A REFORESTATION CASE STUDY ON A RECLAIMED APPALACHIAN MINE SOIL IN WEST VIRGINIA[1]

by

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Abstract: An Eastern white pine (*Pinus strobus* L.) study was established on a reclaimed surface mine in the Appalachian coal fields of West Virginia in 1985. One of the reasons for establishing this study was to demonstrate the growth potential of white pine when mined land is reclaimed in accordance with guidelines developed to maximize long-term forest productivity. Overburden placed at the surface of the study site was an acidic, oxidized, brown sandstone (pH 4.8). Final grading was minimized to avoid compaction and some gullies and boulders were left on the surface of a 40% slope. A tree-compatible ground cover consisting of short-statured plants adapted to acidic soils was used and compared with a traditional "hayland pasture" ground cover. White pine seedlings were hand planted on a 12 x 12 ft spacing (302 trees/acre) to provide optimal crop tree spacing for sawtimber production and black locust was direct seeded at a rate of 0.5 lb acre to establish the additional number of trees required for bond release. After five years, all requirements for bond release were achieved; ground cover percentage was nearly 100%, white pine survival was 73%, and an adequate total number of trees existed to meet tree stocking criteria. Most importantly, excellent growing conditions were created for long-term tree growth. After five years, the average white pine height was 80 inches and some trees were more than ten feet tall. This study shows that productive forests can be established on reclaimed mined land if coal companies exercise controlled overburden selection and placement techniques, minimize grading, and use a tree-compatible ground cover.

Additional key words: forest land productivity, ground cover, compaction.

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Introduction

In the Appalachian coal mining region of Virginia, eastern Kentucky, and southern West Virginia, most surface-mined land was forested before mining. Because of the steep topography and remoteness of many of these areas, only a limited amount of reclaimed mined land can be used for higher-order land-uses such as residential development, commercial development, crops, or hayland or pasture. Consequently, the designated post mining land-use for much of this mined land is forest land. In

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Virginia, the Division of Mined Land Reclamation and the Virginia Department of Forestry strongly encourage coal companies to reclaim mined land with Eastern white pine (Pinus strobus L.).

White pine is a good tree species for planting on reclaimed mined land in the Appalachians. Like most coniferous species, white pine is tolerant of acidic sites and does not require high levels of soil fertility to achieve good growth. White pine is unrivaled for its potential to produce sawtimber. On a good site, a natural stand of white pine will produce about three times as much merchantable timber as a natural oak stand at age 50 (Doolittle, 1958). White pine is relatively free of insect and disease problems in the southern Appalachians, and will probably be avoided by the gypsy moth when it moves into the region. Since natural forests of the southern Appalachians are dominated by deciduous species, the diversity of forest cover types (on a regional scale) can be improved by planting coniferous species such as white pine. The visual and thermal cover provided by white pine during the winter will benefit many wildlife species.

Despite the potential environmental and land-use advantages associated with planting white pine, many coal companies have been frustrated by failed efforts to successfully establish white pine stands. In many cases, coal companies plant trees one or two years after the site has been revegetated with an erosion control cover dominated by Kentucky-31 tall fescue. Seedlings often die because of mishandling before or during planting, or because of competition from the dense ground cover. High mortality can force coal companies to replant seedlings and prolong the bonding period.

The Virginia Tech Forestry Department began a forestry reclamation research program in 1980 with funding from the Powell River Project. The overall goal of this research program has been to develop guidelines which will lead to the reclamation of productive forests and keep reclamation costs as low as possible. The results of some of these studies were summarized during the 1990 Mining and Reclamation Conference in Charleston WV (Torbert et al. 1990a). Briefly stated, much of the mined land in the southern Appalachians can be successfully reclaimed to productive forest land if special consideration is given to: 1) selecting an overburden with chemical and physical properties suitable for trees (as opposed to grasses), 2) avoiding compaction, 3) selecting tree-compatible ground cover species, and 4) employing well trained tree planters to avoid mishandling of seedlings before and during planting.

In 1986, a study was established in West Virginia that incorporated the four considerations mentioned above. The study was partially designed to serve as a demonstration of the potential that white pine can achieve when mined land is carefully reclaimed to enhance forest productivity. Additionally, this study was designed to test some hypotheses concerning the feasibility of direct seeding white pine and black locust, the effect of fertilizer pellets on tree growth, and the long term comparison of alternative ground covers. Fourth-year results were reported by Probert and co-workers (1990). The purpose of this paper is to confirm that, with an experimental variance, this reforestation attempt easily met bond-release requirements after 5 years, reclamation was less expensive for the miner, and the long-term productivity of the land was higher than if standard, required practices were followed.

Study Description

The study was established in Wyoming County, WV on a 40% return-to-contour slope. The study site was selected because it appeared to have desirable spoil characteristics for long term tree growth. The area had been backfilled with brown sandstone overburden. With an experimental variance from the West Virginia Department of Natural Resources, final grading was kept to a minimum. Some boulders and gullies were left and the site was not "tracked-in" with bulldozers before ground cover seeding.

Half of the plots in the study were hydroseeded with a "tree-compatible" ground cover that consisted of fewer grass and legume species and lower seeding rates than the "conventional" ground cover mixture that the coal company typically used (Table 1). White pine seedlings (2-0) in this study were obtained from the Virginia Department of Forestry. Seedlings were graded such that all seedlings had a stem caliper of approximately 0.25 inches; smaller and larger trees were discarded. Stem heights ranged from 8-12 inches. Seedling roots were pruned to a length of 8 inches and dipped in a soil moisturizing slurry. Trees were handplanted in mid April 1986. Soil moisture levels were good for planting and several days of cool rainy weather followed.

A detailed discussion of the methods and fourth year results were provided by Probert and co-workers (1990).

Table 1. Seed and fertilizer rates used for ground cover treatments

	Ground Cover Treatment	
	Standard	Tree Compatible
Plant Species	- - lb / acre - -	
foxtail millet	.	5.0
KY-31 tall fescue	33.8	.
perennial ryegrass	17.0	5.0
annual ryegrass	11.5	.
orchard grass	10.7	.
redtop	.	2.0
highland bentgrass	2.0	.
birdsfoot trefoil	7.3	5.0
mammoth red clover	8.0	.
yellow sweet clover	4.8	.
'Appalow' lespedeza	.	10.0

Results and Discussion

Tree survival

Obtaining good seedling survival is a fundamental problem for many coal companies. Many tree planting efforts have failed on reclaimed mined land as result of negligent tree planting practices. Sometimes planting holes are too shallow because the soil is so compacted that it is difficult for planters to make a deep hole. Some planters compensate for shallow holes by pruning roots so short that only a small stub remains to fit into a shallow hole. In this study, the soil was very rocky, but it was easy to plant seedlings because the soil was uncompacted. Deep planting holes were made with only one or two stabs of the dibble bar. Trees were planted deeply and the planting hole was completely closed. As a result of proper planting, tree survival was good (73%) despite two extremely droughty summers.

Although specific bond release requirements vary from state to state, most states require 400-600 trees and shrubs per acre by the end of the 5-yr bond period. In this study, bond release requirements and forest management objectives were simultaneously achieved by planting pines on a wide spacing (12 x 12 ft; 302 trees/acre) and direct seeding nitrogen-fixing nurse trees to obtain the additional trees needed for bond

release. Yield tables for white pine (Balmer and Williston, 1983) indicate that greater sawtimber harvests will be obtained when trees are planted on a 12 x 12 ft spacing than on closer spacings. By direct seeding the remaining trees needed for bond release, the total cost for tree establishment can be reduced (relative to planting 600 trees/acre). The cost of seed for most N-fixing tree and shrub species is very low. In this study, black locust was seeded at a rate of 0.5 lb/ acre and produced an average of 1,050 stems per acre at age five. The cost to establish these N-fixing trees was about $3.00/acre. Other N-fixing trees and shrubs that can be seeded are autumn olive, bicolor lespedeza, thornless honey locust, redbud, and European black alder.

Tree growth

Forest productivity is a function of tree stocking and growth rate. Most states require trees to be at least 12 inches tall at the end of the bond period. In this study, the average tree height after five years was 80 inches and some trees were more than 10 feet tall. Tree height was not affected by fertilizer tablet treatment (Probert et. al, 1990). Based on height/age curves these trees should be more than 100 ft tall at age 50 (Beck, 1971). By comparison, the average white pine growth in natural stands throughout the southern Appalachians is only 80 ft by age 50 (Doolittle, 1958). It is apparent from this study that mined land can be reclaimed to a level of forest productivity that sometimes exceeds pre-mining levels.

Minesoil properties for tree growth

When the designated post-mining land-use is forestry, the best minesoil for trees (as opposed to grasses) should be selected since trees will be the long term vegetation. This study site was selected because the spoil appeared to have chemical and physical properties desirable for long term tree growth. The surface spoil was a brown, oxidized sandstone, which previous studies in Virginia indicated to be a preferred spoil type for pines (Torbert et al. 1990a). Coal companies often avoid placing this type of spoil at the surface because the low pH (4.0-5.5) and high phosphorus fixing capacity (due to the prevalence of oxidized iron) make it difficult to establish a sustainable cover of grasses and legumes. Most trees and some ground cover species, however, are adapted to infertile, acidic, sandy soils, and grow better in this type of spoil than in some siltstone or non-oxidized sandstone spoils that have a pH near neutral.

In the process of removing boulders, filling gullies, and making smooth slopes, coal mine operators compact the soil. To avoid compaction, the final surface was not graded as intensively as mined land is usually graded. Whereas hayland/pasture requires a smooth surface that can be traversed by machinery, natural forest land is uneven and rough. An experimental variance was obtained from the West Virginia Department of Natural Resources to leave some boulders and gullies on this site, and this site was not "tracked-in" before seeding. Coal companies can save money by grading less, while simultaneously producing more productive forest land by compacting it less.

Tree-compatible ground covers

A ground cover must be established to stabilize the soil, reduce erosion, and initiate the development of a nutrient cycle. When the post mining land use is forest land, it is desirable to use ground cover species that are short-statured and adapted to acidic, sandstone spoil. A tree-compatible cover was used in this study and compared with a conventional

"hayland pasture" cover that included Ky-31 tall fescue and several clover species. After the first year, cover in the conventional plot was slightly greater than the tree-compatible plot (87% vs 81%; Probert et. al, 1990), but by age five both ground cover treatments resulted in almost 100% cover. It was not easy to distinguish between the two ground cover treatments after the second year because of cross seeding between treatments. By the end of the fifth year, Appalow lespedeza dominated the tree-compatible plots and invaded most of the conventional ground cover plots to become a predominant species. Appalow is an aggressive plant that thrives on acidic spoil. However, since Appalow took several years to be completely established, trees had time to grow above the ground cover and were never overtopped.

Reclamation Costs

Historically, coal companies have viewed tree planting as an additional reclamation expense and liability. Since most coal companies do not own the reclaimed land, there is little incentive for them to ensure good long-term productivity. With the reclamation variances used in this study, coal companies could create more productive forest land by spending less money than they typically spend to reclaim land for hayland/pasture.

The greatest cost saving opportunity is in reduced grading costs. Coal companies could save 3-4 hours of bulldozer time and labor expenses per acre by leaving a rough surface more typical of natural forest land. Based on 1990 retail seed prices, the tree compatible cover used in this study cost $50/acre less than the conventional cover ($54.36 vs. $104.26). By creating a good minesoil and using a tree-compatible cover, tree survival and growth will be good. Thus expenses associated with replanting dead trees and prolonging the bond period can be reduced if not eliminated.

Summary

Traditionally, coal companies use the same minesoil construction, grading, and revegetation practices for the reclamation of forest land that they use when the designated post mining land use is hayland or pasture. Consequently, tree survival is often limited by dense herbaceous vegetation during the first year, and long-term tree growth is limited by compacted soil. This study was established to demonstrate that bond release requirements could be achieved, reclamation costs could be reduced, and long-term forest productivity could be increased if coal companies were able to reclaim mined land for forests in a different (and less intensive) manner than they reclaim land for hayland or pasture. Coal mining offers the opportunity to increase the level of forest productivity above premining levels; success can be achieved by selecting an overburden with chemical and physical properties suitable for trees, by minimizing final grading, and by sowing less competitive tree-compatible ground cover species.

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