per-

cent. The site has a uniform dry loamy coarse soil, a root zone of more than forty inches, a slope of five percent, and less than five percent of the ground surface is covered with boulders. A basic question is: "What has to be done to the site in preparation for planting red pine seedlings?" (Red pine is used simply to illustrate the use of this guide. In practice, all suitable species may be considered.) Using this guide and the field data form, the manager would arrive at the following findings.

FIELD DATA FORM

Date *7/1/86* Name *John Doe* Management Unit *Ace District* Aerial Photo *NH* Access *A* Township *59* Range *20* Section *19* Acres *85* Landform *rns* Landscape Position *BA* Cover Type *Aspen* Density Class *6* Basal Area *110* Site Index *60*

ITEM	NUMERICAL VALUE		
	Need	Operability	Impact
overstory	15	0	0
shrubs	5(2,1,2,3)*	0	0
forbs	2	0	0
soil texture	3	3	3
compactability	0	3	3
soil moisture	5	1	3
saturation	0	5	5
root zone	10	1	1
slope gradient	0	1	1
boulders	0	1	0
TOTAL	40	15	16
CLASS	PH III	II	II

*Synecological requirements for beaked hazel.

What this information and analysis suggests to the manager is that there is woody and some forb competition on the site, but the aspen suckers will be the main competition. Subsequently, site preparation (NEED III) will be necessary for converting the site to red pine. The site is dry except during the spring thaw period. Thus, equipment operations will not be hindered as indicated by the OPERABILITY II. Therefore, several site preparation methods may be considered which include the roller chopper, disk, tractor scarification, chemical, shearing, and patch scarification. For maximum effectiveness the mechanical methods must be done during the **peak growing season**. The IMPACT II indicates that prescribed site preparation activities will have little or no adverse impact on the resources. However, activities outside a prescription could result in short-or long-term adverse impacts.

In contrast, consider a conversion to red pine of a site index 75 trembling aspen stand with a closed crown growing on a dry loamy (fine) site, with a four percent slope, no boulders on the surface, a dense shrub layer of mountain maple that shades more that 70 percent of the ground surface, and a forb layer that shades 41 to 70 percent of the ground surface, and a root zone of more than forty inches.

FIELD DATA FORM

Date *7/1/86* Name *John Doe* Management Unit *Ace District* Aerial Photo *NH* Access *A* Township *59* Range *20* Section *18* Acres *155* Landform *rns* Landscape Position *BA* Cover Type *Aspen* Density Class *6* Basal Area *150* Site Index *75*

ITEM	NUMERICAL VALUE		
	Need	Operability	Impact
overstory	15	0	0
shrubs	20(4,2,2,1)*	0	0
forbs	3	0	0
soil texture	7	10	10
compactability	0	15	15
soil moisture	5	1	3
saturated	0	5	5
root zone	10	1	1
slope	0	1	1
boulders	0	1	0
TOTAL	60	34	35
CLASS	PH VI	V	IV

*Synecological requirements for mountain maple.

This information depicts clearly that a conversion of this aspen stand to red pine would require considerable site preparation (NEED VI). Equipment operations would be restricted during the frost free seasons to dry periods when the surface soil can adequately support heavy equipment (OPERABILITY V). Site preparation activities outside of a prescription would normally result in long-term adverse impacts on the resources (IMPACT IV). Site preparation would require a combination of mechanical and chemical treatments used in combination or separately.

During the peak growing season effective methods include roller chopping, disking, patch scarification, or shearing. Application of chemicals could be coupled with, precede, or follow the mechanical treatments.

In conclusion, the risks are somewhat higher than in the first example, but the potential productivity is substantially higher and a manager should not be discouraged from considering this conversion option. It does indicate that an integrated resource prescription is advisable to insure success.

SAMPLE PRESCRIPTIONS

There are several prescriptions which are appropriate for both sites. For the first site, logging in the summer followed with machine planting and chemical control of the aspen suckers the following year should suffice. Another is to log, double disk the aspen suckers the second year during the peak growing season, and to plant the following spring. Lastly, patch scarification coupled with or followed by a chemical treatment may suffice.

For the second site a summer logging followed with a machine planting using a vee plow equipped tractor and a chemical treatment should be considered. Other options are tractor scarification for removal of slash, chemical treatment of the suckers, and machine planting. Double disking the suckers during the

peak growing season and planting the following spring is yet another option. All of these options have been successful when applied as directed. And there are still other integrated prescriptions that would be acceptable. **Keep in mind that as the site productivity increases so does the need for release of the seedlings**. Also, associated with an increase in site productivity is the possibility of grass becoming well established following a disturbance of the forest floor and removal of the broadleaf plants.

Appendix A: Synecological Requirements of Selected Species

Modified from Minnesota Forestry Notes by Bakuzis et al.

Synecological requirements of forest species are given in Minnesota for moisture (M), nutrients (N), heat (H), and light (L) in relative values from 1 (least) to 5 (greatest). A given plant is associated with a particular combination of requirements each having a numerical value. For example, mountain maple has a moderate (3) moisture requirement, and an intermediate level (2) for nutrients and heat and a low (1) requirement for light. In contrast, American hazel has a low (1) moisture requirement, intermediate (2) for nutrients, moderate (3) for heat, and high (5) for light. However, this does not mean that American hazel is only found in openings. A site that has a high moisture-holding capacity, and a high level of nutrients will offset some of the requirement for light and result in American hazel being found under a closed aspen canopy. Its presence indicates the moisture and nutrient levels. Likewise, mountain maple growing in a rich site under a closed aspen canopy may be dense and only six feet tall but will increase in density and height (8-12 feet) with the removal of the aspen canopy.

Species	Relative Values *M N H L*	Species	Relative Values *M N H L*
TREES			
Balsam Fir	4 3 1 2	White Oak	2 5 5 1
White Spruce	3 2 2 2	Northern Pin Oak	1 2 3 5
Black Spruce	4 1 1 4	Bur Oak	2 3 4 4
Jack Pine	1 1 2 5	Northern Red Oak	2 4 4 3
Red Pine	1 2 2 4	Basswood	2 5 4 2
White Pine	2 2 2 3	American Elm	4 5 4 2
N. White Cedar	4 2 1 1	Rock Elm	3 5 5 3
Tamarack	5 1 1 5	Quaking Aspen	2 2 2 4
E. Redcedar	1 3 5 3		
Boxelder	3 5 5 3	**SHRUBS**	
Red Maple	2 2 3 3	Mountain Maple	4 2 2 1
Sugar Maple	3 5 4 1	Serviceberry	3 2 2 5
Silver Maple	3 5 5 4	Bog Birch	5 1 1 5
Yellow Birch	4 5 2 2	Red-Osier Dogwood	4 2 2 3
Paper Birch	3 2 2 5	Am. Hazelnut	1 2 3 5
B.Hickory	3 5 5 1	Bk. Hazelnut	2 1 2 3
Hackberry	3 5 5 2	Crataegus spp.	3 5 4 4
Black Ash	4 4 3 2	Pin Cherry	1 2 3 5
Green Ash	3 5 4 4	Sand Cherry	1 2 2 5
Black Walnut	2 5 5 2	Chokecherry	1 3 3 4
Ironwood	2 5 4 1	Sweetfern	1 1 2 5
Balsam Poplar	4 3 2 4	Ribes spp.	4 4 2 2
Cottonwood	3 5 5 4	Green Alder	2 1 1 4
Bigtooth Aspen	1 3 3 3	Speckled Alder	5 2 1 4

Appendix B: Glossary: Site Preparation

Need

Need for site preparation is an evaluation of the combined biophysical properties of a site in relation to the growth of the prescribed tree and the competing vegetation.

Pre-harvest is that period in the stand's development before any trees are removed.

Post-harvest is that period immediately following the final removal of the stand.

Class I is generally considered a marginal or noncommercial site and vegetation is left to the forces of natural succession.

Class II is a very low productivity site having low shrub and forb growth and in most instances site preparation can be accomplished through harvest operations.

Class III is a low productivity site having a low density shrub and forb growth and harvest activities can be used extensively to complement site preparation. In some instances, harvest activities may be the only site preparation required.

Class IV is a moderately productive site having a moderate density shrub and forb growth and intensive site preparation is commonly not necessary in recently harvested stands. Harvest activities can be used to complement site preparation.

Class V is a highly productive site having a high density shrub and forb growth and intensive site preparation is usually required, but logging operations may provide some control of the competition.

Class VI is a very productive site having a very high density shrub and forb growth and intensive site preparation is required for specie conversion. Natural regeneration may be a problem if the brush is well established in the stand. Older low quality stands of trembling aspen do not regenerate well under that situation.

Operability

Operability is the ability of the land's natural surface to support vehicular traffic.

Class I is land that can support equipment operations associated with site preparation except for a short period during the spring breakup.

Class II is land that can support equipment operations associated with site preparation except for a 10- to 30-day period during the spring breakup.

Class III is land that can support equipment operations associated with site preparation except for a 10- to 30-day period during the spring breakup and about 1- to 3-days following a significant rain during the growing season.

Class IV is land that can support equipment operations associated with site preparation except for 10- to 45-days during the spring breakup and for about 3- to 5-days following a rain during the growing season.

Class V is land that can support equipment operations associated with site preparation except for 15- to 45-days during the spring breakup and for more than 5 days following a rain during the growing season.

Class VI is land that can support equipment operations associated with site preparation only when the ground is frozen.

Impact

Impact is the kind and degree of alteration of the land's ability to support life. In this instance, plant life is of prime interest and no attempt is made to evaluate the impact on animal life. A Class I indicates that the potential for an adverse alteration of the land resulting from site preparation is low. Should the prescription be somewhat in error the land will be forgiving. In contrast, a Class V indicates a high potential for an adverse alteration and an error in a prescription can lead to long-term and possible irreversible impacts.

Class I is little or no alteration of the land's ability to support plant life.

Class II is some alteration of the land's ability to support plant life and the adverse effects are short term.

Class III is some alteration of the land's ability to support plant life and the adverse effects are short or long term.

Class IV is common alteration of the land's ability to support plant life and the adverse effects are dominantly long term.

Class V is substantial alteration of the land's ability to support plant life and adverse effects are long term and some are irreversible.

Adverse impacts

Adverse long-term impacts include soil compaction, soil rutting, soil erosion, and the loss of protective vegetation. Soil compaction reduces plant yields due to decreased root development caused by reduced aeration, reduced soil moisture, and physical barriers to root growth. The mortality of young seedlings will likewise be increased substantially. Soil rutting in moist and wet sites commonly results in dammed surface water, ponded conditions, and lower temperatures in the root zone. In dry sloping sites, it also channels surface runoff causing significant increases in the loss of water from the root zone and is a major cause of gulley erosion. Soil erosion reduces the plant yields from a site due to losses of nutrients, nutrient-holding capacity, soil moisture, water-holding capacity and a reduction in the thickness of the root zone. Erosion can also damage off-site resources due to sedimentation. Thus, site preparation should be prescriptive and match the conditions of the individual site.

Appendix C Selected References

Ballard, Russell and Stanley P. Gessel. 1983. I.U.F.R.O. Symposium on Forest Site and Continuous Productivity. Proc. U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station, Portland, Oregon. Gen. Tech. Rpt. PNW-163.

Balmer, William E. 1978. Soil Moisture Site Productivity Symposium. Proc. U. S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station. Chamblee, Georgia.

Bernier, B. and C. H. Winget. 1975. Forest Soils and Forest Land Management. Proc. Fourth North American Forest Soils Conference. Laval University, Quebec, Canada.

Hendrickson, O. and J. B. Robinson. 1982. The Microbiology of Forest Soils A Literature Review. Petawawa National Forestry Institute, PI-X-19, Canadian Forestry Service, Department of Environment, Canada.

State University of New York. 1979. Impact of Intensive Harvesting on Forest Nutrient Cycling. Proc. College of Environment Science and Forestry, Syracuse, New York.

Issued in furtherance of cooperative extension work in agriculture and home economics, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Patrick J. Borich, Dean and Director of Minnesota Extension Service, University of Minnesota, St. Paul, Minnesota 55108. The University of Minnesota, including the Minnesota Extension Service, is committed to the policy that all persons shall have equal access to its programs, facilities, and employment without regard to race, religion, color, sex, national origin, handicap, age, veteran status, or sexual orientation.

Cover and design: Kevin Taylor