USE OF FIRE IN PLANTING SITE PREPARATION

by J. H. Dieterich 1/

INTRODUCTION

Experience has shown that many of our regeneration efforts are doomed to failure even before the seed is sown or the trees are planted, simply because the site has not been properly prepared. In the Lake States, planting site preparation is currently done with mechanical equipment, chemicals, or fire. Each appears to have its advantages and disadvantages, and these three methods will probably continue to be used to achieve satisfactory stand regeneration at a reasonable cost.

Here we shall consider primarily the use of fire for preparing a site for seeding or planting. There is still much to be learned concerning where, when, and how to burn to achieve our objectives, but we know that fire has a definite place in helping to manage some of our Lake States forest types.

HISTORY

For centuries fire has been influential in destroying and establishing timber stands in all parts of the world. In the Lake States, some of the most impressive stands of timber we have today are a result of fire. On the other hand, some of our nonstocked areas or areas of low-quality timber also have resulted from past wildfires.

The wildfires that prepared the sites for some of today's good stands--particularly in the pines--give us a clue to the use of fire in effective management and regeneration of these species. Planting site preparation with prescribed fire is necessarily based on the premise that controlled fire can create the desirable effects of wildfire and at the same time eliminate the undesirable effects that have no place in stand management or regeneration.

Prescribed burning in the Lake States is not new in theory. It is, however, relatively new in practice. There has been a reluctance in the past' to use fire for silvicultural purposes, and prescribed burning has been limited for the most part to destroying brush piles and windrowed slash. Broadcast burning has not been an accepted practice for either hazard reduction (except meadow grass) or site preparation. This reluctance to use fire seems to

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derive from questions of control, public relations, benefits, application, and costs.

Complete answers to these questions will not evolve overnight, but with the present cooperative attitude, the States, National Forests, and research organizations should produce some worthwhile results that can be used by all.

PREVIOUS WORK - LAKE STATES

In Michigan, prescribed burning research in jack pine has been directed toward stimulating natural regeneration of cutover areas. Natural seed fall, using seed stored in the cones of residual trees, has provided the medium for regeneration. In Minnesota prescribed burning research is being done at Grand Rapids and Ely. Cliff Ahlgren, working out of Ely with the Quetico-Superior Wilderness Research Center and in cooperation with the Superior National Forest, has been directing his efforts toward the ecological effects of wildfire and prescribed fire on regeneration, plant succession, and stand establishment. Cliff's work will help in establishing guides for prescribed burning in jack pine and indicating what might be expected in the way of seedling survival and effects of competition on seedling survival once germination has taken place.

The Lake States Forest Experiment Station's Northern Conifer Laboratory at Grand Rapids, Minn. is studying the effects of annual and periodic fires on brush mortality, soil nutrient characteristics, and growth of residual stand. One of the principal problems there has been to find ways to regenerate red pine stands--either naturally or artificially--and the prescribed burning trials underway should answer many questions concerning the use of fire in red pine management.

The Chequamegon National Forest in northern Wisconsin is cooperating with us in a prescribed burning program aimed at the difficult job of preparing planting sites in off-site aspen, brush, and low-quality hardwood stands.

PRESCRIBED BURN PLANNING

Planning is one of the most important aspects of using fire for any purpose. Experience is needed in planning the burns and carrying them through to completion. With experience comes a corresponding decrease in the cost of using fire and an increase in the number of opportunities where fire can be used. The prescribed burn should be planned with the timber sale so that the area may be blocked out more effectively and slash along the control lines properly handled. Control lines should be located where they will be most effective and so constructed that they are usable by vehicles or 4-wheel drive pumpers.

ADVANTAGES AND LIMITATIONS OF USING FIRE FOR SITE PREPARATION

To do the most efficient job of site preparation with fire, those doing the burning must be familiar with where, when, and how fire can be used and know its limitations as well as its advantages. The major risk is usually considered to be losing control of the fire. Actually, there is as great a risk in terms of overall economic values if the site is lost to brush and inferior tree species following a successful logging operation.

Comparisons should also be made with either mechanical or chemical methods of site preparation, but more experience will be needed with all methods before this can be done accurately.

Advantages

1. Hazard reduction.--Fire used for site preparation during any season reduces the chances of a severe wildfire occurring on that area. Spring burning removes enough of the fine, flashy material to reduce the hazard for a few years until annual fuel accumulation again builds up. Summer burning also removes flashy material plus some of the larger material that has lost moisture during hot weather. Hazard reduction is an important "fringe benefit" when using fire for site preparation purposes.

2. Nutrient advantage.--Fire used properly for site preparation appears to produce at least a temporary increase in available nutrients in the surface soil layers. This temporary increase in nutrients provides a much needed boost to germinating seedlings or planted stock. Although there are conflicting reports concerning nutrient changes, most evidence indicates that soil structure and fertility are not damaged by a single or even multiple light burns. Continuous severe burning is deterimental to good soil development on certain soils. Changes in nutrient content are being followed closely in the prescribed burning experiments on the Cutfoot Experimental Forest near Grand Rapids, Minn.

3. Costs .--It is difficult to compute prescribed burning costs accurately from the early site preparation work, but there appear to be considerable cost advantages from well-planned and managed prescribed burns. There is always the question of what factors should be included in computing costs--planning, overhead from other areas, equipment use and standby, observer time, mopup, etc. The first burning operations will be the most expensive because there is always a tendency to overman until some experience is gained in handling the fires. Later the costs will be reduced as a result of better prefire planning and more efficient suppression-crew activity.

Size of the area has a direct bearing on cost per acre for burning. Small areas take proportionately more time and money to prepare than larger areas because of the time involved in getting safety strips burned out on the downwind side. With some experience we may reasonably expect to prescribe burn 160 acres in 3 to 4 hours or40 acres in 1 to 2 hours.

4. Training.--Prescribed burning for any purpose can provide excellent training for fire suppression crews. This on-the-ground training gives inexperienced members of the fire suppression team a chance to observe fire behavior, operate equipment, and test communications as they work around large areas of burning fuel. As a result they are better prepared for wildfires when they occur. Suppression crews should be organized essentially as they would be for a wildfire. The basic fire suppression organization can be put into effect with only minor changes.

Limitations

1. Technical skills.--Using fire for site preparation requires technical skills in (a) choosing the proper day and time to do the job, and (b) igniting the area to attain the desired fire intensity as well as complete the burn in the safest manner in the allotted time. Guides are available that will help pick the first acceptable day on which burning can take place, and local forecasts can help determine the best time of day to start the fires. But there is no substitute for experience in actually doing the firing job. Ignition must proceed at a rate which will accomplish the job as quickly as possible without causing serious fire suppression problems. For example, area ignition, if used improperly in large blocks of dry slash, can create patterns of extreme fire behavior and cause extensive spot fires outside the control line. Fired properly, the fire on this area would be no more difficult to control than one burning on a low-danger day.

2. High surface temperatures.--Soil surface temperatures immediately after burning frequently reach 135° to 150° F. These high temperatures may be lethal to germinating seedlings or planted stock if they last too long and if precipitation is deficient. However, the larger materials not consumed by the fire and the vegetation that returns to the area provide a measure of shade that may prevent some of this heat-caused mortality. Areas burned for site preparation do not remain barren for long; annual vegetation comes in rapidly to provide shade and lower the surface temperatures.

3. Competition.--Preparing a seeding or planting site with fire rarely eliminates all the competing vegetation for any extended length of time. (This is also true for other methods of site preparation.) Sprouting of woody species and invasion of annuals are especially pronounced after a spring burn. However, any effective summer burn will do a satisfactory job of eliminating competing brush species if the litter fuels are dry enough to be removed by a hot ground fire. Site preparation using fire will not completely eliminate the need for release once the seedlings are established. However, from this standpoint, fire compares favorably with other methods of site preparation, and burned areas are easily identifiable from the air when aerial release is planned. Occasionally, where planted stock gets a good start over the competing vegetation, only a small amount of release may be necessary.

4. Determining when to burn.--Although this is not technically a disadvantage or limitation to using fire, it is the most difficult decision to make once it has been decided to burn. The many factors to be considered in determining the day and hour to burn must somehow be consolidated into an index that can be tied directly to expected fire effects and fire behavior. Fuel moisture is the most important single factor to evaluate. The penetration and vertical distribution of moisture in the litter layer or forest floor determine the type of seedbed that results from a prescribed fire.

5. Fire description.--Describing a fire in terms of its thermal and combustion characteristics is a difficult undertaking. We can make rough approximations of fuel volume and arrangement, but it is difficult to use these factors for making meaningful comparisons between burns. About the best we can do at the present time is to describe our prescribed burns (1) in terms of past weather conditions and fuel moisture to obtain a buildup index, and (2) in terms of current weather or weather having a direct effect on the fire to obtain a current burning index. These variables are then subjectively tied into the effects that are achieved from the fire.

OPERATIONAL BURNING FOR SITE PREPARATION

Several successful operational prescribed burns for site preparation have been made during the past few years. A few of them are described here.

Cass Lake District, Chippewa National Forest.--On May 3, 1961, the Cass Lake District burned 37 acres of 2-year-old slash from a jack pine clearcut. The area had an irregular boundary that made firing and control difficult. The job was accomplished in about 4 hours with a burning index of 13 and a buildup index of 22 (6 days without rain). Humidity was 38 to 40 percent; the wind averaged about 6 to 8 m.p.h. Cost was estimated at $12 per acre. The Chippewa N.F. has nearly 600 acres more ready for burning, but because of unsatisfactory conditions during 1963, burning was postponed.

Willow River No. 1, General Andrews State Forest.--On August 20, 1962, the Minnesota Conservation Department burned, with excellent results, 105 acres of clear-cut, defoliated jack pine that had been killed by the pine tussock moth. The area was nearly rectangular, and woods roads were utilized as firebreaks. The last rain, 2.10 inches, had occurred 9 days previously (Buildup Index 25); fuel moisture averaged 8 to 10 percent in small twigs; humidity, 39-44 percent; and wind 12 m.p.h. with gusts to nearly 20 m.p.h. (higher than generally recommended). Most of this area has been successfully planted to red pine. Cost estimates are unavailable, although they were high because of extreme overmanning. This was the first large-scale burn for timber management purposes undertaken by the Division of Forestry.

Willow River No. 3, General Andrews State Forest.--A quarter section of clear-cut jack pine (defoliated by the tussock moth) was burned on July 11, 1963, nearly a year after the Willow River No. 1 burn. It was adjacent to earlier burns. The firing was completed in less than 3 hours, with a realistic use of suppression forces. The costs were computed at $2.38 per acre.

The area had gone 14 days without appreciable rainfall, the buildup index was 48, and the fuel moisture in the small twig material averaged 6 to 8 percent. Humidity dropped to 34 percent, and the wind from the south averaged 12 to 14 m.p.h. with gusts to 18. The morning of the burn was cool, with high humidity and a trace of rain. This helped reduce the possibility of spot fires. The fire burned hot, and much of the large material was consumed because of relatively low moisture content of the fuel. The combination of high buildup (48) and high burning index (28) resulted in more severe burning conditions than would ordinarily be recommended.

Big Falls Experimental Forest, Big Falls, Minn.--During spring 1961, a clear-cut strip of black spruce was burned to determine if natural regeneration would occur from the surrounding stand. A good seedbed was prepared without any trouble from hangover peat fires. The seed catch in 1961 was poor; but with the favorable conditions for seedling germination in 1962, an excellent stand of seedlings is now established. Since then other successful burns have taken place on the Big Falls Experimental Forest in black spruce. No cost estimates are available on this fire.

Minnesota Department of Conservation.--In addition to the burn on the General Andrews State Forest on July 11, 1963, Conservation Department Areas 6 and 7 at Warroad and Baudette each burned jack pine cutover areas to prepare planting sites. Areas 14, 15, and 18 also completed burns for planting site preparation. These were all summer burns. Costs varied from $2.38 per acre to $42.82 per acre; altogether nearly 350 acres was burned at an average cost of $5.40 per acre.

CURRENT FINDINGS AND RECOMMENDATIONS

The following points summarize some of the more significant findings determined from both experimental and operational prescribed burning trials:

1. Fire may be used successfully for site preparation in the following types and stand conditions:

   a) Jack pine clear cut.--For hazard reduction and/or seedbed preparation for ultimate seeding or planting.

   b) Jack pine-hardwood mixture.--For removal of hardwoods for planting site preparation. Clear-cut jack pine before burning to provide fuel.

   c) Black spruce clear cut (strips).--For hazard reduction and seedbed preparation for natural regeneration.

   d) Mature red pine.--For hazard reduction and preparation of seeding or planting sites prior to final harvest cut.

2. Summer burning with proper buildup will do a satisfactory job of planting site preparation with a minimum of control problems and will generally result in a less expensive fire than will either spring or fall burning on the same area.

3. Spring or fall burning not only appears to stimulate sprouting and competition but also comes at a time when wildfires may be a major concern to those doing the burning job. With spring fires, immediate release may be necessary to insure survival of the planted stock.

4. If spring burning is used, a second fire either the 2nd or 3rd year after the first fire will do the best job of site preparation. The first fire will make available some dead fuel but will also cause heavy resprouting. The second fire will clean up the area of dead material, but resprouting will occur again. This technique may have ready application for wildlife purposes to stimulate food and cover. It may also be possible to use this method for forestry purposes if summer burning cannot be done.

5. During spring and fall burning, the time of day for doing the job must be chosen carefully. Starting the fire an hour too early when the humidity is falling and the wind is coming up may result in the fires getting out of control.

6. During summer burning, the choice of time of day is not so critical. Weather is usually not subject to so many unexpected changes, the vegetation is green, and the days are long.

7. There is a close relationship between buildup (moisture deficiency in the fuels) and burning index (current burning conditions). However, it is more important to understand the concept of how these values are related than to attempt to state numerical relationships. When the buildup index is high or on the increase, burning should be done with a relatively low burning index. If the buildup index is low, as it frequently is in the spring, it may be necessary to burn with a higher burning index to accomplish the job (CAUTION!)

8. In burning for site preparation, it is desirable to strive for. as high a buildup index (moisture deficiency) and as low a burning index as possible. This will permit maximum fuel consumption by the fire with a minimum of control difficulty.

9. In burning for hazard reduction only, it is not necessary to have a long period without rainfall prior to burning. In fact a burn after 3 days without rain and with a burning index of 10 to 15 will do a satisfactory job of eliminating the fine fuels on a clear-cut slash area.

10. Until we learn more about direct seeding through experimental plots or small-scale tests, we recommend planting as the primary means of getting the area back into production quickly.

11. Based on approximately 20 State and Federal prescribed burning operations to date, costs per acre have varied from a low of $2.38 (160-acre block) up to $42.82 (7-acre block). The average for all 20 burns was about $14 per acre. The Kalamazoo Vegetable Products Co. (KVP) in Canada has obtained prescribed burning costs from $4 to $20 per acre for similar areas.

CONCLUSIONS AND RESEARCH NEEDS

Prescribed burning is new in the Lake States but is destined to have a more prominent place in the management of certain northern conifers. For instance, we have seen that fire can be successfully used in jack pine to reduce the fire hazard following logging and at the same time prepare an adequate site for direct seeding or planting. Using fire in red pine and black spruce management also shows a great deal of promise--particularly for site preparation.

Additional research is needed to refine burning practices now being used and to determine for other areas or timber types where fire can and <u>cannot</u> be used, the response of certain stands to controlled fire, and the specific weather and fuel moisture conditions needed to achieve the maximum benefits from fire. Techniques of fire use should be developed to indicate how best to ignite an area so as to take advantage of existing fuel moisture conditions and variations in fire weather. Additional studies may show the need for fuel modification to burn areas that otherwise could not be burned.

Getting an area back into production following logging is at best an expensive process. Costs of getting a new stand established start when the old stand is harvested. Insuring regeneration of the stand costs money;-protecting the stand from fire, insects, and disease is expensive; and the timber stand improvement work that follows right up to the time when commercial thinnings are made represents a substantial expense. Improved knowledge on how prescribed burning can be used for hazard reduction or site preparation to reduce these overall costs will be a major contribution to forestry practices.

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