REFORESTATION OF SURFACE-MINED LAND IN MARYLAND[1]

by
Fred L. Bagley[2]

Collaboration with
Steve Shaffer[3]

Abstract: Maryland's coal region is located in the two most westerly counties on the eastern outlier of the Appalachian coal fields. Five distinct coal basins range from 1200 feet to 3800 feet in elevation. Rainfall ranges from 40 inches to 48 inches per year. Over 8 million trees and shrubs have been planted on 8500 acres since reforestation of reclaimed mined land began in 1960. Maryland's BOM has promoted tree and shrub planting on reclaimed mine land by offering direct contact with landowners and coal operators, professional and technical support, cost-sharing programs, and a variety of species of suitable planting size. The elements of a successful tree planting program are adequate time and money, planting stock selection and care, planting early in the spring and close supervision of all phases of planting. Problems can be overcome by changing or eliminating species susceptible to deer damage, scalping away herbaceous cover, and proper supervision. Where reforestation efforts are unsuccessful, basic technical aspects were never learned or are not practiced.

Additional Key Words: Reforestation success; Maryland; instructions.

PART I: AGENCY ASPECTS

Maryland has been deep-mining coal since the 1830s; surface mining operations began in 1943. The state's coal production is 3.5 to 4 million tons annually, which is small in relationship to other coal-producing states. Only portions of two counties in Maryland, 477,000 acres, (of which 346,000 acres are forested), are involved in mining. There are five distinct coal basins ranging in elevation from a low of 1200 feet to a high of 3800 feet. Rainfall is well distributed, averaging 40 inches per year in the lower elevations up to 48 inches per year in the higher elevations. Soils are generally clay and clay loams with clay comprising 36 to 39 percent.

The entire region was cut over by large timber operations at the turn-of-the-century; the land was sold to homesteaders who tried to farm it. The high percentage of clay in the soil makes farming poor at best. Unsuccessful farming operations contributed to erosion of topsoil during this period. The soil is ideal for woodlands, however, and these are probably the only two counties in the state where the number of forested acres is increasing.

The steepness of the terrain ranges from 0 to 35 degrees but averages 10 to 12 degrees. Since 1974, Maryland is the only state in the country that does not allow mining on slopes greater than

[1]Paper presented at the American Society for Surface Mining and Reclamation Meeting in Duluth, Minnesota, June 14-18, 1992.

[2]Fred L. Bagley is the chief of planning, development and analysis with the Maryland Department of Natural Resources, Bureau of Mines, 106 South Water Street, Frostburg, MD 21532.

[3]Steve Shaffer is a reclamation supervisor with Buffalo Coal Company, Bayard, WV 26707.

Proceedings America Society of Mining and Reclamation, 1992 pp 616-623
DOI: 10.21000/JASMR92010616

20 degrees. Maryland law also requires the land be returned to its original contours as part of the reclamation operation.

Maryland's first surface-mine law was enacted in 1955 but did little for the cause of reclamation until it was substantially amended in 1969. This amendment created the State Land Reclamation Committee (LRC). The committee consists of thirteen members representing the following: Forestry Service (1), Wildlife Service (1), Soil Conservation Districts (2), county governments (2), Maryland Geological Survey (1), Department of the Environment (1), mining industry (2), Bureau of Mines (1), and the general public (2). This committee approves the reclamation portion of the mining plan before the Bureau of Mines (BOM) can issue a permit. The LRC conducts annual field reviews to inspect the progress of reclamation activities on active permits. Its members evaluate and approve the revegetation before BOM can release bond money.

Maryland's 1955 strip mining laws assigned responsibility for revegetation of mined lands to the Maryland Forest Service, thus the concentration on tree planting. In 1975, responsibilities for reclamation and revegetation of mined land were transferred to BOM. In June 1974, requirements for stockpiling topsoiling material, backfilling to original contour and planting a herbaceous cover to control erosion were added. These changes precipitated a decline in tree planting on mined lands.

Tree and Shrub Planting History

Planting trees and shrubs on surface-mined areas began in 1960; an average of 300 acres per year were planted from 1960 through 1975. Tree planting declined after 1975 and this trend lasted until 1987. During this period, an average of 195 acres per year were planted on reclaimed areas. This decline was attributed to several causes:

(1) the requirement to establish a herbaceous cover to control erosion made reforestation more difficult and more complex;
(2) the Maryland Department of Natural Resources (DNR) began charging for trees (previously as many as 100,000 trees per year were given free of charge to any Maryland citizen, including coal operators);
(3) passage of the Federal Surface Mining Act in 1977 created additional requirements that increased costs for coal operators, consequently, the added cost for planting trees was eliminated from reclamation plans; and
(4) there was a general decline of the number of acres mined and reclaimed in Maryland.

During the summer of 1987, the decline in tree planting was addressed through a joint effort of the BOM, LRC and the Maryland Forest Advisory Commission. BOM initiated a program to share costs with the coal operators to encourage the planting of more trees and shrubs on reclaimed mined land.[4] BOM buys the trees and the operator pays the planting costs. As a result an average of 253 acres of reclaimed land have been planted each year during the last four years.

Agency Actions to Promote Tree Planting

For many years Maryland's BOM has promoted tree and shrub planting on reclaimed mine land by offering the following:

* direct contact with landowners and coal operators,
* professional and technical support,
* cost-sharing programs, and
* a variety of species of suitable planting size.

Direct contact with landowners and coal operators allows LRC members and BOM employees to explain the benefits, procedures and costs involved during the permit review process.

The Maryland Forest Service, from 1960 to 1976, and BOM thereafter, have provided professional and technical support. These services include performing soil sampling and analyses, recommending areas and species to plant, assisting in filing the necessary forms when ordering trees, delivering trees to the planting site, demonstrating the proper methods and techniques of planting, assisting in obtaining contractors to plant the trees and evaluating the planting operation.

---

[4]Maryland's surface coal mining law has a provision that allows the Bureau of Mines to expend up to 50 percent of the cost to revegetate reclaimed mined land.

Funding for the cost-sharing program are derived from a 17 cent per ton reclamation fee paid by coal operators on each ton of coal mined in Maryland. A portion of this fee (six cents per ton), earmarked for BOM's programs yeilds approximately $75,000 annually.

By working in cooperation with the DNR nursery and private vendors, BOM is able to supply a wide variety of species at the proper time of year and of suitable planting size.

Success of Planting

A successful reforestation program requires the following:

* commitment;
* healthy planting stock;
* early planting; and
* proper planting practices.

The most important variable is total commitment. This includes adequate funding and sufficient manpower resources, a flexible management style that allows the on-site supervisor latitude to make needed changes and decisions and cooperation with other county, state and federal agencies.[5]

Planting stock must be properly selected and cared for from the time of harvesting until the actual planting on the mining site. Trees should not be stored for longer than four weeks and proper watering procedures are very important.

Planting the trees as early as possible in the spring is another extremely important point. Start planting as soon as frost leaves the ground and complete planting within a four week period. Preplanning and preparedness, as evidenced by ordering trees, hiring crews, determining and visiting job sites, etc., are essential so time will not be wasted during the actual tree planting time frame.

Supervision is essential to assure proper tree care and the planting practices. When agencies and coal companies do not spend the time and money that is necessary to assure this, the results are often disappointing. One of the most critical planting practices is the scalping or removal of the grass layer approximately 12 inches in diameter around each seedling where herbaceous cover has formed a sod layer.

Problems and Solutions

In recent years, the problems Maryland has encountered with tree planting include the following:

* damage to and destruction of new plantings by deer;
* establishment of trees in heavy herbaceous cover; and
* availability of trees at the proper time and size to plant.

As deer problems intensify, monitoring of potential planting sites and general knowledge about deer herd location are very beneficial. To combat the deer damage problem, Maryland plants species that the deer are less likely to eat and eliminates highly-susceptible species from planting. (See Table 1 for a species listing.)

The effect of heavy herbaceous cover on the survival and growth of trees can be mitigated with the proper care, planting techniques and supervision of the actual tree planting operation.

Maryland is planting black locust as a first crop particularly on slopes greater than twelve degrees. Foresters have chosen this species because black locust is a legume, a natural invader, fast grower and easy to establish. There is a market for its products; Westvaco Resources, Inc. has a paper mill located in the center of the coal region providing an available market for pulpwood.

PART II: TECHNICAL ASPECTS

Methods cited here have been developed by experienced foresters engaged in surface-mine planting over the past 30 years. Although these methods are very basic, experience has shown that most problems with tree planting on mined land result when the basics have not been learned or are not practiced. The procedure and tools explained give the best results with the least amount of confusion.

The area to be planted should be reviewed in the field by the supervisor before the planting operations begin to determine the size, the shape, and the hazards (if any) of the planting area.

---

[5]Each state may have other unique requirements or functions that must be considered.

Table 1

MINED LAND TREE PLANTING IN MARYLAND
Results from Species Planted in Western Maryland

Species	*Results*			*Remarks*
	Good	*Fair*	*Poor*	
Scotch Pine *(Pinus sylvestris)*	X			Not much deer damage
Virginia Pine *(Pinus virginiana)*			X	Does not withstand vegetative competition well; needs a low vegetation
White Pine *(Pinus strobus)*		X		Deer damage when in juvenile stage
Red Pine *(Pinus resinosa)*	X			Deer damage when in juvenile stage
European Larch *(Larix decidua)*	X			No deer damage; breaks bud very early; plant early
Dogwood *(Cornus spp.)*			X	Cannot withstand heavy grass competition
Norway Spruce *(Picea abies)*	X			Very slow initial growth; some deer damage
Tulip Poplar *(Liriodendron tulipifera)*			X	Deer damage; does not withstand vegetative competition well
Black locust *(Robina pseudoacacia)*	X			Fairly easy to establish if seedlings are not too small; no deer problem
Chinese Chestnut *(Castanea mollissima)*		X		Good survivability but poor height growth
European Black Alder *(Alnus glutinosa)*	X			No deer damage; die-back noted after 15 to 20 years; good cover tree
Black Walnut *(Juglans nigra)*			X	Due to poor site conditions; poor form
Sycamore *(Platanus occidentalis)*			X	Needs low elevations
Red Oak *(Quercus rubra)*		X		Good survivability but very poor height growth
Table Mountain Pine *(Pinus pungens)*	X			Heavy deer damage when young; has ability to sprout following deer damage
Pitch Pine (Pinus rigida)		X		Susceptible to deer damage; does well in heavy competition
White Ash *(Fraxinus americana)*		X		Moderate survivability but poor height growth
Autumn Olive *(Elaeagnus umbellata)*	X			Very good wildlife species; appears to withstand all conditions well
Arnot Bristly Locust *(Robina fertilis)*		X		Slow growth; survival good
Fraser Fir *(Abies fraseri)*			X	Extremely heavy deer damage
Yellow Birch *(Betula alleghaniensis)*			X	Does very poorly in grass cover
Paper Birch *(Betula papyrifera)*		X		Some deer damage; responds fairly well to vegetative cover
Black Cherry *(Prunus serotina)*			X	Responds poorly in herbaceous cover
Choke Cherry *(Prunus virginiana)*		X		Survivability good but height growth poor
Winterberry Holly *(Ilex verticillata)*			X	Believed due mainly to small planting stock
American Mountain Ash *(Sorbus americana)*	X			Initial results look good
Staghorn Sumac *(Rhus typhina)*		X		Smaller planting stock seems to do better than larger
Red Maple *(Acer rebrum)*			X	Deer damage; responds poorly in heavy grass

Species	*Results*			*Remarks*
	Good	*Fair*	*Poor*	
Common Apple *(Malus pumila)*		X		Fair growth; deer damage not as much as expected initially
Siberian Crabapple *(Mulus baccata)*			X	Fair growth; deer damage not as much as expected initially
Bigtooth Aspen *(Populas grandidentata)*		X		Survivability good; height growth fair
Tartarian Honeysuckle *(Lonicera spp.)*		X		Did poorly in heavy herbaceous cover
Purple Osier Willow *(Salix spp.)*	X			Did good in extremely wet areas, otherwise only fair survival
Speckled Alder *(Alnus rugosa)*			X	Responded well under all extremes and conditions; good survival and height growth
Douglas Fir (Pseudotsuga menziesii)		X		Heavily deer damaged; appears to sprout profusely but poor height growth
White Spruce *(Picea glauca)*		X		Good survival but poor height growth initially
Red Spruce *(Picea rubens)*		X		Fair survival but poor height growth
Rhododendron *(Rhododendron maximum)*			X	Did poorly
Hybrid Poplar *(Populus spp.)*			X	Does not do well when planted in heavy grass cover
Redbud *(Cercis canadensis)*			X	Low elevation; plant early
Lob-Pitch Pine *(Pinus taeda x rigida)*			X	Does well where herbaceous competition is slight; otherwise did poorly
Serviceberry *(Amelanchier arborea)*		X		Believed due to very small planting stock
Sugar Maple *(Acer saccharum)*			X	Responds poorly in heavy grass cover
Green Ash *(Fraxinus pennsylvanica)*		X		Good survival; poor height growth; plant very early, no heavy competition
Pin Oak *(Quercus palustris)*		X		Moderate survival; deer damage
Sawtooth Oak *(Quercus acutissima)*		X		Moderate survival; deer damage
Bicolor Lespedeza *(Lespedeza bicolor)*			X	Low elevation; no heavy competition
White Oak *(Quercus alba)*		X		Good survival; poor height growth
Japanese Larch *(Larix leptolepis)*	X			Good survival and growth; plant early
Black Pine *(Pinus nigra)*	X			Wet areas

Although each surface-mine is unique, basic methods can be used to prevent confusion during the tree planting operation. Normally, surface-mines are irregular in shape and can vary in length and width at different locations. If the crews are not closely supervised, small areas may not be planted and near the end of the planting job all of the planting units will converge, creating poor planting, causing confusion and wasting time and money. The ideal method is to keep the planting units working in one direction and as far apart as possible. This is best accomplished by the crews planting in a circular pattern.

Mechanics of Planting

BOM has certain guidelines for planting trees on reclaimed mined areas. Briefly, these guidelines are as outlined below:

Spacing:

Space black locust 600 trees per acre and conifers and hardwoods 750 trees per acre. Spacing for shrubs depends on site and goals.

Planting season in Western Maryland:

Begin planting as soon as frost leaves the ground. Once plants are harvested, plant within a four week period for surface-mined areas. The earlier trees are planted, the higher the survival rate will be.

Planting methods:

Foresters recommend hand planting for small and odd-shaped areas or for special purposes. This methods is best for areas where the site conditions are not conducive to machine planting, e.g. stony, steep or rough.

Machine planting is best for areas of at least three acres and on gentle slopes of less than 12 degrees.

Planting precautions:

Plant as soon as possible after trees are received. Keep seedling roots moist at all times. Store seedlings in a cool and dark location. Plant properly. Do not jam or push roots into the hole. Do not insert seedling at an angle. Plant at proper depth, which is the same depth as in the nursery. Protect the plantation from grazing and fire during and after the planting operation.

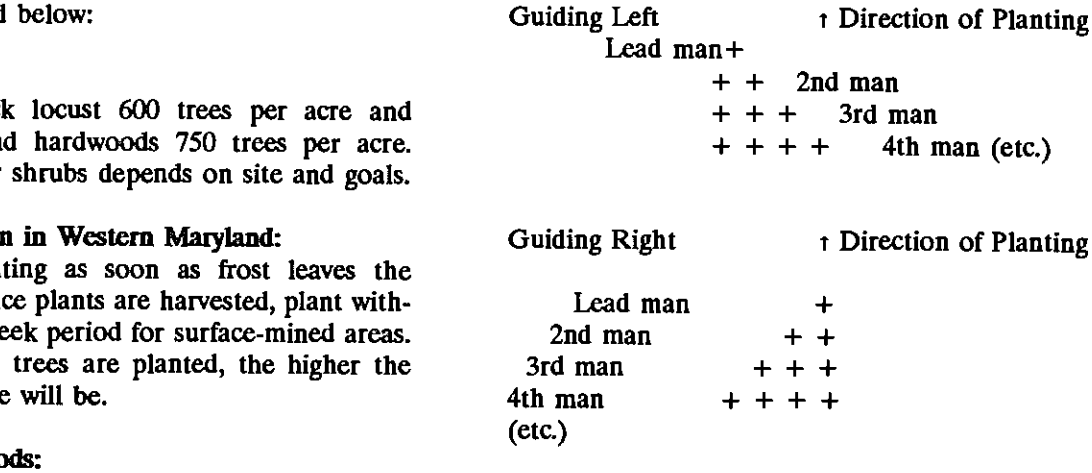
Supervision:

Close supervision enhances success.

Method of Working a Crew

Before the actual planting operation begins, it is necessary to give the planters complete instructions. Divide the men into crews and designate a foreman. Give each planter the particular species of tree to be planted. In some cases, alternate rows of compatible tree species are required. When all members of the crew have trees, assign a lead person and place the crew. Normally, the lead person is a good planter who can follow instructions. Inform the lead planter of the area to be planted, with each planter staying one tree behind the person he is using as a guide. See illustration below:

Step Method



Crew size and necessary crew control will yield the best planting results. Without control, there will be considerable waste of tree seedlings, time and money.

The best planting unit is composed of 8-10 planters per foreman. When a planting unit is larger, the foreman may lose control; poor planting usually results.

In Western Maryland, BOM has used crew sizes ranging from four to 65 planters. As you can imagine, different size crews present many different problems.

For best control, the smaller crew is desirable. A small crew is considered to be 20 or fewer planters. With a crew of this size, fewer supervisors are needed and general confusion is minimized.

Unfortunately, small crews cannot always be

used especially when large acreages are to be planted in a short period of time. When large crews are used, it is advisable to have several experienced people supervising the planting job. These supervisors should organize the crew into the smaller planting units.

The following is a diagram of different size crews:

Small Crew (Less than 20 Planters)

Supervisor
Foreman
Planting Unit
8 to 10 Planters

Planting Unit
8 to 10 Planters

Large Crew (More than 20 Planters)

Supervisor		Supervisor	
Foreman	Foreman	Foreman	Foreman
Planting Unit	Planting Unit	Planting Unit	Planting Unit
8 to 10 Planters	8 to 10 Planters	8 to 10 Planters	8 to 10 Planters

The foreman's duties consist of maintaining spacing, supplying planters with trees and tools, maintaining good tree planting methods and promoting crew harmony. Maryland's record of 30 years indicates that the average rate per planter per eight hour day is 625 trees. Of course, individual planter rates can vary from 400-1500 trees per man per day.

Hand Planting Method

Surface-mine reforestation is a special operation. In some respects, it is easier planting than old fields or woodlands because heavy sod, roots, brush, and stumps are not present. However, there can be problems. A surface-mined area will dry out considerably faster. Wind can cause extremely wet areas to become very dry within a few days. Consequently, BOM recommends a five-pound mattock to break the hard surface of the soils. With this size mattock, a good hole can be dug to plant the seedling without over-exertion by the planter.

The standard method of tree planting called slit planting has proven to give much lower survival than planting by digging a hole. Slit planting tends to produce a J-rooted condition and, unless the first few years after planting are extremely wet, many seedlings will die. **Slit planting is *NOT* recommended.**

Digging a too shallow hole will produce the same results as slit planting. The best method to plant seedlings is to dig a hole several inches deeper and wider than the root system of the seedling. This will also help to break compacted soil. If a hole is dug properly, one side will be vertical to the width of the hole. Hold the tree at the root collar with the thumb and forefinger, and place the tree roots into the hole until the finger and thumb touch the original soil line.

Make sure that the seedling is in an upright position. Then use the foot to push the freshly-dug soil back into the hole around the roots. Care should be taken not to put stones around the seedling roots. After planting, use the foot to compact the soil around the seedling. There should be a depression where the soil was compacted and a divot of turf beside the seedling if planted correctly.

Machine planting

Since 1974, all reclaimed mine areas have been returned to the original contour in Maryland. This practice has created, in many cases, relatively flat areas for planting and tree planting machines can be used. The planting machine has very definite advantages:

* Fewer men are needed (however it is imperative that the planting machine is followed for corrective planting, particularly in stony and rough terrain).
* More trees can be planted in a given time frame.
* Survival is normally better.
* Planting costs are cheaper.

Disadvantages include the following:

* Machine planting is unsuccessful on slopes greater than 12 degrees.
* Stones may cause a tree to be improperly planted by machine requiring planters to follow the machine and replant.
* Breakdowns are frequent because the terrain is tough on equipment.

Breakdowns can be reduced if a tree planting machine especially designed for strip-mines is available. Steep, stony or rough areas should be planted by hand.

CONCLUSIONS

Surface-mine tree reforestation seems to be a simple process. However, if the operation is carefully analyzed, there are many important components within the total operation. Lack of success with reforestation projects can usually be attributed to failure to follow basic forestry practices. As with any task, the finer points learned through experience make the job easier and more successful.

Maryland has some distinct advantages when it comes to planting trees and shrubs on reclaimed mined land:

* a small mining region;
* many years of experience, which has been a learning and refining process;
* a Land Reclamation Committee;
* a total commitment to a tree planting program; and
* close relationships with other agencies and coal operators.

To date, our efforts are producing very good results. Maryland is constantly reviewing its procedures and making necessary changes to maintain high tree planting standards.