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P.C. Bates

C.R. Blinn

A.A. Alm

A SURVEY OF THE HARVESTING HISTORIES OF SOME POORLY REGENERATED ASPEN STANDS IN NORTHERN MINNESOTA

Peter C. Bates, Charles R. Blinn, and Alvin A. Alm[1]

ABSTRACT.--The increasing demand for quaking aspen in the Lake States illustrates the importance of successfully regenerating existing stands. A number of studies have shown that timber harvesting activities can greatly influence the physiological and environmental factors that control the amount and vigor of suckering. At the same time, forest managers in northern Minnesota have observed instances where some aspen stands have not regenerated satisfactorily following harvest. This paper summarizes the results of a survey comparing the site properties and harvest histories of a number of poorly regenerated stands to successfully regenerated stands in north central Minnesota.

INTRODUCTION

In addition to the large volume of high quality aspen in northern Minnesota, one of the most attractive features of the aspen resource is its ability to vigorously regenerate itself from root suckers following harvest. This makes aspen a relatively simple species to manage with the standard silvicultural prescription consisting of complete clearcutting with the intention of allowing suckers to regenerate the stand.

There has been a considerable amount of research which has identified a number of the most important factors which can affect the suckering response of aspen. These include stand and site characteristics such as the concentrations of growth regulating compounds in aspen roots (Schier 1973), root carbohydrate reserves (Schier 1981, Schier and Zasada 1973, Tew 1970), parent stand density (Graham et al. 1963, Perala 1983, Schier et al. 1985), parent stand condition (Schier 1975), clonal variation (Barnes 1969, Schier 1974), and soil temperature, moisture, and aeration (Maini and Horton 1964).

Timber harvesting activities have a direct impact on some of the above stand and site properties and thus may affect the level of regeneration in some areas. For example, the timing of harvesting activities can influence the root carbohydrates available to developing suckers. In addition, harvesting equipment can greatly influence soil temperature and moisture regimes which can be critical to suckering.

[1]Peter C. Bates, Charles R. Blinn, and Alvin A. Alm. The authors are respectfully, Graduate Research Assistant and Associate Professor/Extension Specialist, Department of Forest Resources, University of Minnesota, St. Paul, Minnesota 55108 and Professor, Department of Forest Resources, University of Minnesota, Cloquet, Minnesota 55720. This research was supported by the College of Natural Resources and the University of Minnesota Agricultural Experiment Station under Projects MN 42-18 and MN 42-40 of the General Agricultural Research Program, the Minnesota Extension Service, and the Minnesota Deer Hunters Association. Published as Paper No. 17,393 of the Minnesota Agricultural Experiment Station.

In recent years, forest managers in northern Minnesota have observed instances where some productive aspen stands have not regenerated satisfactorily following harvest. While at the present time the number of such sites is relatively small, it is important to investigate aspen regeneration on these sites if we are to efficiently and effectively manage our aspen resource for the future.

The purpose of this study was to survey a number of regenerating aspen stands in northern Minnesota to determine if regeneration quality was related to harvest activities and/or site properties. Some of the information required for this survey is not routinely or uniformly maintained by all forest managers; therefore the information for some stands is more precise than for others. While the authors do not feel that this detracts from the potential utility of the survey, they recognize that this survey is limited to identifying general trends and that it is not capable of identifying specific cause and effect relationships.

SURVEY AREA

The survey area is located in north central Minnesota. The climate is continental with warm summers and cold winters. The average length of the frost-free season is about 122 days and the average annual precipitation is about 26 inches (Baker and Strub 1965).

The major soils in the area are derived from a loamy glacial till that is high in shale and limestone which was reworked throughout much of the region by glacial Lake Agassiz. The result is that much of the area is characterized by heavy textured soils on landforms exhibiting little or no relief, although there are some remnant rolling moraines. In some areas there are thin mantles of soil over bedrock and in other areas there are sandy deposits associated with former beaches. Also, there are large expanses of organic soils throughout the region; however, these organic soils generally do not support aspen forests.

METHODS

Specific stands were selected by local forest managers. Each cooperating manager was asked to identify several stands in their region which had been clearcut within the past ten years (since 1979) and had not regenerated satisfactorily. In addition, they were asked to identify satisfactorily-regenerated stands located in close proximity to the poorly-regenerated stands. The intention was not to perform a paired experiment, but rather to select stands representing a range of regeneration qualities. For each stand they were asked to provide the following information:

1. Parent stand characteristics. The age, site index, basal area, and volume/acre of aspen in the parent stand.

2. Harvest history.

    a. Season.--Four seasons were defined:
        1) EARLY SUMMER (June and July),
        2) LATE SUMMER (August through mid- September),
        3) FALL (mid-September through October), and
        4) WINTER (November through May).
        Each stand was assigned a season of harvest based on when the harvesting operation began.
    b. Felling equipment.
    c. Skidding equipment.

Each site was visited and the following data were collected:

1. Topographic class. Each site was classified as either LEVEL (dominated by slopes ≤ 3 percent), GENTLY ROLLING (dominated by slopes > 3 and ≤ 6 percent), or ROLLING (dominated by slopes > 6 percent).

2. Soil type. The soil at each site was classified in the field as either FINE (texture of clay loam or heavier), FINE/ROCK (texture of clay loam or heavier with bedrock commonly within 5 feet of the surface), COARSE/FINE (twenty to forty inches of sand over clay loam or finer material), or COARSE (texture of fine to medium sand).

3. Regeneration category. The overall quality of regeneration in each stand was classified as either POOR, MODERATE, or GOOD based on visual inspection of the stand with major emphasis on sucker density, crown closure, and sucker form. Fourteen stands were transected using 60, systematically located, mil-acre plots per stand in order to estimate density and percent stocking of aspen stems greater than or equal to 4.5 feet tall for each regeneration category.

4. General observations were recorded concerning site condition and regeneration patterns.

RESULTS AND DISCUSSION

A total of 41 stands were used in the survey. Twenty-three stands were submitted by forest managers as "unsatisfactorily" regenerated, and 18 were submitted as "satisfactorily" regenerated. Of the "unsatisfactorily" regenerated stands, sixteen were placed in the POOR category, six were placed in the MODERATE category, and one was placed in the GOOD category. All 18 of the stands submitted as "successfully" regenerated were placed in the GOOD category. The estimates of stem density and percent stocking are presented in Table 1.

PARENT STAND CHARACTERISTICS

There were no major differences between the parent stand characteristics of the three regeneration categories (Table 2). These data also demonstrate that the stands were generally high quality stands that were not overmature and were sufficiently well stocked to regenerate successfully.

Table 1.--Average density (stems/acre) and percent stocking in each regeneration category[1].

	Regeneration Category		
	Poor	Moderate	Good
(n)	(4)	(4)	(6)
Density	2070	3223	5587
Percent Stocking	53	71	87

[1]Considers only aspen stems ≥ 4.5 feet tall.

Table 2.--Mean and standard deviation of parent stand characteristics for each regeneration category.

Regeneration Category		Parent Stand Characteristics: Site Index	Age	Basal Area (ft^2/acre)	Volume (cd/acre)
Poor	mean	76	55	115	31
	s	9.8	9.7	19.3	9.1
Moderate	mean	82	52	118	36
	s	11.1	4.8	10.9	4.8
Good	mean	78	54	118	36
	s	11.9	5.9	27.2	6.1

HARVESTING EQUIPMENT

The felling equipment used on these sites is representative of that which is used throughout much of the region. Thirty-one of the forty-one stands were mechanically felled with the rest felled by hand (Fig. 1). The three types of mechanical felling equipment include 1) small, track-mounted shears (SM shear), 2) larger rubber-tired-mounted shears (RT shear), and 3) boom-shears that were mounted on both track and rubber-tired machines (boom shear). There is some evidence that hand-felling resulted in GOOD regeneration more often than mechanical felling, although it does not appear that the type of felling equipment affected regeneration quality.

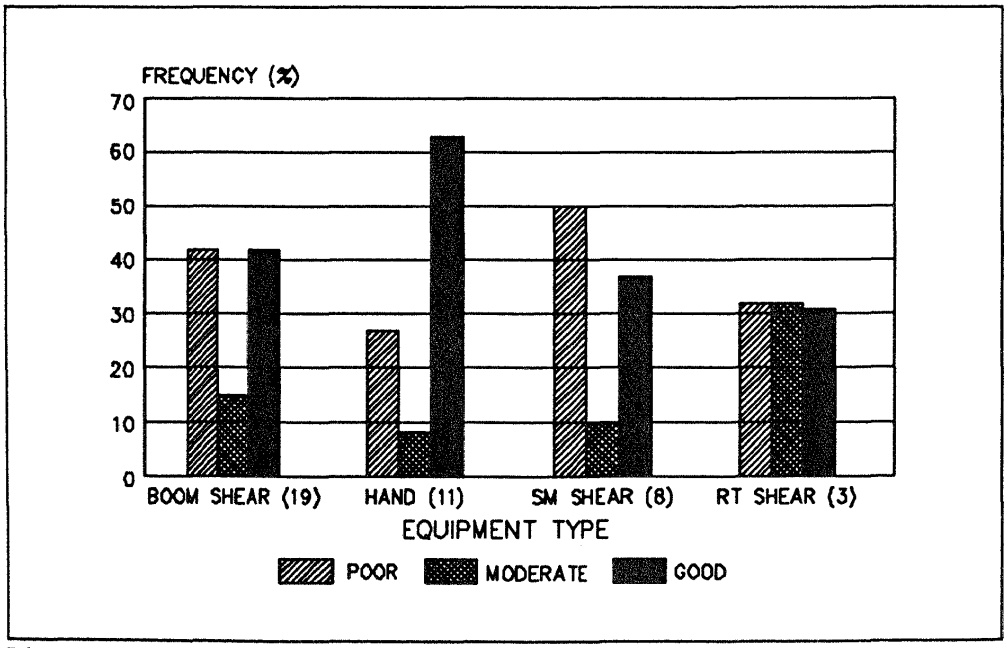

Figure 1.--Frequency of each regeneration category for each type of felling equipment. Numbers in parentheses refer to the number of observations for that equipment type.

The most common size of skidding equipment is that comparable to the John Deere 540B[2] (Fig. 2). There is no clear correlation between size of skidding equipment and regeneration quality. However, this may be partially due to the small number of observations for the larger machines.

SITE CHARACTERISTICS

Aspen in this area grows primarily on the heavier textured soils which may explain why coarser textured soils were underrepresented in our survey (Fig. 3). Again, because of the small sample size for some of the soil categories, it is difficult to evaluate how soil type by itself influences regeneration quality. However, in terms of topographic class, there is evidence that POOR regeneration was more common on level sites and GOOD regeneration was more frequent on rolling sites (Fig. 4).

SEASON OF HARVEST

The results for season of harvest are presented in Figure 5. Most of the POOR regeneration was associated with early summer harvests. Also, the frequency of GOOD regeneration increased on sites harvested later in the year.

To further examine the above observations, the regeneration categories of the different topographic classes were compared considering only the early summer harvests (Fig. 6). These results support the suggestion that regeneration problems are potentially most severe on level sites that are harvested early in the summer.

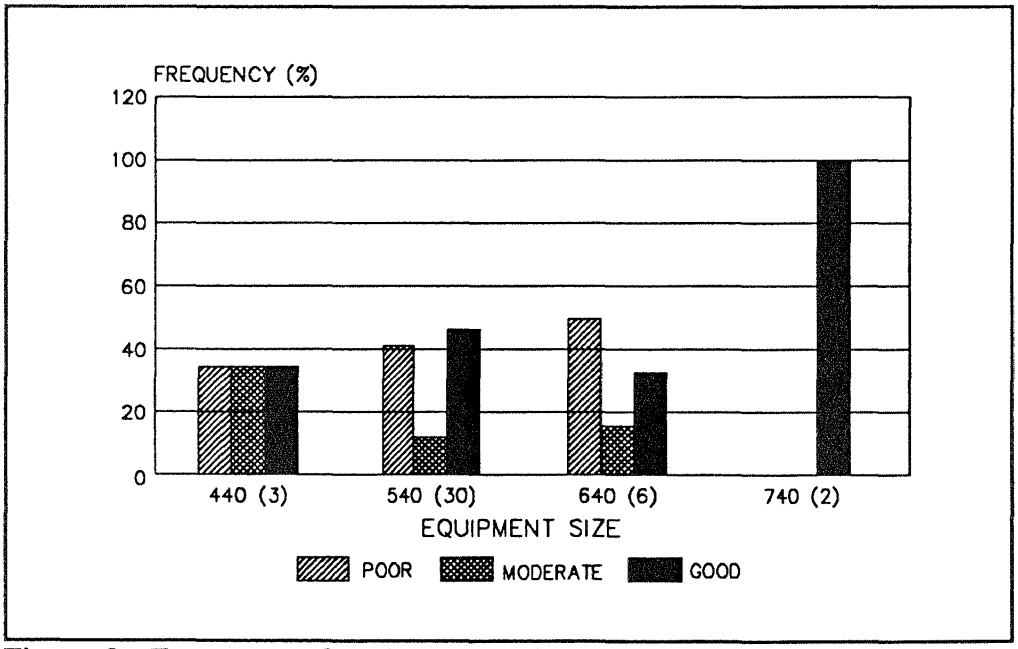

Figure 2.--Frequency of each regeneration category for each size of skidding equipment. Numbers in parentheses refer to the number of observations for that equipment size.

[2]Use of tradenames does not imply endorsement by the authors, but is merely for the convenience of the readers.

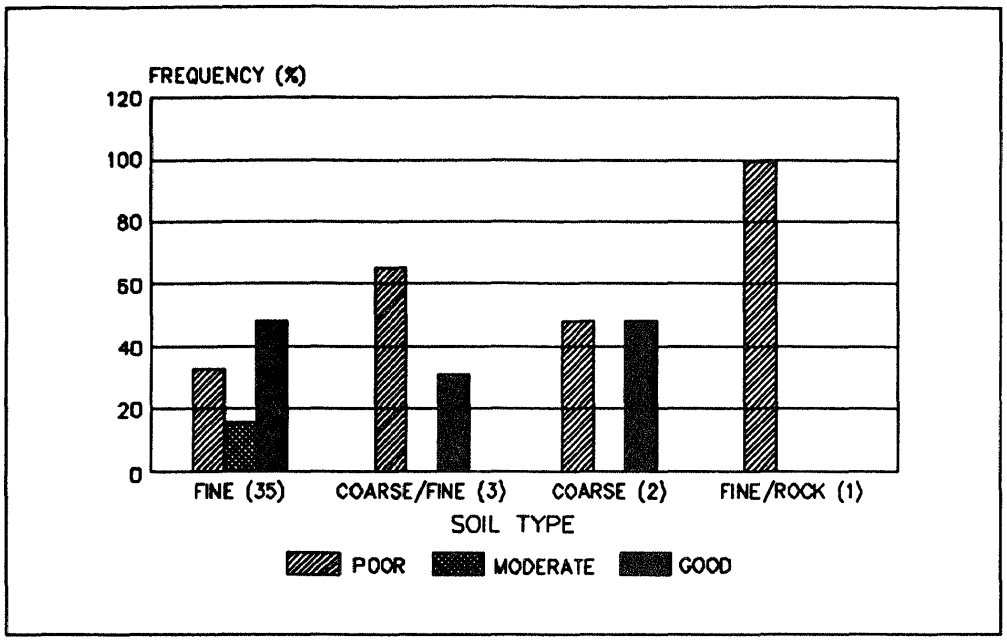

Figure 3.--Frequency of each regeneration category for each soil type. Numbers in parentheses refer to the number of observations for that soil type.

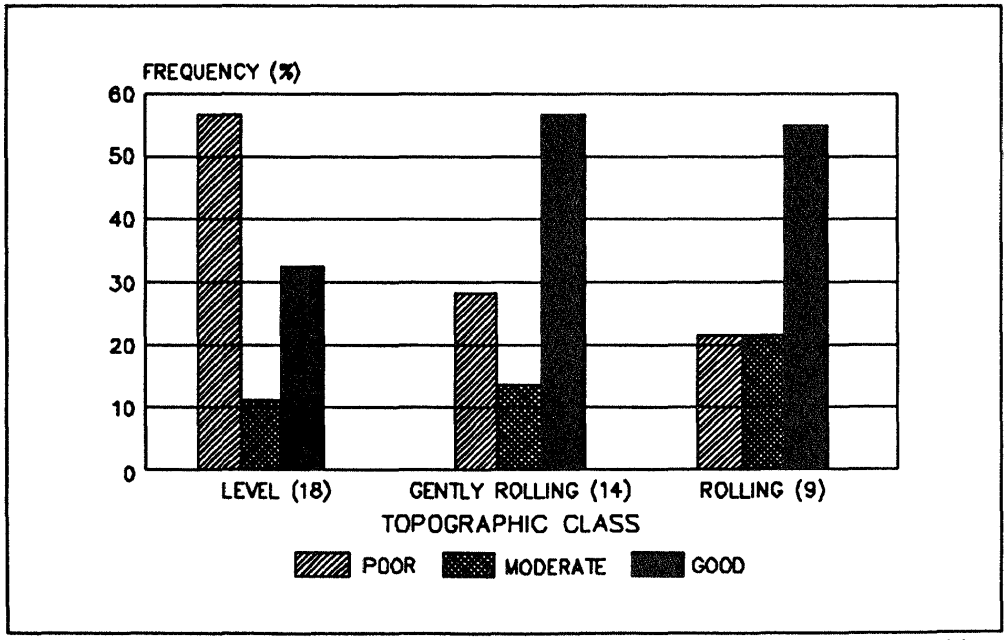

Figure 4.--Frequency of each regeneration category for each topographic class. Numbers in parentheses refer to the number of observations for that topographic class.

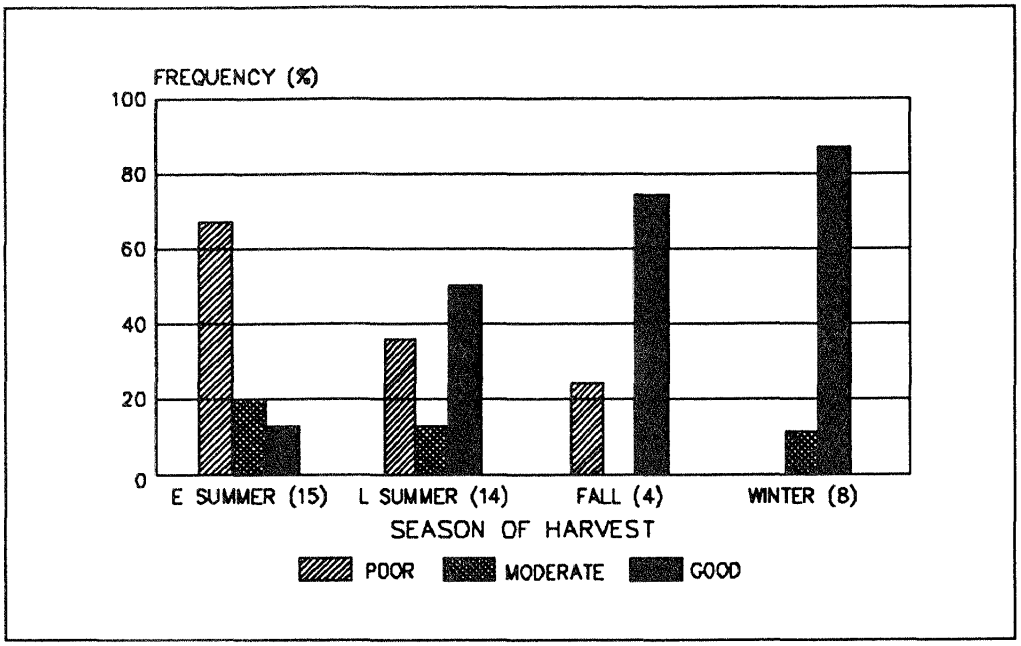

Figure 5.--Frequency of each regeneration category for each season of harvest. Numbers in parentheses refer to the number of observations for that season.

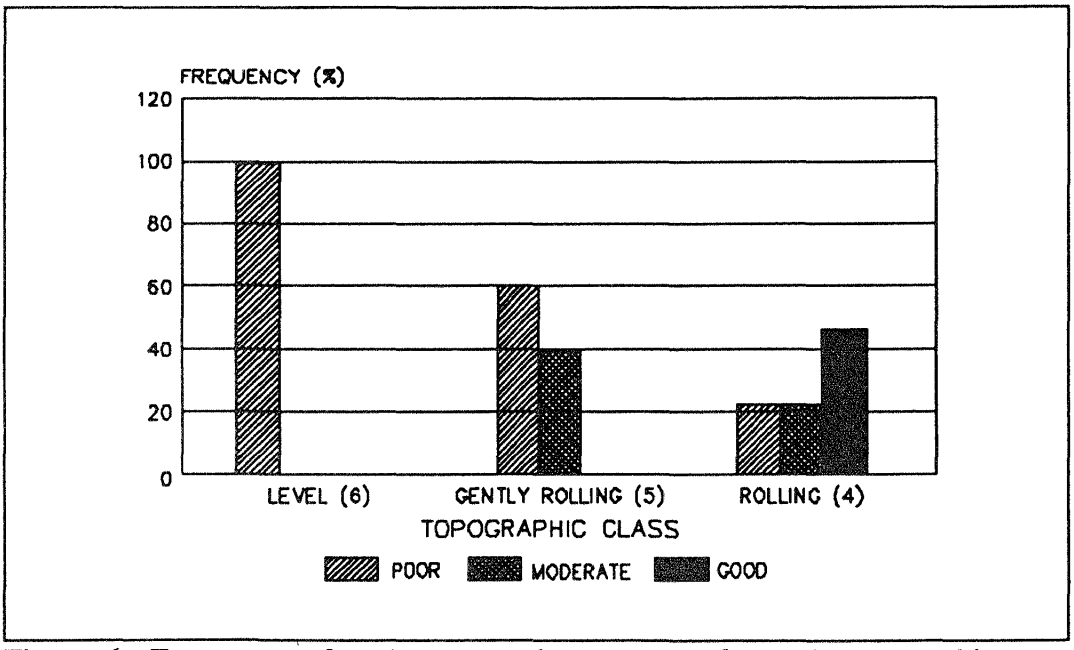

Figure 6.--Frequency of each regeneration category for each topographic class for early summer harvests only. Numbers in parentheses refer to the number of observations for that topographic class.

MULTIPLE ENTRY INTO A STAND

The survey indicated that managers should consider the effects of repeated entry into a stand. Eleven of the stands were entered on more than one occasion, often with the removal of different products at each period of entry. Six of these (55 percent) were in the POOR category, one was MODERATE and four were GOOD.

GENERAL OBSERVATIONS

The following observations were not specifically quantified, but were noted during field inspection of the sites.

Trafficking

In virtually all of the stands, good quality regeneration was lacking in areas that had been obviously trafficked. This was particularly true in MODERATE and GOOD stands where skid trails and landings were easily identifiable by the lack of regeneration. Conversely, in many of the POOR sites it was equally clear that patches of successful regeneration were associated with areas that had not been trafficked, such as, the back edges of sites and areas where equipment obviously went around snags and stumps.

Rutting

Rutting was considered to occur where harvesting equipment broke through the organic soil surface and left definite depressions (ruts) in the mineral soil. In many cases, areas of POOR regeneration were associated with excessive rutting. There were no sites exhibiting widespread rutting that had GOOD regeneration.

Swales/Depressions

Much of this landscape is quite wet and virtually all of the stands contain swales which support vegetation ranging from cattails to ash and balm of gilead. These depressions generally lack aspen, suggesting that these areas do not contain aspen roots and would not sucker regardless of how or when the stand was cut.

These areas stand out as obvious gaps in young sucker stands and upon casual inspection may lead some observers to conclude that they are due to harvesting impacts. However, it did appear that trafficking through and around swales when they were not frozen could increase their size. This situation might be worsened by the increased use of larger, more powerful machinery which makes it possible to operate under marginal conditions.

POSSIBLE CAUSES OF REGENERATION PROBLEMS

After concluding this survey, there appear to be several factors which alone, or in combination, might explain the occurrences of POOR regeneration observed.

Excessive Wetness

The high incidence of POOR regeneration on level sites seems to support this contention. Many of the level sites are poorly drained and have high water tables, particularly in the early summer before they have had a chance to dry out after snow-melt. These sites may be too low in soil oxygen when harvested at this time to be able to sucker; harvesting at a later date when the soil had an opportunity to dry out may yield better regeneration.

Compaction And Rutting

Widespread trafficking can compact and smear the soil surface which reduces porosity and decreases the rate of water movement through a soil. Also, many of these sites have a very subtle surface drainage pattern which might be disrupted by rutting. Both of these can result in increased wetness, particularly on poorly drained sites. Soils become more susceptible to rutting and compaction as their moisture content increases. Consequently, many of these soils are most susceptible to rutting and compaction in the early summer.

Physical Damage To Aspen Roots

Aspen roots are characteristically shallow, and are often present in the humus layer above the mineral soil. Thus they are very susceptible to damage by harvesting equipment which can either kill root segments or open up wounds which can serve as entry ports for various pathogens. Obviously, when rutting is occurring, aspen roots are being broken and wounded. However, damage may also occur in the absence of any rutting. This could explain why some areas of POOR regeneration exist in skid trails on better drained sites that are not rutted and do not become saturated.

SUMMARY

Aspen is a species that regenerates well through complete clearcutting. In a few instances certain harvesting activities may influence its regeneration ability. While this survey did not identify all possible areas of concern, it did seem to indicate several situations that may be particularly sensitive to regeneration problems. These include:

1. Stands growing on level, poorly drained soils.

2. Stands harvested in early summer.

3. Stands where there is widespread trafficking that might damage the shallow aspen roots.

4. Repeated entry into a stand.

Managers should consider these factors when prescribing and monitoring aspen harvests.

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