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DEBRIS AND VEGETATION MANAGEMENT

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Abstract--Thinnings and periodic burning during the rotation can reduce the need for debris and vegetation management after final harvest. The harvesting of smaller material also reduces the need for such management. Site preparation treatments that leave organic matter and nutrients in place, such as prescribed burning, chopping and herbicide applications, are generally preferred over treatments that pile debris or expose mineral soil to compaction, erosion, leaching and other damages.

At a forestry meeting several years ago, speakers were discussing means of controlling or eliminating from pine stands what they kept referring to as the competition, or the flammable rough, or the undesirable vegetation, or the brush and weeds. Finally, the time came for J. B. Hilmon, a range ecologist with the U. S. Forest Service, to speak. He jumped up and announced that he was going to talk about what his fellow speakers had been calling brush and weeds, but what he called browse and forage for wildlife and livestock. Furthermore, he said, he was going to discuss managing this understory as a resource, not eliminating it.

That range scientist had to try to turn an audience's concept of understory vegetation from that of a nuisance to be eliminated to that of a resource to be managed. I'm in somewhat the same position with this presentation, although I think that we in forestry have developed a more holistic approach to the environment and to resource management during the last several years. As a case in point, the topic assigned to me was not titled, "Debris and Vegetation Control" or "Debris and Vegetation Eradication", as it might have been a few years ago, but "Debris and Vegetation Management". Debris and vegetation are resources that should be managed, so it's a good title.

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Initially, however, I was concerned about the word "debris" in the title. Debris means broken, scattered remains of something destroyed and no longer of value. This suggests that debris should be pushed aside to make room for something that is of value. Essentially, this is what we do when we push logging debris into windrows to facilitate the site preparation and planting of a pine stand. With a name such as "debris" for this material, it is easy to forget we are pushing valuable organic matter and nutrients beyond the reach of pine roots.

I consulted my dictionary for a synonym for debris which I could use in the title that would connote some usefulness for this material. The first synonym listed was "rubbish", which seemed a rather unpropitious title for my talk. I then considered the synonym "waste", for waste not only means discarded material, but it has also come to be used in such terms as "waste water" from sewage plants used to irrigate tree stands, and "waste wood" from sawmills used to make chipboard. Finally, however, I came back to the word "debris" for it is, after all, the accepted term. Nevertheless, like the word "waste", let's think of debris not only as discarded material, but let's also start regarding it as a resource that should be managed.

My topic is debris and vegetation management. Actually debris is mostly dead vegetation, so debris and vegetation are simply phases of the same concept. Thinking of them as one concept has certain advantages:

--If we think of debris as vegetation, we are reminded that it contains essential nutrients that were absorbed from the soil rather uniformly across the site, and thus should be allowed to return to the soil rather uniformly across the site so that they will be available to the next generation of pines.

--Also, if we think of debris as dead vegetation, we can better see that the type and amount of debris remaining after final harvest depends to a large extent upon how we managed the vegetation throughout the rotation. That's what I want to talk about next.

TOTAL BIOMASS HARVESTING

Debris included the tops and branches and sometimes the sheared stumps of harvested trees, the downed cull trees and small unmerchantable trees, and perhaps, shrubs torn loose during harvesting. Sometimes the above-ground debris and even the standing understory shrubs are run through portable chippers and hauled to the mill. In some places, stumps are pulled and sent to the mill. The details and concerns of such biomass harvesting do not belong in this paper on site preparation. It should be noted in passing, however, that the more debris and competing vegetation that are harvested, the less remains to be dealt with during site preparation.

INTERMEDIATE TREATMENTS AS SITE PREPARATION

Some silvicultural treatments applied during the rotation affect the type and amount of debris and competing vegetation found after final harvest. This in turn affects the establishment and growth of the next generation. For this reason, I'm going to stretch the definition of site preparation temporarily so that I may include such intermediate treatments in this discussion.

Thinning is one such treatment. Thinning may be prescribed to realize an early financial return or to help meet a wood quota. One of its results, however, can be a reduction in debris after final harvest. This, in a sense,

makes thinning a site preparation measure. As examples:

- Diseased but still merchantable stems removed during a thinning might otherwise deteriorate into culls that would contribute to debris at the end of the rotation.
- Small trees released by thinning may grow into the merchantable class by final harvest (that's one of our reasons for thinning), and growing into the merchantable class means growing out of a class that contributes to debris.
- The tops and stumps left after a thinning often have deteriorated so much by final harvest that they are no impediment to planting and thus not in need of debris management.

Speaking of the deterioration of logging debris suggests another possible, but not yet proven, advantage of thinning:

The considerable amount of debris from a single end-of-rotation harvest may release so many nutrients in such a short time that the rooting zone of the soil does not have enough exchange sites to capture them all. Consequently some nutrients may be leached below the reach of pine roots. If this is so, two or more harvestings during a rotation would conserve nutrients by allowing more frequent but smaller releases of nutrients to the soil.

I've been discussing commercial thinning. Precommercial thinning would have many of the same benefits as commercial thinning in vegetation and debris management.

I've also been speaking of thinning as a positive treatment in debris and vegetation management. Is it always? Perhaps so, where understories contain few hardwood trees, such as the sawpalmetto-gallberry understories in Florida and Georgia and the bluestem understories along the Gulf Coast. On most pine sites, however, opening up the overstory by thinning accelerates the succession toward hardwoods and thus increases the problems of hardwood competition and hardwood debris.

The succession toward hardwood climax, whether accelerated by thinning or not, can be checked by either of two other intermediate silvicultural treatments: herbicide application (2,4) and prescribed burning (7). As forest managers, you may be burning your stands periodically anyway, for fuel reduction or for improvement in wildlife habitat or forest range. If so, you may find that hardwood control in thinned stands is not much more of a problem than it is in unthinned stands.

Sometimes periodic burning can even eliminate the need for more conventional site preparation practices, as it did in a study on the Coastal Plain of Virginia. There, a winter burn followed by three annual summer burns just before the harvest of loblolly seed trees was compared with disk harrowing before harvest. The series of burns controlled more hardwoods and resulted in higher stocking of pine seedlings than did the disking treatment, and at one-quarter the cost (6).

Prescribed burning, whether performed during the rotation or after final harvest, is relatively inexpensive and requires less fossil fuel than does mechanical preparation. The more competition and debris that is controlled or consumed by prescribed burning, the less mechanical preparation is needed, and consequently the less chance of erosion, soil compaction or other site

damages caused by mechanical equipment. Somewhat like periodic thinning, periodic burning results in periodic return of nutrients to the soil during a pine rotation, which probably had advantages in the recycling and conserving of nutrients.

Thus, prescribed fires, thinnings and total tree harvesting performed for various management purposes during one rotation can, through their control of competition and debris, benefit the establishment and growth of the next rotation. Often, however, because of past management practices, or lack of a market for small material or the nature of the site, preparation after final harvest must include vegetation and debris management.

SITE PREPARATION AFTER FINAL HARVEST

Sites are prepared by machines, chemicals and fire, alone or in various combinations. These treatments cause changes in the soil and microclimate, as well as in vegetation and debris. These changes, in turn, can have beneficial or adverse effects upon the new crop of pines and upon other factors of the ecosystem. It is not always possible to determine whether an effect was due to a change in the soil, or in the microclimate or in the vegetation or the debris. Sometimes we don't even know if an effect was due to site preparation or to harvesting. A comprehensive discussion of what is known and hypothesized about the effects of vegetation and debris management in site preparation would make a very lengthy presentation.

Fortunately, a wealth of information on the effects of harvesting and site preparation, including vegetation and debris management, was published in 1978 under one cover. It is the Proceedings of a Symposium on Maintaining Productivity on Prepared Sites (5), and it is a useful reference for forest managers and researchers. I will draw heavily from those proceedings in the

discussion below, which concerns the effects of vegetation and debris, and the effects of their management, upon pines and upon other factors of the ecosystem.

ALLELOPATHIC EFFECTS OF VEGETATION

In one of the papers delivered at that Symposium, Ralston mentions that in the Sandhills, turkey oak and wiregrass may have allelopathic (inhibitory) effects upon pine growth. Similarly, Priester and Pennington (3) found that water extracts from the shoots of broomsedge bluestem grass slowed the growth of loblolly pine seedlings. Also, a coworker and I have unpublished evidence that bluestem grasses may be having a growth-slowing effect upon slash pine seedlings. So, understory species not only compete with pines for light, water and nutrients, but some of them produce chemicals that inhibit pine growth. Remember, though that the effects of understories upon pines are not always negative. Brender (1) discusses the role of hardwood leaves in improving physical properties of the soil and in increasing the quantity of essential nutrients in the zone of feeder roots in the soil.

VEGETATION AS COMPETITION AND AS WILDLIFE HABITAT

To return to papers of the Symposium (5), Harris and Smith observed that, because site preparation is specifically aimed at reducing competitive species that also happen to provide wildlife food and cover, each succeeding process of site preparation exacerbates the negative impact on wildlife. From their review of the literature, they conclude that mechanical preparation has more severe short-term effects on wildlife than does chemical preparation. They point out the inadequacies of talking about forest management effects on "wildlife" when "wildlife" in most southeastern states refers to scores of mammalian, hundreds of avian and perhaps 100 reptilian and amphibian species.

They also point out that, although site preparation and other intensive silvicultural practices affect some ecological values adversely, the impact of silviculture is considerably less, and more easily managed, than the impact of agriculture or urban development.

BENEFITS OF DEBRIS

In a Symposium paper on nutrient mobilization, Pritchett and Wells pointed out that many of our forest sites are already marginally deficient in nitrogen, phosphorus, and possibly potassium, and that these deficiencies can be aggravated by site preparation treatments that cause erosion or leaching. Windrowing is undesirable in that it removes both organic debris and some mineral soil from the planting site. Bedding might be undesirable if nutrients are leached from the beds before an effective nutrient sink is developed by the planted pine seedlings and the recovering ground vegetation. Debris and litter not only contain essential nutrients but, if left in place, they act as a protective cover for mineral soil, lessen runoff and erosion losses and often insure a favorable environment for soil fauna and flora, including mycorrhizal fungi.

CHOICE OF SITE PREPARATION TECHNIQUES

At the same meeting, Balmer and Little discussed many of the advantages and the trade-offs of preparing sites with prescribed fire, herbicides, rolling choppers, tree crushers, V-blades, K-G blades, disk harrows, rootrakes, and bedding harrows. They decided that biologic and economic factors vary so much among forest landholdings that the local land manager will have to determine which site preparation techniques are best suited for his sites. Some of their statements have particular application to this discussion: The use of

herbicides is becoming more popular as a site preparation technique. Granular herbicides are now being tested that should reduce the drift and water pollution problems associated with sprayed herbicides. Chemical preparation does nothing about the problem of debris, but burning after chemical application will facilitate planting. Drum chopping is one of the best mechanical treatments in that it reduces early competition, disturbs the soil little, and retains the organic matter and nutrients from debris on the site. Chopped areas usually must be hand planted, but chopping plus burning often clear the site enough for machine planting.

PREPARATION OF PIEDMONT SITES

In a discussion of Piedmont sites at the Symposium, Nutter and Douglass warn that increases in soil erosion are to be expected as one cost of mechanical site preparation. As alternatives to mechanical preparation on sloping land, they propose either prescribed burns that do not destroy all of the protective organic matter, or, herbicide treatments kept away from streams, roads, and skid trails to avoid pollution. As an alternative to mechanical preparation that seems necessary for high-survival machine planting, they suggest simply planting more trees per acre by hand.

PREPARATION OF UPPER COASTAL PLAIN SITES

In discussing site preparation in the upper Coastal Plain, McLurkin and Moehring report that such practices as shearing and piling, chopping, tree crushing, burning, chemical treatment, disking and bedding are being applied for the first time to large areas of sloping, fragile soils in that region. They cite references indicating that chopping or crushing vegetation and debris tends to buffer soil temperature extremes, reduce the speed of drying winds,

prevent soil compaction, and reduce overland flow of water; thus chopping and crushing are preferred to treatments in which debris is piled and mineral soil is bared. They are concerned that scalping of litter and mineral soil during windrowing or in front of the planting tractor may deprive young seedlings of more nutrients than does removal of nutrients through timber harvesting. They state that chemical control of unwanted vegetation would reduce the intensity of physical site disturbance in the upper Coastal Plain, but existing public concern over possible damage to the environment precludes its immediate, effective use. They also point out that some of the site preparation activities may be affected by restraints imposed by the Federal Water Pollution Control Act Amendments of 1972 (PL 92-500).

PREPARATION OF LOWER COASTAL PLAIN SITES

In discussing lower Coastal Plain sites at the Symposium, Shoulders and Terry made these statements or observations: Shearing, rootraking, windrowing or burning to rid sites of unmerchantable stems and debris will eventually be replaced by utilization of this material for fuel or fiber. Pine growth is improved by preparation treatments that substantially reduce competing vegetation, remove excess surface moisture, and improve soil aeration. Chopping, furrowing, flat disking and bedding are among the methods used to eliminate competing vegetation. Bedding should be prescribed for vegetation control only if bedding is also necessary for improving soil aeration or for increasing depth to free water during critical wet periods of the year. On most lower Coastal Plain sites, bedding does not lead to serious soil erosion. Individual studies have produced conflicting early results, and the questions of how long growth is accelerated by bedding and draining, and how long the response persists have not been resolved.

PINE YIELD ON PREPARED SITES

Clutter and Dell discussed expected yields on prepared sites at the Symposium. They stated that the data base on site-prepared rotation-age plantations is quite small at present. However, it appears that site-prepared slash pine plantations are producing lower yields than comparable old-field plantations, but higher yields than comparable rough-woods plantations. They point out that height growth increases aside, site preparation usually increases yields because a much higher and more consistent stocking level will be achieved on most prepared sites.

MAINTAINING PRODUCTIVITY ON PREPARED SITES

In discussing strategies for maintaining forest productivity, Bengston argues that actions taken in anticipation of productivity declines will be more effective in the long run than attempts at restoration. He believes that a fundamental rule in harvesting and site preparation is to minimize displacement and loss of topsoil and organic residues. He recognizes the well-documented benefits of prescribed burning, but thinks that the impacts of nitrogen volatilization from organic matter during burning needs further study.

In leaving this review of debris and vegetation management as discussed at the Productivity Symposium, I'd like to add that some of the soil scientists in the Southeastern Forest Experiment Station are pursuing some of the prescribed burning research that Bengtson suggested would be desirable. The nitrogen contents of litter and mineral soil are being determined in several long-term prescribed burning studies throughout the Southeast, and nitrogen gains to the ecosystem through native and cultivated legumes are also being determined.

CONCLUSIONS

Unpublished data from a site preparation study on the Lower Coastal Plain of South Carolina graphically illustrate many of the concerns of debris and vegetation management that I have been discussing (fig. 1). In this study, a well drained to somewhat poorly drained site of mostly Goldsboro loamy sand was prescribed burned, clearcut, burned again, site prepared, and dibble planted to loblolly pine. A few months after planting, the resprouting hardwoods were sprayed with 2, 4, 5-T. Generally, the more intensive the mechanical site preparation had been, the fewer hardwoods that resprouted, and therefore, the less herbicide that was sprayed and the lower the cost of the herbicide treatment.

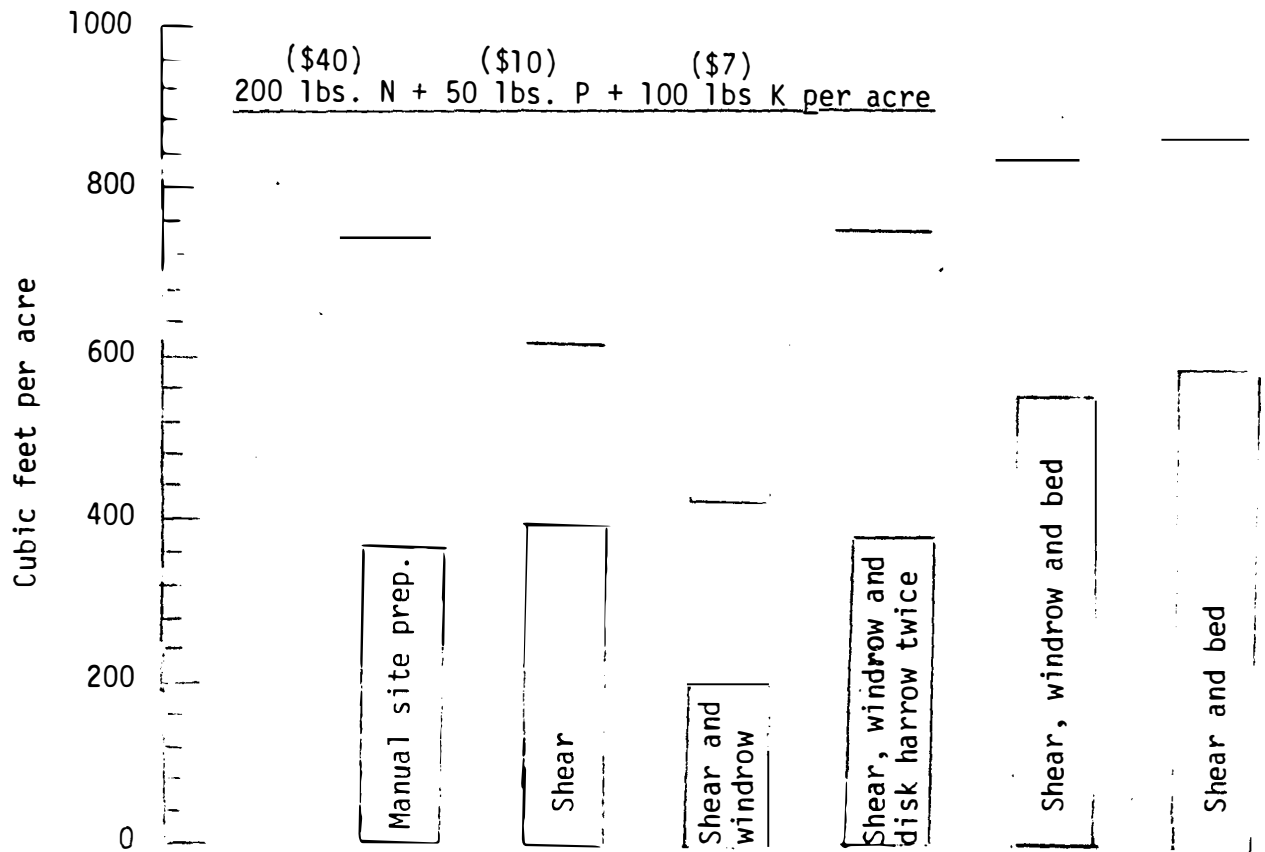
Eight years after planting, per cubic foot yields (inside bark from a 6-inch high stump to stem tip) were similar for the two least expensive site preparation treatments. However, shearing shrubs and non-merchantable trees with a tractor-mounted K-G blade plus a medium application of herbicide cost \$9 more per acre than felling non-merchantable stems with chain saws plus a heavier application of herbicide.

Following the shearing with rootraking of debris (and some topsoil) into windrows added \$21 per acre to the cost of preparation, and, probably through loss of organic matter and nutrients, reduced growth so much that volume was about half that of the less expensive treatments.

Following shearing and windrowing with two disk harrowings and a low intensity herbicide treatment recouped the volume loss due to windrowing, possibly because harrowing resulted in more rapid mineralization of nutrients or in the loosening of topsoil compacted during the shearing and windrowing operations.

The total cost of this treatment, however, was more than double that of the manual treatment.

Bedding after windrowing more than offset the loss in volume resulting from windrowing. The improved growth and yield on beds are probably due to better soil aeration, although the concentrating of nutrients and organic matter by the bedding harrow may have contributed to the better growth. The cost of this treatment also was more than double that of the manual treatment.



Preharvest burn	\$ 1	1	1	1	1	1
Fell nonmerchantables	11					
Postharvest burn	1	1	1	1	1	1
Shear with K-G blade		25	25	25	25	25
Windrow with rootrake			21	21	21	
Disk harrow twice				16		
Bed					18	18
Spray 2,4,5-T	<u>21</u>	<u>16</u>	<u>16</u>	<u>8</u>	<u>8</u>	<u>6</u>
Subtotal	\$34	43	64	72	74	51
Total with fertilizers	\$91	100	121	129	131	108

Figure 1.--Cubic foot volumes per acre of loblolly pine eight years after planting.

Anticipating that windrowing might be detrimental to growth, Glyndon Hatchell, who established this study, included a treatment in which sheared plots were bedded without being windrowed. The beds in this treatment were poorly formed, and in some places not formed at all, because debris often became lodged between the disks of the bedding harrow. Nevertheless, volume from this treatment was slightly greater than that from the windrowed and bedded treatment, and the cost per acre was \$23 less.

A fertilization comparison was also included in this study. One year after planting, randomly selected plots within each site preparation treatment received 50 pounds of elemental phosphorus per acre applied as triple superphosphate or 100 pounds of elemental potassium applied as muriate of potash or the combination of P and K or were left as unfertilized checks. Five years after planting, 200 pounds of elemental nitrogen were applied as urea to those plots that had received fertilizer at one year.

The combined N + P + K treatment increased volumes of the six site preparation treatments by 44 to 117 percent. Notice in Figure 1 that fertilization of the sheared-windrowed plots raised their average volume to slightly above those of the unfertilized plots receiving the two site preparation treatments of lowest cost. This is heartening, but only from the standpoint that it suggests that productivity lost by detrimental treatments might be restored on some sites by expensive applications of fertilizer.

Figure 1 can be used to summarize the three main points that I wish to leave with you:

1. Vegetation and debris management should be incorporated into thinning and periodic burning whenever possible, so that detrimental effects from debris-management treatments after final harvest--such as windrowing--will be minimized.
2. Even when considerable debris and vegetation are present after final harvest, site preparation techniques are available that do not necessitate piling of organic matter or undue exposing of the mineral soil.
3. The expense of the disking or fertilization treatments required to restore the productivity lost by windrowing emphasize the argument that actions taken in anticipation of productivity declines will be less expensive and probably more effective than attempts at resotation of productivity..

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