[1]EVALUATION OF NATURAL SUCCESSION OF RECLAIMED COAL MINE LAND IN WESTERN KENTUCKY

by

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ABSTRACT: In 1989 Peabody Coal Company began a comprehensive inventory program on roughly 2000 acres of reclaimed land in various stages of reforestation. Although the information gathered was intended for in-house use, accurate maps and records were created.

Since the inception of public law 95-87, reclamation managers have discussed their observations that compaction and ground cover requirements make the establishment of tree seedlings extremely difficult and the role that this has played in natural regeneration. To examine this situation more closely an isolated area that had been seeded in 1987 to a tree compatible grass\legume ground cover was selected. The area was tree planted in the spring of 1988 and again in the spring of 1989. The area is approximately 250 acres and is surrounded by unmined remnants of upland forest and cast overburden areas planted to trees in the late 1950's. Trees observed in the unmined area included Red oak (*Quercus rubra*), White ash (*Fraxinus americana*) and Sugar maple (*Acer saccharum*). Trees observed on the previously mined area include Loblolly pine (*Pinus taeda*), White pine (*Pinus strobus*), Sycamore (*Platanus occidentalis*), Black locust (*Robinia pseud-oacacia*) and various other reclamation type species planted in the late 1950's.

In August of 1990, 22 plots were run in a random method to determine tree survival. Plots were circular and 50 feet in diameter. Results from this inventory indicated that stocking was 388 trees per acre. Using the map from the 1990 survey the area was resurveyed in July 1995. The 1995 survey indicated an increase in stocking to 427 trees per acre. However, Winged sumac (*Rhus copallina*) and Eastern red cedar (*Juniperus virginiana*) were the only 2 tree species that have regenerated and accounted for the increase in stocking.

Ground cover changed greatly; Redtop grass (*Agrostis alba*) was the only component of the original grass\legume mix present to any extent. Serecia lespedeza (*Lespedeza cuneata*) was present on 17 of the 22 plots and was the dominant vegetation on 8 plots; only 1 plot was free of Serecia lespedeza.

It is our summation that this area will lag far behind pre-law areas in the amount of time required to regenerate to woodland.

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Introduction

With the implementation of approximate original contour (A.O.C.) grading in the late 1960's as required by Kentucky state law and the subsequent passage of public law 95-87, the contour of post mining land has changed dramatically in Western Kentucky. Obviously, topography is significantly different. Adherence to approximate original contour (A.O.C.) grading requirements has achieved the desired effect of blending mining areas into the surrounding unmined landscape. Along with the change in topography there is a pronounced change in vegetation cover.

As a rule, pre-law ungraded or strike-off graded sites are in some sort of tree cover, either planted or naturally regenerated. Conversely, graded sites are dominated by herbaceous plants or remnants of tree and shrub plantings and herbaceous plants.

Difficulty with establishing trees on graded sites has been well documented. As early as 1951 concerns were raised that grading could be detrimental to reforestation. In 1954 Kentucky adopted strike-off grading of spoil ridges and it soon became evident to foresters that even limited grading of sites produced a negative effect on reforestation. There have been numerous research studies since public law 95-87 to the substantiate compaction problems associated with grading and ground cover requirements (Vogel and Gray 1987), (Cunningham and Allen 1989), (Hutnik and Hughes 1990) and (Probert 1990). Also, numerous unpublished research studies exist in the Mid-west coal fields.

Reforestation of surface mine sites in Western Kentucky has dwindled since the enactment of public law 95-87. In reviewing Kentucky Reclamation Association, Inc., archives, we compiled a comparison of the total acres that have been revegetated to pasture hayland versus reforestation for the period 1980 through 1995. Since 1980 Kentucky Reclamation Association, Inc., has revegetated approximately 86,000 acres. Less than 1500 acres of this total were reforested and less that 4000 acres of the total received any wildlife plantings. Kentucky Reclamation Association, Inc., was founded in 1948 and has planted nearly 67,000,000 tree and seedlings since its inception. Only 10,000,000 trees and/or shrubs have been planted since 1980, mostly on Peabody Coal Company lands (Table #1).

Erosion control became the primary responsibility of reclamation managers when it became apparent that these graded, highly compacted sites were subject to severe erosion; especially those areas where topsoil was replaced. In order to control erosion, a dense grass\legume ground cover has to be established. The combination of compaction and ground cover made reforestation nearly unattainable for post mining land use. To compound the problem of reforestation, pasture hayland acreage was considered a higher priority for land use than reforestation by the public law 95-87.

Concern that (A.O.C.) and it's associated problems had effectively regulated reforestation out of existence was negated by the assumptions that eventually these lands would return to forest by natural succession. The mining industry and regulatory agencies assumed that land use change to pasture/hayland was only temporary. This assumption was based upon the natural regeneration that had occurred on ungraded pre-law mined areas.

In the early 1980's we began to notice some disturbing problems associated with graded spoil and graded spoil with replaced topsoil. A stand of grass and legumes could be established using proper tillage and soil amendments. The stand would maintain itself for a few growing seasons and then the legume component would die out. Coarse weeds began to replace the legumes and eventually the grasses. What has continued to surprise us is the relative absence of invasion by trees. We are finding that large tracts of reclaimed lands in Western Kentucky are not regenerating to forest but are being invaded and dominated by Serecia lespedeza.

Methods

To examine this situation in more detail we selected a unique site in Ohio County, Kentucky. The site at Peabody Coal Company's Ken mine is an isolated tract approximately 250 acres in size. All reclamation at the site was done under the regulations in Public law 95-87. The site is surrounded by cast overburden spoil ridges that were reforested in the 1950's (Table #2).

The mining area had a pre-mining vegetation survey performed by Dan Williamson in December 1982. The findings were as follows: This area has been extensively cut over within the last 5 years. Because such a large volume of timber was removed, there is not enough residual overstory present to constitute a logical size class ranking. The area is characterized by clumps of 8"-18" diameter at breast height Pignut hickory (*Carya pallida*), Mockernut hickory (*Carya tomentosa*), Shagbark hickory (*Carya ovata*) and Sugar maple with some White oak (*Quercus alba*), Blackgum (*Nyssa sylvatica*) and Sassafras (*Sassafras albidum*). These clumps of residuals are heavily fire scared or of poor form. Surrounding these clumps are large, relatively open sections with dense seedling and sapling size White oak, Red oak, Black oak (*Quercus velutina*), Southern red oak (*Quercus falcata*), Flowering dogwood (*Cornus florida*), Sugar maple, American beech (*Fagus grandifolia*), White ash, and Sassafras with Devils walking stick (*Aralia spinosa*), Greenbriar species (*Smilax sp.*) and Sumac (*Rhus*).

Soils present were predominantly Frondorf-Wellston-Rosine silt loams, 12-20% slopes on the side slopes and Zanesville 2-12% slopes along the ridges.

The area was mined using the "area" method. Topsoil was removed by dozer and scrapers before mining; overburden was removed by a dragline. The number 11 and 13 seams of coal were removed. After the coal was removed the spoil was graded to (A.O.C.) using dozers. Topsoil

was redistributed over the area by dozers and scrapers.

Final grading and seeding of permanent ground cover was completed in the fall of 1987. Soil amendments included 7 tons of agricultural lime per acre incoporated with a disc-harrow to a depth of 6 inches. The fertilizer used was a combination of 400 pounds of 18-46-0 and 200 pounds of 0-0-60 per acre. Seed mixture was a grass and legume mixture comprised of:

Species	**lbs.per acre**
Timothy (*Phleum pratense*)	5 lbs.
Orchard grass(*Dactylis glomerata*)	15 lbs.
Perennial ryegrass(*Lolium perenne*)	15 lbs.
Redtop (*Agrostis alba*)	5 lbs.
Korean lesp.(*Lespedezastipulocea*)	5 lbs.
Red clover (*Trifolium pratense*)	10 lbs.
White clover (*Trifolium repens*)	5 lbs.

In the spring of 1988 the site was planted with approximately 150,000 tree and shrub seedlings. Tree species planted included Loblolly pine, White pine, Virginia pine (*Pinus virginiana*), Eastern redbud (*Cercis canadensis*), Autumn olive (*Elaeagnus umbellata*), Crabapple (*Malus sp.*), Persimmon (*Diospyros virginiana*), Flowering dogwood, Shrub lespedeza (*Lespedeza bicolor*), Bayberry (*Myricaceae*), Silver maple (*Acer saccharinum*), Yellow-poplar (*Liridendron tulipifera*), Green ash (*Fraxinus pennsylvanica*), River birch (*Betula nigra*), Pin oak (*Quercus prinus*), Pecan (*Carya illinoensis*), Black walnut (*Juglano nigra*) and Willow oak (*Quercus phellos*). Planting was done by hand, using dibble bars. No site preparation was implemented. We assumed that the ground cover seeded was very compatible for reforestation and less competitive that a typical fescue\alfalfa mix.

Drought in the summer of 1988 led to poor seedling survival. The area was completely replanted in the Spring of 1989 using tree species similar to those planted in 1988.

Concern for tree survival and regeneration on this area began in 1989. In May 1989, 3, 1 acre observation plots were established. The plots were monitored monthly to determine when planted seedlings were dying; all natural regeneration was also recorded. During the summer of 1989 3 Winged sumac became established by natural regeneration on this study area.

In August 1990 a tree survival inventory was conducted using 22, 50' diameter circular plots. This inventory ascertained that only 3 Winged sumac had become established through natural regeneration and that the stocking rate for planting seedlings was 388 trees per acre.

During the summer of 1991 new observation plots were established to continue our investigation into tree survival. Based upon the finding of the 1990 inventory we determined that 5, 50' diameter circular plots would provide a commensurate example. During the summer of 1991 it was detected that no regeneration had occurred on the 5 plots with the exception of 1 Winged sumac.

We discontinued our observation plots in 1991. We had determined when seedling mortality was occurring and concluded that natural regeneration was not occurring

quickly enough to offset the loss of the planted seedlings.

In August 1995 we reinventoried the area utilizing the same 22, 50' diameter circular plots established in 1990. Stocking had increased to 427 trees per acre; Winged sumac and Eastern red cedar accounted for the increase in stocking. However, of the 22 plots only 10 plots had any natural regeneration. Four of these plots accounted for 85% of the natural regeneration. It was also discovered that seedling mortality was continuing to occur. Stocking for planted trees dropped from 338 seedling to 330 seedlings per acre. Summary as follows:

SUMMARY OF 1995 INVENTORY
(22 50' diameter plots)

plot #	Number & Species
1	1 Winged sumac
2	1 Eastern red ceder
5	8 Winged sumac
6	1 Winged sumac
12	1 Winged sumac
14	23 Winged sumac
15	30 Winged sumac
16	17 Winged sumac
19	1 Winged sumac
20	13 Eastern red cedar

Serecia lespedeza was never seeded on this site. The 1995 inventory found Serecia lespedeza was present on 17 of the 22 plots and was the dominant vegetation of 8 plots and only 1 plot was free of this species. Redtop grass was the only component of the original ground cover still well represented.

Soil samples were taken in 1995 to determine if soil chemistry was responsible for loss of ground cover; water p.H. results were between 6.2 and 6.4.

Conclusion

In our opinion the assumption that natural regeneration of the original pre-mining tree species will readily occur on compacted soil lands reclaimed under Public law 95-87 is inaccurate. High mortality with artificial regeneration on these sites is well documented. Reduced water capacity and impervious rooting zones are the result of unnecessary compaction; ground cover and soil chemistry also limit the chances for tree establishment. Colonization of these sites by highly competitive herbaceous plants like Serecia lespedeza will slow the return of pre-mined tree species.

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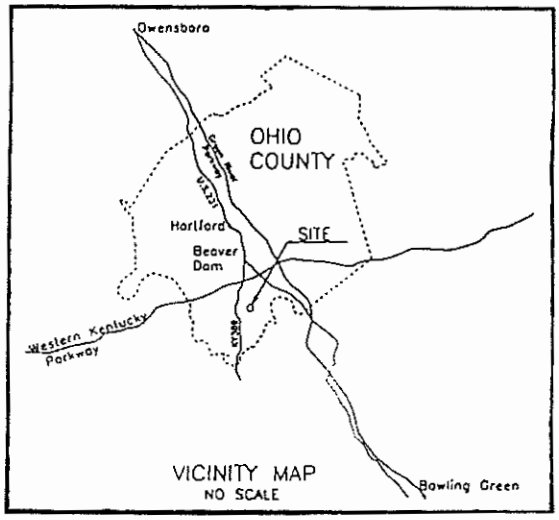
Table #1

Kentucky Reclamation Association, Inc.
Cumulative Summary
1994

Trees and Game Food 1948-1994 Inclusive	Western Kentucky	Eastern Kentucky	Total
Trees and Game Food	65,120,819	2,610,645	67,731,464
Estimated Acres	77,206	3,372	80,578
Forage Crop Seed - Lbs.	7,821,947	1,239,354	9,061,301
Estimated Acres	142,242	28,752	170,994
Estimated Total Acreage Planted and/or Seeded Since 1948*	186,228	31,749	217,977

* Acres reclaimed (planted to trees, planted and seeded both or seeded only).

Table #2



UNDISTURBED
UNMINED MIXTURE OF NATIVE
UPLAND HARDWOODS AND
LATE SUCCESSIONAL AREAS

PRE-LAW RECLAMATION

SMCRA RECLAMATION
WITH INTERSPERSED PLANTINGS
OF SHRUB AND TREE SPECIES

GRAPHIC SCALE