WOODY PLANT SEEDLING SURVIVAL AS RELATED TO SITE CONDITIONS ON SOUTHEASTERN KENTUCKY ORPHAN LANDS

by

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Chapter 1

INTRODUCTION

Statement of Purpose

Reclamation of lands mined for coal has had limited success in the United States to date. This thesis research attempts to prove that successful reclamation is possible even on the old, abandoned or orphan mines, where little preplanning was used to assist the reclamation. The author also attempts to show, through analysis of site data collected on southeastern Kentucky orphan mine lands, that available woody plant seedlings can be used for revegetation. Additionally the author attempts to prove that by knowing the major site characteristics of a mine the reclamation planner can choose particular plants to best survive on and adapt to those particular site conditions encountered.

Background

Kentucky has been a large producer of coal throughout this century. It has produced more tons of coal than any other state in our nation every year since 1973 according to U.S. Department of Energy statistics. The Kentucky Energy Center has forecast United States' coal production will double between 1973 and 1990 at the current rate of increase. President Carter has made a plea for production to double by 1985.

One has but to drive through Kentucky's coal producing regions, the gently rolling hills of western Kentucky and the mountains of
eastern Kentucky, to see the many scars left by mining. Figure 1 shows the approximate location of both Kentucky coal regions. Eastern Kentucky, lying on the western edge of the Appalachian Mountains, has been a coal producing area since eastern United States manufacturing companies bought mineral rights to large acreages in the late 1800's and early 1900's. The first surface mining in eastern Kentucky occurred in 1905 at Lilly in Laurel County. Surface mining became extensive during the World War II years.

Coal production and its consequences have affected every family in eastern Kentucky. Coal mining has been, and still is, ingrained in the lives of the local populace. Before 1966 mining companies did not have a legal obligation to extensively repair the damage caused by their mining operations. Particularly with contour mining (see Appendix A for definitions of terms), where extra soil and rock was pushed over the edge of the hill, operators seldom felt the necessity to change, since production meant income and reclamation meant expenses. The steep terrain, illustrated in Figure 2, has magnified the damages from mining operations.

These factors have resulted in a large number of improperly reclaimed mines in both the Eastern and Western Kentucky Coal Regions. In 1966, Kentucky passed a tougher version of its mining and reclamation laws. However, the law itself was not a solution for the reclamation of current mined land nor orphan land.

Thousands of acres of orphan lands exist in Kentucky today. Orphan land, for the purposes of this thesis, is land that was mined prior to the 1966 mining and reclamation legislation of Kentucky. Some of these acres were reclaimed by the mining companies and some were
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Figure 1
Kentucky Coal Regions
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reclaimed by nature. Many still have not healed. There is not a long history of efforts to heal orphan land. Until the Surface Mining Control and Reclamation Act of 1977 was passed by Congress, Kentucky had minimal provisions for reclaiming orphan lands within the state. Very little research has been undertaken on orphan land in eastern Kentucky and, for lack of interest on the part of the government and the people, only a portion of that research has been published.
In 1976 the Tennessee Valley Authority established a four state demonstration project for the reclamation of abandoned mine lands. The demonstration area involved parts of Kentucky, Tennessee, Virginia, and Alabama. In Kentucky, the project was administered by the Bureau of Surface Mining Reclamation and Enforcement. It was labeled Project Orphan Land (P.O.L.). It was through cooperation with Project Orphan Land that this thesis research was done.

With an average per acre cost of $200–$250 set by T.V.A., only basic reclamation was envisioned for the orphan lands. The extensive use of hand planted tree seedlings was proposed as the main method of reclamation, to be supplemented by the use of many small silt dams and occasional grading by bulldozers followed by seeding of herbaceous vegetation.

The use of tree seedlings had many advantages. Most of the orphan land sites were small in size, were partially revegetated, normally adjacent to existing woodland, and difficult to reach because of poor access roads. T.V.A. set the policies of (1) not adding spoil amendments for tree seedlings and (2) adding spoil amendments for the seeding of herbaceous vegetation. Use of herbaceous vegetation required the site to be redisturbed by earth moving equipment. This temporarily increased erosion, exposed acidic spoil to runoff by rainwater, and eliminated all but black locust tree seeds from being used in the seed mixture. Use of herbaceous vegetation was limited to benches and other flat areas because of the steep terrain, seen in Figure 3, which makes spoil amending much more difficult and expensive. Liming, a necessary spoil amending activity, is very expensive in eastern Kentucky. It is used to neutralize acidic material to an acceptable pH needed for
vegetation establishment. Steep outslopes also make spoil amending ineffective since much of the lime, fertilizer, seed, and mulch is washed away as the slope is eroded.

Although seedlings are not tremendously expensive, labor, management costs, and other fixed expenses increase the cost per plant tremendously. Therefore, it is to everyone's economic advantage to get the best plant survival possible. Repeated failures tend to give landowners more excuses for not trying to improve upon nature's reclamation, which can be very slow where extreme conditions have been established. Seedlings selected for southeastern Kentucky orphan lands should be tolerant of poor spoil conditions — low pH, high rates of aluminum and
manganese, low fertility, and low organic matter content. In addition
spoils often have a high rock content or high percentage of large soil
particles on outslopes, are droughty, and reach extremely high tempera-
tures during the growing season.

The Kentucky Project Orphan Land staff was limited by state
government policy to use the plant materials grown and sold by the
Department for Natural Resources, Division of Forestry. Plants used by
the staff were autumn olive, bicolor lespedeza, black locust, Chinese
chestnut, European black alder, loblolly pine, Scotch pine, shortleaf
pine, tulip poplar, Virginia pine, and white pine. These trees are nor-
mally used for wildlife habitat, woodland, and aesthetic improvement
throughout the state. None of these plants were introduced or developed
specifically for reclamation of surface mined lands, where conditions
are normally very different from the woodland or home grounds. A data
base for survival of these plants on eastern Kentucky orphan lands was
not available.

**Hypothesis for Solution**

It is possible to reclaim surface mined lands in eastern
Kentucky, including those with extreme site conditions, with little
additional effort to that historically shown by mine owners and
operators. Specifically, it is possible to revegetate orphan lands by
choosing the correct plant to fit the site specifics. By taking data,
specifically aspect, position on the mine, slope, degree of erosion,
occurrence of rock fragments, percent of existing plant cover, type of
plant invaders, spoil color, water pH and buffer pH at many test plots
and comparing the data with seedling survival on those plots, enough
information can be generated so that reliable revegetation recommendations can be made for the great variety of conditions found on orphan lands in eastern Kentucky.
Chapter 2

REVIEW OF LITERATURE

Introduction

Much research has been published on numerous aspects of surface mine reclamation. However, the vast majority of revegetation research is done on newly mined land which has been disturbed less than two years. During the author's library search, no publications were found describing vegetative efforts on old surface mines or orphan lands in eastern Kentucky of the age investigated (12 to 24 years old).

The Soil Conservation Service or S.C.S. (33) based much of its recommendations on spoils planted less than one year after mining. Plass (41) investigated trees planted two years after mining in Ky. 31 tall fescue, sampled spoils six months after mining in West Virginia (42), and planted spoils less than one year old in eastern Kentucky (34).

Regardless of the spoil's age, it has specific characteristics that are critical predictors of revegetation success. The most useful data for prediction purposes are pH and slope. Texture, spoil color, aspect, parent material, and existing vegetation growing on the spoil may also be useful in predicting success of revegetative efforts. Climate must be considered also.
Site Characteristics

pH

Most important among spoil characteristics is the pH, or numerical measure of the hydrogen ion concentration. This characteristic has received a great deal of attention from researchers. Berg (2) thoroughly described spoil sampling for pH measurement on strip-mined land and indicated (4) that concentrations of soluble iron, copper, zinc, and nickel could be toxic to plants in extremely acid spoils. Toxic concentrations of aluminum were found in spoils with a pH of 5.5 or lower (4) and manganese toxicity to legumes was found at pH 5.4 or lower. Figure 4 shows how the University of Kentucky (30) illustrated the potential for occurrence of these toxicity problems. In Figure 4 the availability of the elements, at pH levels between 4.5 and 8.0, is shown by the width of the element band; the wider the band, the more available the element to plant uptake. For example, at pH 8.0 manganese is almost totally unavailable. As the spoil pH becomes lower, the manganese band becomes wider, indicating that the manganese is much more available at pH 4.5 than at 8.0. Figure 5 shows toxic precipitate near the top of spoil containers being used for greenhouse experiments on eastern Kentucky spoils. These toxicities would indicate low survival rates for plants in spoils with low pH. Czapowskyj (16) stated that toxic conditions primarily were due to high concentrations of sulfur present in pyritic shales and rejected coal. Boyce (6) found that toxic conditions in Illinois spoils persisted for many years as evidenced by tree kill five to ten years after planting when plant roots extended into buried toxic material.
Figure 4
Relationship of Plant Nutrient Availability to Soil pH (30)
Plass (40) found that in southern West Virginia nutrient deficiencies were a more frequent problem than the acidity. Cummins (11) found that some essential nutrients became less available at pH values below 4.5. Plass (42) found that phosphorous, in particular, is deficient in spoils with low pH values because insoluble compounds are formed with iron and aluminum.

Figure 5

U.S. Forest Service Experiments With Spoils

Spoil composition ranges widely because of the different types of parent material found at different locations in eastern Kentucky and the different mining methods used. Vogel (57) found pH ranges of 3.8 to 7.5 on eastern Kentucky spoils in 1967 and 1968. As an example, overburden pH ranging from 2.8 to 6.6 is noted in Figure 6, illustrating geologic strata associated with the Horse Creek coal seam,
extensively mined in Clay County, Kentucky. Plass (34) found a pH distribution in southern West Virginia spoils of 5% for pH less than 4.0; 27% for 4.1 to 5.0; 48% for 5.1 to 6.0; 20% for 6.1 or greater.

The S.C.S. (29) found that in Kentucky autumn olive grows in spoils with pH of 4.0 to 7.5; black locust 4.0 to 8.0; European black alder 3.5 to 7.5; loblolly pine 4.0 to 7.5; Virginia pine 4.0 to 7.5; white pine 4.0 to 7.5; Chinese chestnut 4.5 to 7.5; yellow poplar 4.5 to 7.5. S.C.S. (33) also reported that black locust had been grown on spoils as low as 3.0; Virginia pine as low as 3.5; bicolor lespedeza 4.5. The Appalachian Regional Commission or A.R.C. reported shortleaf pine could grow on spoils as low as 4.5, as did Boyce (6) in southern Illinois.

Slope

Slope has a major influence on revegetation success because of its effect on water movement over the spoil surface. Length of slope and degree of slope angle determine the velocity of rainfall runoff, other factors being equal, and therefore are a major influence on the degree of erosion. The A.R.C. (45) discussed the difficulty of establishing vegetation on long or steep slopes, especially on the lower portions of steep outslopes.

Riley (46) in southeastern Ohio discovered the length of the slope was directly related to the rate of erosion. On a constant 12% slope 36.3 feet long, 72.4 tons of spoil per acre eroded; on a 72.6 foot slope, 76.9 tons per acre eroded; on a 145.2 foot slope, 91.6 tons per acre eroded. Curtis (12) found on eastern Kentucky surface mines that erosion and sediment yield have a half life of six months. The sediment
Figure 6

Horse Creek Coal Seam Highwall Section
produced during the second six months of erosion is about one-half the yield during the first six months, and so on, provided spoil stabilization progresses at an acceptable rate. Because of the erosion factor vigorous seedlings are needed for long or steep slopes.

The S.C.S. (29) reported that white, Virginia, and loblolly pine could be used on all slopes, along with black locust, European black alder, and Chinese chestnut. Yellow poplar was proposed for the better sites, meaning the less erosive slopes. Boyce (5) found from his western Kentucky studies pines could be established on upper slopes and ridges but best growth was on the lower slopes and well drained bottoms.

**Spoil Texture**

Van Lear (41) discussed the importance of spoil texture, finding toxic ion concentration greater on fine-textured spoil than on coarse-textured material. Clay loam spoils are created from the weathering of shales, seen in Figure 7, and sandy loam spoils from sandstones. Vogel (52) found shales and some sandstones weather rapidly to produce spoil with 15 to 45% soil size particles. Plass (34) concluded the greater the percentage of soil size particles, the more vulnerable become the spoils to erosion. Shale spoil normally has a higher percentage of soil size particles than sandstone. Curtis (13) found in southeastern Kentucky that sediment yield on shale spoils was always greater than yield on sandstone spoils for all storms during his two year study.

Clay spoils may compact too tightly from heavy machinery and thereby affect plant growth for as much as ten years according to Boyce (6). The spoil texture, if too high in clay content, may crust over and prevent rainwater infiltration or, if too sandy, permit too much percolation and create a dry spoil environment.
Parent Material

Knowledge of the parent material for which a spoil is derived can be a tremendous tool for the reclamation planner. Berg (3) stated that most toxic material in eastern Kentucky is caused by a relatively thin strata, known as a rider seam, which usually is found directly over the coal seam. Before Kentucky had strict reclamation laws acid material was often spread throughout the overburden with little regard given to the implications to revegetation. Being directly over the coal seam, the acid material was often cast on the top of the spoil pile. Despard (22) found that when acid strata was left at the surface, spoil was difficult or impossible to revegetate.
Figure 8

Lily Coal Seam Highwall Section
Figure 8 shows overburden representative of the Lily coal seam. The Lily seam, according to the Kentucky Geological Survey, is the same as the Horse Creek coal seam. Elevation of the two seams varies somewhat as does the composition of the overburden. Plass (37) found spoil samples from the Lily coal seam, found in Laurel County, ranged in pH from 2.9 to 4.2. About 70% of the samples had pH values of 3.5 or less. From this information alone, the planner will know he has only a few trees from which to choose. The A.R.C. (45) found spoil material from the Horse Creek coal seam, found in Clay County, was among the most acid and toxic encountered. Spoils were found with pH down to 2.2.

**Existing Vegetation**

Boyce (6) determined from his Illinois research that sparse and scattered vegetation helped survival of planted trees by lowering surface temperatures during the summer and increasing organic matter. The species found on orphan lands, extent of survival, and vigor of growth can be extremely good indicators of revegetation possibilities. Both invaders and planted species offer information to the planner. However, the author found almost no references to these possibilities in his literature search.

**Climate**

The landscape architect, horticulturalist, or reclamation planner knows climate influences plant survival. Plant hardiness zones have been established to indicate macroclimate. Southeastern Kentucky, which lies within the Cumberland Plateau and Mountains, is characterized by an average annual precipitation of about 46 inches, 21 inches occurring during the growing season. Snowfall averages about 20 inches per
year (33). Precipitation is nearly uniformly distributed among the 12 months (56). Monthly precipitation at Mullins Fork in Breathitt County (eastern Kentucky) during the five year period 1969 to 1973 averaged as follows: January, 3.61 inches; February, 3.87; March, 3.53; April, 5.88; May, 4.48; June, 3.66; July, 3.97; August, 2.89; September, 4.31; October, 3.16; November, 3.22; December, 4.58 (12). The average annual temperature is about 55 degrees Fahrenheit, varying from an average low of -4 to an average high of +100.4 degrees Fahrenheit. The average annual freeze-free period is about 175 days.

Information on microclimate is much more difficult to find. Boyce (6) summarized that conifers were better suited for planting on ridges and upper slopes, hardwoods on lower slopes and valleys. Pines did not tolerate flooding, however pines and black locust did well on hot west and south facing slopes. Extremely steep and erosive slopes were difficult for all plants.

Aspect

High temperatures on spoils may prevent or limit seedling growth according to Vogel (55). Vogel also found that exchangeable aluminum greatly increased with increased temperature. Ruffner (47) projected that it is not as difficult to establish vegetation on cool north or east slopes. The A.R.C. (45) found that high surface temperatures occurred on south and southwesterly slopes due to solar radiation. Figure 9 shows how the microclimate provided by a pine tree, in this case shade and surface mulch, can provide a suitable environment for vegetative growth while the surrounding area remains barren.
Spoil Color

The Commission also found that dark color spoils absorb more heat from the sun than do light color spoils. Moisture loss and stress occur more quickly on dark spoils. During summer and particularly on south and southwesterly slopes black spoils can reach temperature levels lethal to seedlings.

Figure 9
Microclimate Created by Pine Tree
Woody Plant Species Available For Testing

Kentucky surface mine regulations (49) between 1966 and 1978 required no less than 800 seedlings planted per acre on all disturbed areas in eastern Kentucky except those approved for grasses and legumes only. Bond release standards for revegetation required a minimum of 600 live woody plants per acre at the end of two growing seasons.

The U.S. Environmental Protection Agency or E.P.A. (24) included wildlife cover and food production, erosion control, aesthetics, and timber production as uses for reclamation trees. S.C.S. (33) generalized from their research pines survived as well as the hardwoods excepting black locust and European black alder. However, they felt pines also needed herbaceous cover for eight to ten years to provide suitable erosion control. A.R.C. (45) found that, in general, pine trees perform better than hardwoods, and nitrogen fixers perform better than non-nitrogen fixers. Plass (39) found evidence that woody species capable of fixing atmospheric nitrogen may contribute to the increased growth of other species planted nearby. He also stated that fast growing species are desirable for their ability to curb extremes of wind and temperature, as well as erosion.

Autumn Olive

The S.C.S. (29) found that autumn olive was useful for erosion control and wildlife food, while A.R.C. (45) recommended it for wildlife cover and nitrogen fixation. S.C.S. (33) found autumn olive outstanding for its early and vigorous growth and exceptional cover-producing qualities surpassed only by black locust. Plass (34) reported a survival rate of 48% after four years of growth on eastern Kentucky spoils.
Black Locust

Geyer (26) found black locust a good erosion control plant while Vogel (56) discovered it to be tolerant of a wide range of site conditions and an aid to adjacent plants since it fixed nitrogen in the soil. S.C.S. (29) reported black locust as a rapid grower but a plant with insect problems. S.C.S. (33) went on to report that black locust reproduced by root suckers and also produced seed at an early age. Its leaf litter and light shade created an environment that encouraged the invasion of herbaceous cover. A.R.C. (45) recommended black locust be planted in pure stands on steep slopes for erosion control. E.P.A. (24) recommended using it in mixed plantings as a nurse plant. Boyce (5) found in western Kentucky studies the black locust canopy plus litter accumulation on the spoil surface insulated the spoil against rapid temperature changes and slowed evaporation and runoff. Further, Boyce (6) reported that when used with timber producing species black locust should be less than 25% of the total plant population. All hardwoods except cottonwood and sycamore were suitable for interplanting; no conifers were suitable. Geyer's Kansas study (26) showed a 32% survival rate after 22 years of growth; Boyce's western Kentucky study (5) showed a 50% survival rate after 10 years; S.C.S. (33) showed survival of 80% or better 10 to 20 years after planting and considered black locust to be the best tree species available for the eastern United States coal region for quick cover and stabilizing a wide variety of sites.

European Black Alder

European black alder also has a wide adaptation according to E.P.A. (24). Good qualities recorded were rapid growth and the ability
to fix nitrogen in the spoil. S.C.S. (33) reported alder had the same advantageous qualities as black locust but to a slightly lower extent with the exception of being more tolerant to very acid spoil.

Loblolly Pine

A.R.C. (45) and E.P.A. (24) reported loblolly pine to be a fast growing tree and a desirable timber species. S.C.S. (29) recommended planting loblolly pine in bands or blocks to promote species growth. Boyce (6) recorded loblolly as the fastest growing pine used in the southern Illinois experiments, further noting that loblolly grew better on the ridges and upper slopes than most hardwoods. Plass (35) found loblolly adapted to a wide range of spoils in eastern Kentucky. S.C.S. (33) reported 54% survival in southern Illinois after 10 years; Boyce (5) reported 28% after 10 years in western Kentucky; Boyce (6) found 29% survival in southern Illinois after 10 years; Vogel (53) found 36% survival in eastern Kentucky after three years for trees planted in 1968 and 93% survival for trees, of similar size and in similar conditions to that shown in Figure 10, planted in 1969 where no spoil treatment was used. S.C.S. (29), A.R.C. (45), and E.P.A. (24) all reported loblolly pine susceptible to snow and ice damage in Kentucky.
Scotch Pine

Although S.C.S. (29) reported scotch pine to have as wide a range of acceptable spoil conditions as shortleaf, loblolly, white, and Virginia pines, very little information was found by the author about its use as a reclamation plant. S.C.S. (33) cited a study by Brown which rated scotch pine as the best conifer for spoils in West Virginia and a Pennsylvania study by Hart and Byrnes where survival was 80% after 10 years.

Shortleaf Pine

E.P.A. (24) reported shortleaf pine as a good marketable timber that sprouted freely if cut or fire killed when young. Boyce (6) found
shortleaf as the best pine for use on southern Illinois spoils. He cited its best growth on acid spoils, pH 4.5 to 6.9, and greater resistance to winter damage than loblolly pine. However, Plass (35) found shortleaf pine growth reduced on extremely acid spoils and S.C.S. (33) noted severe winter snow damage. E.P.A. (24) also found shortleaf had some insect problems. Survival has been reported as 20 to 30% on acid spoil to 60% on slightly acid spoil by S.C.S. (33) and 25% by Boyce (5) after 10 years in western Kentucky.

**Virginia Pine**

Virginia pine was recognized by S.C.S. (29), E.P.A. (24), and Boyce (6) as good wildlife cover. Boyce (6) noted that Virginia pine branches extended to the ground and persisted. E.P.A. (24) also noted its use for aesthetics. E.P.A. (24) reported Virginia pine being slow to develop and S.C.S. (29) found it had tipmoth problems. Boyce (6) found the highest survival on slopes, ridges, and acid areas. Plass (37) found survival ranged from 47 to 91% after the second growing season in southeastern Kentucky and (35) 60% after direct seeded pines had been emerged four months. S.C.S. (33) found the survival rate usually more than 50%; Boyce (5) found 27% after 10 years in western Kentucky; Vogel (53) reported 74% for 1968 - 1972 tests and 91% survival for 1969 - 1972 tests in southeastern Kentucky.

**White Pine**

E.P.A. recommended white pine for use as Christmas trees rather than erosion control, wildlife cover, or timber production (24). It has poor initial growth but does improve with time. S.C.S. (33) found adequate soil protection could not be provided by white pine for the first
eight to ten years. E.P.A. (24) and S.C.S. (29) recommended planting white pine in bands or blocks. S.C.S. (33) did find white pine ideal for mixed plantings because it was shade tolerant. Although white pine had 90% survival in Plass's eastern Kentucky study (35), growth was very slow on all spoils. In northern Illinois (6) Boyce found survival of 22 to 54%, while in southern Illinois it had only 12% survival and made the slowest growth of all the conifers.

**Chinese Chestnut**

Wildlife food and cover was the major use recommended for Chinese chestnut by S.C.S. (29). S.C.S. (33) found Chinese chestnut needed moderately good sites for spoil quality, pH 5.0 to 7.0, and exposure for good survival. Survival rates varied from 50 to 80% for plantings up to 15 years old.

**Bicolor Lespedeza**

E.P.A. (24) reported bicolor lespedeza ineffective as a ground cover for erosion control. S.C.S. (33) went on to recommend it for wildlife food only, as it provided only fair to poor cover for erosion control.

**Tulip Poplar**

Yellow poplar or tulip poplar were found to grow best on slightly acid spoils and on the lower parts of slopes and in cove-like areas by S.C.S. (33). Boyce (5) also found yellow poplar grew best only on the good sites, such as well-drained bottoms. S.C.S. (29) recommended the yellow poplars be planted in mixtures with other hardwoods; Boyce (6) also stated they were not suitable for pure stands since
survival under these conditions ranged from 0 to 37%. Boyce (5) found 24% survival after 10 years in western Kentucky.

Tables 1-A and 1-B summarize the survival data compiled by Boyce (5) and (6), Davidson (17), Davis (19), Geyer (26), Plass (34), S.C.S. (33), and Vogel (53) for species common to their research and this study.
Table 1-A

Plant Survival Results for Research by Other Authors

<table>
<thead>
<tr>
<th>Research Author</th>
<th>Species Tested</th>
<th>Average Plot Age</th>
<th>Average % Seedling Survival</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boyce (5)</td>
<td>black locust</td>
<td>10 years</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>loblolly pine</td>
<td>10 years</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>shortleaf pine</td>
<td>10 years</td>
<td>25</td>
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<tr>
<td></td>
<td>Virginia pine</td>
<td>10 years</td>
<td>27</td>
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<tr>
<td></td>
<td>yellow poplar</td>
<td>10 years</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Average = 22 years</td>
<td>26.0</td>
</tr>
<tr>
<td>Boyce (6)</td>
<td>black locust</td>
<td>10 years</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td>loblolly pine</td>
<td>10 years</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>shortleaf pine</td>
<td>10 years</td>
<td>9</td>
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<td></td>
<td>Virginia pine</td>
<td>10 years</td>
<td>16</td>
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<td></td>
<td>white pine</td>
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<td></td>
<td>yellow poplar</td>
<td>10 years</td>
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<td></td>
<td></td>
<td>Average = 10 years</td>
<td>18.5</td>
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<tr>
<td>Davidson (17)</td>
<td>Scotch pine</td>
<td>5 years</td>
<td>50.0</td>
</tr>
<tr>
<td>Davis (19)</td>
<td>autumn olive</td>
<td>1 year</td>
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<td>white pine</td>
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<td></td>
<td></td>
<td>Average = 1 year</td>
<td>44.0</td>
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</tbody>
</table>
## Table 1-B
Plant Survival Results for Research by Other Authors

<table>
<thead>
<tr>
<th>Research Author</th>
<th>Species Tested</th>
<th>Average Plot Age</th>
<th>Average % Seedling Survival</th>
</tr>
</thead>
<tbody>
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<td>Geyer (26)</td>
<td>black locust</td>
<td>22 years</td>
<td>32</td>
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<tr>
<td></td>
<td>loblolly pine</td>
<td>22 years</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>shortleaf pine</td>
<td>22 years</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>Virginia pine</td>
<td>22 years</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td><strong>Average = 22 years</strong></td>
<td></td>
<td><strong>26.0</strong></td>
</tr>
<tr>
<td>Plass (34)</td>
<td>autumn olive</td>
<td>4 years</td>
<td>48.0</td>
</tr>
<tr>
<td>S.C.S. (33)</td>
<td>black locust</td>
<td>8 years</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>Chinese chestnut</td>
<td>7 years</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>loblolly pine</td>
<td>7 years</td>
<td>54</td>
</tr>
<tr>
<td></td>
<td>shortleaf pine</td>
<td>7 years</td>
<td>45</td>
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<td></td>
<td>Virginia pine</td>
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<td><strong>Average = 7.2 years</strong></td>
<td></td>
<td><strong>55.8</strong></td>
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<tr>
<td>Vogel (53)</td>
<td>loblolly pine</td>
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<td>36</td>
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<td></td>
<td>Virginia pine</td>
<td>4 years</td>
<td>77</td>
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<td></td>
<td><strong>Average = 4 years</strong></td>
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<td><strong>56.5</strong></td>
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</table>
Chapter 3

GENERAL DESCRIPTION OF PLANT SPECIES STUDIED

The following general plant descriptions are included to provide the reader with information which may be useful in 1) identifying the plants studied, 2) interpreting the data summaries and conclusions drawn from the summaries, and 3) helping the reader visualize other reclamation possibilities for the plants studied on orphan or abandoned mine lands.

The hardiness zone system included was created by Alfred Rehder and used as early as 1927 in the *Manual of Cultivated Trees and Shrubs*. This hardiness system has become standard among horticulturalists in the United States.

![Hardiness Zones of the United States](image)

**LIMITS OF THE AVERAGE ANNUAL MINIMUM TEMPERATURES FOR EACH ZONE:**

- **ZONE 1** (N. CANADA)  
- **ZONE 2** | -50° to -35°  
- **ZONE 3** | -35° to -20°  
- **ZONE 4** | -20° to -10°  
- **ZONE 5** | -10° to -5°  
- **ZONE 6** | -5° to 0°  
- **ZONE 7** | 0° to 5°  
- **ZONE 8** | 5° to 10°  
- **ZONE 9** | 10° to 20°  
- **ZONE 10** | 20° to 30°  
- **ZONE 11** | 30° to 40°  

HARDINESS ZONES OF THE UNITED STATES
General Description of *Alnus glutinosa*, European black alder

Growth Habit: tree; single or multistemmed; slender at youth, ovoid to oblong head at maturity; to 75 feet high with a trunk diameter of one to two feet

Foliage: deciduous; dark green leaves, two to five inches long, blunt-tipped and usually double-toothed

Fruit: pine cone-like catkins, to three-fourths inch long or slender stalks

Bark: dark with numerous short warty stripes; twigs are reddish or tinged with red

Native Habitat: Europe to Siberia

Hardiness Zone: three

Limitations: no serious problems

Special Features: withstands very acid spoil, pH 4.0 to 7.0; has vigorous early growth; not a legume but fixes nitrogen; adaptable to wet conditions
General Description of *Castanea mollisima*, Chinese Chestnut

Growth Habit: tree; to 60 feet high with an equal spread; dense, round headed

Foliage: deciduous; coarse lustrous leaves, alternate simple, three and one-half to eight inches long and one to two inches wide, oval to oblong

Fruit: one to three nuts to one inch diameter enclosed within a spiny bur, light to dark brown in color

Bark: olive-brown; bark on second and third year stems is cherry-like in appearance; mature trunk is strongly ridged and furrowed

Native Habitat: China and Korea

Hardiness Zone: four

Limitations: requires moderately good spoil quality and slight acidity, pH 5.0 to 7.0; prefers well drained sites

Special Features: excellent nut production possible for wildlife food

Foliage

Fruit
General Description of *Elaeagnus umbellata*, Autumn Olive

Growth Habit: shrub; spreading and upright, 12 to 18 feet high with a width to 20 or 30 feet; branches often extending to the ground

Foliage: deciduous; alternate leaves, olive-green above and silvery below, elliptic or oval, one and one-half to three inches long

Fruit: produces dependable crops of abundant berries in three to four years; berries approximately one-fourth inch diameter with one-third to one-half inch stalks, starting as silver and turning to red

Bark: yellow-brown branchlets, often partially silver; spines profuse; bark smooth except on very old stems where it is scaly

Native Habitat: China, Korea, Japan

Hardiness Zone: four

Limitations: does not grow well on very dry sites or sites with shallow root medium

Special Features: although not a legume, a good nitrogen fixer; can be used as a barrier or screen; has a tendency to spread; provides excellent wildlife cover; prefers acid soil, pH 4.5 to 7.0
General Description of *Lespedeza bicolor*, Bicolor Lespedeza

**Growth Habit**: shrub; upright to 12 feet high and slightly less in spread; somewhat open and loosely branched; weak stemmed when young but becoming woody with age; twigs slender

**Foliage**: deciduous; leaves one to three inches long, compound, three-parted with leaflets blunt-tipped; middle leaflet longer stalked than the two side ones; undersides of leaves are gray-green

**Fruit**: one-fourth inch long single seeded pods; found in clusters two to four inches long on the current year's growth; seed crops in three to four years

**Bark**: brown

**Native Habitat**: northern China, Manchuria, Japan

**Hardiness Zone**: five

**Limitations**: requires well drained soils; dies back in severe winters; does not provide good erosion control

**Special Features**: excellent wildlife cover and food; grows in slightly acid, pH 5.0 to 7.0, spoils with low fertility; can be direct seeded

![Foliage](image)
General Description of *Liriodendron tulipifera*, Tulip Poplar

Growth Habit: tree; broadly pyramidal with massive branches; to 150 feet high with a straight clear trunk to six feet in diameter; dense crown

Foliage: deciduous; leaves uniquely squarish in form, bright green above and paler below

Fruit: pyramidal conelike dry pod two to three inches long composed of single-winged samaras

Bark: on young trees, whitened within small grooves but nearly smooth; on mature trees bark is gray-brown with regular ridges and furrows

Native Habitat: eastern United States

Hardiness Zone: four

Limitations: requires best site conditions available, such as lower slopes and coves; prefers slightly acid spoils, pH 5.0 to 7.0

Special Features: tree is commercially valuable for many wood products
General Description of *Pinus echinata*, Shortleaf Pine

**Growth Habit**: tree; normally grows with a straight trunk and slender branches; at maturity has a narrow pyramidal crown; 80 to 100 feet high with a trunk diameter of two to three feet

**Foliage**: evergreen; needles mostly in bundles of two, three to five inches long, dark yellow-green, slender, flexible

**Fruit**: small cones, one and one-half to two and one-half inches long, each scale tipped with a weak prickle

**Bark**: dark brown; dark furrows between irregular shaped smooth plates; twigs whitened with a powdery covering

**Native Habitat**: southeastern United States

**Hardiness Zone**: six

**Limitations**: subject to winter injury from heavy snow or ice; survival rates lower than for other pines; subject to tipmoth injury

**Special Features**: can be used for screening and wildlife cover; grows well in light dry spoils; prefers acid spoil, pH 4.5 to 6.0
General Description of *Pinus strobus*, White Pine

**Growth Habit**: tree; pyramidal when young, flat topped when old; to 100 feet high when a two to four foot diameter trunk

**Foliage**: evergreen; needles five in a bundle, two and one-half to five and one-half inches long, soft and flexible

**Fruit**: cones four to eight inches long; scales lack spines

**Bark**: on mature trees bark is gray and broken into small rectangular blocks; smooth on young trees

**Native Habitat**: eastern North America

**Hardiness Zone**: three

**Limitations**: white pine weevil injury; does not do well on exposed ridges or severely eroded sites

**Special Features**: shade tolerant, therefore can be used in mixed plantings with hardwoods; grows best in acid spoil, pH 4.5 to 6.0
General Description of *Pinus sylvestris*, Scotch Pine

Growth Habit: tree; open, pyramidal while young but round-topped and irregular when old; to 75 feet high; trunk to one and one-half feet in diameter, often crooked

Foliage: evergreen; blue-green needles are twisted, two in a bundle, three-fourths inch to three inches long, stiff and sharp-pointed

Fruit: brown cone near same length as needles, oblong in shape

Bark: red to orange on older branches; trunk becomes dark and furrowed at maturity

Native Habitat: Europe to Siberia

Hardiness Zone: two

Limitations: no serious problems

Special Features: tolerant to dry sites; can be used for screening and wildlife cover; prefers acid spoils, pH 4.5 to 6.0
General Description of *Pinus taeda*, Loblolly Pine

**Growth Habit**: tree; to 100 feet high with a trunk diameter of two to three feet; normally develops a tall, straight trunk with short, thick branches; relatively dense crown is usually compact and round-topped

**Foliage**: evergreen; needles usually in bundles of three but sometimes two, six to nine inches long, slender, stiff, yellow-green

**Fruit**: oval to conical stout cones, two to six inches long, each scale tipped with a prickle

**Bark**: red-brown with scaly plates on mature trees

**Native Habitat**: southeastern United States

**Hardiness Zone**: six

**Limitations**: subject to severe winter damage from cold and snow in northernmost range

**Special Features**: does best in acid spoils, pH 4.5 to 6.0; can be used for screening and wildlife cover; can withstand a wide range of conditions including root flooding for several months at a time
General Description of Pinus virginiana, Virginia Pine

Growth Habit: tree; open, branching sparse; variable form when young; to 45 feet high with a trunk diameter of one to two feet at maturity, when it also may have a very wide top and stiff appearance

Foliage: evergreen; needles in bundles of two, one and one-fourth to three inches long, twisted

Fruit: cones, somewhat egg-shaped, one and one-half to two and one-half inches long with a prickle on each scale; remain on the tree for many years

Bark: red-brown and scaly with age; twigs are somewhat yellow or purple

Native Habitat: eastern United States

Hardiness Zone: four

Limitations: tip moth injury

Special Features: prefers acid spoil, pH 4.5 to 6.0; can be used for screening; low branches provide excellent wildlife cover; can be direct seeded
General Description of *Robinia pseudoacacia*, Black Locust

**Growth Habit**: tree; to 80 feet high with a trunk diameter of two to four feet; normally open with few branches

**Foliage**: deciduous; pinnately compound leaves, eight to fourteen inches long with seven to nineteen smooth-margined egg-shaped leaflets one to two inches long and one-half to three-fourths inch wide

**Fruit**: flat, brown to black pods, two to six inches long and one-half inch wide, containing four to eight kidney-shaped orange-brown seeds

**Bark**: dark on old trunks, nearly black; deeply ridged and crosshatched

**Native Habitat**: eastern United States

**Hardiness Zone**: three

**Limitations**: subject to injury from locust borer and locust leaf miner

**Special Features**: a legume; can be direct seeded; provides good shade and spoil surface litter, encouraging plant invaders; excellent for erosion control; vigorous early growth; prefers acid spoil, pH 4.5 to 7.5
Chapter 4

METHODS AND PROCEDURES

Only those Project Orphan Land mines which had been completed or were completed except for remedial work were used for research plots. Of these, only mines where the woody plant materials had been planted on the sites for two months or more were chosen.

The author attempted to do all the research within Clay and adjacent Laurel County but was forced to establish plots in Harlan County also in an attempt to get a larger data base. The general research location is shown in Figure 11.

A significant problem encountered in choosing mines was the unequal number of plantings for the different species. For example, almost every mine used black locust in large enough quantities so that a black locust plot could be established there. However, autumn olive and Chinese chestnut were available in such small quantities that normally only a few could be used on each mine making a plot difficult to establish. Loblolly pine was not available in quantities equal to that for the other pines. Bicolor lespedeza, tulip poplar, white pine, and scotch pine were used in small quantities because the P.O.L. staff thought they required better spoil conditions than normally found on the Clay and Laurel County orphan mines.

An adequate data sheet evolved from early attempts at gathering site information that were only partially successful. The final data sheet, as seen in Appendix D, represents a refinement, encompassing sufficient information to describe each site's characteristics. The
Figure 11
Regional Location Map
mine number, site reconnaissance number, subwatershed, coal seam name, approximate elevation, last known mining disturbance, and original planting date were obtained from the Project Orphan Land files and staff interviews.

The author attempted to establish plots with a size of 40' x 40' or larger, however, the plot size varied considerably because of terrain, mining pattern, invading vegetation, and area of the mine operation. Plots ranged from 75' x 10' or .02 acre to 95' x 45' or .10 acre. Sixty-three different variations in plot area were used. Dimensions for the plots were approximate, established by pacing.

![Figure 12](image)

**Figure 12**

Seedling Test Plot Site

The major consideration in locating a plot was establishing it within an area of homogeneous site conditions. Figure 12, shows a site
that had a large enough area of homogeneous site conditions so that the
author could establish a test plot. From the foreground to the center
of the photo, where this plot was located, is a relatively flat area
where pine seedlings were planted as part of the reclamation of the
orphan mine. When a continuous planting of the same species had differ-
ent aspects or positions on the mine within that continuous planting, it
was broken into separate plots.

Plot location was used to describe, in a general sense, the
plot. References to the plot location indicate that the plot was rela-
tively flat or steep, wet or dry, slightly or severely eroded, and so
forth.

Most plots were located on the bench, berm, or outslope. Figure
13 illustrates these general locations. Other locations on the mine
where plots were established were on a hollow fill, highwall toe, adja-
cent to the highwall, gully side, haul road, berm side, and filled
gully. Plots adjacent to the highwall were located on areas where the
highwall had ended, resulting in a steep, scalped area subject to severe
erosion and sliding. Plots on gully sides were located on the steep
side walls of the gullies as opposed to the flatter bottom areas. Plots
on filled gullies were established on the new surface resulting from
sediment filling a gully to a near level area. Several plots were
located on berm sides where slopes were steep in comparison to the
gently sloping areas of the berm top.

Plot aspect, or the directional orientation of the plot, was
determined in the field by compass. Plot slope was determined by use of
an Abney hand level.
Figure 13

Typical Contour Mine Section for Southeastern Kentucky Orphan Lands
The number of living seedlings within the plot was obtained by visually checking for leaf growth and stem viability. Since the amount of growth was not a consideration, every live plant was counted, regardless of its condition. The spacing, or distance between plants, was determined visually or by pacing. The sum of the dead seedlings found plus those thought to be missing because of known spacing added to the number of live seedlings resulted in the number of original seedlings within the plot boundaries.

Seedling age and size information was obtained from the Kentucky Division of Forestry price list for available seedlings. This information was dependable except for a few situations when the Project Orphan Land staff was notified of changes. For example, if a shipment of loblolly pine was going to be two year old seedlings instead of the normal one year old seedlings, then officials of the state nursery would inform the Project Orphan Land staff of this fact.

The percent of existing vegetative cover was determined by a visual analysis of crown or stem cover provided by the invading plants plus any additional plants that may have been seeded or planted during earlier reclamation attempts by the mining company or landowner. Figure 15 illustrates existing vegetative cover. Broomsedge, seen in the foreground, comprises part of the existing vegetation in this test plot. Identification was made by the author or Project Orphan Land staff members. Several plants which could not be identified in the field were keyed by state plant biologists. Abbreviations for common names were made by the author and used on the plot data sheets because of space limitations only.
Spoil samples were collected with a small shovel or a hand trowel. Spoil material was taken at a depth of 2-6" beneath the surface. Approximately one-half pint of spoil was collected and placed in a small plastic bag with an identification number enclosed. Rock fragments of $\frac{1}{4}"$ diameter or greater were discarded.

The first six spoil samples were taken from one location each, which appeared to be representative of the majority of the plot. Thereafter, subsamples were taken, as seen in Figure 14, from four different locations within each plot and mixed in the plastic bag to form a composite sample of the same size. Spoil samples were turned over to the Project Orphan Land staff who had them tested at the University of Kentucky Laboratory.

Figure 14
Taking a Spoil Sample
Vegetation of adjacent areas included plants that were located within approximately 300 feet of the plot. These plants were identified in the same manner as those within the plots and included plants on mined and unmined areas. This section of the data was collected in an attempt to see if the mined areas were supporting the same types of vegetation that were growing near the disturbed areas.

Spoil color was visually identified in the field without the use of color wheels or charts. The decision to not use charts was made after consultation with an eastern Kentucky soil scientist employed by the U.S. Soil Conservation Service. All spoil colors were noted in the
field, from black to all shades of gray and brown to tan. They were then grouped into grays, browns, and mixtures of the two for analysis.

The degree of rock fragment occurrence on the test plots was determined by visual analysis. This analysis was subdivided into three categories: few, several, and many in an attempt to find some correlations with seedling survival. The degree of erosion was also determined visually. It was categorized as slight, moderate, or severe. Spoil parent material was determined by looking at the spoil color and texture in addition to rock fragment shape and hardness. Figure 16 shows angular rock fragments on the surface of this spoil indicating that the upper portion was dominated by sandstone parent material. A complicating factor for this data analysis was the fact that when these mines were in operation good spoil handling practices had not been developed, resulting in a haphazard placement rather than uniform placement of spoil. As a result, a great deal of variation occurred from mine to mine, within the mine, and even within the test plots.

Seedling survival results were obtained by summarizing numerical data obtained from the thesis data sheets. Summaries of data for each plant species studied are presented in Chapter 5. Summaries of seedling survival as a function of each site factor are presented in Chapter 6.
Figure 16

Sandstone Spoil
Chapter 5

PRESENTATION OF DATA

Each table in this chapter displays the data compiled from all the data sheets for each individual plant species studied. Each table also summarizes the data into averages, where possible, and categories to be used for further analysis. For example, Table 3, the Autumn Olive Summary, shows the average slope of the 15 test plots was 16.5 degrees. It further categorizes the slope into the number of plots with slopes between zero and 10 degrees; the number of plots with slopes between 11 and 20 degrees; and number of plots with slopes greater than 20 degrees. In Chapter 6 each of these three slope categories will be compared with the average seedling survival for each species and for all species to see if a direct relationship exists between plot slope and seedling survival. Each category of predetermined site conditions will be analyzed in this manner, the relationship indicating the reliability of each particular site condition as a predictor of seedling survival.
**Table 2**

**AUTUMN OLIVE SUMMARY**

<table>
<thead>
<tr>
<th>Mine No.</th>
<th>Plot Location</th>
<th>Slope (degrees)</th>
<th>Aspect</th>
<th>% Existing Cover</th>
<th>Major Invader</th>
<th>pH Water/Filler</th>
<th>Spoil Age (years)</th>
<th>Spoil Color</th>
<th>Degree of Erosion</th>
<th>Root Fragments</th>
<th>Planting Age (months)</th>
<th>% Survival</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0008 - A outsole</td>
<td>35</td>
<td>S.E.</td>
<td>20</td>
<td>blackberry</td>
<td>4.5 / 5.9</td>
<td>20</td>
<td>light gray</td>
<td>slight</td>
<td>few</td>
<td>14</td>
<td>65</td>
</tr>
<tr>
<td>2</td>
<td>0009 - A bench</td>
<td>0 - 2</td>
<td>W.</td>
<td>0 - 5</td>
<td>wire grass</td>
<td>3.3 / 4.7</td>
<td>20</td>
<td>dark gray-black</td>
<td>slight</td>
<td>several</td>
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<td>17</td>
</tr>
<tr>
<td>3</td>
<td>0011 - A berm</td>
<td>2 - 10</td>
<td>S.</td>
<td>50</td>
<td>wire grass</td>
<td>4.6 / 5.7</td>
<td>19</td>
<td>light gray &amp; light brown</td>
<td>moderate</td>
<td>few</td>
<td>6</td>
<td>93</td>
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<tr>
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<td>N.</td>
<td>30</td>
<td>wire grass</td>
<td>3.7 / 4.7</td>
<td>19</td>
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<td>S.E.</td>
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<td>broomedge</td>
<td>3.8 / 4.6</td>
<td>19</td>
<td>medium gray</td>
<td>moderate</td>
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<td>89</td>
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<tr>
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<td>3.5 / 5.1</td>
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<td>S.</td>
<td>0 - 5</td>
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<td>3.8 / 5.1</td>
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<td>4.5 / 6.1</td>
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<td>severe</td>
<td>several</td>
<td>3</td>
<td>28</td>
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<td>0036 - A outsole</td>
<td>37</td>
<td>S.W.</td>
<td>10</td>
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<td>2.5 / 4.7</td>
<td>18</td>
<td>medium gray</td>
<td>severe</td>
<td>several</td>
<td>3</td>
<td>93</td>
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<td>0 - 30</td>
<td>S.E.</td>
<td>0 - 5</td>
<td>black gum</td>
<td>5.2 / 5.8</td>
<td>19</td>
<td>light brown</td>
<td>severe</td>
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<td>dark gray</td>
<td>moderate</td>
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<td>0 - 2</td>
<td>N.</td>
<td>0 - 5</td>
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<td>3.6 / 4.9</td>
<td>19</td>
<td>light gray</td>
<td>slight</td>
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<td>N.</td>
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<td>3.8 / 5.1</td>
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<td>light brown</td>
<td>slight</td>
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<td>3.7 / 4.4</td>
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<td>light-medium gray &amp; light brown</td>
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<td>0 - 5</td>
<td>wire grass</td>
<td>4.2 / 5.4</td>
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**Average Values**

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<td>3.9 / 5.1</td>
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<td>13: 0-30</td>
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<td>1 deer tongue</td>
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Table 3

BICOLOR LESPEDEZA SUMMARY

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<th>Mine No.</th>
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<th>Slope</th>
<th>aspect</th>
<th>% Existing cover</th>
<th>Major Invader</th>
<th>Water/Buffer</th>
<th>Spoil Age (years)</th>
<th>Spoil Color</th>
<th>Degree of erosion</th>
<th>Rock Fragments (months)</th>
<th>Planting Age</th>
<th>% Survival</th>
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<td>W.</td>
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<td>broomedge</td>
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<td>1 bench</td>
<td>Ave. - 1.0</td>
<td>W. Ave. - 5.0</td>
<td>1 broomedge Ave. - Ave. -</td>
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<td>slight</td>
<td>few</td>
<td>1</td>
<td>several</td>
<td>3</td>
<td>85</td>
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<td>Spout Color</td>
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<td>Rock Fragments</td>
<td>Planting Age (months)</td>
<td>% Survival</td>
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<td>slight</td>
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<td>20</td>
<td>dark gray</td>
<td>severe</td>
<td>several</td>
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<td>60</td>
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<td>0 - 5</td>
<td>blackberry</td>
<td>3.9 / 5.1</td>
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<td>slight</td>
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<td>13</td>
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<td>0010 - A</td>
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<td>several</td>
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<td>100</td>
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<td>3.7 / 5.1</td>
<td>22</td>
<td>light brown &amp; light gray</td>
<td>severe</td>
<td>few</td>
<td>13</td>
<td>93</td>
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Table 4: Black Locust Summary
### Table 5

**CHINESE CHESTNUT SUMMARY**

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<th>Mine No.</th>
<th>Plot Location</th>
<th>Slope (degrees)</th>
<th>Aspect</th>
<th>% Existing Cover</th>
<th>Major Invader</th>
<th>pH Water/Buffer</th>
<th>Spoil Age (years)</th>
<th>Spoil Color</th>
<th>Degree of Erosion</th>
<th>Rock Fragments</th>
<th>Planting Age (months)</th>
<th>Survival</th>
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<td>1</td>
<td>0036 - A berm</td>
<td>7</td>
<td>N.E.</td>
<td>25</td>
<td>wire grass</td>
<td>4.2 / 5.2</td>
<td>18</td>
<td>dark gray</td>
<td>slight</td>
<td>many</td>
<td>3</td>
<td>96</td>
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<tr>
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<td>1 berm</td>
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<td>wire grass</td>
<td>Ave. =</td>
<td>4.2 / 5.2</td>
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<td>1: 0-30</td>
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1: slight
0: few
O: moderate
O: severe
L: many
<table>
<thead>
<tr>
<th>Mine No.</th>
<th>Plot Location</th>
<th>Slope (degrees)</th>
<th>Aspect</th>
<th>% Existing Cover</th>
<th>Major Invader</th>
<th>Water/Buffer</th>
<th>Spoilage (years)</th>
<th>Spoil Color</th>
<th>Degree of Erosion</th>
<th>Rock Fragments</th>
<th>Planting Age (months)</th>
<th>% Survival</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>J02 - A bench</td>
<td>0 - 6</td>
<td>S.E.</td>
<td>0 - 5</td>
<td>wire grass</td>
<td>2.7 / 4.3</td>
<td>20</td>
<td>dark grey</td>
<td>slight</td>
<td>many</td>
<td>5</td>
<td>80</td>
</tr>
<tr>
<td>2.</td>
<td>J04 - A bench</td>
<td>5</td>
<td>S.</td>
<td>0 - 5</td>
<td>blackberry</td>
<td>4.7 / 5.8</td>
<td>19</td>
<td>light grey</td>
<td>severe</td>
<td>many</td>
<td>6</td>
<td>56</td>
</tr>
<tr>
<td>3.</td>
<td>J05 - A bench</td>
<td>0 - 6</td>
<td>E.</td>
<td>25</td>
<td>tall sedge</td>
<td>3.6 / 5.3</td>
<td>19</td>
<td>light grey &amp; light brown</td>
<td>slight</td>
<td>severe</td>
<td>4</td>
<td>94</td>
</tr>
<tr>
<td>4.</td>
<td>J09 - A fully side</td>
<td>28</td>
<td>S.N.</td>
<td>30</td>
<td>wire grass</td>
<td>4.1 / 5.3</td>
<td>19</td>
<td>light brown</td>
<td>moderate</td>
<td>many</td>
<td>4</td>
<td>98</td>
</tr>
<tr>
<td>5.</td>
<td>J21 - B bench</td>
<td>2</td>
<td>S.E.</td>
<td>60</td>
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<td>4.0 / 5.3</td>
<td>19</td>
<td>light brown</td>
<td>slight</td>
<td>many</td>
<td>4</td>
<td>100</td>
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<tr>
<td>6.</td>
<td>J25 - C filled gully</td>
<td>2</td>
<td>N.</td>
<td>0</td>
<td>none</td>
<td>3.5 / 4.9</td>
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<td>slight</td>
<td>few</td>
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<td>7.</td>
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<td>0 - 8</td>
<td>N.</td>
<td>0 - 5</td>
<td>saw grass</td>
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<td>19</td>
<td>light grey</td>
<td>severe</td>
<td>many</td>
<td>5</td>
<td>89</td>
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<tr>
<td>8.</td>
<td>J32 - A bench</td>
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<td>S.W.</td>
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<td>none</td>
<td>3.4 / 4.6</td>
<td>20</td>
<td>light grey</td>
<td>moderate</td>
<td>few</td>
<td>14</td>
<td>91</td>
</tr>
<tr>
<td>9.</td>
<td>J33 - A bench</td>
<td>0 - 8</td>
<td>S.W.</td>
<td>35</td>
<td>wire grass</td>
<td>4.0 / 5.8</td>
<td>19</td>
<td>light-dark grey &amp; light brown</td>
<td>slight</td>
<td>few</td>
<td>5</td>
<td>100</td>
</tr>
<tr>
<td>10.</td>
<td>J33 - A bench</td>
<td>1</td>
<td>S.E.</td>
<td>20</td>
<td>tall sedge</td>
<td>3.7 / 5.6</td>
<td>18</td>
<td>light-dark grey &amp; light brown</td>
<td>slight</td>
<td>few</td>
<td>3</td>
<td>90</td>
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<tr>
<td>11.</td>
<td>J37 - C bench</td>
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<td>N.E.</td>
<td>65</td>
<td>wire grass</td>
<td>4.7 / 5.6</td>
<td>15</td>
<td>medium-dark grey &amp; light medium brown</td>
<td>slight</td>
<td>few</td>
<td>5</td>
<td>98</td>
</tr>
<tr>
<td>12.</td>
<td>J37 - C bottom highwall 0 - 5</td>
<td>5</td>
<td>N.W.</td>
<td>50</td>
<td>small sedge</td>
<td>5.1 / 6.6</td>
<td>15</td>
<td>medium brown</td>
<td>slight</td>
<td>few</td>
<td>5</td>
<td>100</td>
</tr>
<tr>
<td>13.</td>
<td>J37 - B bench</td>
<td>3</td>
<td>W.</td>
<td>60</td>
<td>broom sedge</td>
<td>5.6 / 6.6</td>
<td>14</td>
<td>tan-light brown</td>
<td>slight</td>
<td>several</td>
<td>5</td>
<td>88</td>
</tr>
<tr>
<td>14.</td>
<td>J37 - B bench</td>
<td>1</td>
<td>N.W.</td>
<td>50</td>
<td>wire grass</td>
<td>4.9 / 5.7</td>
<td>14</td>
<td>light grey &amp; light brown</td>
<td>slight</td>
<td>many</td>
<td>5</td>
<td>86</td>
</tr>
</tbody>
</table>

**Table 6**

**EUROPEAN BLACK ALDER SUMMARY**
## Table 7
### LOBLOLLY FINE SUMMARY

<table>
<thead>
<tr>
<th>Mine No.</th>
<th>Plot Location</th>
<th>Slope (degrees)</th>
<th>Aspect</th>
<th>% Existing Cover</th>
<th>Major Invader</th>
<th>pH (water/buffer)</th>
<th>Spoil Age (years)</th>
<th>Spoil Color</th>
<th>Degree of Erosion</th>
<th>Rock Fragments (months)</th>
<th>Planting Age</th>
<th>% Survival</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0006 - A haul road</td>
<td>0 - 5</td>
<td>W.</td>
<td>0 - 5</td>
<td>wire grass</td>
<td>4.9 / 6.1</td>
<td>22</td>
<td>medium gray</td>
<td>slight</td>
<td>few</td>
<td>5</td>
<td>89</td>
</tr>
<tr>
<td>2</td>
<td>0006 - A hollow fill</td>
<td>6</td>
<td>N.E.</td>
<td>5</td>
<td>broomedge</td>
<td>3.7 / 5.2</td>
<td>22</td>
<td>light brown</td>
<td>slight</td>
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<td>0</td>
</tr>
<tr>
<td>3</td>
<td>0025 - A berm</td>
<td>0 - 5</td>
<td>W.</td>
<td>15</td>
<td>steeple bush</td>
<td>3.9 / 4.9</td>
<td>22</td>
<td>medium brown</td>
<td>slight</td>
<td>few</td>
<td>14</td>
<td>70</td>
</tr>
<tr>
<td>4</td>
<td>0026 - A bench</td>
<td>2</td>
<td>S.E.</td>
<td>10</td>
<td>wire grass</td>
<td>4.9 / 6.0</td>
<td>22</td>
<td>medium brown</td>
<td>slight</td>
<td>many</td>
<td>7</td>
<td>82</td>
</tr>
<tr>
<td>5</td>
<td>0033 - B above highwall</td>
<td>20</td>
<td>S.</td>
<td>10</td>
<td>sourwood</td>
<td>5.3 / 4.3</td>
<td>22</td>
<td>light brown</td>
<td>moderate</td>
<td>many</td>
<td>7</td>
<td>89</td>
</tr>
<tr>
<td>6</td>
<td>0033 - C berm</td>
<td>12</td>
<td>S.W.</td>
<td>5</td>
<td>broomedge</td>
<td>3.8 / 4.9</td>
<td>22</td>
<td>light gray &amp; light brown</td>
<td>moderate</td>
<td>many</td>
<td>7</td>
<td>68</td>
</tr>
</tbody>
</table>

1. above highwall: Ave. = 1 S. Ave. = 1 S.E. Ave. = 2 wire grass Ave. = 2 broomedge Ave. = 2 steeple bush Ave. = 1 sourwood Ave. =
2. bench: Ave. = 1 S. Ave. = 1 S.E. Ave. = 1 S.W. Ave. = 1 N. Ave. = 1 W. Ave. = 1 E. Ave. = 1 N. Ave. = 1 W. Ave. =
3. hollow fill: Ave. = 1 W. Ave. = 1 S. Ave. = 1 N. Ave. = 1 E. Ave. = 1 S. Ave. = 1 W. Ave. = 1 S. Ave. = 1 E. Ave. =
4. berm: Ave. = 1 W. Ave. = 1 S. Ave. = 1 N. Ave. = 1 E. Ave. = 1 S. Ave. = 1 W. Ave. = 1 S. Ave. = 1 E. Ave. =
5. haul road: Ave. = 1 W. Ave. = 1 S. Ave. = 1 N. Ave. = 1 E. Ave. = 1 S. Ave. = 1 W. Ave. = 1 S. Ave. = 1 E. Ave. =
<table>
<thead>
<tr>
<th>Mine No.</th>
<th>Plot Location</th>
<th>Slope (Degrees)</th>
<th>Aspect</th>
<th>% Existing Cover</th>
<th>Major Invader</th>
<th>pH Water Buffer</th>
<th>Spoil Age (years)</th>
<th>Spoil Color</th>
<th>Degree of Erosion</th>
<th>Rock Fragments</th>
<th>Planting Age (months)</th>
<th>Survival</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. 0619 - A bottom highwall</td>
<td>28</td>
<td>W.</td>
<td>90</td>
<td>blackberry</td>
<td>5.2 / 5.8</td>
<td>14</td>
<td>medium brown</td>
<td>slight</td>
<td>several</td>
<td>6</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>2. 0095 - A blastwall</td>
<td>33</td>
<td>N.</td>
<td>25</td>
<td>ground moss</td>
<td>5.1 / 6.0</td>
<td>12</td>
<td>light-medium brown</td>
<td>severe</td>
<td>many</td>
<td>8</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>3. 0095 - A bottom highwall</td>
<td>34</td>
<td>N.W.</td>
<td>10</td>
<td>blackberry</td>
<td>5.3 / 6.4</td>
<td>12</td>
<td>light brown</td>
<td>severe</td>
<td>many</td>
<td>7</td>
<td>100</td>
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</tbody>
</table>

3 highwall

<table>
<thead>
<tr>
<th>Aver.</th>
<th>1</th>
<th>2 blackberry</th>
<th>Ave.</th>
<th>1 ground cover</th>
<th>Ave.</th>
<th>1 light brown</th>
<th>1 light-medium brown</th>
<th>1 medium brown</th>
<th>2 severe</th>
<th>2 many</th>
</tr>
</thead>
<tbody>
<tr>
<td>30.3</td>
<td>N.</td>
<td>44.2</td>
<td>5.2</td>
<td>12.7</td>
<td>1.0</td>
<td>3.0</td>
<td>2.0</td>
<td>1.5</td>
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<td></td>
</tr>
</tbody>
</table>

0-10, 11-20, 21-30, 31-40, 41-60, 61-80
## Table 9

**SHORTLEAF PINE SUMMARY**

<table>
<thead>
<tr>
<th>Pine No.</th>
<th>Plot Location</th>
<th>Slope (degrees)</th>
<th>Aspect</th>
<th>% Existing Cover</th>
<th>Major Invader</th>
<th>pH Water/Buffer</th>
<th>Spoil Age (years)</th>
<th>Spoil Color</th>
<th>Degree of Erosion</th>
<th>Rock Fragments</th>
<th>Planting Age (months)</th>
<th>% Survival</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0014 - A bench</td>
<td>1 - 5</td>
<td>S.E.</td>
<td>50</td>
<td>wire grass</td>
<td>4.5 / 6.1</td>
<td>19</td>
<td>light brown</td>
<td>moderate</td>
<td>many</td>
<td>6</td>
<td>86</td>
</tr>
<tr>
<td>2</td>
<td>0021 - B bench</td>
<td>4</td>
<td>N.W.</td>
<td>0 - 5</td>
<td>tall sedge</td>
<td>3.3 / 4.7</td>
<td>19</td>
<td>light gray &amp; light brown</td>
<td>severe</td>
<td>many</td>
<td>5</td>
<td>86</td>
</tr>
<tr>
<td>3</td>
<td>0021 - B berm</td>
<td>1</td>
<td>E.</td>
<td>0</td>
<td>none</td>
<td>3.6 / 4.9</td>
<td>19</td>
<td>light gray &amp; light brown</td>
<td>moderate</td>
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<td>60</td>
</tr>
<tr>
<td>4</td>
<td>0021 - C berm</td>
<td>0 - 4</td>
<td>N.</td>
<td>0</td>
<td>none</td>
<td>3.4 / 4.7</td>
<td>19</td>
<td>light gray</td>
<td>moderate</td>
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<td>5</td>
<td>88</td>
</tr>
<tr>
<td>5</td>
<td>0021 - C berm</td>
<td>1</td>
<td>N.</td>
<td>0 - 5</td>
<td>wire grass</td>
<td>3.7 / 4.9</td>
<td>19</td>
<td>light brown</td>
<td>moderate</td>
<td>many</td>
<td>5</td>
<td>96</td>
</tr>
<tr>
<td>6</td>
<td>0021 - C berm</td>
<td>3</td>
<td>N.</td>
<td>0 - 5</td>
<td>tall sedge</td>
<td>3.5 / 4.7</td>
<td>19</td>
<td>light gray &amp; light brown</td>
<td>slight</td>
<td>many</td>
<td>5</td>
<td>100</td>
</tr>
<tr>
<td>7</td>
<td>0034 - C bench</td>
<td>2 - 16</td>
<td>N.W.</td>
<td>40</td>
<td>wire grass</td>
<td>4.1 / 5.3</td>
<td>19</td>
<td>light brown</td>
<td>moderate</td>
<td>many</td>
<td>5</td>
<td>91</td>
</tr>
<tr>
<td>8</td>
<td>0037 - B berm</td>
<td>8</td>
<td>S.E.</td>
<td>50</td>
<td>broomedge</td>
<td>4.4 / 5.4</td>
<td>19</td>
<td>light gray</td>
<td>slight</td>
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<td>4</td>
<td>98</td>
</tr>
<tr>
<td>9</td>
<td>0041 - A highwall</td>
<td>4</td>
<td>N.E.</td>
<td>20</td>
<td>red oak</td>
<td>5.1 / 6.3</td>
<td>24</td>
<td>tan</td>
<td>severe</td>
<td>many</td>
<td>6</td>
<td>90</td>
</tr>
<tr>
<td>10</td>
<td>0049 - A bench</td>
<td>4</td>
<td>N.</td>
<td>70</td>
<td>pokeberry</td>
<td>5.0 / 5.5</td>
<td>14</td>
<td>light-medium gray &amp; light brown</td>
<td>slight</td>
<td>many</td>
<td>6</td>
<td>100</td>
</tr>
<tr>
<td>11</td>
<td>0049 - A berm</td>
<td>3</td>
<td>S.E.</td>
<td>65</td>
<td>pokeberry</td>
<td>5.3 / 6.4</td>
<td>14</td>
<td>light brown</td>
<td>slight</td>
<td>many</td>
<td>6</td>
<td>83</td>
</tr>
<tr>
<td>12</td>
<td>0058 - A berm</td>
<td>0 - 2</td>
<td>W.</td>
<td>60</td>
<td>wire grass</td>
<td>4.7 / 6.3</td>
<td>15</td>
<td>light brown</td>
<td>slight</td>
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<td>5</td>
<td>51</td>
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<td>13</td>
<td>0058 - A bench</td>
<td>1</td>
<td>W.</td>
<td>60</td>
<td>wire grass</td>
<td>5.0 / 6.2</td>
<td>35</td>
<td>medium brown</td>
<td>slight</td>
<td>many</td>
<td>5</td>
<td>65</td>
</tr>
</tbody>
</table>

**Notes:**
- Ave. = Average
- 1: S.E. = South East
- 2: N.W. = North West
- 3: N. = North
- 4: E. = East
- 5: W. = West
- 6: S.E. = South East
- 7: N.W. = North West
- 8: N. = North
- 9: E. = East
- 10: W. = West
<table>
<thead>
<tr>
<th>Mine No.</th>
<th>Plot Location</th>
<th>Slope (degrees)</th>
<th>Aspect</th>
<th>% Existing Cover</th>
<th>Major Invader</th>
<th>pH water/buffer</th>
<th>Spoil Ave (years)</th>
<th>Spoil Color</th>
<th>Degree of Erosion</th>
<th>Book Fragments</th>
<th>Planting Age (months)</th>
<th>% Survival</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. C03A</td>
<td>A bottom outslp</td>
<td>80</td>
<td>NE</td>
<td>20</td>
<td>wire grass</td>
<td>4.9 / 6.1</td>
<td>19</td>
<td>light gray &amp; light brown</td>
<td>slight</td>
<td>few</td>
<td>17</td>
<td>93</td>
</tr>
<tr>
<td></td>
<td>Ave. = 8.0</td>
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<td>0 &lt; 20</td>
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</table>
### Table 11

**VIRGINIA PINE SUMMARY**

<table>
<thead>
<tr>
<th>Pine No.</th>
<th>Plot Location</th>
<th>Slope (degrees)</th>
<th>Aspect</th>
<th>% Existing Cover</th>
<th>Major Invader</th>
<th>Water/Buff</th>
<th>Spill Age (years)</th>
<th>Spill Color</th>
<th>Degree of Erosion</th>
<th>Rock Fragments (months)</th>
<th>Planting Age</th>
<th>% Survival</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0034 - A outslope</td>
<td>20</td>
<td>N.E.</td>
<td>10</td>
<td>green brier</td>
<td>4.7 / 5.1</td>
<td>20</td>
<td>light gray</td>
<td>moderate</td>
<td>several</td>
<td>14</td>
<td>94</td>
</tr>
<tr>
<td>2</td>
<td>0034 - A berm</td>
<td>0 - 5</td>
<td>N.E.</td>
<td>30</td>
<td>broomedge</td>
<td>4.4 / 5.5</td>
<td>20</td>
<td>light gray</td>
<td>slight</td>
<td>several</td>
<td>14</td>
<td>86</td>
</tr>
<tr>
<td>3</td>
<td>0034 - A outslope</td>
<td>30</td>
<td>N.E.</td>
<td>35</td>
<td>blackberry</td>
<td>6.8 / 6.2</td>
<td>20</td>
<td>light gray</td>
<td>severe</td>
<td>several</td>
<td>2</td>
<td>90</td>
</tr>
<tr>
<td>4</td>
<td>0032 - A hollow fill</td>
<td>8</td>
<td>S.W.</td>
<td>0 - 5</td>
<td>blackberry</td>
<td>3.3 / 4.9</td>
<td>21</td>
<td>light gray</td>
<td>moderate</td>
<td>few</td>
<td>3</td>
<td>56</td>
</tr>
<tr>
<td>5</td>
<td>0032 - A berm</td>
<td>7</td>
<td>W.</td>
<td>20</td>
<td>none</td>
<td>3.3 / 4.9</td>
<td>21</td>
<td>light gray &amp; light brown</td>
<td>moderate</td>
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<td>3</td>
<td>55</td>
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<tr>
<td>6</td>
<td>0032 - A berm</td>
<td>10</td>
<td>N.</td>
<td>30</td>
<td>wire grass</td>
<td>4.0 / 5.2</td>
<td>22</td>
<td>light gray</td>
<td>moderate</td>
<td>many</td>
<td>14</td>
<td>78</td>
</tr>
<tr>
<td>7</td>
<td>0033 - A bench</td>
<td>1</td>
<td>S.</td>
<td>10</td>
<td>small sedge</td>
<td>4.5 / 5.9</td>
<td>22</td>
<td>light brown-black</td>
<td>slight</td>
<td>few</td>
<td>7</td>
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<tr>
<td>8</td>
<td>0034 - C berm side</td>
<td>22</td>
<td>N.W.</td>
<td>0</td>
<td>none</td>
<td>3.7 / 5.0</td>
<td>19</td>
<td>light-medium gray &amp; light brown</td>
<td>severe</td>
<td>many</td>
<td>5</td>
<td>76</td>
</tr>
<tr>
<td>9</td>
<td>0037 - A bench</td>
<td>4</td>
<td>S.</td>
<td>25</td>
<td>broomedge</td>
<td>3.6 / 4.9</td>
<td>19</td>
<td>light gray</td>
<td>slight</td>
<td>few</td>
<td>4</td>
<td>96</td>
</tr>
<tr>
<td>10</td>
<td>0038 - A berm</td>
<td>7</td>
<td>S.</td>
<td>25</td>
<td>broomedge</td>
<td>3.8 / 5.1</td>
<td>20</td>
<td>medium brown</td>
<td>moderate</td>
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<td>85</td>
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<tr>
<td>11</td>
<td>0036 - A berm</td>
<td>0 - 2</td>
<td>N.R.</td>
<td>0 - 5</td>
<td>Virginia pine</td>
<td>4.2 / 4.9</td>
<td>15</td>
<td>light gray &amp; light brown</td>
<td>slight</td>
<td>several</td>
<td>5</td>
<td>86</td>
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<tr>
<td>12</td>
<td>0036 - A berm</td>
<td>9</td>
<td>S.W.</td>
<td>10</td>
<td>blackberry</td>
<td>3.8 / 4.7</td>
<td>15</td>
<td>light-medium gray</td>
<td>severe</td>
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<td>93</td>
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<tr>
<td>13</td>
<td>0038 - A beside highwall</td>
<td>19</td>
<td>S.R.</td>
<td>30</td>
<td>wire grass</td>
<td>5.4 / 6.0</td>
<td>19</td>
<td>light brown</td>
<td>severe</td>
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<td>5</td>
<td>75</td>
</tr>
<tr>
<td>14</td>
<td>010L - A outslope</td>
<td>30</td>
<td>E.</td>
<td>0 - 5</td>
<td>blackberry</td>
<td>3.6 / 5.2</td>
<td>19</td>
<td>light brown</td>
<td>severe</td>
<td>many</td>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td>15</td>
<td>010L - A berm</td>
<td>0 - 1</td>
<td>E.</td>
<td>25</td>
<td>broomedge</td>
<td>3.6 / 5.1</td>
<td>19</td>
<td>medium gray</td>
<td>slight</td>
<td>many</td>
<td>3</td>
<td>25</td>
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</tbody>
</table>

1 beside highwall Ave. = 2 S. Ave. = 3 broomedge Ave. = 4 blackberry Ave. = 5 wire grass Ave. = 6 light gray
2 berm 11.7 3 S.W. 17.7 4 light gray & light brown
7 berm 1 S.E. 5 light gray & light brown
1 berm side 10: 0 - 10 6 light gray & light brown
1 hollow fill 2:11:20 7 S.R. 1:31-60 8 medium gray
3 outslope 30 8 S. 2:00 9 Virginia pine 1 medium gray

Additional notes:
- 3 light gray & light brown
- 5 moderate
- 6 severe
- 7 green brier
- 8 small sedge
- 9 medium gray
- 10 light brown-black
Table 12

WHITE PINE SUMMARY

<table>
<thead>
<tr>
<th>Mine No.</th>
<th>Plot Location</th>
<th>Slope (degrees)</th>
<th>Aspect</th>
<th>% Existing Cover</th>
<th>Major Invader</th>
<th>pH Water/Bufffer</th>
<th>Spoil Age (years)</th>
<th>Spoil Color</th>
<th>Degree of Erosion</th>
<th>Rock Fragments</th>
<th>Planting Age (months)</th>
<th>% Survival</th>
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</thead>
<tbody>
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<td>1. 004:9 - A highwall</td>
<td>35</td>
<td>s.</td>
<td>30</td>
<td>broomedge</td>
<td>4.9 / 6.1</td>
<td>2x</td>
<td>tan-light brown</td>
<td>severe</td>
<td>many</td>
<td>7</td>
<td>92</td>
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<td>5,</td>
<td>40</td>
<td>none</td>
<td>5.3 / 6.1</td>
<td>2x</td>
<td>light gray &amp; light brown</td>
<td>slight</td>
<td>many</td>
<td>7</td>
<td>89</td>
<td></td>
</tr>
<tr>
<td>2 highwall</td>
<td>Ave. - 24.0</td>
<td>Ave. - 3</td>
<td>Ave. - 50.0</td>
<td>1 broomedge</td>
<td>Ave. - 1</td>
<td>Ave. - 1 light gray</td>
<td>light brown</td>
<td>light brown</td>
<td>Ormoderate</td>
<td>1: several</td>
<td>7.0</td>
<td>90.5</td>
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</tbody>
</table>
Chapter 6

SUMMARY AND CONCLUSIONS

The first portion of this chapter deals with results found for the six species studied with six or more experimental plots tested. Results for each of these six species is broken down into an analysis of each site condition studied. Five additional species had three or fewer plots tested. Results for these five were not considered fully valid because of the much smaller number of seedlings tested. Therefore, only highlights of these results are presented.

The second and last portion of the chapter presents data based on information gained from all eleven woody plant species tested.

Correlations between invaders and seedling survival was done on an individual basis only. For example, seedling survival was averaged for all Virginia pine plots with blackberry as the major invader. No other invaders were lumped with blackberry. However, group relationships were investigated for the degree of existing vegetative cover.

Each category of predetermined site conditions was compared to the percent of seedling survival to see what, if any, relationship existed. Straight line relationships were considered to be reliable, this being a situation where the percent of seedling survival continued in the same direction on a graph with each increment change of a site condition. Although some type of relationship was established for each set of site specific results, a reversal of direction for the graph line was termed an unreliable relationship for purposes of seedling survival prediction on orphan mine lands in southeastern Kentucky.
Results for Individual Species

Autumn Olive Summary

Fifteen autumn olive plots were selected for testing. A total of 1,334 seedlings were planted on those plots. Survival averaged 61%, the lowest of all species tested. Autumn olive survival ranged from 17% to 95% on individual plots. Seedlings had been planted an average of six months, ranging from three to fourteen months.

As can be seen in Table 2, autumn olive plots were located so that all aspects were represented except northwest, with 63% survival on the warm aspects versus 59% survival on the cool aspects.

Survival was higher for plots located on mine positions with steeper slopes, with the exception of those located on outslopes. Survival on the berm side was 89%, on the highwall, 89%; on the berm, 67%; on the outslope, 60%; and on the bench, 23%.

The average slope for all plots was 17 degrees, ranging from 0 to 37 degrees. On the eight plots that ranged from 0-10 degrees slope, 56% of the seedlings survived; no plots were established with slopes between 11 and 20 degrees; on the seven plots with slopes greater than 20 degrees, there was 68% survival.

On the five plots with slight erosion, 51% of the seedlings survived; on the six plots with moderate erosion, survival averaged 65%; on the three plots with severe erosion, survival averaged 69%.

There appeared to be no direct relationship between the amount of rock fragments on the spoil surface and the seedling survival. On the six plots with few rock fragments, survival was 64%; on the five plots with several rock fragments, survival was 50%; on the four plots with many rock fragments, survival averaged 73%.
There appeared to be a direct relationship between the percentage of existing plant cover on the plots and the seedling survival. On the thirteen plots with 0-30% existing cover, seedling survival was 57%; on the one plot with 31-60% cover, survival was 93%; on the one plot with more than 60% cover, seedling survival was 95%. From the data collected it appears the greater the percentage of existing plant cover on the orphan land, the higher the autumn olive survival.

Six invading plant species on the autumn olive plots were identified. Two plots with broomsedge as the major invader averaged 71%. Six plots with wire grass as the major invader averaged 57% seedling survival; three plots with no major invaders averaged 47%. Four additional major invaders were found on only one plot each. They were blackberry, deertongue, shining sumac, and black gum; seedling survival for those plots was 65%, 51%, 93%, and 89% respectively.

Ten variations of spoil color were found on the autumn olive plots including shades of gray, brown, and mixtures of the two. Brown spoils had an average seedling survival of 86%. Spoils with mixtures of brown and gray coloration had an average seedling survival of 58%. Gray spoils had survival of 55%.

Water pH averaged 3.9, ranging from 2.5 to 4.6; buffer pH averaged 5.1, ranging from 4.4 to 6.1. When water pH was less than 4.0, survival averaged 61%; with water pH from 4.0 to 5.0, survival was 55%; with water pH greater than 5.0, survival was 89%. When the buffer pH was less than 5.0, seedling survival was 59%; between 5.0 and 6.0 survival was 67%; with the buffer pH greater than 6.0, seedling survival was 28%.
Black Locust Summary

A total of fifteen plots were chosen for black locust testing. On those fifteen plots 1,430 seedlings were planted. Survival averaged 79%, ranging from 9% to 100%. Seedlings had been planted an average of five months, ranging from two to thirteen months.

Black locust plots were located on all aspects except east facing slopes, with 84% survival on the warm aspects versus 73% on the cool aspects.

When the plots were evaluated according to position on the mine, survival was better on the steeper locations. Survival on outslopes averaged 77%, on the highwall, 94%; above the highwall, 100%; and on the bench, 62%.

The average slope for all plots was 25 degrees, ranging from 0 degrees to 39 degrees. On the three plots that ranged from 0-10 degrees, 63% of the seedlings survived; no plots were established on slopes of 11-20 degrees; on the twelve plots with slopes greater than 20 degrees, survival averaged 81%.

On the three plots with slight erosion, 72% of the seedlings survived; on the one plot with moderate erosion, survival was 100%; on the eleven plots with severe erosion, survival was 88%.

The amount of rock fragments on the plot surface was originally thought to relate directly to the degree of erosion; however, the black locust studies did not bear this out. There appeared to be a direct relationship between the number of rock fragments on the plot and the plant survival. On the three plots with few rock fragments, seedling survival was 94%; on the six plots with several rock fragments, survival was 76%, on the six plots with many rock fragments, survival was 74%.
There appeared to be a direct relationship between the percentage of existing cover and the seedling survival. On the thirteen plots with 0-30% existing plant cover, seedling survival was 75%; on the two plots with 31-60% existing cover, survival was 99%; no black locust plots were established with existing cover of greater than 60%.

Six different invaders, which made up the majority of the existing plant material on their respective plots at the time of testing, were identified. Two plots with green brier as the major invader averaged 90% seedling survival; three plots with wire grass as the major invader averaged 83% seedling survival; two plots with no invaders averaged 69% survival; five plots with blackberry as the major invader averaged 65% seedling survival. Three additional invaders were found to be a majority of the existing vegetation on only one plot. They were shining sumac, goldenrod, and broomsedge. Seedling survival on those plots was 93%, 100%, and 97% respectively.

When local geologic conditions are known, spoil color can be an indicator of parent material and therefore plant survival. Eleven variations of spoil color were recorded on the black locust plots including shades of gray, brown, and mixtures of the two. Seedling survival on brown spoils averaged 95%; on gray spoils, 80%; on spoils with mixed gray and brown coloration, 63%.

Water pH averaged 4.2, ranging from 3.1 to 5.5; buffer pH averaged 5.2, ranging from 4.6 to 6.7. There appeared to be a direct relationship between pH and plant survival, which increased as the pH range increased. When water pH was less than 4.0, survival was 73%; when 4.0 to 5.0, survival was 75%; when greater than 5.0, survival was
96%. When the buffer pH was less than 5.0, survival was 33%; at buffer pH 5.0 to 6.0, survival was 83%; with buffer pH greater than 6.0, survival was 100%.

**European Black Alder Summary**

Fifteen plots were established for European black alder testing. On those fifteen plots 1,087 seedlings were planted. Survival averaged 92%, ranging from 80% to 100%. Seedlings had been planted an average of five months, ranging from three to fourteen months.

European black alder plots were located on all aspects except southwest facing slopes, with 89% survival on the warm aspects versus 94% survival on the cool aspects.

Survival was better for plots located on steeper mine positions. Survival on the highwall was 100%, 98% on a gully side, 93% on the bench, 92% on a filled gully, 89% on the berm, and 80% on a hollow fill.

The average slope for all plots was 6 degrees, ranging from 0 to 28 degrees. On the thirteen plots that ranged from 0-10 degrees, 91% of the seedlings survived; on the one plot within the range of 11-20 degrees slope, 94% of the seedlings survived; on the one plot with a slope greater than 20 degrees, survival was 98%.

On the eleven plots with slight erosion, 93% of the seedlings survived; on the two plots with moderate erosion, survival was 95%; on the two plots with severe erosion, survival was 87%.

The amount of rock fragments on the plot surfaces appeared to have a direct relationship to the seedling survival. On the seven plots with few rock fragments, survival was 94%; on the two plots with several rock fragments, seedling survival was 91%; on the six plots with many rock fragments, survival was 90%.
There appeared to be no direct relationship between European black alder seedling survival and the degree of existing plant cover. On the nine plots with 0-30% existing plant cover, seedling survival was 90%; on the five plots with 31-60% existing cover, survival was 95%; on the one plot established with existing plant cover greater than 60%, survival was 65%.

Seven invading plant species, which made up the majority of the existing plant material on their respective plots at the time of testing, were identified. Six plots with wire grass as the major invader averaged 94% seedling survival; two plots with tall sedge as the major invader averaged 92% seedling survival; two plots with no invaders averaged 91% seedling survival. Five additional major invaders were recorded on one plot each. They were blackberry, short sedge, orchard grass, saw grass, and broomsedge; their survival was 86%, 100%, 90%, 89%, and 88% respectively.

Nine variations of spoil color were recorded on the European black alder plots including shades of gray, brown, and mixtures of the two. Survival on brown spoils averaged 97%; on gray spoils 88%; on spoils with mixed gray and brown coloration 78%.

Water pH averaged 4.1, ranging from 2.7 to 5.6; buffer pH averaged 5.4, ranging from 4.4 to 6.8. As the pH increased, European black alder survival also increased for both water and buffer pH. When water pH was less than 4.0, survival was 89%; when water pH was 4.0 to 5.0, survival was 94%; when water pH was greater than 5.0, survival was 94%. When the buffer pH was less than 5.0, survival averaged 88%; when buffer pH was 5.0 to 6.0, survival was 94%; and when the buffer pH was greater than 6.0, survival was again 94%.
Virginia Pine Summary

Fifteen Virginia pine plots were established for testing with a total of 1,049 seedlings planted on them. Seedling survival averaged 73%, ranging from 15% to 96%. Seedlings had been planted an average of seven months, ranging from two to fourteen months.

Virginia pine plots were located on all aspects, with 77% survival on the warm aspects versus 69% on the cool aspects.

Results from the analysis of plots on various mine positions were so varied that no conclusions could be drawn from them. Survival on the two bench plots averaged 87%; on the berm side, 78%; on the slope adjacent to the highwall, 75%; on the berm, 73%; on the outslope, 66%; on the hollow fill, 56%.

The average slope for all plots was 12 degrees, ranging from 0 to 30 degrees. On the ten plots located on slopes 0-10 degrees, seedling survival averaged 74%; on the two plots with slopes of 11-20 degrees, seedling survival was 85%; on the three plots with slopes greater than 20 degrees, survival was 61%.

On the five plots with slight erosion, 74% of the seedlings survived; on the five plots with moderate erosion, survival also averaged 74%; on the five plots with severe erosion, seedling survival averaged 70%.

There was no apparent correlation between the number of rock fragments on the spoil surface and the percentage of seedling survival for the Virginia pine plots. On the four plots with few rock fragments, survival was 79%; on the four plots with several rock fragments, survival was 89%; on the seven plots with many rock fragments, survival was 60%.
Again there did not appear to be a direct relationship between the percentage of existing plant cover on the plots and the seedling survival. On the fourteen plots with 0-30% existing cover, seedling survival was 71%; on the one plot with 31-60% cover, survival was 90%; no plots were established with cover greater than 60%.

Six plant species were identified as being a majority of the invading plants on their respective plots. Two plots with wire grass as the major invader had 67% seedling survival; four plots with blackberry as the major invader had 63% survival. Three additional existing plant species were found to be the major invader on only one Virginia pine plot each. They were short sedge, Virginia pine, and green brier; seedling survival on these plots was 77%, 88%, and 94% respectively.

Eight variations of spoil color were found on the Virginia pine plots including shades of gray and brown along with mixtures of the two. Gray spoils had an average seedling survival of 77%. Spoils with mixtures of gray and brown coloration had seedling survival of 75%. Brown spoils had 50% survival.

Water pH averaged 4.1, ranging from 3.3 to 5.4; buffer pH averaged 5.3, ranging from 4.7 to 6.4. When water pH was less than 4.0, survival was 63%, when water pH was 4.0 to 5.0, survival was 85%, with water pH greater than 5.0, survival was 75%. When buffer pH was less than 5.0, survival was 78%; when between 5.0 and 6.0, seedling survival averaged 63%; with buffer pH greater than 6.0, survival of Virginia pine seedlings averaged 86%.

*Shortleaf Pine Summary*

Thirteen shortleaf pine plots were established for testing. A total of 1,046 seedlings were planted on those plots. Survival averaged
85%, ranging from 54 to 100%. Seedlings had been planted an average of five months, ranging from three to six months.

Shortleaf pine plots were established on all aspects except south and southwest. Seedling survival averaged 77% on warm aspects and 90% on cool aspects.

Survival of seedlings was better on the plot locations with steeper slopes. Survival on the highwall was 96%; on the berm, 89%; and on the bench, 79%.

The average slope for all shortleaf pine plots was seven degrees, ranging from 0 to 46 degrees. On the eleven plots that ranged from 0-10 degrees slope, 83% of the seedlings survived; on the one plot with a slope of 11-20 degrees, survival was 91%; on the one plot with slope greater than 20 degrees, survival was 96%.

On the six plots with slight erosion, 83% of the seedlings survived; on the five plots with moderate erosion, 84% of the seedlings survived; on the two plots with severe erosion, 91% survival was noted.

On the one plot with few rock fragments, survival was 98%; there were no shortleaf pine plots with several rock fragments; on the twelve plots with many rock fragments, survival averaged 84%.

There did not appear to be a direct relationship between seedling survival and the percentage of existing vegetative cover on the plots at the time of testing. On the six plots with 0–30% existing cover, 88% of the seedlings survived; on the five plots with 31–60% cover, 79% of the seedlings survived; on the two plots with greater than 60% cover, survival was 91%.

Five major invading plant species were identified. Two plots with tall sedge as the major invader averaged 93% seedling survival; two
plots with pokeberry as the major invader had 91% survival; five plots with wire grass as the major invader averaged 78% seedling survival; two plots with no invaders averaged 74% survival. Two additional invaders were a majority on only one plot each. They were broomsedge and red oak; seedling survival on these plots was 98 and 96% respectively.

Six variations of spoil color were found on the shortleaf pine plots. Gray spoils had an average seedling survival of 93%. Spoils with mixtures of gray and brown colors had 87% survival. Brown spoils averaged 82% seedling survival.

Water pH for all shortleaf pine plots averaged 4.3, ranging from 3.3 to 5.3; buffer pH averaged 5.5, ranging from 4.7 to 6.4. When water pH was less than 4.0, survival averaged 86%; with water pH at 4.0 to 5.0, survival averaged 82%; with water pH greater than 5.0, seedling survival was 89%. When the buffer pH was less than 5.0, survival was 86%; with pH at 5.0 to 6.0, seedling survival was 96%; with buffer pH greater than 6.0, shortleaf pine survival was 77%.

Loblolly Pine Summary

Six loblolly pine plots were chosen for testing with a total of 338 seedlings planted on them. Seedling survival averaged 66%, ranging from 0 to 89% on individual plots. Seedlings had been planted an average of seven months, ranging from five to fourteen months.

Loblolly pine plots were located on all aspects except east and northwest, with plots on warm aspects having 82% seedling survival versus 35% survival on cool aspects.

Results with regard to plot locations on the mine were varied. That is, no direct relationship was evident. Survival on the slope adjacent to the highwall was 89%; 84% on the haul road; 82% on the bench;
69% on the berm; 0% on the hollow fill. Total failure on the hollow fill can best be attributed to seedling injury at some point between the nursery and the mine site.

The average slope for all plots was 9 degrees, ranging from 0 to 20 degrees. On the four plots with slopes of 0-10 degrees, survival was 60%; on the two plots with slopes of 11-20 degrees, survival was 79%; no plots were located on slopes greater than 20 degrees.

On the three plots with slight erosion, seedling survival averaged 53%; on the three plots with moderate erosion, survival was 80%; there were no plots with severe erosion.

On the two plots with few rock fragments, seedling survival averaged 79%; on the one plot with several rock fragments, survival was 0%; on the three plots with many rock fragments, loblolly pine seedling survival averaged 80%. These results indicate no apparent relationship between the presence of rock fragments on the spoil surface and the survival rate of loblolly pine.

There appeared to be a direct relationship between the percentage of existing plant cover on the plots and the seedling survival. On the five plots with 0-30% existing plant cover, seedling survival was 63%; on the one plot with 31-60% cover, survival was 82%; no plots were established with more than 60% existing plant cover.

Four invading plant species were identified. Two plots with wire grass as the major invader averaged 85% seedling survival; two plots with broomsedge as the major invader had 34% survival. Two additional plants which made up the majority of the plant invaders were found on only one plot each. They were steeplebush and sourwood with 70 and 89% seedling survival respectively.
Four variations of spoil color were found on the loblolly pine plots. Gray spoils had an average seedling survival of 89%. Spoils with mixtures of gray and brown colors had 68% survival. Plots with brown surface spoils had 60% seedling survival.

Water pH averaged 4.4, ranging from 3.7 to 5.3; buffer pH averaged 5.6, ranging from 4.9 to 6.3. When water pH was less than 4.0, survival of loblolly pine seedlings was 46%; with pH 4.0 to 5.0, survival was 85%; with water pH greater than 5.0, seedling survival was 89%. These results show a strong correlation between water pH and loblolly pine seedling survival. When buffer pH was less than 5.0, seedling survival averaged 69%; with buffer pH at 5.0 to 6.0, survival was 41%; with buffer pH greater than 6.0, loblolly pine seedlings survival averaged 89%. These results do not show a straight line relationship between buffer pH and seedling survival. However, seedling tests for other species usually did show similar results for water and buffer pH. That situation did not occur here because of the low survival occurring with buffer pH between 5.0 and 6.0 where one plot had 0% survival.

Summary for Scotch Pine, White Pine, Bicolor Lespedeza, Chinese Chestnut, and Tulip Poplar

Three Scotch pine plots were chosen for testing with a total of 134 seedlings planted on them. Seedling survival averaged 100%, the highest of any plant species tested. Seedlings had been planted an average of seven months, ranging from six to eight months. No conclusions were drawn from the data base because of the small number of Scotch pine plots.
Two white pine plots were established for testing with a total of 253 seedlings. Seedling survival averaged 91%, ranging only from 89 to 92%. Both plots had been planted seven months at the time of testing. Again, because of the small number of plots, no relationships between site conditions and seedling survival were examined.

One bicolor lespedeza plot was established with 49 seedlings planted. Eighty-five percent of these seedlings had survived at the time of testing, which was three months after the planting date. No further conclusions regarding relationships of site conditions and seedling survival were made from this small data sample.

One Chinese chestnut plot was established with 80 seedlings originally planted on it. Seedling survival was 96% after three months. No conclusions were drawn from this Chinese chestnut plot data.

One tulip poplar plot was established with 33 seedlings planted on it. Seedling survival was 93% seventeen months after planting. No relationships between site conditions and seedling survival were examined nor conclusions drawn from the tulip poplar plot data because of the small sample.
Summary and Conclusions for All Species

Average seedling survival figures, as related to particular site conditions, include plot data from all eleven plant species tested, even though the averages for species with less than six plots are not displayed in the tables.

Water pH

Water pH was the most reliable predictor of seedling survival. This does not mean that the planner could always predict seedling survival results but that he could predict a range of results and be correct most of the time. As seen in Table 13, when water pH was less than 4.0, for all species tested, the average seedling survival was 70%; when the water pH ranged from 4.0 to 5.0, survival averaged 82%; when

<table>
<thead>
<tr>
<th>Species</th>
<th>pH</th>
<th>Water pH</th>
<th>Buffer pH</th>
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<td>&lt;4.0</td>
<td>4.0-5.0</td>
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<td>autumn olive</td>
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<td></td>
<td>63</td>
<td>85</td>
</tr>
</tbody>
</table>
the water pH was greater than 5.0, seedling survival averaged 93%. These results show a definite improvement in the survival rate as the water pH increases. Using the autumn olive plot with a slope of 0-3 degrees on mine number 0034 - A as an example, where the water pH was 3.8, the planner could predict that seedling survival would be relatively low. While 70% survival was the average for all plots with a water pH of less than 4.0, survival on this plot was 51%. The water pH results were similar to findings of Boyce (6), S.C.S. (33), and Plass (39).

Buffer pH

Buffer pH results were similar to water pH results. When the buffer pH was less than 5.0, seedling survival for all species averaged 72%; when buffer pH was 5.0 to 6.0, survival averaged 79%; when the buffer pH was greater than 6.0, survival was 85%.

Thus both water and buffer pH results appear to have direct relationships to seedling survival and should be good predictors of seedling survival. However, pH is a chemical characteristic of spoil and therefore cannot be noted visually. The author's research results indicate with laboratory pH results in hand the planner could predict, on the average, how many seedlings of a certain species would need to be planted to meet certain vegetation standards.

Existing Plant Cover

The percentage of existing plant cover on the plots was also a good indicator of seedling survival. Table 14 summarizes the data collected for existing plant cover: when the plots had 0-30% existing cover, seedling survival for all species averaged 75%; when the plots
Table 14
Percentage of Seedling Survival for Existing Plant Cover

<table>
<thead>
<tr>
<th>Species</th>
<th>Existing Plant Cover</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0-30%</td>
</tr>
<tr>
<td>autumn olive</td>
<td>57</td>
</tr>
<tr>
<td>black locust</td>
<td>75</td>
</tr>
<tr>
<td>European black alder</td>
<td>90</td>
</tr>
<tr>
<td>loblolly pine</td>
<td>63</td>
</tr>
<tr>
<td>shortleaf pine</td>
<td>88</td>
</tr>
<tr>
<td>Virginia pine</td>
<td>71</td>
</tr>
</tbody>
</table>
had 31-60% cover, survival averaged 89%; when the plots had existing cover greater than 60%, survival also averaged 89%. The greater the plant cover, the better the seedling survival in most cases. Competition with the seedlings from existing plant cover did not become a factor since a large percentage of the invaders did not produce a dense shade nor a dense leaf litter. The implication is that if the percentage of existing plant cover is small at the time the seedlings are planted, for orphan mines at least twelve years old, site conditions are sufficiently severe to limit seedling survival. A further observation suggests the establishment of any vegetation will aid in the survival of seedlings for areas where site conditions indicate physiological stresses. This nurse vegetation proved to assist survival to a certain point, at which the survival rate decreased again. The author’s results show that point may be near 60% existing vegetative cover.

**Spoil Color**

Results of the spoil color summary, displayed in Table 15, show that spoil color may be an indicator of seedling survival but it will be less reliable than pH or the percentage of existing plant cover. Plots with gray spoils only, for all species, had an average seedling survival of 75%; brown spoils had an average survival of 83%; spoils with mixtures of the two colors had an average seedling survival of 81%. Planners could expect to get slightly higher seedling survival rates on brown spoils as compared to gray spoils for orphan lands where the same coal seams were present as in this research. The survival rates, however, did not show enough variation between the different colors to make spoil color a reliable indicator of seedling survival. The theory
that dark spoils absorb more solar radiation, increasing surface temperatures to the point of seedling kill is probably correct but could only be proved via the use of spoil temperature recording equipment over an extended period of time.

Table 15
Percentage of Seedling Survival for All Spoil Colors

<table>
<thead>
<tr>
<th>Species</th>
<th>Spoil Color</th>
<th>Grays</th>
<th>Mixtures</th>
<th>Browns</th>
</tr>
</thead>
<tbody>
<tr>
<td>autumn olive</td>
<td></td>
<td>55</td>
<td>58</td>
<td>86</td>
</tr>
<tr>
<td>black locust</td>
<td></td>
<td>80</td>
<td>63</td>
<td>95</td>
</tr>
<tr>
<td>European black alder</td>
<td></td>
<td>88</td>
<td>78</td>
<td>97</td>
</tr>
<tr>
<td>loblolly pine</td>
<td></td>
<td>89</td>
<td>68</td>
<td>60</td>
</tr>
<tr>
<td>shortleaf pine</td>
<td></td>
<td>93</td>
<td>87</td>
<td>82</td>
</tr>
<tr>
<td>Virginia pine</td>
<td></td>
<td>77</td>
<td>75</td>
<td>50</td>
</tr>
</tbody>
</table>

Plant Invaders

Plant invaders also may be indicators of seedling survival. This is assuming that the different invaders prefer different sets of site conditions and therefore will dominate on those plots where their preferred conditions exist. It is also assuming that seeds from many plants somehow have been transported to each plot and had the opportunity to germinate and grow.

The most common invaders found were wire grass, seen in Figure 17, the major invader on 26 plots; blackberry, seen in Figure 18, the
Figure 17

Wire Grass Sketch
major invader on 13 plots; and broomsedge, seen in Figure 15, the major invader on 12 plots. No invaders were found on 12 plots.

Although a wide range of survival rates was found for seedlings planted on plots with invaders, 51% to 100%, only one plant invader was associated with an unacceptable average seedling survival rate, that being 51%. This particular survival rate was for one plot only, where deertongue was the major invader on the plot. The average seedling survival rate associated with deertongue might have been higher with a larger sample, meaning more plots where deertongue was the major invader, since the next lowest seedling survival rate was 70%.

Figure 18
Blackberry, An Invader
### Table 16

Percentage of Seedling Survival for Plots With Plant Invaders

<table>
<thead>
<tr>
<th>Species</th>
<th>wire grass</th>
<th>blackberry</th>
<th>broomedge</th>
<th>Others</th>
<th>No Invader</th>
</tr>
</thead>
<tbody>
<tr>
<td>autumn olive</td>
<td>57</td>
<td>65</td>
<td>71</td>
<td>80</td>
<td>47</td>
</tr>
<tr>
<td>black locust</td>
<td>83</td>
<td>65</td>
<td>97</td>
<td>93</td>
<td>69</td>
</tr>
<tr>
<td>European black alder</td>
<td>94</td>
<td>86</td>
<td>88</td>
<td>93</td>
<td>91</td>
</tr>
<tr>
<td>loblolly pine</td>
<td>85</td>
<td>none</td>
<td>34</td>
<td>79</td>
<td>none</td>
</tr>
<tr>
<td>shortleaf pine</td>
<td>78</td>
<td>none</td>
<td>98</td>
<td>93</td>
<td>74</td>
</tr>
<tr>
<td>Virginia pine</td>
<td>77</td>
<td>63</td>
<td>73</td>
<td>86</td>
<td>67</td>
</tr>
</tbody>
</table>

*Invaders listed were observed to be a majority of all the invaders identified on the plot.*
Of the invaders with a sample of three plots or more, tall sedge and green brier results of 93% and 91% seedling survival respectively were most unexpected. The most common invaders recorded, wire grass, broomsedge, and blackberry were associated with similar average seedling survival rates of 79%, 73%, and 71% respectively for all plots where they were a majority. Survival rates for autumn olive, black locust, European black alder, loblolly pine, shortleaf pine, and Virginia pine plots with these invaders are shown in Table 16.

Without larger samples for most of the invaders the planner could make few predictions about seedling survival based on invader occurrence alone. Multiple relationships between plant invaders and combinations of other site conditions such as pH, slope, aspect, etc., should reveal much more information about predicting seedling survival, as there appears to be a strong interdependence between the site conditions.

Survival for seedlings on plots with no plant invaders averaged 69%, which is on the low end of the survival results recorded in this research. This was probably due to extreme, adverse conditions. The planner can predict relatively low survival when the plot has no invaders growing. This coincides with the results of percentage of existing plant cover, see Table 14, which showed relatively low seedling survival can be predicted when the percentage of existing plant cover found on the plot is 0-30%, again probably due to very adverse conditions at those sites.

Aspect

Results of the author's aspect summaries show this site condition to have only limited value in predicting seedling survival. The
average survival for all plots with warm south and west aspects was 78%; the average survival for plots with cool north and east aspects was 79%. As shown in Table 17, species which did best on warm aspects were black locust, 11% better than on cool aspects; autumn olive, 4% better; Virginia pine, 8% better; and loblolly pine, 47% better. Species that did best on cool aspects were European black alder, 5% better than on warm aspects; and shortleaf pine, 13% better. If the planner used a 10% survival difference as significant, then only three of the species showed a significant preference for warm or cool aspects. Black locust preferred warm south and east aspects by an 11% margin; loblolly pine preferred warm aspects by a 47% margin; and shortleaf pine preferred cool north and east aspects by a 13% margin.

Table 17
Percentage of Seedling Survival for Warm and Cool Aspects

<table>
<thead>
<tr>
<th>Species</th>
<th>Aspects</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>warm</td>
</tr>
<tr>
<td>autumn olive</td>
<td>63</td>
<td>59</td>
</tr>
<tr>
<td>black locust</td>
<td>84</td>
<td>73</td>
</tr>
<tr>
<td>European black alder</td>
<td>89</td>
<td>94</td>
</tr>
<tr>
<td>loblolly pine</td>
<td>82</td>
<td>35</td>
</tr>
<tr>
<td>shortleaf pine</td>
<td>77</td>
<td>90</td>
</tr>
<tr>
<td>Virginia pine</td>
<td>77</td>
<td>69</td>
</tr>
</tbody>
</table>
Slope

From the data collected, slope could not be used as a reliable predictor of seedling survival. On all plots with slopes of 0-10 degrees, seeding survival averaged 77%; on plots with slopes of 11-20 degrees, survival averaged 86%; on plots with slopes greater than 20 degrees, survival averaged 79%. Results were even more unexpected when each species was studied individually. Black locust did best on slopes greater than 20 degrees, as did European black alder, autumn olive, and shortleaf pine. Virginia pine and loblolly pine did best on slopes of 11-20 degrees. None of the species studied, encompassing six test plots or more, did best on slopes of 0-10 degrees. This was totally unexpected since it was thought that the steep slopes would be a great disadvantage to plant survival and growth. No statistical explanation was apparent. Table 18 illustrates the unexpected results and, in particular, the surprising results for European black alder and shortleaf pine, which both showed excellent adaptation to steep slopes.
Table 18

Percentage of Seedling Survival for All Slopes

<table>
<thead>
<tr>
<th>Species</th>
<th>Slope 0-10°</th>
<th>11-20°</th>
<th>&gt;20°</th>
</tr>
</thead>
<tbody>
<tr>
<td>autumn olive</td>
<td>56</td>
<td>none</td>
<td>68</td>
</tr>
<tr>
<td>black locust</td>
<td>68</td>
<td>none</td>
<td>81</td>
</tr>
<tr>
<td>European black alder</td>
<td>91</td>
<td>94</td>
<td>98</td>
</tr>
<tr>
<td>loblolly pine</td>
<td>60</td>
<td>79</td>
<td>none</td>
</tr>
<tr>
<td>shortleaf pine</td>
<td>83</td>
<td>91</td>
<td>96</td>
</tr>
<tr>
<td>Virginia pine</td>
<td>74</td>
<td>85</td>
<td>61</td>
</tr>
</tbody>
</table>

Plot Position on the Mine

Figure 19 shows the relationship of the three major mine positions: the nearly vertical highwall, in the upper portion of the photo; the relatively flat bench, in the center; and the steep outslope, in the lower center of the photo. Table 19 shows that the author's research was only partially successful in gaining data related to plot position, due in large part to T.V.A.'s policy of using particular species in a limited manner. For example, black locust was used almost exclusively on the steeper slopes when a range of slopes was available for planting, resulting in a data void for some relationships. Table 19 shows survival on the steeper mine positions was higher than on those relatively flat positions, the opposite of what had been expected. The statistical results do not illustrate a straight line relationship, making plot position on the mine an unreliable predictor of seedling survival for all of the seedlings tested as a whole.
Table 19

Percentage of Seedling Survival for All Plot Positions on the Mine

<table>
<thead>
<tr>
<th>Species</th>
<th>Plot Position On the Mine</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bench</td>
</tr>
<tr>
<td>autumn olive</td>
<td>23</td>
</tr>
<tr>
<td>black locust</td>
<td>62</td>
</tr>
<tr>
<td>European black alder</td>
<td>93</td>
</tr>
<tr>
<td>loblolly pine</td>
<td>82</td>
</tr>
<tr>
<td>shortleaf pine</td>
<td>79</td>
</tr>
<tr>
<td>Virginia pine</td>
<td>87</td>
</tr>
</tbody>
</table>
Figure 19

Landscape After Contour Mining

Degree of Erosion

Other site conditions that did not show expected results included the degree of erosion and occurrence of rock fragments. It was originally expected that severe erosion would reduce the survival rate of the planted seedlings. Results did not bear this out. Table 20 shows the degree of erosion relationships with the seedlings that had six or more test plots. Figure 20 shows that on all test plots with slight erosion, seedling survival averaged 79% and on all plots with moderate erosion, survival was 77%. However, on plots with severe erosion, seedling survival was 83%. Expectations were that the degree of erosion results would parallel the degree of slope results. In
essence the data gathered indicates the degree of erosion, as well as
the degree of slope could not be used as reliable predictors of seedling
survival. Because erosion is an ongoing process its effect upon
seedling survival may not be apparent over the short time period of this
study; however, a study completed over five to ten years would probably
provide results more in line with the author’s expectations.

Table 20
Percentage of Seedling Survival for
All Degrees of Erosion

<table>
<thead>
<tr>
<th>Species</th>
<th>Degree of Erosion</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>slight</td>
</tr>
<tr>
<td>autumn olive</td>
<td>51</td>
</tr>
<tr>
<td>black locust</td>
<td>72</td>
</tr>
<tr>
<td>European black alder</td>
<td>93</td>
</tr>
<tr>
<td>loblolly pine</td>
<td>53</td>
</tr>
<tr>
<td>shortleaf pine</td>
<td>83</td>
</tr>
<tr>
<td>Virginia pine</td>
<td>74</td>
</tr>
</tbody>
</table>
Rock Fragments

The summary of rock fragment occurrence, Figure 21, showed 83% seedling survival on all plots with few rock fragments and 75% survival on plots with several fragments. However, on plots with many fragments, survival averaged 79%. It was originally expected that a direct relationship would exist between seedling survival and the occurrence of rock fragments; in other words, the greater the occurrence of rock fragments the less the rate of seedling survival. Table 21 shows the relationship between the major species tested and the occurrence of rock fragments. The occurrence of rock fragments is apparently not a factor in seedling survival for the coal seams investigated in this research. This site factor obviously does play a more important role in the establishment of herbaceous vegetation where the more spoil surface covered by rock fragments, the less the percent vegetative cover that can be achieved.
Figure 21
Occurrence of Rock Fragments for All Plots

Table 21
Percentage of Seedling Survival for Rock Fragment Occurrence

<table>
<thead>
<tr>
<th>Species</th>
<th>Rock Fragments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>few</td>
</tr>
<tr>
<td>autumn olive</td>
<td>64</td>
</tr>
<tr>
<td>black locust</td>
<td>94</td>
</tr>
<tr>
<td>European black alder</td>
<td>94</td>
</tr>
<tr>
<td>loblolly pine</td>
<td>79</td>
</tr>
<tr>
<td>shortleaf pine</td>
<td>98</td>
</tr>
<tr>
<td>Virginia pine</td>
<td>79</td>
</tr>
</tbody>
</table>
Table 22 shows a summary of the average seedling survival for the species that were tested. Figure 22 shows a best approximation of the plant survival results obtained from this study and the studies of other authors. The curve can be used to predict approximate survival results for extended periods for the group of plants tested, as a whole. The information, from sources other than the author's research, is listed in detail in Tables 1-A and 1-B.

Table 22

<table>
<thead>
<tr>
<th>Species</th>
<th>Number of Seedlings Planted</th>
<th>Average Plot Age</th>
<th>Average % Seedling Survival</th>
</tr>
</thead>
<tbody>
<tr>
<td>autumn olive</td>
<td>1,334</td>
<td>6 months</td>
<td>61.5</td>
</tr>
<tr>
<td>bicolor lespedeza</td>
<td>49</td>
<td>3 months</td>
<td>85.0</td>
</tr>
<tr>
<td>black locust</td>
<td>1,430</td>
<td>5 months</td>
<td>78.7</td>
</tr>
<tr>
<td>Chinese chestnut</td>
<td>80</td>
<td>3 months</td>
<td>96.0</td>
</tr>
<tr>
<td>European black alder</td>
<td>1,087</td>
<td>5 months</td>
<td>92.1</td>
</tr>
<tr>
<td>loblolly pine</td>
<td>338</td>
<td>7 months</td>
<td>66.3</td>
</tr>
<tr>
<td>Scotch pine</td>
<td>134</td>
<td>7 months</td>
<td>100</td>
</tr>
<tr>
<td>shortleaf pine</td>
<td>1,046</td>
<td>5 months</td>
<td>84.8</td>
</tr>
<tr>
<td>tulip poplar</td>
<td>33</td>
<td>17 months</td>
<td>93.0</td>
</tr>
<tr>
<td>Virginia pine</td>
<td>1,049</td>
<td>7 months</td>
<td>72.7</td>
</tr>
<tr>
<td>white pine</td>
<td>253</td>
<td>7 months</td>
<td>90.5</td>
</tr>
</tbody>
</table>

Average = 5.7 months 83.7
Figure 22

Plant Survival Curve for Tested Species
In order to compare the species tested against each other, in a manner related to site conditions, an arbitrary seedling survival standard of 70% was chosen as being desirable for each site condition. Using the 70% figure, each species summary was reviewed for survival on warm aspect, cool aspect, each position on the mine, slope of 0-10 degrees, slope of 11-20 degrees, slope of greater than 20 degrees, slight erosion, moderate erosion, severe erosion, few rock fragments, several rock fragments, many rock fragments, 0-30% existing plant cover, 31-60% existing plant cover, greater than 60% existing plant cover, each plant invader, plots with no invaders, gray spoils, brown spoils, mixtures of gray and brown spoils, water pH less than 4.0, water pH of 4.0-5.0, water pH greater than 5.0, buffer pH less than 5.0, buffer pH of 5.0-6.0, and buffer pH greater than 6.0.

Table 23
Seedling Tolerance to All Site Conditions

<table>
<thead>
<tr>
<th>Species</th>
<th>Survival Standard Achieved</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>shortleaf pine</td>
<td>31/31</td>
<td>100</td>
</tr>
<tr>
<td>European black alder</td>
<td>36/37</td>
<td>97</td>
</tr>
<tr>
<td>black locust</td>
<td>26/32</td>
<td>81</td>
</tr>
<tr>
<td>Virginia pine</td>
<td>25/36</td>
<td>69</td>
</tr>
<tr>
<td>loblolly pine</td>
<td>16/29</td>
<td>55</td>
</tr>
<tr>
<td>autumn olive</td>
<td>10/34</td>
<td>29</td>
</tr>
</tbody>
</table>

*Using a scale of 100, with 100 being the most tolerant
As seen in Table 23, not all the plant species were used with an equal number of site conditions. However, shortleaf pine achieved the desired standard for 31 of 37 site conditions examined; European black alder, 36 of 37; black locust, 26 of 32; Virginia pine, 25 of 36; loblolly pine, 16 of 29; and autumn olive, 10 of 34. This indicates some unexpected results. For example, autumn olive has been highly recommended in the past, yet it ranked sixth best here, and black locust, also highly recommended, ranked only third. These unexpected results may indicate that seedling survival results are somewhat altered for orphan mine lands as opposed to what has been experienced on recently mined lands.

While water pH, buffer pH, and the extent of existing vegetation on the orphan mines proved, individually, to be the most reliable indicators of seedling survival, it is obvious one factor alone cannot be used to predict seedling survival rates. Computer analysis would be most useful in determining various multiple relationships of site factors needed for more reliable predictions.

Figure 23, from the 1978 U.S.D.A. Soil Conservation Service's Environmental Impact Statement for the Rural Abandoned Mine Program, shows all counties in the United States where abandoned mine lands are located. Results of the thesis research are most applicable to those areas where contour mining has occurred, principally the Appalachian area of the eastern United States.
Figure 23
Abandoned Coal Mine Locations in the United States


44. Reclamation...A Peabody Coal Environmental Specialty. Coal Age., 1971, 76, 124-129.


APPENDIX A

DEFINITIONS
1. auger bench - A horizontal bench that is wide enough to accommodate auger equipment. It is narrower than the traditional bench resulting from contour strip mining.

2. auger mining - The type of mining where a machine drills, in a closely spaced single horizontal row, into a coal seam to extract the coal. Auger mining is practiced when law prohibits normal contour strip mining because of excessive slope, because the depth of overburden is economically undesirable for mountaintop removal, or, in the past, because large enough machinery was not available to contour strip mine.

3. bench - The horizontal surface that is left after the existing earth and rock have been removed to extract the mineral. The width of the bench, regulated by state law, is determined by the slope of the premining land surface.

4. berm - A mound of spoil which has been placed on the bench after the coal has been removed. On most contour orphan mines the berm parallels the highwall and is broken occasionally by a drainageway.

5. buffer pH - A measure of the hydrogen ion concentration in relation to the cation exchange capacity. This test is run in order to get a recommendation for liming the soil or spoil to achieve a more desirable pH for a specific type of vegetation.

6. colluvium - material which has been eroded and accumulated downhill from its origin.

7. contour mining - That type of mining, predominant in mountainous terrain, where the extracting process is carried on horizontally around the hill or mountain on the same contour or elevation. There may be several separate coal seams mined at different
elevations on the same mountain, which may run continuously for several miles.

8. erosion - The natural process by which soil and rock is moved from its landform to another site. The most common cause of erosion on eastern Kentucky strip mines is the force of the raindrop striking and dislodging soil from its landform, whereupon the soil particles continue downhill, often entering a stream.

9. grasses - Plants which may be annual, biennial, or perennial in growth cycle; members of the Gramineae plant family, typically with long, narrow leaves, jointed stems, flowers in spikelets and seed-like fruit.

10. gully - The area of spoil which has been voided by erosion activity. The size of the gully is dependent upon slope, length of slope, spoil texture, intensity and duration of local rainfalls, and length of time active erosion has continued.

11. highwall - The vertical portion of the hill or mountain that is exposed above the mineral seam when the overburden is removed and not replaced.

12. hollow fill - A valley area adjacent to a hill or mountain that is filled by layers of dumped rock and earth. This process is normally used as permanent storage for excess materials from mountain-top removal.

13. invading species - Of the total plant population in a disturbed area, those which have become established naturally rather than by being planted by humans. An orphan mine may have only a few invaders, such as path rush, blackberry, or broomsedge, after many years.
14. legumes - Members of the Leguminosae plant family, which have the unique ability to fix nitrogen from soil air by action of bacteria in root nodules.

15. mountaintop removal - That type of mining, as opposed to contour mining, where the entire top of the hill or mountain is removed in order to extract the mineral to the lowest elevation economically feasible. Normally, more than one mineral seam is removed. The topographic result of this type of mining is a large, nearly level area.

16. orphan mine - For the purposes of the thesis study, any area that was strip mined for coal before 1966.

17. outslope - The slope below the bench that is a result of the mining process, whereby the overburden that was removed has been pushed downhill on top of the original ground surface.

18. overburden - The soil and rock which lies above the mineral seam. A part of this material may have been disturbed previously when a seam closer to the original soil surface was mined.

19. parent material - The type of rock from which a subsoil and soil are developed through natural climatic and geological processes. Sandstone, limestone, and shale are the major types of parent material in eastern Kentucky.

20. pH - The measure of potential chemical reaction of a soil or spoil ranging from 0 to 14, 0 being the most acidic possible and 14 the most basic possible. Every plant has a pH range within which it can grow. Knowing the pH will give the reclamationist a good idea of which plants may be successful for a particular spoil area.
21. *reclamation* - The act of restabilizing the land surface which has been disturbed by a mining process. This may require the installation of structures to control water, in addition to establishing vegetation which will hold the soil surface in place under normal climatic conditions.

22. *regrowth timber* - Woodland which has regrown after it has been cut or burned. In eastern Kentucky nearly all woodland is regrowth rather than virgin.

23. *ridges* - The areas of spoil between gullies which have not been completely eroded. The ridges may be as barren of vegetation as the gullies.

24. *rock fragments* - During the strip mining process many pieces of rock parent material, varying considerably in size, are mixed into the spoil. Some of these pieces are left on the spoil surface where they are weathered by climatic forces.

25. *sediment* - The soil or spoil material which has been transported as a result of erosion, usually by water action.

26. *spoil* - The heterogeneous mixture of topsoil, subsoil, and rock that results from upheaval and mixing during the mining process as opposed to the homogeneous soil horizons that develop in place by weathering over a long period of time.

27. *subsoil* - That layer or total of layers of soil found below the layer of topsoil and above the bedrock or parent material. Subsoil seldom contains significant organic matter. It does not provide a medium for plant growth equal to that of topsoil.

28. *surface mining* - The removal of rock, mineral, soil, earth, etc., from the earth's surface for the purpose of extracting a specific
material to process and sell. Surface mining for coal is often called strip mining.

29. undisturbed area – The area of land adjacent to the mined area that was neither removed nor filled.

30. water pH – The standard pH reading of a soil or spoil obtained by mixing the sample material at a 1:1 ratio with water; a measure of the negative log of the hydrogen ion concentration.

31. watershed – A geographical area, the boundaries of which are determined by topography which in turn determines the flow of water into a particular drainage body, such as a creek or river.

32. weathering – The breakdown of spoil material by the climatic processes of rain, wind, freeze, and thaw.
APPENDIX B

MINE LOCATIONS ON TOPOGRAPHIC MAPS
THIS BOOK IS OF POOR LEGIBILITY DUE TO LIGHT PRINTING THROUGHOUT ITS ENTIRETY.

THIS IS AS RECEIVED FROM THE CUSTOMER.
APPENDIX C

PLANT NAMES
<table>
<thead>
<tr>
<th>Scientific Name</th>
<th>Common Name</th>
<th>Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. Evergreen Trees</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Ilex opaca</td>
<td>American holly</td>
<td>A. holly</td>
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<tr>
<td>2. Juniperus virginians</td>
<td>Eastern red cedar</td>
<td>E. r. cedar</td>
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<tr>
<td>3. Pinus echinata</td>
<td>shortleaf pine</td>
<td>sh. pine</td>
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<tr>
<td>4. Pinus rigida</td>
<td>pitch pine</td>
<td>p. pine</td>
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<tr>
<td>5. Pinus strobus</td>
<td>white pine</td>
<td>w. pine</td>
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<tr>
<td>6. Pinus sylvestris</td>
<td>Scotch pine</td>
<td>Sc. pine</td>
</tr>
<tr>
<td>7. Pinus taeda</td>
<td>loblolly pine</td>
<td>l. pine</td>
</tr>
<tr>
<td>8. Pinus virginiana</td>
<td>Virginia pine</td>
<td>V. pine</td>
</tr>
<tr>
<td><strong>B. Deciduous Trees</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Acer rubrum</td>
<td>red maple</td>
<td>r. maple</td>
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<tr>
<td>2. Acer saccharum</td>
<td>sugar maple</td>
<td>s. maple</td>
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<tr>
<td>3. Aesculus octandra</td>
<td>yellow buckeye</td>
<td>y. buckeye</td>
</tr>
<tr>
<td>4. Ailanthus altissima</td>
<td>tree of heaven</td>
<td>***</td>
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<tr>
<td>5. Alnus glutinosa</td>
<td>European black alder</td>
<td>E. b. alder</td>
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<tr>
<td>6. Alnus serrulata</td>
<td>native alder</td>
<td>n. alder</td>
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<tr>
<td>7. Betula lenta</td>
<td>sweet birch</td>
<td>s. birch</td>
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<tr>
<td>8. Betula nigra</td>
<td>river birch</td>
<td>r. birch</td>
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<tr>
<td>9. Carya cordiformis</td>
<td>bitternut hickory</td>
<td>b. hickory</td>
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<tr>
<td>10. Carya glabra</td>
<td>pignut hickory</td>
<td>p. hickory</td>
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<td>11. Carya lacinosa</td>
<td>shellbark hickory</td>
<td>sh. hickory</td>
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<td>12. Carya ovata</td>
<td>shagbark hickory</td>
<td>sg. hickory</td>
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<td>13. Carya tomentosa</td>
<td>mockernut hickory</td>
<td>m. hickory</td>
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<td>14. Castanea mollissima</td>
<td>Chinese chestnut</td>
<td>C. chestnut</td>
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<td>15. Cercis canadensis</td>
<td>Eastern redbud</td>
<td>E. redbud</td>
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<tr>
<td>Number</td>
<td>Species</td>
<td>English Name</td>
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<td>16.</td>
<td><em>Cornus florida</em></td>
<td>flowering dogwood</td>
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<td>17.</td>
<td><em>Fagus grandifolia</em></td>
<td>American beech</td>
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<td>18.</td>
<td><em>Fraxinus americana</em></td>
<td>white ash</td>
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<td>19.</td>
<td><em>Fraxinus pennsylvanica</em></td>
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<td>20.</td>
<td><em>Liquidambar styraciflua</em></td>
<td>sweet gum</td>
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<td>21.</td>
<td><em>Liriodendron tulipifera</em></td>
<td>tulip poplar</td>
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<td>22.</td>
<td><em>Magnolia tripetala</em></td>
<td>umbrella magnolia</td>
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<tr>
<td>23.</td>
<td><em>Malus pumila</em></td>
<td>native apple</td>
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<tr>
<td>24.</td>
<td><em>Nyssa sylvatica</em></td>
<td>black gum</td>
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<tr>
<td>25.</td>
<td><em>Oxydendrum arboreum</em></td>
<td>sourwood</td>
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<td>26.</td>
<td><em>Paulownia tomentosa</em></td>
<td>royal paulownia</td>
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<tr>
<td>27.</td>
<td><em>Platanus occidentalis</em></td>
<td>sycamore</td>
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<td>28.</td>
<td><em>Populus deltoides</em></td>
<td>cottonwood</td>
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<td>29.</td>
<td><em>Populus species x</em></td>
<td>hybrid poplar</td>
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<tr>
<td>30.</td>
<td><em>Prunus serotina</em></td>
<td>black cherry</td>
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<td>31.</td>
<td><em>Quercus alba</em></td>
<td>white oak</td>
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<td>32.</td>
<td><em>Quercus coccinea</em></td>
<td>scarlet oak</td>
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<td>33.</td>
<td><em>Quercus muehlenbergii</em></td>
<td>chinkapin oak</td>
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<tr>
<td>34.</td>
<td><em>Quercus palustris</em></td>
<td>pin oak</td>
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<td>35.</td>
<td><em>Quercus prinus</em></td>
<td>chestnut oak</td>
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<td>36.</td>
<td><em>Quercus rubra</em></td>
<td>Northern red oak</td>
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<tr>
<td>37.</td>
<td><em>Quercus stellata</em></td>
<td>post oak</td>
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<tr>
<td>38.</td>
<td><em>Quercus velutina</em></td>
<td>black oak</td>
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<tr>
<td>39.</td>
<td><em>Robinia pseudoacacia</em></td>
<td>black locust</td>
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<tr>
<td>40.</td>
<td><em>Salix nigra</em></td>
<td>black willow</td>
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<td>41.</td>
<td><em>Sassafras albidum</em></td>
<td>sassafras</td>
</tr>
<tr>
<td>42.</td>
<td><em>Tilia americana</em></td>
<td>American linden</td>
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</tbody>
</table>
43. *Ulmus americana*  American elm  A. elm
44. *Ulmus rubra*  slippery elm  s. elm

**C. Deciduous Shrubs and Vines**

1. *Elaeagnus umbellata*  autumn olive  a. olive
2. *Kalmia latifolia*  mountain laurel  m. laurel
3. *Lespedeza bicolor*  bicolor lespedeza  b. lespedeza
4. *Lonicera japonica*  honeysuckle  ---
5. *Rhus copallina*  shining sumac  sh. sumac
6. *Rhus typhina*  staghorn sumac  st. sumac
7. *Rosa multiflora*  multiflora rose  m. rose
8. *Rubus allegheniensis*  blackberry  ---
9. *Rubus hispidus*  dewberry  ---
10. *Smilax species*  green brier  g. brier

**D. Grasses and Legumes**

1. *Andropogon virginicus*  broomsedge  ---
2. *Coronilla varia*  crowvetch  ---
3. *Dactylis glomerata*  orchard grass  o. grass
4. *Digitaria species*  crabgrass  ---
5. *Eragrostis curvula*  weeping lovegrass  w. lovegrass
6. *Erianthus species*  plume grass  p. grass
7. *Festuca arundinacea "Ky. 31"*  Kentucky 31 tall fescue  K. 31 t. fescue
8. *Lespedeza cuneata*  sericea lespedeza  s. lespedeza
9. *Lespedeza stipulacea*  Korean lespedeza  Kr. lespedeza
10. *Lespedeza striata*  kobe lespedeza  kb. lespedeza
11. *Panicum clandestinum*  deer-tongue  ---
E. Other Herbaceous Species

<table>
<thead>
<tr>
<th>No.</th>
<th>Scientific Name</th>
<th>Common Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Bryophyte - unidentified</td>
<td>ground moss</td>
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<tr>
<td>2.</td>
<td>Calonida rangifera</td>
<td>lichens</td>
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<tr>
<td>3.</td>
<td>Cirsium arvense</td>
<td>Canadian thistle</td>
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<tr>
<td>4.</td>
<td>Cyperus esculentus</td>
<td>saw grass</td>
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<td>5.</td>
<td>Dipsacus sylvestris</td>
<td>teasel</td>
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<td>6.</td>
<td>Fragaria virginiana</td>
<td>wild strawberry</td>
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<tr>
<td>7.</td>
<td>Juncus tenuis</td>
<td>wire grass or path rush</td>
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<tr>
<td>8.</td>
<td>Phytoleacca americana</td>
<td>pokeberry</td>
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<tr>
<td>9.</td>
<td>Polystichum acrostichoides</td>
<td>Christmas fern</td>
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<td>10.</td>
<td>Rhus radicans</td>
<td>poison ivy</td>
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<tr>
<td>11.</td>
<td>Rumex acetosella</td>
<td>sheep sorrel</td>
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<tr>
<td>12.</td>
<td>Scirpus pedicellatus</td>
<td>tall sedge or wool grass</td>
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<tr>
<td>13.</td>
<td>Scirpus polyphyllus</td>
<td>short sedge or bulrush</td>
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<td>14.</td>
<td>Solidago species</td>
<td>goldenrod</td>
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<td>15.</td>
<td>Spirea tomentosa</td>
<td>steeplebush</td>
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<tr>
<td>16.</td>
<td>Typha latifolia</td>
<td>cattail</td>
</tr>
<tr>
<td>17.</td>
<td>Veronica altissima</td>
<td>ironweed</td>
</tr>
</tbody>
</table>
APPENDIX D

PLOT DATA SHEETS
THESIS PLOT DATA

Plant name, common  autumn olive

Plant name, scientific  Elaeagnus umbellata

Mine no.  0002 - A  Site recon. no.  282

State: Ky.  County: Laurel  Subwatershed: Slate Lick Creek

Coal seam name  Lily  Approx. elevation MSL  1200

Last known mining disturbance  1955 - 1958

Plot aspect  southeast  Plot slope in degrees  35

Plot size  50' x 30'

Original planting date  3/16/77

Seedlings at time of planting: size  6 - 12"  age in years  1

Approximate spacing  6' x 6'

Original number of plants within plot  55

Number of plants living at  5/30/78  was  36  =  65  %

Spoil pH from lab test: water  4.5  buffer  5.9

Plot location  outslope

Spoil color  light gray

Rock fragments  few to 3" D.

Parent material of surface spoil  majority is shale

Degree of erosion  no gullies visible within plot

Existing vegetation: % cover  20  description  blackberry, V. pine

Vegetation of adjacent areas  b. gum, g. ash, b. cherry, n.r. oak,

sycamore, r. maple, t. poplar, V. pine, cattails, sh. sumac
THESIS PLOT DATA

Plant name, common black locust
Plant name, scientific Robinia pseudoacacia
Mine no. 0002 - A Site recon. no. 282
State: Ky. County: Laurel Subwatershed: Slate Lick Creek
Coal seam name Lily Approx. elevation MSL 1200
Last known mining disturbance 1955 - 1958
Plot aspect southeast Plot slope in degrees 0 - 6
Plot size 55' x 25'
Original planting date 12/5/77
Seedlings at time of planting: size 8 - 16" age in years 1
Approximate spacing 6' x 6'
Original number of plants within plot 52
Number of plants living at 5/30/78 was 30 = 57 %
Spoil pH from lab test: water 3.1 buffer 4.6
Plot location top of fill located between county road and creek
Spoil color dark gray
Rock fragments many small fragments to 4" D.
Parent material of surface spoil majority is shale
Degree of erosion no current gullying seen
Existing vegetation: % cover 0 - 5 description small grasses only

Vegetation of adjacent areas n.r. oak, sycamore, g. ash, r. maple,
t. poplar, V. pine, cattails, sh. sumac
THESIS PLOT DATA

Plant name, common: European black alder
Plant name, scientific: Alnus glutinosa

Mine no.: 0002 - A Site recon. no.: 282

State: Ky. County: Laurel Subwatershed: Slate Lick Creek
Coal seam name: Lily Approx. elevation MSL: 1200
Last known mining disturbance: 1955 - 1958

Plot aspect: southeast Plot slope in degrees: 0 - 6
Plot size: 55' x 25'

Original planting date: 12/16/77
Seedlings at time of planting: size: 6 - 12" age in years: 1
Approximate spacing: 6' x 6'

Original number of plants within plot: 57
Number of plants living at 5/30/78 was 46 = 80 %

Spoil pH from lab test: water: 2.7 buffer: 4.4
Plot location: top of fill located between county road and creek

Spoil color: dark gray
Rock fragments: many small fragments to 4" D.
Parent material of surface spoil: majority is shale, some reject coal
Degree of erosion: no gullies seen

Existing vegetation: % cover: 0 - 5 description: w. grass

Vegetation of adjacent areas: n.r. oak, sycamore, r. maple, t. poplar, w. ash, V. pine, cattails, sh. sumac
THESIS PLOT DATA

Plant name, common: black locust

Plant name, scientific: Robinia pseudoacacia

Mine no.: 0003 - B  Site recon. no.: 284

State: Ky.  County: Laurel  Subwatershed: Slate Lick Creek

Coal seam name: Lily  Approx. elevation MSL: 1200

Last known mining disturbance: 1955 - 1958

Plot aspect: south  Plot slope in degrees: 0 - 3

Plot size: 40' x 30'

Original planting date: 3/17/77

Seedlings at time of planting: size: 8 - 16"  age in years: 1

Approximate spacing: 6' x 6'

Original number of plants within plot: 56

Number of plants living at 6/30/77 was 45 = 80 %

Spoil pH from lab test: water 4.3 buffer 5.0

Plot location: flat section on outslope

Spoil color: dark gray

Rock fragments: several fragments to 3" D.

Parent material of surface spoil: majority is shale

Degree of erosion: severely eroded

Existing vegetation: % cover: 10 description: few V. pine and green brier

Vegetation of adjacent areas: V. pine, t. poplar, blackberry, goldenrod
THESIS PLOT DATA

Plant name, common black locust

Plant name, scientific Robinia pseudoacacia

Mine no. 0003 - C Site recon. no. 284

State: Ky. County: Laurel Subwatershed: Slate Lick Creek

Coal seam name Lily Approx. elevation MSL 1200

Last known mining disturbance 1955 - 1958

Plot aspect north Plot slope in degrees 4

Plot size 40' x 20'

Original planting date 4/5/77

Seedlings at time of planting: size 8 - 16" age in years 1

Approximate spacing 6' x 6'

Original number of plants within plot 52

Number of plants living at 6/30/77 was 35 = 67 %

Spoil pH from lab test: water 3.9 buffer 5.3

Plot location bench

Spoil color varies from light to dark gray

Rock fragments several to 4" D.

Parent material of surface spoil majority is shale

Degree of erosion no current gullies visible

Existing vegetation: % cover 0 - 5 description blackberry

Vegetation of adjacent areas V. pine, deertongue, blackberry, r. maple
THESIS PLOT DATA

Plant name, common tulip poplar

Plant name, scientific Liriodendron tulipifera

Mine no. 0004 - A Site recon. no. 265

State: Ky. County: Laurel Subwatershed: Slate Lick Creek

Coal seam name Lily Approx. elevation MSL 1200

Last known mining disturbance 1955 - 1958

Plot aspect northeast Plot slope in degrees 8

Plot size 40' x 40'

Original planting date 12/28/76

Seedlings at time of planting: size 6 - 16" age in years 1

Approximate spacing 8' x 8'

Original number of plants within plot 33

Number of plants living at 5/30/78 was 31 = 93 %

Spoil pH from lab test: water 4.9 buffer 6.1

Plot location base of outcrop

Spoil color light gray to light brown

Rock fragments few fragments to 4" D.

Parent material of surface spoil majority is shale

Degree of erosion slight; no current gullies seen

Existing vegetation: % cover 20 description w. grass

Vegetation of adjacent areas sycamore, n.r. oak, b. willow, t. poplar, e. redbud
THESIS PLOT DATA

Plant name, common  Virginia pine

Plant name, scientific  Pinus virginiana

Mine no.  0004 - A  Site recon. no.  265

State: Ky.  County: Laurel  Subwatershed: Slate Lick Creek

Coal seam name  Lily  Approx. elevation MSL  1200

Last known mining disturbance  1955 - 1958

Plot aspect  northeast  Plot slope in degrees  0 - 5

Plot size  70' x 20'

Original planting date  4/1/77

Seedlings at time of planting: size  6 - 12"  age in years  1

Approximate spacing  6' x 6'

Original number of plants within plot  66

Number of plants living at  5/30/78  was  57  =  86  %

Spoil pH from lab test: water  4.4  buffer  5.5

Plot location  berm

Spoil color  light gray

Rock fragments  several fragments to 3" D.

Parent material of surface spoil  majority is shale

Degree of erosion  no gullies seen

Existing vegetation: % cover  30  description  sh. sumac, greenbrier, broomsedge, V. pine, f. dogwood, b. cherry

Vegetation of adjacent areas  t. poplar, r. maple, sycamore, blackberry
THESIS PLOT DATA

Plant name, common ________________ Virginia pine
Plant name, scientific ____________ Pinus virginiana
Mine no. _____________ 0004 - A Site recon. no. ____________ 265
State: Ky. County: Laurel Subwatershed: Slate Lick Creek
Coal seam name ___ Lily Approx. elevation MSL ____________ 1200
Last known mining disturbance ____________ 1955 - 1958
Plot aspect ____________ northeast Plot slope in degrees ____________ 20
Plot size ____________ 55' x 25'
Original planting date ____________ 3/24/77
Seedlings at time of planting: size ____________ 6 - 12" age in years ____________ 1
Approximate spacing ____________ 6' x 6'
Original number of plants within plot ____________ 68
Number of plants living at ____________ 5/30/78 was ____________ 64 = ____________ 94 %
Spoil pH from lab test: water ____________ 4.7 buffer ____________ 6.1
Plot location ____________ outslope
Spoil color ____________ light gray
Rock fragments ____________ several light brown fragments to 4" D.
Parent material of surface spoil ____________ majority is shale; some sandstone
Degree of erosion ____________ moderate; several gullies to 1' deep and 3' wide
through entire length of plot
Existing vegetation: % cover ____________ 10 description ____________ V. pine to 6', green
briers, blackberry, broomsedge

Vegetation of adjacent areas ____________ sycamore, b. willow, r. maple, f. dogwood,
V. pine, blackberry
THEESIS PLOT DATA

Plant name, common ________________ Virginia pine

Plant name, scientific ________________ Pinus virginiana

Mine no. __________ 0004 - A __________ Site recon. no. __________ 265

State: Ky. County: __________ Laurel __________ Subwatershed: __________ Slate Lick Creek

Coal seam name __________ Lily __________ Approx. elevation MSL __________ 1200

Last known mining disturbance __________ 1955 - 1958

Plot aspect __________ northeast __________ Plot slope in degrees __________ 30

Plot size __________ 40' x 40'

Original planting date __________ 4/1/77

Seedlings at time of planting: size __________ 6 - 12'' __________ age in years __________ 1

Approximate spacing __________ 6' x 6'

Original number of plants within plot __________ 32

Number of plants living at __________ 6/1/77 __________ was __________ 29 __________ = __________ 90 __________ %

Spoil pH from lab test: water __________ 4.8 __________ buffer __________ 6.2

Plot location __________ outslope

Spoil color __________ light gray

Rock fragments __________ several fragments to 5'' D.

Parent material of surface spoil __________ majority is shale

Degree of erosion __________ severe erosion

Existing vegetation: % cover __________ 35 __________ description __________ blackberry, goldenrod, sh. sumac

Vegetation of adjacent areas __________ blackberry, goldenrod, t. poplar, V. pine, sh. sumac, t. poplar, sycamore, s. lespedeza
THESIS PLOT DATA

Plant name, common __________________________ black locust

Plant name, scientific ________________________ Robinia pseudacacia

Mine no. ___________ 0006 - A ___________ Site recon. no. ___________ 765

State: Ky. County: Clay ___________ Subwatershed: Urban Fork

Coal seam name ___________ Horse Creek ___________ Approx. elevation MSL ___________ 1100 - 1150

Last known mining disturbance ___________ 1953 - 1958

Plot aspect ___________ northeast ___________ Plot slope in degrees ___________ 27

Plot size ___________ 40' x 30'

Original planting date ___________ 3/28/78

Seedlings at time of planting: size ___________ 8 - 16" ___________ age in years ___________ 1

Approximate spacing ___________ 3' x 3'

Original number of plants within plot ___________ 95

Number of plants living at ___________ 5/26/78 ___________ was ___________ 46 = ___________ 48 ___________ %

Spoil pH from lab test: water ___________ 4.1 ___________ buffer ___________ 5.4

Plot location ___________ top of outslope

Spoil color ___________ light gray

Rock fragments ___________ many fragments to 12" D.

Parent material of surface spoil ___________ majority is shale

Degree of erosion ___________ severely eroded with 2 gullies 1' deep & 3' wide;
plot bordered on 1 side by a gully to 4' deep

Existing vegetation: % cover ___________ 0 - 5 description blackberry, w. grass

Vegetation of adjacent areas: 1. pine to 75', broomsedge, w. grass
THESIS PLOT DATA

Plant name, common  loblolly pine

Plant name, scientific  Pinus taeda

Mine no.  0006 - A  Site recon. no.  765

State: Ky.  County: Clay  Subwatershed: Urban Fork

Coal seam name  Horse Creek  Approx. elevation MSL  1100-1150

Last known mining disturbance  1953 - 1958

Plot aspect  northeast  Plot slope in degrees  6

Plot size  60' x 20'

Original planting date  12/9/77

Seedlings at time of planting: size  6 - 14"  age in years  1

Approximate spacing  6' x 6'

Original number of plants within plot  50

Number of plants living at  5/26/78  was  0  =  0  %

Spoil pH from lab test: water  3.7  buffer  5.2

Plot location  hollow fill

Spoil color  light brown

Rock fragments  several fragments to 4" D.

Parent material of surface spoil  majority is shale, some sandstone

Degree of erosion  slight, no gullies within plot

Existing vegetation: % cover  5  description  broomsedge, s. sedge

Vegetation of adjacent areas  t. poplar, w. oak to 30', b. oak, sg. hickory
THESIS PLOT DATA

Plant name, common  loblolly pine

Plant name, scientific  Pinus taeda

Mine no.  0006 - A  Site recon. no.  765

State: Ky.  County: Clay  Subwatershed: Urban Fork

Coal seam name  Horse Creek  Approx. elevation MSL  1100 - 1150

Last known mining disturbance  1953 - 1958

Plot aspect  west  Plot slope in degrees  0 - 8

Plot size  80' x 25'

Original planting date  12/9/77

Seedlings at time of planting: size  6 - 14''  age in years  1

Approximate spacing  6' x 6'

Original number of plants within plot  64

Number of plants living at  5/26/78  was  57  =  89  %

Spoil pH from lab test:  water  4.9  buffer  6.1

Plot location  haul road between 2 mines

Spoil color  medium gray

Rock fragments  few fragments to 4'' D.

Parent material of surface spoil  majority is shale

Degree of erosion  slight; no gullies visible

Existing vegetation: % cover  0 - 5  description  w. grass

Vegetation of adjacent areas  sassafras, r. maple to 20', st. sumac,
b. cherry, w. oak to 30', s. oak, p. hickory, b. oak
THESIS PLOT DATA

Plant name, common: bicolor lespedeza

Plant name, scientific: Lespedeza bicolor

Mine no.: 0006 - C  Site recon. no.: 765

State: Ky.  County: Clay  Subwatershed: Urban Fork

Coal seam name: Horse Creek  Approx. elevation MSL: 1100 - 1150

Last known mining disturbance: 1953 - 1958

Plot aspect: west  Plot slope in degrees: 1

Plot size: 40' x 25'

Original planting date: 4/15/77

Seedlings at time of planting: size 6 - 12"  age in years 1

Approximate spacing: 6' x 6'

Original number of plants within plot: 49

Number of plants living at 6/30/77 was 42  = 85 %

Spoil pH from lab test: water 4.0  buffer 5.8

Plot location: bench

Spoil color: light gray

Rock fragments: none

Parent material of surface spoil: shale

Degree of erosion: no current gullies visible

Existing vegetation: % cover 5  description: broomsedge, blackberry

Vegetation of adjacent areas: V. pine, sh. pine, blackberry, m. hickory, n.r. oak, t. poplar
THESIS PLOT DATA

Plant name, common black locust

Plant name, scientific Robinia pseudoacacia

Mine no. 0006 - C Site recon. no. 765

State: Ky. County: Clay Subwatershed: Urban Fork

Coal seam name Horse Creek Approx. elevation MSL 1100 - 1150

Last known mining disturbance 1953 - 1958

Plot aspect southwest Plot slope in degrees 32

Plot size 40' x 40'

Original planting date 4/22/77

Seedlings at time of planting: size 8 - 16" age in years 1

Approximate spacing 3' x 3'

Original number of plants within plot 143

Number of plants living at 6/30/77 was 143 = 100 %

Spoil pH from lab test: water 4.1 buffer 5.1

Plot location top of outslope

Spoil color dark gray

Rock fragments several fragments 1 to 24" D.

Parent material of surface spoil majority is shale

Degree of erosion severely eroded with gullies to 3' deep formed

approximately every 10' across plot

Existing vegetation: % cover 10 description broomedge, w. grass, blackberry

Vegetation of adjacent areas w. oak, s. oak, b. oak, t. poplar,
r. maple, p. hickory, l. pine, V. pine, broomedge, blackberry
THESIS PLOT DATA

Plant name, common _______ autumn olive

Plant name, scientific _______ Elaeagnus umbellata

Mine no. _______ 0009 - A _______ Site recon. no. _______ 279

State: Ky. County: _______ Laurel _______ Subwatershed: _______ Slate Lick Creek

Coal seam name _______ Lily _______ Approx. elevation MSL _______ 1200

Last known mining disturbance _______ 1955 - 1958

Plot aspect _______ north _______ Plot slope in degrees _______ 0 - 2

Plot size _______ 40' x 30'

Original planting date _______ 3/14/77

Seedlings at time of planting: size _______ 6 - 12" _______ age in years _______ 1

Approximate spacing _______ 6' x 6'

Original number of plants within plot _______ 39

Number of plants living at 6/1/77 _______ was _______ 7 _______ = _______ 17 _______ %

Spoil pH from lab test: water _______ 3.3 _______ buffer _______ 4.7

Plot location _______ fill area between road and mine

Spoil color _______ dark gray to black

Rock fragments _______ several fragments to 6" D.

Parent material of surface spoil _______ majority is shale

Degree of erosion _______ no current gullying visible

Existing vegetation: _______ % cover 0 - 5 _______ description _______ small _______ grasses only

Vegetation of adjacent areas _______ V. pine, t. poplar, r. maple, _______ cattails, sycamore
THEESIS PLOT DATA

Plant name, common  autumn olive
Plant name, scientific  Elaeagnus umbellata
Mine no.  0014 - A  Site recon. no.  736
State: Ky.  County: Clay  Subwatershed: Little Goose below Urban
Coal seam name  Horse Creek  Approx. elevation MSL  1100 - 1150
Last known mining disturbance  1955 - 1962
Plot aspect  south  Plot slope in degrees  2 - 10
Plot size  75' x 35'
Original planting date  4/21/78
Seedlings at time of planting: size  6 - 12"  age in years  1
Approximate spacing  6' x 6'
Original number of plants within plot  91
Number of plants living at  10/18/78  was  85  =  93  %
Spoil pH from lab test: water  4.6  buffer  5.7
Plot location  berm
Spoil color  light gray and light brown
Rock fragments  few to 4" D.
Parent material of surface spoil  shale majority
Degree of erosion  moderate; several old gullies to 3' deep and 10' wide
stabilizing now
Existing vegetation: % cover  50  description sourwood to 4', g. brier, w. grass majority, broomedge, steeplebush, blackberry to 3'
Vegetation of adjacent areas V. pine to 15', sassafras to 15', b. oak to 15', n.r. oak to 50', f. dogwood to 10', r. maple to 20', sycamore to 20', s. birch to 3', p. hickory to 60', e. redbud to 6', broomedge, cattails, steeplebush, goldenrod, g. brier, ironweed
THESIS PLOT DATA

Plant name, common autumn olive

Plant name, scientific Elaeagnus umbellata

Mine no. 0014 - A Site recon. no. 736

State: Ky. County: Clay Subwatershed: Little Goose below Urban

Coal seam name Horse Creek Approx. elevation MSL 1100 - 1150

Last known mining disturbance 1955 - 1962

Plot aspect west Plot slope in degrees 3

Plot size 70' x 25'

Original planting date 4/21/78

Seedlings at time of planting: size 6 - 12'' age in years 1

Approximate spacing 8' x 8'

Original number of plants within plot 49

Number of plants living at 10/18/78 was 37 = 75 %

Spoil pH from lab test: water 3.7 buffer 4.7

Plot location berm

Spoil color medium brown

Rock fragments many to 6" D.

Parent material of surface spoil shale majority; some sandstone

Degree of erosion moderate; no gullies present but much unevenness to the surface

Existing vegetation: % cover 30 description 1 b. oak to 4', blackberry, broomsedge, w. grass majority

Vegetation of adjacent areas n.r. oak to 60', sourwood to 20', sycamore to 50', A. beech to 30', w. oak to 30', b. cherry to 25', V. pine to 5', r. maple to 5', E. r. cedar to 1', f. dogwood to 5', blackberry, ironweed, pokewerry, t. sedge
THESIS PLOT DATA

Plant name, common  European black alder
Plant name, scientific  Alnus glutinosa
Mine no.  0014 - A  Site recon. no.  736
State: Ky.  County: Clay  Subwatershed: Little Goose below Urban
Coal seam name  Horse Creek  Approx. elevation MSL  1100 - 1150
Last known mining disturbance  1955 - 1962
Plot aspect  south  Plot slope in degrees  5
Plot size  90' x 20'
Original planting date  4/21/78
Seedlings at time of planting: size  6 - 12"  age in years  1
Approximate spacing  6' x 6'
Original number of plants within plot  80
Number of plants living at 10/18/78 was  69  =  86  %
Spoil pH from lab test: water  4.1  buffer  5.4
Plot location  berm
Spoil color  light gray
Rock fragments  many to 4" D.
Parent material of surface spoil  shale majority
Degree of erosion severe: 2 gullies run through the plot to 3' deep & 6' wide
Existing vegetation: % cover 0 - 5 description blackberry majority, broomsedge
Vegetation of adjacent areas sassafras to 15', V. pine to 15', b. oak to 15', n.r. oak to 50', f. dogwood to 10', r. maple to 20', sycamore to 20', r. birch to 3', broomsedge to 3', cattails, steeplebush, goldenrod, g. brier, ironweed to 6'
THESIS PLOT DATA

Plant name, common  shortleaf pine
Plant name, scientific  Pinus echinata
Mine no.  0014 - A  Site recon. no.  736
State:  Ky.  County:  Clay  Subwatershed:  Little Goose below Urban
Coal seam name  Horse Creek  Approx. elevation MSL  1100 - 1150
Last known mining disturbance  1955 - 1962
Plot aspect  southeast  Plot slope in degrees  1 - 5
Plot size  60' x 35'
Original planting date  4/21/78
Seedlings at time of planting:  size  6 - 12"  age in years  1
Approximate spacing  6' x 6'
Original number of plants within plot  69
Number of plants living at  10/18/78  was  60  =  86  %
Spoil pH from lab test:  water  4.5  buffer  6.1
Plot location  bench
Spoil color  light brown
Rock fragments  many to 4" D.
Parent material of surface spoil  shale majority
Degree of erosion  moderate; no gullies present
Existing vegetation:  % cover  50  description goldenrod to 3', blackberry to 3', broomsedge to 3', w. grass majority, sourwood to 1', V. pine to 4'
Vegetation of adjacent areas  V. pine to 15', sassafras to 15', b. oak to 15', n.r. oak to 50', f. dogwood to 10', r. maple to 20', sycamore to 20', s. birch to 3', p. hickory to 60', e. redbud to 6', broomsedge, cattails, steeplebush, goldenrod, g. brier, ironweed
THESIS PLOT DATA

Plant name, common          autumn olive

Plant name, scientific      Elaeagnus umbellata

Mine no.                    0016 - A  Site recon. no.     739

State: Ky.  County:      Clay  Subwatershed:  Little Goose

Coal seam name:           Horse Creek  Approx. elevation MSL  1100-1150

Last known mining disturbance  1955 - 1962

Plot aspect        northeast  Plot slope in degrees        32

Plot size          85' x 20'

Original planting date        4/25/78

Seedlings at time of planting: size  6 - 12"  age in years  1

Approximate spacing          5' x 5'

Original number of plants within plot  98

Number of plants living at 10/18/78 was 88 = 89 %

Spoil pH from lab test: water 3.8  buffer 4.6

Plot location        side of berm (next to highwall)

Spoil color           medium gray

Rock fragments        several to 3" D.

Parent material of surface spoil  shale majority

Degree of erosion    moderate; several gullies formed to 6" deep & 2' wide

Existing vegetation: % cover  20  description  b. oak to 10',
deertongue to 2', blackberry, w. grass, broomsedge majority

Vegetation of adjacent areas  n.r. oak to 60', V. pine to 30', s. oak
to 40', w. oak to 30', b. gum to 15', sh. pine to 20', t. sedge to
3', blackberry to 3', broomsedge, pokeberry
THESIS PLOT DATA

Plant name, common ____________________________ European black alder

Plant name, scientific ____________________________ Alnus glutinosa

Mine no. 0019 - A Site recon. no. 758

State: Ky. County: Clay Subwatershed: Little Goose

Coal seam name: Horse Creek Approx. elevation MSL 1100 - 1150

Last known mining disturbance 1955 - 1962

Plot aspect east Plot slope in degrees 0 - 18

Plot size 60' x 30'

Original planting date 4/14/78

Seedlings at time of planting: size 6 - 12" age in years 1

Approximate spacing 3' x 3'

Original number of plants within plot 192

Number of plants living at 8/10/78 was 181 = 94 %

Spoil pH from lab test: water 3.9 buffer 5.3

Plot location bench

Spoil color light gray to light brown

Rock fragments varies from 1 - 12" D. coal

Parent material of surface spoil shale and sandstone

Degree of erosion No gullies visible. All surface material is sed-
iment eroded from highwall and fill bench into pit.

Existing vegetation: % cover 25 description t. sedge to 3' are majority; few s. sedge to 12"; many blackberry to 4' on highwall

side out of water

Vegetation of adjacent areas a few ironweed and s. lespedeza, sh.

and V. pine to 25', r. maple to 15', b. gum to 10', m. hickory to

40', w. oak to 35', t. poplar to 5', b. locust to 20'
Plant name, common: European black alder

Plant name, scientific: Alnus glutinosa

Mine no.: 0019 - A Site recon. no.: 758

State: Ky. County: Clay Subwatershed: Little Goose

Coal seam name: Horse Creek Approx. elevation MSL: 1100 - 1150

Last known mining disturbance: 1955 - 1962

Plot aspect: northeast Plot slope in degrees: 28

Plot size: 70' x 15'

Original planting date: 4/14/78

Seedlings at time of planting: size 6 - 12" age in years: 1

Approximate spacing: 3' x 3'

Original number of plants within plot: 83

Number of plants living at 8/10/78 was 82 = 98 %

Spoil pH from lab test: water 4.1 buffer 5.3

Plot location: side of gully eroded through fill bench

Spoil color: light brown with black fragments

Rock fragments: many fragments 1 - 12" D, both coal and brown shale

Parent material of surface spoil: shale

Degree of erosion: plot has several small gullies currently eroding from 3 - 12" deep and 6 - 24" wide; much material eroding from above

Existing vegetation: % cover 30 description: short 3" w. grass majority; also g. brier to 2', pokeberry to 3', 1 multiflora rose to 1'.

Vegetation of adjacent areas: ironweed, s. lespedeza, sh. pine, V. pine to 25', r. maple to 15', b. gum to 10', m. hickory to 40', w. oak to 35', t. poplar to 5', b. locust to 20'
THESIS PLOT DATA

Plant name, common __________________________ European black alder

Plant name, scientific ________________________ Alnus glutinosa

Mine no. ______ 0021 - B ______ Site recon. no. ______ 506

State: Ky. County: Clay ______ Subwatershed: Little Goose

Coal seam name ___________ Horse Creek ______ Approx. elevation MSL ______ 1100 - 1150

Last known mining disturbance ___________ 1955 - 1962

Plot aspect ___________ southeast ______ Plot slope in degrees ______ 2

Plot size ______ 100' x 20'

Original planting date ___________ 4/7/78

Seedlings at time of planting: size ______ 6 - 12'' ______ age in years ______ 1

Approximate spacing ______ 6' x 6'

Original number of plants within plot ______ 50

Number of plants living at ___________ 8/25/78 ______ was ______ 50 ______ = ______ 100 ______ %

Spoil pH from lab test: water ______ 4.0 ______ buffer ______ 5.3

Plot location ______ bench

Spoil color ______ light brown

Rock fragments ______ many small 1 - 4'' D.; some coal fragments

Parent material of surface spoil ______ shale majority

Degree of erosion ______ only slightly eroded; bench has been filled with sediment to 3' deep; 1 gully to 1' deep and 3' wide

Existing vegetation: % cover ______ 60 ______ description w. strawberry, deer-tongue to 1', sh. sumac to 5', t. sedge to 4', ironweed to 5', majority is w. grass to 8'', blackberry to 3', t. poplar to 3'

Vegetation of adjacent areas g. brier, blackberry, l., sh., V. pine to 35', deer-tongue, goldenrod, sassafras to 6', f. dogwood to 10', p. hickory to 35', n.r. oak to 50', r. maple to 25', sycamore to 40'
THESE IS PLOT DATA

Plant name, common ___________________________ shortleaf pine

Plant name, scientific ___________________________ Pinus echinata

Mine no. ___________________________ Site recon. no. ___________________________ 506

State: Ky. County: Clay Subwatershed: Little Goose

Coal seam name __________ Horse Creek __________ Approx. elevation MSL __________ 1100 - 1150

Last known mining disturbance ___________________________ 1955 - 1962

Plot aspect __________ east __________ Plot slope in degrees __________ 1

Plot size ___________________________ 120' x 35'

Original planting date ___________________________ 4/7/78

Seedlings at time of planting: size __________ 6 - 14" __________ age in years __________ 1

Approximate spacing ___________________________ 6' x 6'

Original number of plants within plot ___________________________ 120

Number of plants living at __________ 8/25/78 __________ was __________ 72 __________ = __________ 60 __________ %

Spoil pH from lab test: water __________ 3.6 __________ buffer __________ 4.9

Plot location ___________________________ top of fill berm

Spoil color ___________________________ mixed - light gray to light brown

Rock fragments ___________________________ many small 1 - 4" D., mostly shale and coal

Parent material of surface spoil ___________________________ mostly shale

Degree of erosion moderate; some gullies formed on slopes of plot from __________ 6" to 3' deep and 1' to 5' wide

Existing vegetation: % cover __________ 0 __________ description ___________________________

Vegetation of adjacent areas __________ V. pine to 8', ironweed to 5', sycamore to 20', t. sedge to 3', p. hickory to 45', sh. pine to 20', cottonwood to 55', t. poplar to 40', n.r. oak to 60', sassafras to 10', g. brier, blackberry to 5', st. sumac to 10', b. locust to 20'
THESIS PLOT DATA

Plant name, common ______________________ shortleaf pine

Plant name, scientific ____________________ Pinus echinata

Mine no. ___________ 0021 - B ___________ Site recon. no. ___________ 506

State: Ky. County: Clay Subwatershed: Little Goose

Coal seam name ___________ Horse Creek ___________ Approx. elevation MSL ___________ 1100 - 1150

Last known mining disturbance ___________ 1955 - 1962

Plot aspect ___________ northwest ___________ Plot slope in degrees ___________ 4

Plot size ___________ 60' x 45'

Original planting date ___________ 4/7/78

Seedlings at time of planting: size ___________ 6 - 14" ___________ age in years ___________ 1

Approximate spacing ___________ 6' x 6'

Original number of plants within plot ___________ 86

Number of plants living at ___________ 9/7/78 ___________ was ___________ 74 ___________ = ___________ 86 ___________ %

Spoil pH from lab test: water ___________ 3.3 ___________ buffer ___________ 4.7

Plot location ___________ fill bench

Spoil color ___________ mixed - light brown majority to medium gray

Rock fragments ___________ many from 1 - 14" D. siltstone and coal

Parent material of surface spoil ___________ shale and sandstone

Degree of erosion ___________ 1 gully to 4' wide & 2' deep, 2 gullies to 5' wide & 15' deep

Existing vegetation: % cover ___________ 0 - 5 description V. pine to 6', l t. sedge to 3', 1 clump deertongue to 6", K. 31 t. fescue to 1'

Vegetation of adjacent areas t. sedge to 4', goldenrod to 3', sycamore to 15', n.r. oak to 60', s. birch to 25', t. poplar to 55', s.g. hickory to 60', r. maple to 30', sourwood to 10', b. gum to 15', f. dogwood to 20'
## THESIS PLOT DATA

<table>
<thead>
<tr>
<th>Plant name, common</th>
<th>European black alder</th>
</tr>
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<tbody>
<tr>
<td>Plant name, scientific</td>
<td><em>Alnus glutinosa</em></td>
</tr>
<tr>
<td>Mine no.</td>
<td>0021 - C</td>
</tr>
<tr>
<td>Site recon. no.</td>
<td>506</td>
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<tr>
<td>State:</td>
<td>Ky.</td>
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<td>County:</td>
<td>Clay</td>
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<td>Subwatershed:</td>
<td>Little Goose</td>
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<td>Coal seam name</td>
<td>Horse Creek</td>
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<tr>
<td>Approx. elevation MSL</td>
<td>1100 - 1150</td>
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<tr>
<td>Last known mining disturbance</td>
<td>1955 - 1962</td>
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<tr>
<td>Plot aspect</td>
<td>north</td>
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<tr>
<td>Plot slope in degrees</td>
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<tr>
<td>Plot size</td>
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<td>Original planting date</td>
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<td>Seedlings at time of planting:</td>
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<td>Approximate spacing</td>
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<td>Original number of plants within plot</td>
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<td>Number of plants living at</td>
<td>9/7/78 was 50 = 92 %</td>
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<td>Spoil pH from lab test:</td>
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<tr>
<td>Plot location</td>
<td>sediment filled gully on bench</td>
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<td>Spoil color</td>
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<tr>
<td>Rock fragments</td>
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<tr>
<td>Parent material of surface spoil</td>
<td>shale (sediment) majority</td>
</tr>
<tr>
<td>Degree of erosion gully surface has stabilized; no erosion visible</td>
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</tbody>
</table>

Existing vegetation: % cover 0 description

Vegetation of adjacent areas: r. maple to 20', b. willow to 20', ironweed to 5', cattail to 5', t. poplar to 3', sycamore to 40', sh. & V. pine to 20', p. hickory to 60', m. hickory to 35', f. dogwood to 15', w. oak to 40', blackberry to 4', n.r. oak to 45', st. sumac to 8', s. birch to 12', s. maple to 10', sassafras to 20'
THESIS PLOT DATA

Plant name, common __________________ European black alder

Plant name, scientific __________________ Alnus glutinosa

Mine no. ___________ 0021 - C ___________ Site recon. no. ___________ 506

State: Ky. County: Clay Subwatershed: Little Goose

Coal seam name ___________ Horse Creek ___________ Approx. elevation MSL ___________ 1100 - 1150

Last known mining disturbance ___________ 1955 - 1962

Plot aspect ___________ north ___________ Plot slope in degrees ___________ 0 - 4

Plot size ___________ 35' x 25'

Original planting date ___________ 4/5/78

Seedlings at time of planting: size ___________ 6 - 12" ___________ age in years ___________ 1

Approximate spacing ___________ 2' x 2'

Original number of plants within plot ___________ 100

Number of plants living at ___________ 9/7/78 ___________ was ___________ 89 ___________ = ___________ 89 ___________ %

Spoil pH from lab test: water ___________ buffer ___________

Plot location ___________ bench

Spoil color ___________ light gray

Rock fragments ___________ many from 1 - 12" D.; mostly sandstone

Parent material of surface spoil ___________ shale majority

Degree of erosion ___________ erosion has been slowed considerably by check dam at edge of plot; several gullies still exist to 2' deep and 6' wide

Existing vegetation: % cover ___________ 0 - 5 description saw grass only

Vegetation of adjacent areas r. maple to 20', b. willow to 20', ironweed to 5', cattail to 5', t. poplar to 30', sycamore to 40', sh. & v. pine to 20', p. hickory to 60', m. hickory to 35', f. dogwood to 15', w. oak to 40'
THESIS PLOT DATA

Plant name, common __________ shortleaf pine

Plant name, scientific ___________ Pinus echinata

Mine no. 0021 - C Site recon. no. 506

State: Ky. County: Clay Subwatershed: Little Goose

Coal seam name Horse Creek Approx. elevation MSL 1100 - 1150

Last known mining disturbance 1955 - 1962

Plot aspect north Plot slope in degrees 1

Plot size 150' x 12'

Original planting date 4/5/78

Seedlings at time of planting: size 6 - 14", age in years 1

Approximate spacing 6' x 6'

Original number of plants within plot 62

Number of plants living at 9/7/78 was 60 = 96 %

Spoil pH from lab test: water 3.7 buffer 4.9

Plot location top of berm on bench

Spoil color light brown

Rock fragments many coal 1 - 16" D. & few sandstone 1 - 14" D.

Parent material of surface spoil shale majority

Degree of erosion moderate; several gullies eroded to 4' deep and 3' wide

Existing vegetation: % cover 0 - 5 description w. grass

Vegetation of adjacent areas r. maple to 20', b. willow to 20', ironweed to 5', cattail to 5', t. poplar to 30', sycamore to 40', sh. and V. pine to 20', p. hickory to 60', m. hickory to 35', f. dogwood to 15', w. oak to 40', blackberry to 4', n.r. oak to 45', st. sumac to 8', s. birch to 12', s. maple to 10', sassafras to 20'
THESIS PLOT DATA

Plant name, common __________________ shortleaf pine

Plant name, scientific ________________ Pinus echinata

Mine no. _____0021 - C____ Site recon. no. _______ 506

State: Ky. County: __Clay___ Subwatershed: _______ Littlegoose

Coal seam name __Horse Creek____ Approx. elevation MSL _______ 1100 - 1150

Last known mining disturbance ____________ 1955 - 1962

Plot aspect ______ north_________ Plot slope in degrees _______ 0 - 4

Plot size __________ 120' x 15'

Original planting date ____________ 4/5/78

Seedlings at time of planting: size ______ 6 - 14"____ age in years ______ 1

Approximate spacing __________ 8' x 8'

Original number of plants within plot _______ 59

Number of plants living at _______ 9/7/78 ______ was ______ 52 ______ = ______ 88 ______ %

Spoil pH from lab test: water ______ 3.4 ______ buffer ______ 4.7

Plot location __________ berm on bench

Spoil color __________ light gray

Rock fragments many coal fragments 1 - 12" D. & some sandstone 1 - 12" D.

Parent material of surface spoil _______ shale majority

Degree of erosion moderate erosion; several gullies eroded to 3' deep and 6' wide

Existing vegetation: % cover ______ 0 ______ description ______ no vegetation despite good shale from highwall

Vegetation of adjacent areas: r. maple to 20', b. willow to 20', ironweed to 5', cattail to 5', t. poplar to 30', sycamore to 40', sh. and V. pine to 20', p. hickory to 60', m. hickory to 35', f. dogwood to 15', w. oak to 40', blackberry to 4', n.r. oak to 45'
THEESIS PLOT DATA

Plant name, common         shortleaf pine
Plant name, scientific      Pinus echinata
Mine no.                0021 - C        Site recon. no.      506
State: Ky.  County: Clay  Subwatershed: Little Goose
Coal seam name       Horse Creek  Approx. elevation MSL  1100 - 1150
Last known mining disturbance      1955 - 1962
Plot aspect            north        Plot slope in degrees  3
Plot size              45' x 20'
Original planting date   4/5/78
Seedlings at time of planting: size 6 - 14"  age in years 1
Approximate spacing   8' x 8'
Original number of plants within plot  40
Number of plants living at 9/7/78 was  40 = 100  %
Spoil pH from lab test: water  3.5  buffer  4.7
Plot location           berm
Spoil color           light brown to light gray
Rock fragments         many to 18" D.
Parent material of surface spoil shale majority, some sandstone
Degree of erosion only slight current gullyng; 1 gully to 6" deep and 6' wide
Existing vegetation: % cover 0 - 5 description 2 t. sedge to 3', 1 clump deertongue to 6"
Vegetation of adjacent areas r. maple to 20', b. willow to 20', ironweed to 5', cattail to 5', t. poplar to 30', sycamore to 40', sh. & V. pine to 20', p. hickory to 60', m. hickory to 35', f. dogwood to 15', w. oak to 40'
THESIS PLOT DATA

Plant name, common black locust

Plant name, scientific Robinia pseudoacacia

Mine no. 0021 - D Site recon. no. 506

State: Ky. County: Clay Subwatershed: Little Goose

Coal seam name Horse Creek Approx. elevation MSL 1100 - 1150

Last known mining disturbance 1955 - 1962

Plot aspect north Plot slope in degrees 38

Plot size 40' x 30'

Original planting date 4/6/78

Seedlings at time of planting: size 8 - 16" age in years 1

Approximate spacing 3' x 3'

Original number of plants within plot 75

Number of plants living at 8/25/78 was 7 = 9 %

Spoil pH from lab test: water 4.0 buffer 4.9

Plot location steep outslope

Spoil color mixed; light brown to medium gray

Rock fragments several 1 - 12" D.; several 6 - 10' boulders

Parent material of surface spoil mostly shale with some sandstone

Degree of erosion severe; 1 large gully eroded to 4' deep and 12' wide

borders 1 side of plot; 2 small gullies to 6" deep and 3' wide

Existing vegetation: % cover 20 description blackberry to 3',

majority, several t. sedge to 4'

Vegetation of adjacent areas V. pine to 12', sycamore to 35', n.r. oak
to 45', sassafras to 10', b. locust to 10', p. hickory to 40', A. beech
to 40', cattails to 3', t. sedge to 4'
THESIS PLOT DATA

Plant name, common  black locust

Plant name, scientific  Robinia pseudoacacia

Mine no.  0021 - D  Site recon. no.  506

State: Ky. County: Clay  Subwatershed: Little Goose

Coal seam name Horse Creek  Approx. elevation MSL  1100 - 1150

Last known mining disturbance  1955 - 1962

Plot aspect northwest  Plot slope in degrees  31

Plot size  50' x 25'

Original planting date  4/6/78

Seedlings at time of planting: size 8 - 16'' age in years 1

Approximate spacing  4' x 4'

Original number of plants within plot  100

Number of plants living at 8/25/78 was 98 = 98 %

Spoil pH from lab test: water 4.2  buffer 5.5

Plot location steep outcrops

Spoil color light brown

Rock fragments many; from 1'' D. to 6' D.

Parent material of surface spoil shale majority

Degree of erosion severely eroded slide area; several gullies

present to 6'' deep and 2' wide

Existing vegetation: % cover 50  description 2 y. buckeye

to 8', b. locust to 5', 1 V. pine to 12', ironweed to 6', black-
berry to 3', f. dogwood to 5', w. grass.

Vegetation of adjacent areas s. birch to 20', t. poplar to 30',
sycamore to 30', cottonwood to 50', sh. sumac to 5', b. locust to
15', V. pine to 10', A. beech to 50', n.r. oak to 50'.
THESIS PLOT DATA

Plant name, common: European black alder

Plant name, scientific: Alnus glutinosa

Mine no.: 0022 - A Site recon. no.: 285

State: Ky. County: Laurel Subwatershed: Slate Lick Creek

Coal seam name: Lily Approx. elevation MSL: 1200

Last known mining disturbance: 1955 - 1958

Plot aspect: northwest Plot slope in degrees: 0 - 6

Plot size: 30' x 25'

Original planting date: 3/31/77

Seedlings at time of planting: size: 6 - 12" age in years: 1

Approximate spacing: 4' x 4'

Original number of plants within plot: 57

Number of plants living at 5/30/78 was 52 = 91 %

Spoil pH from lab test: water: 3.4 buffer: 4.8

Plot location: berm

Spoil color: light gray

Rock fragments: few fragments to 3" D.

Parent material of surface spoil: majority is shale

Degree of erosion: moderate; 3 gullies to 6" deep & 2' wide

Existing vegetation: % cover: 5 description: V. pine, sh. pine

Vegetation of adjacent areas: V. pine to 15', n.r. oak to 30', sh. pine to 15', t. poplar, r. maple
Thesis Plot Data

Plant name, common: Virginia pine

Plant name, scientific: Pinus virginiana

Mine No.: 0022 - A  Site recon. no.: 285

State: Ky.  County: Laurel  Subwatershed: Slate Lick Creek

Coal seam name: Lily  Approx. elevation MSL: 1200

Last known mining disturbance: 1955 - 1958

Plot aspect: southwest  Plot slope in degrees: 8

Plot size: 60' x 20'

Original planting date: 3/17/78

Seedlings at time of planting: size 6 - 12"  age in years: 1

Approximate spacing: 6' x 6'

Original number of plants within plot: 41

Number of plants living at 5/30/78 was 23 = 56 %

Spoil pH from lab test: water 3.3  buffer 4.9

Plot location: hollow fill

Spoil color: light gray

Rock fragments: few fragments to 4" D.

Parent material of surface spoil: shale majority

Degree of erosion: moderate; 2 gullies to 1' deep & 18'' wide run

Length of plot:

Existing vegetation: % cover: 0 - 5  description: blackberry only

Vegetation of adjacent areas: V. pine, sh. pine, n.r. oak, b. oak, cs. oak to 50', r. maple, t. poplar, sh. sumac, sassafras, blackberry
THESIS PLOT DATA

Plant name, common Virginia pine

Plant name, scientific Pinus virginiana

Mine no. 0022 - A Site recon. no. 285

State: Ky. County: Laurel Subwatershed: Slate Lick Creek

Coal seam name Lily Approx. elevation MSL 1200

Last known mining disturbance 1955 - 1958

Plot aspect west Plot slope in degrees 7

Plot size 40' x 25'

Original planting date 3/17/78

Seedlings at time of planting: size 6 - 12" age in years 1

Approximate spacing 3' x 3'

Original number of plants within plot 79

Number of plants living at 5/30/78 was 44 = 55 %

Spoil pH from lab test: water 3.3 buffer 4.9

Plot location berm

Spoil color light brown to light gray

Rock fragments many fragments to 6" D.

Parent material of surface spoil sandstone and shale

Degree of erosion moderate; 2 gullies to 18" deep & 18" wide

Existing vegetation: % cover 20 description sh. pine to 6', V. pine to 6'

Vegetation of adjacent areas sh. pine to 20', V. pine to 20', r. maple, t. poplar, n.r. oak to 50', b. oak
THESIS PLOT DATA

Plant name, common: loblolly pine

Plant name, scientific: Pinus taeda

Mine no.: 0025 - A  Site recon. no.: 762

State: Ky.  County: Clay  Subwatershed: Urban Fork

Coal seam name: Horse Creek  Approx. elevation MSL: 1100 - 1150

Last known mining disturbance: 1953 - 1958

Plot aspect: north  Plot slope in degrees: 0 - 5

Plot size: 60' x 35'

Original planting date: 3/14/77

Seedlings at time of planting: size 6 - 14"  age in years: 1

Approximate spacing: 6' x 6'

Original number of plants within plot: 30

Number of plants living at 5/26/78: was 21 = 70  %

Spoil pH from lab test: water: 3.9  buffer: 4.9

Plot location: berm

Spoil color: medium brown

Rock fragments: very few to 3" D.

Parent material of surface spoil: majority is shale

Degree of erosion: slight; no gullies visible

Existing vegetation: % cover: 15  description: steeplebush, w. grass, V. pine to 7', w. pine to 7'

Vegetation of adjacent areas: sg. hickory, w. oak to 60', t. poplar to 60', b. locust to 60', V. pine
THESIS PLOT DATA

Plant name, common  loblolly pine
Plant name, scientific  Pinus taeda
Mine no.  0026 - A  Site recon. no.  507
State: Ky.  County: Clay  Subwatershed: Urban Fork
Coal seam name  Horse Creek  Approx. elevation MSL  1100 - 1150
Last known mining disturbance  1953 - 1958
Plot aspect  southeast  Plot slope in degrees  2
Plot size  50' x 50'
Original planting date  3/15/77
Seedlings at time of planting: size  6 - 14"  age in years  1
Approximate spacing  6' x 6'
Original number of plants within plot  57
Number of plants living at  11/3/77  was  47  =  82  %
Spoil pH from lab test: water  4.9  buffer  6.0
Plot location  bench
Spoil color  medium brown
Rock fragments  many fragments 1 - 6" D.
Parent material of surface spoil  majority is shale
Degree of erosion  moderate; 1 gully to 3' deep & 7' wide runs diagonally through the plot
Existing vegetation: % cover  40  description  w. grass, broomsedge

Vegetation of adjacent areas  n. apple, V. pine, g. brier, honeysuckle, f. dogwood, t. poplar
THEESIS PLOT DATA

Plant name, common black locust

Plant name, scientific Robinia pseudoacacia

Mine no. 0032 - A Site recon. no. 764

State: Ky. County: Clay Subwatershed: Urban Fork

Coal seam name Horse Creek Approx. elevation MSL 1100 - 1150

Last known mining disturbance 1953 - 1958

Plot aspect north Plot slope in degrees 10 - 26

Plot size 50' x 30'

Original planting date 4/8/77

Seedlings at time of planting: size 8 - 16" age in years 1

Approximate spacing 4' x 4'

Original number of plants within plot 73

Number of plants living at 5/30/78 was 68 = 93 %

Spoil pH from lab test: water 4.4 buffer 5.4

Plot location top of outslope

Spoil color light gray

Rock fragments few fragments to 4" D.

Parent material of surface spoil shale majority

Degree of erosion slight; no gullies

Existing vegetation: % cover 25 description s. maple, b. gum
to 8', r. maple, V. pine, broomsedge, sh. sumac

Vegetation of adjacent areas V. pine to 15', n.r. oak to 50',
A. beech to 70', sassafras to 15', m. hickory
THESIS PLOT DATA

Plant name, common Virginia pine

Plant name, scientific Pinus virginiana

Mine no. 0032 - A Site recon. no. 764

State: Ky. County: Clay Subwatershed: Urban Fork

Coal seam name Horse Creek Approx. elevation MSL 1100 - 1150

Last known mining disturbance 1953 - 1958

Plot aspect north Plot slope in degrees 10

Plot size 30' x 30'

Original planting date 4/8/77

Seedlings at time of planting: size 6 - 12'' age in years 1

Approximate spacing 6' x 6'

Original number of plants within plot 33

Number of plants living at 5/30/78 was 26 = 78 %

Spoil pH from lab test: water 4.0 buffer 5.2

Plot location berm

Spoil color light gray

Rock fragments many fragments to 4'' D.

Parent material of surface spoil shale and sandstone

Degree of erosion moderate; several gullies to 18'' deep and 3' wide

Existing vegetation: % cover 30 description V. pine, blackberry, w. grass

Vegetation of adjacent areas t. poplar to 100', b. locust, r. maple, n.r. oak to 100', e. redbud, b. gum
THEESIS PLOT DATA

Plant name, common ______________________ autumn olive

Plant name, scientific ____________________ Elaeagnus umbellata

Mine no. _______ 0033 - A ______ Site recon. no. _______ 761

State: Ky. County: Clay Subwatershed: Urban Fork

Coal seam name Horse Creek Approx. elevation MSL 1100 - 1150

Last known mining disturbance ____________ 1953 - 1958

Plot aspect _______ east _______ Plot slope in degrees _______ 29

Plot size ___________ 70' x 30'

Original planting date ___________ 4/1/77

Seedlings at time of planting: size _______ 6 - 12" _______ age in years _______ 1

Approximate spacing ___________ 4' x 4'

Original number of plants within plot ___________ 101

Number of plants living at ___________ 10/12/77 was _______ 69 _______ = _______ 68 _______ %

Spoil pH from lab test: water _______ 3.5 _______ buffer _______ 5.1

Plot location ___________ outslope

Spoil color ___________ dark gray

Rock fragments ___________ many fragments to 2" D.

Parent material of surface spoil ___________ shale majority

Degree of erosion severe; gullies irregularly spaced across the plot 12 - 20' apart and to 3' deep

Existing vegetation: % cover _______ 0 _______ description ____________________________

Vegetation of adjacent areas sh. pine, V. pine, pokeberry, broomsedge, s. maple to 10', blackberry, ironweed, steeplebush
THESIS PLOT DATA

Plant name, common ____________ black locust
Plant name, scientific ____________ Robinia pseudoacacia
Mine no. ____________ 0033 - A Site recon. no. ____________ 761
State: Ky. County: Clay Subwatershed: Urban Fork
Coal seam name ____________ Horse Creek Approx. elevation MSL ____________ 1100 - 1150
Last known mining disturbance ____________ 1953 - 1958
Plot aspect ____________ south Plot slope in degrees ____________ 26
Plot size ____________ 60' x 30'
Original planting date ____________ 3/25/77
Seedlings at time of planting: size ____________ 8 - 16" ____________ age in years ____________ 1
Approximate spacing ____________ 4' x 4'
Original number of plants within plot ____________ 207
Number of plants living at ____________ 10/12/77 was _207_ = ____________ 100 ____________ %
Spoil pH from lab test: water ____________ 5.2 ____________ buffer ____________ 6.3
Plot location ____________ immediately above highwall
Spoil color ____________ tan to light brown
Rock fragments ____________ several fragments to 18" D.
Parent material of surface spoil ____________ shale majority
Degree of erosion ____________ severe; gullies formed every 6 - 12' to a depth of ____________ 2 1/2'
Existing vegetation: ____________ % cover ____________ 0 - 5 ____________ description blackberry, l b. gum
to 6', w. grass

Vegetation of adjacent areas ____________ n.r. oak, broomsedge, pokeberry, t. sedge
THESIS PLOT DATA

Plant name, common ____________________________ Virginia pine

Plant name, scientific ____________________________ Pinus virginiana

Mine no. __________ Site recon. no. __________

State: Ky. County: Clay Subwatershed: Urban Fork

Coal seam name Horse Creek Approx. elevation MSL ________

Last known mining disturbance ________

Plot aspect south Plot slope in degrees ________

Plot size ________

Original planting date __________

Seedlings at time of planting: size ________ age in years ________

Approximate spacing ________

Original number of plants within plot ________

Number of plants living at ________ was ________ = ________ %

Spoil pH from lab test: water ________ buffer ________

Plot location ________ bench

Spoil color very variable; light brown to black

Rock fragments few fragments to 6" D.

Parent material of surface spoil shale majority

Degree of erosion slight

Existing vegetation: % cover ________ description ________ s. sedge

Vegetation of adjacent areas n.r. oak, w. oak, l. pine to 20'
Plant name, common: loblolly pine

Plant name, scientific: Pinus taeda

Mine no.: 0033 - B  Site recon. no.: 761

State: Ky.  County: Clay  Subwatershed: Urban Fork

Coal seam name: Horse Creek  Approx. elevation MSL: 1100 - 1150

Last known mining disturbance: 1953 - 1958

Plot aspect: south  Plot slope in degrees: 20

Plot size: 70' x 25'

Original planting date: 3/21/77

Seedlings at time of planting: size: 6 - 14"  age in years: 1

Approximate spacing: 6' x 6'

Original number of plants within plot: 57

Number of plants living at 11/3/77 was 51 = 89 %

Spoil pH from lab test: water: 5.3  buffer: 6.3

Plot location: one side of cove just above highwall

Spoil color: light brown

Rock fragments: many fragments to 8" D.

Parent material of surface spoil: shale majority

Degree of erosion: moderate; several gullies to 6" deep & 18" wide

Existing vegetation: % cover: 10  description: 1' 7' V. pine, sourwood to 3', w. grass

Vegetation of adjacent areas: n.r. oak to 40', w. oak to 40', t. poplar, V. pine, blackberry, broomedge
THEESIS PLOT DATA

Plant name, common  loblolly pine

Plant name, scientific  Pinus taeda

Mine no.  0033 - C  Site recon. no.  761

State: Ky.  County: Clay  Subwatershed: Urban Fork

Coal seam name  Horse Creek  Approx. elevation MSL  1100 - 1150

Last known mining disturbance  1953 - 1958

Plot aspect  southwest  Plot slope in degrees  12

Plot size  150' x 25'

Original planting date  3/16/77

Seedlings at time of planting: size  6 - 14"  age in years  1

Approximate spacing  6' x 6'

Original number of plants within plot  80

Number of plants living at  10/12/77  was  55  =  68  %

Spoil pH from lab test: water  3.8  buffer  4.9

Plot location  hem

Spoil color  light brown and light gray

Rock fragments  many fragments to 12" D.

Parent material of surface spoil  shale majority; some sandstone

Degree of erosion  moderate; 2 gullies to 6' deep & 18" wide

Existing vegetation: % cover  5  description broomsedge only

Vegetation of adjacent areas p. oak, b. gum, sycamore, broomsedge, blackberry, r. maple, V. pine, pokeberry, t. sedge, sh. sumac
THESIS PLOT DATA

Plant name, common  autumn olive

Plant name, scientific  Elaeagnus umbellata

Mine no.  0034 - A  Site recon. no.  760

State:  Ky.  County:  Clay  Subwatershed:  Urban Fork

Coal seam name  Horse Creek  Approx. elevation MSL  1100 - 1150

Last known mining disturbance  1953 - 1958

Plot aspect  south  Plot slope in degrees  0 - 3

Plot size  55' x 30'

Original planting date  4/29/77

Seedlings at time of planting:  size  6 - 12''  age in years  1

Approximate spacing  4' x 4'

Original number of plants within plot  87

Number of plants living at  5/26/78  was  45  =  51  %

Spoil pH from lab test:  water  3.8  buffer  5.1

Plot location  berm

Spoil color  light to medium gray

Rock fragments  few to 6'' D.

Parent material of surface spoil  shale majority

Degree of erosion  moderate: 2 gullies to 6'' deep & 3' wide

Existing vegetation:  % cover  0 - 5  description  V. pine to 4',
deertongue to 2'

Vegetation of adjacent areas  p. hickory to 50',  w. oak,  V. pine
THESIS PLOT DATA

Plant name, common black locust

Plant name, scientific Robinia pseudoacacia

Mine no. 0034 - A Site recon. no. 760

State: Ky. County: Clay Subwatershed: Urban Fork

Coal seam name Horsa Creek Approx. elevation MSL 1100 - 1150

Last known mining disturbance 1953 - 1958

Plot aspect northeast Plot slope in degrees 39

Plot size 50' x 20'

Original planting date 4/29/77

Seedlings at time of planting: size 8 - 16" age in years 1

Approximate spacing 3' x 3'

Original number of plants within plot 107

Number of plants living at 5/26/78 was 100 = 93 %

Spoil pH from lab test: water 3.7 buffer 5.1

Plot location outslope

Spoil color light gray and light brown

Rock fragments few fragments, but to 3' D.

Parent material of surface spoil shale majority; some sandstone

Degree of erosion severe; several gullies to 18" deep and 3' wide criss-cross the plot

Existing vegetation: % cover 5 description V. pine to 6', w. grass

Vegetation of adjacent areas V. pine to 20', t. poplar to 60', g. ash, w. oak, p. hickory
THESIS PLOT DATA

Plant name, common: European black alder

Plant name, scientific: Alnus glutinosa

Mine no.: 0034 - C  Site recon. no.: 760

State: Ky.  County: Clay  Subwatershed: Little Goose above Urban

Coal seam name: Horse Creek  Approx. elevation MSL: 1100 - 1150

Last known mining disturbance: 1955 - 1962

Plot aspect: northwest  Plot slope in degrees: 0 - 4

Plot size: 65' x 20'

Original planting date: 5/12/78

Seedlings at time of planting: size: 6 - 12"  age in years: 1

Approximate spacing: 6' x 6'

Original number of plants within plot: 22

Number of plants living at 10/25/78 was: 22  = 100 %

Spoil pH from lab test: water: 4.0  buffer: 5.8

Plot location: bench

Spoil color: light brown & light - dark gray

Rock fragments: few; most are coal fragments

Parent material of surface spoil: shale majority

Degree of erosion: slight; one gully to 1' deep & 1' wide

Existing vegetation: % cover: 35  description: w. grass, blackberry to 2', goldenrod, 2 r. maple to 7', 1 t. sedge, deertongue

Vegetation of adjacent areas: pokeberry, ironweed, blackberry, deertongue, goldenrod, b. locust to 15', t. poplar to 60', sourwood to 5', sycamore to 20', sh. pine to 15', f. dogwood to 20', u. magnolia, n.r. oak to 50', A. beech to 30', p. hickory to 60', sh. hickory to 50', s. birch to 6'
THESIS PLOT DATA

Plant name, common shortleaf pine

Plant name, scientific Pinus echinata

Mine no. 0034 - C Site recon. no. 760

State: Ky. County: Clay Subwatershed: Little Goose above Urban

Coal seam name Horse Creek Approx. elevation MSL 1100 - 1150

Last known mining disturbance 1955 - 1962

Plot aspect northwest Plot slope in degrees 2 - 16

Plot size 80' x 35'

Original planting date 5/12/78

Seedlings at time of planting: size 6 - 12" age in years 1

Approximate spacing 8' x 8'

Original number of plants within plot 82

Number of plants living at 10/25/78 was 75 = 91 %

Spoil pH from lab test: water 4.1 buffer 5.3

Plot location berm

Spoil color light brown

Rock fragments many to 12" D.; shale and sandstone

Parent material of surface spoil shale majority

Degree of erosion moderate; several small gullies to 2' deep & 4' wide on edge of berm

Existing vegetation: % cover 40 description w. grass majority, blackberry, broomedge, g. brier, t. sedge, deertongue to 6"

Vegetation of adjacent areas pokeberry, ironweed, blackberry, deertongue, goldenrod, sourwood to 5', f. dogwood to 20', s. birch to 6', sycamore to 20', u. magnolia, n.r. oak to 50', p. hickory to 60', sh. hickory to 50', A. beech to 30', sh. pine to 15'
THESIS PLOT DATA

Plant name, common Virginia pine

Plant name, scientific Pinus virginiana

Mine no. 0034 - C Site recon. no. 760

State: Ky. County: Clay Subwatershed: Little Goose above Urban

Coal seam name Horse Creek Approx. elevation MSL 1100 - 1150

Last known mining disturbance 1955 - 1962

Plot aspect northwest Plot slope in degrees 22

Plot size 55' x 35'

Original planting date 5/12/78

Seedlings at time of planting: size 6 - 12" age in years 1

Approximate spacing 6' x 6'

Original number of plants within plot 65

Number of plants living at 10/25/78 was 51 = 78 %

Spoil pH from lab test: water 3.7 buffer 5.1

Plot location side of berm

Spoil color light brown & light - medium gray

Rock fragments many to 18" D.

Parent material of surface spoil shale majority

Degree of erosion severe; few gullies present but much previous erosion

Existing vegetation: % cover 0 description

Vegetation of adjacent areas pokewberry, ironweed, blackberry, deertongue, goldenrod, t. poplar to 60', u. magnolia, n.r. oak to 50', p. hickory to 60', sh. hickory to 50', sourwood to 5', sycamore to 20', f. dogwood to 20', A. beech to 30', s. birch to 6', b. locust to 15', sh. pine to 15'
THESIS PLOT DATA

Plant name, common _________________ autumn olive

Plant name, scientific _______________ Elaeagnus umbellata

Mine no. ______________ Site recon. no. ____________

State: Ky. County: Laurel Subwatershed: Rockcastle

Coal seam name _______ Lily _______________ Approx. elevation MSL _______ 1200

Last known mining disturbance ____________ 1958 - 1959

Plot aspect _______ south _______________ Plot slope in degrees _______ 25

Plot size _______________ 45' x 40'

Original planting date ____________ 4/15/77

Seedlings at time of planting: size _______ 6 - 12" ____ age in years _______ 1

Approximate spacing _______________ 6' x 6'

Original number of plants within plot ____________ 52

Number of plants living at _______ 7/21/77 _______ was _______ 15 _______ = _______ 28 _______ %

Spoil pH from lab test: water _______ 4.5 _______ buffer _______ 6.1

Plot location _______________ outslope

Spoil color _______ light brown, light gray, and dark gray

Rock fragments _______________ several fragments to 12" D.

Parent material of surface soil _______ shale majority

Degree of erosion _______________ severe; several gullies to 7' deep

Existing vegetation: % cover _______ 10 _______ description _______ V. pine

Vegetation of adjacent areas _______ V. pine, n.r. oak, w. oak, t. poplar, p. hickory
THESIS PLOT DATA

Plant name, common ___________________ autumn olive

Plant name, scientific ___________________ Elaeagnus umbellata

Mine no. 0036 - A Site recon. no. 37

State: Ky. County: Laurel Subwatershed: Rockcastle

Coal seam name Lily Approx. elevation MSL 1200

Last known mining disturbance 1958 - 1959

Plot aspect southwest Plot slope in degrees 37

Plot size 65' x 40'

Original planting date 4/15/77

Seedlings at time of planting: size 6 - 12" age in years 1

Approximate spacing 3' x 3'

Original number of plants within plot 108

Number of plants living at 7/21/77 was 101 = 93 %

Spoil pH from lab test: water 2.5 buffer 4.7

Plot location outslope

Spoil color medium gray

Rock fragments few fragments to 10" D.

Parent material of surface spoil shale majority

Degree of erosion severe; several gullies to 3' deep

Existing vegetation: % cover 10 description several sh. sumac

Vegetation of adjacent areas V. pine, n.r. oak, w. oak, t. poplar, p. hickory
THESIS PLOT DATA

Plant name, common  Chinese chestnut
Plant name, scientific  Castanea mollis
Mine no.  0036 - A  Site recon. no.  37
State: Ky.  County: Laurel  Subwatershed: Rockcastle
Coal seam name  Lily  Approx. elevation MSL  1200
Last known mining disturbance  1958 - 1959
Plot aspect  northeast  Plot slope in degrees  7
Plot size  100' x 10'
Original planting date  4/15/77
Seedlings at time of planting: size  6 - 12"  age in years  1
Approximate spacing  4' x 4'
Original number of plants within plot  80
Number of plants living at  7/21/77  was  77  =  96  %
Spoil pH from lab test: water  4.2  buffer  5.2
Plot location  berm
Spoil color  dark gray, almost black
Rock fragments  many fragments to 2" D.
Parent material of surface spoil  shale majority
Degree of erosion  slight; no gullies visible

Existing vegetation: % cover  25  description  sh. pine, V. pine, w. grass

Vegetation of adjacent areas  sycamore, sh. sumac, sh. pine, V. pine, s. birch, s. lespedeza, n.r. oak, w. oak, t. poplar, p. hickory
THESIS PLOT DATA

Plant name, common European black alder

Plant name, scientific Alnus glutinosa

Mine no. 0036 - A Site recon. no. 37

State: Ky. County: Laurel Subwatershed: Rockcastle

Coal seam name Lily Approx. elevation MSL 1200

Last known mining disturbance 1958 - 1959

Plot aspect southeast Plot slope in degrees 1

Plot size 100' x 10'

Original planting date 4/22/77

Seedlings at time of planting: size 6 - 12" age in years 1

Approximate spacing 4' x 4'

Original number of plants within plot 42

Number of plants living at 7/21/77 was 38 = 90%

Spoil pH from lab test: water 3.7 buffer 5.4

Plot location berm

Spoil color light brown & light gray to dark gray

Rock fragments none

Parent material of surface spoil shale majority

Degree of erosion slight

Existing vegetation: % cover 20 description s. and t. sedges

Vegetation of adjacent areas V. pine, n.r. oak, w. oak, t. poplar.
r. maple, p. hickory, b. gum
THESIS PLOT DATA

Plant name, common ______ autumn olive

Plant name, scientific ______ Elaeagnus umbellata

Mine no. ______ 0037 - A ______ Site recon. no. ______ 695

State: Ky. County: Clay ______ Subwatershed: Gray's Fork

Coal seam name ______ Horse Creek ______ Approx. elevation MSL ______ 1100 - 1150

Last known mining disturbance ______ 1955 - 1962 ______

Plot aspect ______ southeast ______ Plot slope in degrees ______ 0 - 30

Plot size ______ 55' x 45'

Original planting date ______ 4/14/78

Seedlings at time of planting: size ______ 6 - 12" ______ age in years ______ 1

Approximate spacing ______ 8' x 8'

Original number of plants within plot ______ 113

Number of plants living at ______ 8/10/78 ______ was ______ 101 ______ = ______ 89 ______ %

Spoil pH from lab test: water ______ 5.2 ______ buffer ______ 5.8

Plot location ______ lower highwall and adjacent bench

Spoil color ______ light brown

Rock fragments ______ several to 3" D.

Parent material of surface spoil ______ shale

Degree of erosion ______ well eroded and current gullying; many small gullies to 3' deep and 3' wide.

Existing vegetation: % cover ______ 0 - 5 description ______ several b. gum trees________

_____ to 4' high, few w. grass

Vegetation of adjacent areas ______ sassafras to 15', n.r. oak to 40', b. oak ______

_____ to 60', broomsedge to 3', blackberry to 3', st. sumac to 8', s. lespedeza to 3'
THESIS PLOT DATA

Plant name, common black locust

Plant name, scientific Robinia pseudoacacia

Mine no. 0037 - A Site recon. no. 695

State: Ky. County: Clay Subwatershed: Gray's Fork

Coal seam name Horse Creek Approx. elevation MSL 1100 - 1150

Last known mining disturbance 1955 - 1962

Plot aspect south Plot slope in degrees 22

Plot size 70' x 35'

Original planting date 4/14/78

Seedlings at time of planting: size 8 - 16" age in years 1

Approximate spacing 6' x 6'

Original number of plants within plot 94

Number of plants living at 8/10/78 was 94 = 100 %

Spoil pH from lab test: water 5.5 buffer 6.7

Plot location bottom of highwall

Spoil color varies from light gray to tan

Rock fragments many rock fragments from 1 - 6" D.

Parent material of surface spoil shale

Degree of erosion well eroded, several gullies currently eroded to 18" deep & 24" wide

Existing vegetation: % cover 40 description blackberry to 1', goldenrod to 2', b. lespedeza to 3', s. lespedeza to 4', g. brier to 1', kb. lespedeza to 6'

Vegetation of adjacent areas m. hickory to 60', b. oak to 20', n.r. oak to 40', r. maple to 25', t. poplar to 5', V. pine to 3', sourwood to 15', st. sumac to 3'
THESIS PLOT DATA

Plant name, common: shortleaf pine
Plant name, scientific: Pinus echinata
Mine no.: 0037 - B Site recon. no.: 695
State: Ky. County: Clay Subwatershed: Little Goose
Coal seam name: Horse Creek Approx. elevation MSL: 1100 - 1150
Last known mining disturbance: 1955 - 1962
Plot aspect: southeast Plot slope in degrees: 8
Plot size: 50' x 25'
Original planting date: 4/14/78
Seedlings at time of planting: size: 6 - 14" age in years: 1
Approximate spacing: 4' x 4'
Original number of plants within plot: 53
Number of plants living at: 8/10/78 was: 52 = 98 %
Spoil pH from lab test: water: 4.4 buffer: 5.4
Plot location: top of berm on fill bench
Spoil color: light gray
Rock fragments: few between 2 - 4" D.
Parent material of surface spoil: majority shale, some sandstone
Degree of erosion: slight; few gullies to 1' wide & 6" deep; some weathered new soil eroded leaving only shale.
Existing vegetation: % cover: 50 description: s. birch to 3', f. dogwood to 3', V. pine to 5', deertongue to 1', broomsedge to 3', g. brier to 1', blackberry to 1'
Vegetation of adjacent areas: s. birch to 25', A. elm to 10', V. pine & sh. pine to 15', w. oak to 60', sycamore to 25', m. hickory to 50', ironweed to 6', f. dogwood to 5'.
THESIS PLOT DATA

Plant name, common __________________ autumn olive

Plant name, scientific __________________ Elaeagnus umbellata

Mine no. ____________ 0039 - A ____________ Site recon. no. ____________ 757

State: Ky. County: Clay Subwatershed: Urban Fork

Coal seam name Horse Creek Approx. elevation MSL ____________ 1100 - 1150

Last known mining disturbance ____________ 1953 - 1958

Plot aspect southwest Plot slope in degrees ____________ 30

Plot size ____________ 50' x 30'

Original planting date ____________ 4/15/77

Seedlings at time of planting: size ____________ 6 - 12" age in years ____________ 1

Approximate spacing ____________ 5' x 5'

Original number of plants within plot ____________ 70

Number of plants living at ____________ 5/26/78 was ____________ 32 = ____________ 45 %

Spoil pH from lab test: water ____________ 3.4 buffer ____________ 5.0

Plot location ____________ top of outslope

Spoil color ____________ dark gray

Rock fragments ____________ few fragments to 4" D.

Parent material of surface spoil ____________ shale majority; some waste coal

Degree of erosion ____________ moderate; several gullies to 1' deep & 2' wide

Existing vegetation: % cover ____________ 0 ____________ description __________________

Vegetation of adjacent areas ____________ w. oak to 40', V. pine, sh. pine, s. lespedeza, K. 31 t. fescue, A. beech
THESSIS PLOT DATA

Plant name, common __________ Virginia pine

Plant name, scientific ________ Pinus virginiana

Mine no. _______ 0039 - A ______ Site recon. no. ______ 757

State: Ky. County: __________ Clay __________ Subwatershed: __________ Urban Fork

Coal seam name __________ Horse Creek __________ Approx. elevation MSL __________ 1100 - 1150

Last known mining disturbance _______ 1953 - 1958

Plot aspect __________ southwest __________ Plot slope in degrees ______ 7

Plot size _______ 55' x 30'

Original planting date ______ 4/15/77

Seedlings at time of planting: size __________ 6 - 12" __________ age in years ______ 1

Approximate spacing _______ 6' x 6'

Original number of plants within plot ______ 40

Number of plants living at ______ 5/26/78 ______ was ______ 34 ______ = ______ 85 ______ %

Spoil pH from lab test: water ______ 3.8 ______ buffer ______ 5.1

Plot location _______ berm

Spoil color _______ medium brown

Rock fragments _______ few to 18" D.

Parent material of surface spoil ______ shale majority; some sandstone

Degree of erosion ______ moderate; several gullies to 18" deep & 6' wide

Existing vegetation: % cover ______ 25 ______ description ______ V. pine to 6', t.
poplar to 4', broomsedge

Vegetation of adjacent areas ______ blackberry, cattails, b. willow to 6',
t. poplar, r. maple, mg. hickory, b. oak to 60', V. pine, broomsedge,
sh. pine
THESIS PLOT DATA

Plant name, common: black locust

Plant name, scientific: Robinia pseudoacacia

Mine no.: 0040 - A Site recon. no.: 696

State: Ky. County: Clay Subwatershed: Gray's Fork

Coal seam name: Horse Creek Approx. elevation MSL: 1100 - 1150

Last known mining disturbance: 1955 - 1962

Plot aspect: north Plot slope in degrees: 31

Plot size: 35' x 30'

Original planting date: 4/6/78

Seedlings at time of planting: size: 8 - 16" age in years: 1

Approximate spacing: 5' x 5'

Original number of plants within plot: 76

Number of plants living at 8/10/78 was 76 = 100 %

Spoil pH from lab test: water: 4.0 buffer: 5.1

Plot location: out-slope (adjacent to existing drag strip)

Spoil color: medium gray (some brown mixed)

Rock fragments: several to 4" D.

Parent material of surface spoil: shale

Degree of erosion: severely gullied; plot bordered by gullies on both sides, divided in middle by one gully 3' deep and to 6' wide

Existing vegetation: % cover: 10 description: few g. brier, few V. pine to 3' high, few K. 31 t. fescue clumps

Vegetation of adjacent areas: p. pine to 20', t. poplar to 30', s. maples to 35', w. oak to 45', A. beech to 50', w. grape
THESIS PLOT DATA

Plant name, common: black locust

Plant name, scientific: *Robinia pseudoacacia*

Mine no.: 0040-B

Site recon. no.: 696

State: Ky. County: Clay

Subwatershed: Little Goose

Coal seam name: Horse Creek

Approx. elevation MSL: 1100 - 1150

Last known mining disturbance: 1955 - 1962

Plot aspect: southwest

Plot slope in degrees: 32

Plot size: 45' x 30'

Original planting date: 4/6/78

Seedlings at time of planting:

- size: 8 - 16"
- age in years: 1

Approximate spacing: 4' x 4'

Original number of plants within plot: 103

Number of plants living at 8/10/78:

- was: 100
- %: 97

Spoil pH from lab test:

- water: 3.8 (buffer: 5.2)

Plot location: outslope (adjacent to drag strip)

Spoil color: light gray

Rock fragments: a few fragments greater than 6". D. on surface

Parent material of surface spoil: shale

Degree of erosion: severe; many small gullies eroding 6 - 36" deep & 6 - 24" wide

Existing vegetation:

- % cover: 0 - 5
- description: few sprigs of K. 31 t. fescue, crabgrass, s. sorrel, 1 clump broomsedge

Vegetation of adjacent areas:

- t. poplar to 25', A. elm to 20', r. maple to 20', V. and sh. pine to 15', sh. sumac to 5', deertongue to 2'
- blackberry
**THESIS PLOT DATA**

<table>
<thead>
<tr>
<th>Description</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant name, common</td>
<td>scotch pine</td>
</tr>
<tr>
<td>Plant name, scientific</td>
<td><em>Pinus sylvestris</em></td>
</tr>
<tr>
<td>Mine no.</td>
<td>0049 - A</td>
</tr>
<tr>
<td>Site recon. no.</td>
<td>1214</td>
</tr>
<tr>
<td>State: County: Subwatershed</td>
<td>Ky. Harlan / Cranks Creek</td>
</tr>
<tr>
<td>Coal seam name: Approx. elevation MSL</td>
<td>Creech / 1900</td>
</tr>
<tr>
<td>Last known mining disturbance</td>
<td>1964</td>
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<tr>
<td>Plot aspect: Plot slope in degrees</td>
<td>west / 24</td>
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<tr>
<td>Plot size</td>
<td>130' x 15'</td>
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<tr>
<td>Original planting date</td>
<td>5/8/78</td>
</tr>
<tr>
<td>Seedlings at time of planting: size / age in years</td>
<td>6 - 12&quot; / 2</td>
</tr>
<tr>
<td>Approximate spacing</td>
<td>6' x 6'</td>
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<tr>
<td>Original number of plants within plot</td>
<td>45</td>
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<tr>
<td>Number of plants living at 11/1/78 was</td>
<td>45 = 100%</td>
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<tr>
<td>Spoil pH from lab test: water / buffer</td>
<td>5.2 / 5.8</td>
</tr>
<tr>
<td>Plot location</td>
<td>lower edge of highwall</td>
</tr>
<tr>
<td>Spoil color</td>
<td>medium brown</td>
</tr>
<tr>
<td>Rock fragments (most from highwall collapse)</td>
<td>several to 48&quot; D.</td>
</tr>
<tr>
<td>Parent material of surface spoil</td>
<td>shale majority; some sandstone</td>
</tr>
<tr>
<td>Degree of erosion</td>
<td>slight; no gullies present</td>
</tr>
<tr>
<td>Existing vegetation: % cover description</td>
<td>90 Ky. 31 t. fescue, blackberry, pokeweed, s. lespedeza, w. lovegrass, steeplebush</td>
</tr>
<tr>
<td>Vegetation of adjacent areas</td>
<td>r. maple to 35', ck. oak, n.r. oak to 35', s. maple to 25', sassafras to 35', A. linden, m. laurel to 10'</td>
</tr>
</tbody>
</table>
THESIS PLOT DATA

Plant name, common: shortleaf pine

Plant name, scientific: Pinus echinata

Mine no.: 0049 - A Site recon. no.: 1214

State: Ky. County: Harlan Subwatershed: Cranks Creek

Coal seam name: Creech Approx. elevation MSL: 1900

Last known mining disturbance: 1964

Plot aspect: north Plot slope in degrees: 4

Plot size: 95' x 45'

Original planting date: 4/24/78

Seedlings at time of planting: size: 6 - 12" age in years: 1

Approximate spacing: 6' x 6'

Original number of plants within plot: 97

Number of plants living at: 11/1/78 was: 97 = 100 %

Spoil pH from lab test: water: 5.0 buffer: 5.5

Plot location: bench

Spoil color: light brown & light - medium gray

Rock fragments: many to 6" D.

Parent material of surface spoil: shale majority

Degree of erosion: slight; no gullies present

Existing vegetation: % cover: 70 description: K. 31 t. fescue. pokeberry

Vegetation of adjacent areas: pokeberry, K. 31 t. fescue, w. lovegrass. c. fern, n.r. oak to 60', s. maple to 15', b. gum to 70', b. locust to 10', sg. hickory to 65'
### THESIS PLOT DATA

<table>
<thead>
<tr>
<th>Plant name, common</th>
<th>shortleaf pine</th>
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</thead>
<tbody>
<tr>
<td>Plant name, scientific</td>
<td><em>Pinus echinata</em></td>
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<tr>
<td>Mine no.</td>
<td>0049 - A</td>
</tr>
<tr>
<td>Site recon. no.</td>
<td>1214</td>
</tr>
<tr>
<td>State:</td>
<td>Ky.</td>
</tr>
<tr>
<td>County:</td>
<td>Harlan</td>
</tr>
<tr>
<td>Subwatershed:</td>
<td>Cranks Creek</td>
</tr>
<tr>
<td>Coal seam name</td>
<td>Creech</td>
</tr>
<tr>
<td>Approx. elevation MSL</td>
<td>1900</td>
</tr>
<tr>
<td>Last known mining disturbance</td>
<td>1954</td>
</tr>
<tr>
<td>Plot aspect</td>
<td>northeast</td>
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<tr>
<td>Plot slope in degrees</td>
<td>46</td>
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<tr>
<td>Plot size</td>
<td>125' x 30'</td>
</tr>
<tr>
<td>Original planting date</td>
<td>4/24/78</td>
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<tr>
<td>Seedlings at time of planting:</td>
<td>size 6 - 12&quot; age in years 1</td>
</tr>
<tr>
<td>Approximate spacing</td>
<td>6' x 6'</td>
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<tr>
<td>Original number of plants within plot</td>
<td>99</td>
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<tr>
<td>Number of plants living at</td>
<td>11/1/78</td>
</tr>
<tr>
<td>was</td>
<td>96</td>
</tr>
<tr>
<td>%</td>
<td></td>
</tr>
<tr>
<td>Spoil pH from lab test: water</td>
<td>5.1</td>
</tr>
<tr>
<td>buffer</td>
<td>6.3</td>
</tr>
<tr>
<td>Plot location</td>
<td>highwall</td>
</tr>
<tr>
<td>Spoil color</td>
<td>tan</td>
</tr>
<tr>
<td>Rock fragments</td>
<td>many to 3&quot; D.</td>
</tr>
<tr>
<td>Parent material of surface spoil</td>
<td>shale majority</td>
</tr>
<tr>
<td>Degree of erosion</td>
<td>severe; several gullies to 18&quot; deep &amp; 4' wide; sheet erosion also evident</td>
</tr>
<tr>
<td>Existing vegetation:</td>
<td>% cover 20 description several b. locust to 25' tall, 1 r. maple to 7', 2 n.r. oak to 20', K. 31 t. fescue, black-berry, g. brier, w. pine to 25'</td>
</tr>
<tr>
<td>Vegetation of adjacent areas</td>
<td>broomsedge, s. lespedeza, sourwood to 10', r. maple to 15', b. locust to 40', sycamore to 25', t. poplar to 45', b. cherry to 20', l. pine to 25'</td>
</tr>
</tbody>
</table>
THESIS PLOT DATA

Plant name, common __________ shortleaf pine

Plant name, scientific __________ Pinus echinata

Mine no. ______ 0049 - A ______ Site recon. no. ______ 1214

State: Ky. County: Harlan Subwatershed: Cranks Creek

Coal seam name ______ Creech ______ Approx. elevation MSL ______ 1900

Last known mining disturbance ______ 1964

Plot aspect ______ southeast ______ Plot slope in degrees ______ 3

Plot size ______ 95' x 25'

Original planting date ______ 4/24/78

Seedlings at time of planting: size ______ 6 - 12" ______ age in years ______ 1

Approximate spacing ______ 6' x 6'

Original number of plants within plot ______ 86

Number of plants living at ______ 11/1/78 ______ was ______ 72 ______ = ______ 83 ______ %

Spoil pH from lab test: water ______ 5.3 ______ buffer ______ 6.4

Plot location ______ bench

Spoil color ______ light brown

Rock fragments ______ many to 2" D.

Parent material of surface spoil ______ shale and sandstone

Degree of erosion ______ slight; no gullies present

Existing vegetation: % cover ______ 65 ______ description K. 31 t. fescue, pokeberry is majority, w. lovegrass

Vegetation of adjacent areas w. lovegrass, K. 31 t. fescue, pokeberry, blackberry, w. grape, w. oak to 25', n.r. oak to 50', t. poplar to 80', s. maple to 15', w. ash to 30', b. hickory to 30', sg. hickory to 60', b. cherry to 45', b. locust to 40', A. beech to 40', r. paulownia to 65'
THESIS PLOT DATA

Plant name, common  Virginia pine
Plant name, scientific  Pinus virginiana
Mine no.  0056 - A  Site recon. no.  705
State: Ky. County: Clay  Subwatershed: Rader Creek
Coal seam name  Horse Creek  Approx. elevation MSL  950 - 1150
Last known mining disturbance  1955 - 1963
Plot aspect  northeast  Plot slope in degrees  0 - 2
Plot size  125' x 20'
Original planting date  5/12/78
Seedlings at time of planting: size  6 - 12"  age in years  1
Approximate spacing  5' x 5'
Original number of plants within plot  101
Number of plants living at 10/18/78 was  89  =  88  %
Spoil pH from lab test: water  4.1  buffer  4.9
Plot location  berm
Spoil color  light brown & light gray (surface crust)
Rock fragments  several to 3" D.
Parent material of surface spoil  shale majority
Degree of erosion  slight; no gullies present

Existing vegetation: % cover  0 - 5 description broomedge, w. grass, several V. pine to 4' is majority
Vegetation of adjacent areas  sycamore to 30', V. pine to 25', sh. pine to 30', f. dogwood to 10', s. birch to 20', e. redbud to 10', r. maple to 30', t. poplar to 50', honeysuckle, t. sedge to 4', ironweed to 7', s. lespedeza, blackberry to 3', steeplebush, st. sumac, cattails to 4'
THESIS PLOT DATA

Plant name, common          Virginia pine

Plant name, scientific      Pinus virginiana

Mine no.                   0056 - A
Site recon. no.             705

State: Ky. County: Clay     Subwatershed: Rader Creek

Coal seam name             Horse Creek
Approx. elevation MSL      950 - 1150

Last known mining disturbance         1955 - 1963

Plot aspect                southwest
Plot slope in degrees      9

Plot size                   90' x 40'

Original planting date     5/5/78

Seedlings at time of planting: size 6 - 12'  age in years 1

Approximate spacing         6' x 6'

Original number of plants within plot          105

Number of plants living at 10/18/78 was 98 = 93 %

Spoil pH from lab test: water 3.8  buffer 4.7

Plot location               berm

Spoil color                 light to medium gray

Rock fragments              many to 12" D.

Parent material of surface spoil             shale majority

Degree of erosion            severe; 7 gullies to 3' deep and 8' wide

Existing vegetation:  % cover 10 description V. pine to 6',
brroomsedge to 3', blackberry to 4' is majority, w. grass

Vegetation of adjacent areas sycamore to 30', V. pine to 25', sh. pine
         to 30', f. dogwood to 10', s. birch to 20', e. redbud to 10', r. maple
         to 30', t. poplar to 50', honeysuckle, t. sedge to 4', cattails to 4',
         ironweed to 7', s. lespedeza, blackberry to 3', steeplebush, st. sumac,
g. brier to 3', w. grape, n.r. oak to 45', s. gum to 15'
# THESIS PLOT DATA

<table>
<thead>
<tr>
<th>Plant name, common</th>
<th>European black alder</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant name, scientific</td>
<td><em>Alnus glutinosa</em></td>
</tr>
<tr>
<td>Mine no.</td>
<td>0057 - C</td>
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<tr>
<td>Site recon. no.</td>
<td>659</td>
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<tr>
<td>State: Ky. County:</td>
<td>Clay</td>
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<td>Subwatershed:</td>
<td>Rader Creek</td>
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<tr>
<td>Coal seam name</td>
<td>Horse Creek</td>
</tr>
<tr>
<td>Approx. elevation MSL</td>
<td>950 - 1150</td>
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<tr>
<td>Last known mining disturbance</td>
<td>1955 - 1963</td>
</tr>
<tr>
<td>Plot aspect</td>
<td>northeast</td>
</tr>
<tr>
<td>Plot slope in degrees</td>
<td>3</td>
</tr>
<tr>
<td>Plot size</td>
<td>85' x 15'</td>
</tr>
<tr>
<td>Original planting date</td>
<td>5/4/78</td>
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<tr>
<td>Seedlings at time of planting:</td>
<td>size 6 - 12&quot; age in years 1</td>
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<tr>
<td>Approximate spacing</td>
<td>5' x 5'</td>
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<tr>
<td>Original number of plants within plot</td>
<td>56</td>
</tr>
<tr>
<td>Number of plants living at 10/18/78</td>
<td>was 55 = 98 %</td>
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<tr>
<td>Spoil pH from lab test:</td>
<td>water 4.7 buffer 5.8</td>
</tr>
<tr>
<td>Plot location</td>
<td>bench (slightly filled)</td>
</tr>
<tr>
<td>Spoil color</td>
<td>medium - dark gray &amp; light - medium brown</td>
</tr>
<tr>
<td>Rock fragments</td>
<td>few to 8&quot; D.; coal fragments to 3&quot; D.</td>
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<tr>
<td>Parent material of surface spoil</td>
<td>shale majority; some sandstone</td>
</tr>
<tr>
<td>Degree of erosion</td>
<td>slight; no gullies present</td>
</tr>
</tbody>
</table>

Existing vegetation: % cover 65 description w. grass is majority, s. sedge

Vegetation of adjacent areas: cattails, broomsedge, steeplebush, honeysuckle, deer tongue, t. sedge, r. maple to 3', v. pine to 35', sourwood to 4', b. oak to 20', t. poplar to 40', f. dogwood to 10', sassafras to 15', sycamore to 25'
THESIS PLOT DATA

Plant name, common European black alder

Plant name, scientific Alnus glutinosa

Mine no. 0057 - C Site recon. no. 659

State: Ky. County: Clay Subwatershed: Rader Creek

Coal seam name Horse Creek Approx. elevation MSL 950 - 1150

Last known mining disturbance 1955 - 1963

Plot aspect northeast Plot slope in degrees 0 - 5

Plot size 75' x 10'

Original planting date 5/4/78

Seedlings at time of planting: size 6 - 12" age in years 1

Approximate spacing 5' x 5'

Original number of plants within plot 24

Number of plants living at 10/18/78 was 24 = 100 %

Spoil pH from lab test: water 5.1 buffer 6.6

Plot location base of highwall and adjacent edge of bench

Spoil color medium brown

Rock fragments few: coal fragments to 4", sandstone to 8" D.

Parent material of surface spoil shale majority

Degree of erosion slight; no gullies present

Existing vegetation: % cover 50 description s. sedge is majority, t. sedge, steeplebush

Vegetation of adjacent areas steeplebush, honeysuckle, deertongue to 2', p. ivy to 3', t. sedge, r. maple to 3', V. pine to 35', b. oak to 20', t. poplar to 40', f. dogwood to 10', sassafras to 15', sycamore to 25'
THESIS PLOT DATA

<table>
<thead>
<tr>
<th>Plant name, common</th>
<th>black locust</th>
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</thead>
<tbody>
<tr>
<td>Plant name, scientific</td>
<td><em>Robinia pseudoacacia</em></td>
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<td>Mine no.</td>
<td>0058 - A</td>
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<td>Site recon. no.</td>
<td>618</td>
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<tr>
<td>State: Ky. County: Clay</td>
<td>Subwatershed: Rader Creek</td>
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<tr>
<td>Coal seam name</td>
<td>Horse Creek</td>
</tr>
<tr>
<td>Approx. elevation MSL</td>
<td>950 - 1150</td>
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<tr>
<td>Last known mining disturbance</td>
<td>1955 - 1963</td>
</tr>
<tr>
<td>Plot aspect</td>
<td>west</td>
</tr>
<tr>
<td>Plot slope in degrees</td>
<td>25</td>
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<tr>
<td>Plot size</td>
<td>55' x 45'</td>
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<tr>
<td>Original planting date</td>
<td>3/19/78</td>
</tr>
<tr>
<td>Seedlings at time of planting: size</td>
<td>8 - 16''</td>
</tr>
<tr>
<td>age in years</td>
<td>1</td>
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<tr>
<td>Approximate spacing</td>
<td>4' x 4'</td>
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<tr>
<td>Original number of plants within plot</td>
<td>127</td>
</tr>
<tr>
<td>Number of plants living at 10/18/78 was</td>
<td>112 = 88%</td>
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<tr>
<td>Spoil pH from lab test: water</td>
<td>5.1</td>
</tr>
<tr>
<td>buffer</td>
<td>5.7</td>
</tr>
<tr>
<td>Plot location</td>
<td>highwall</td>
</tr>
<tr>
<td>Spoil color</td>
<td>light - medium brown</td>
</tr>
<tr>
<td>Rock fragments</td>
<td>many to 10'' D.</td>
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<tr>
<td>Parent material of surface spoil</td>
<td>shale majority</td>
</tr>
<tr>
<td>Degree of erosion</td>
<td>severe; many gullies to 4' deep &amp; 6' wide</td>
</tr>
<tr>
<td>Existing vegetation: % cover</td>
<td>0</td>
</tr>
<tr>
<td>description</td>
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</table>

Vegetation of adjacent areas ironweed to 5', blackberry to 6', sycamore to 30', V. pine to 15', sh. pine to 30', t. poplar to 80', p. hickory to 25', sg. hickory to 50', f. dogwood to 5', sourwood to 10', r. maple to 30'
THESIS PLOT DATA

Plant name, common ________ shortleaf pine

Plant name, scientific ________ Pinus echinata

Mine no. ________ 0058 - A ________ Site recon. no. ________ 618

State: Ky. County: Clay ________ Subwatershed: Rader Creek

Coal seam name ________ Horse Creek ________ Approx. elevation MSL ________ 950 - 1150

Last known mining disturbance ________ 1955 - 1963

Plot aspect ________ west ________ Plot slope in degrees ________ 1

Plot size ________ 60' x 40'

Original planting date ________ 5/19/78

Seedlings at time of planting: size ________ 6 - 12" ________ age in years ________ 1

Approximate spacing ________ 5' x 5'

Original number of plants within plot ________ 96

Number of plants living at ________ 10/18/78 ________ was ________ 62 ________ = ________ 65 ________ %

Spoil pH from lab test: water ________ 5.0 ________ buffer ________ 6.2

Plot location ________ fill bench

Spoil color ________ medium brown

Rock fragments ________ many small fragments to 6" D.; some sandstone

Parent material of surface spoil ________ shale majority

Degree of erosion ________ slight; no gullies present

Existing vegetation: % cover ________ 60 ________ description w. grass is majority, blackberry, kb. lespedeza, goldenrod, g. brier

Vegetation of adjacent areas ironweed to 5′, blackberry to 6′, sycamore to 30′, V. pine to 15′, sh. pine to 30′, p. hickory to 25′, sg. hickory to 50′, f. dogwood to 5′, sourwood to 10′, r. maple to 30′
THESIS PLOT DATA

Plant name, common __________ shortleaf pine

Plant name, scientific __________ Pinus echinata

Mine no. _______ 0058 - A ______ Site recon. no. _______ 618

State: Ky. County: Clay Subwatershed: Rader Creek

Coal seam name __________ Horse Creek Approx. elevation MSL __________ 950 - 1150

Last known mining disturbance __________ 1955 - 1963

Plot aspect __________ west ______ Plot slope in degrees __________ 0 - 2

Plot size __________ 65' x 35'

Original planting date __________ 5/19/78

Seedlings at time of planting: size __________ 6 - 12" ______ age in years __________ 1

Approximate spacing __________ 6' x 6'

Original number of plants within plot __________ 97

Number of plants living at __________ 10/18/78 ______ was __________ 52 ______ = ______ 54 ______ %

Spoil pH from lab test: water __________ 4.7 ______ buffer __________ 6.3

Plot location __________ bench

Spoil color __________ light brown

Rock fragments __________ many small fragments to 6" D.

Parent material of surface spoil __________ shale majority; some sandstone

Degree of erosion slight; one gully to 6" deep & 6' wide; plot bordered by gully on one end to 6' deep and 15' wide

Existing vegetation: % cover __________ 60 ______ description: kb. lespedeza, w. grass is majority, g. brier, broomsedge, steeplebush, n. apple to 2'

Vegetation of adjacent areas: ironweed to 5', blackberry to 6', t. sedge, n. alder, n.r. oak to 80', sycamore to 30', V. pine to 15', t. poplar to 80', p. hickory to 25', sg. hickory to 50', f. dogwood to 5', sourwood to 10', r. maple to 30', sh. pine to 30'
THESIS PLOT DATA

Plant name, common  European black alder

Plant name, scientific  Alnus glutinosa

Mine no.  0076 - B  Site recon. no.  623

State: Ky.  County: Clay  Subwatershed: Laurel Creek

Coal seam name  Horse Creek  Approx. elevation MSL  950 - 1150

Last known mining disturbance  1962 - 1963

Plot aspect  northwest  Plot slope in degrees  1

Plot size  90' x 15'

Original planting date  5/19/78

Seedlings at time of planting: size  6 - 12"  age in years  1

Approximate spacing  6' x 6'

Original number of plants within plot  35

Number of plants living at 10/25/78 was  30  =  86  %

Spoil pH from lab test: water  4.9  buffer  5.7

Plot location  bench

Spoil color  light gray & light brown

Rock fragments  many to 4" D.

Parent material of surface spoil  shale majority

Degree of erosion  slight; no gullies present

Existing vegetation: % cover  50  description lichens, w. grass is

majority, steeplebush, broomsedge, goldenrod, V. pine to 5'

Vegetation of adjacent areas goldenrod, sh. sumac to 10', blackberry,

pokewberry, E. r. cedar to 4', sh. pine to 30', sycamore to 20', n.r. oak
to 30', p. hickory to 60', t. poplar to 70', b. willow to 5'
THESIS PLOT DATA

Plant name, common ______________________ European black alder
Plant name, scientific ____________________ Alnus glutinosa
Mine no. ____________ Site recon. no. ________ 0076 - B 623
State: Ky. County: Clay Subwatershed: Laurel Creek
Coal seam name __________ Approx. elevation MSL _______ Horse Creek 950 - 1150
Last known mining disturbance _____________ 1962 - 1963
Plot aspect __________ Plot slope in degrees _______ west 3
Plot size ___________________________ 100' x 20'
Original planting date _____________ 5/19/78
Seedlings at time of planting: size __________ age in years _______ 6 - 12" 1
Approximate spacing ______________________ 6' x 6'
Original number of plants within plot _______ 113
Number of plants living at __________ was __________ % 10/25/78 100 88
Spoil pH from lab test: water _______ buffer _______ 5.6 6.8
Plot location __________________________ bench
Spoil color ____________________________ tan - light brown
Rock fragments __________________________ several to 8" D.
Parent material of surface spoil ___________ shale majority
Degree of erosion ________________________ slight; no gullies present

Existing vegetation: % cover ______ description w. strawberry, broomsedge is majority, t. sedge, goldenrod, w. grass, deer-tongue, Kr. lespedeza, K. 31 t. fescue

Vegetation of adjacent areas s. lespedeza, sh. sumac, goldenrod, blackberry, w. strawberry, ironweed, dewberry, r. maple to 15', n.r. oak to 35', sycamore to 20', A. beech to 70', sh. pine to 25'
THESIS PLOT DATA

Plant name, common  scotch pine

Plant name, scientific  *Pinus sylvestris*

Mine no.  0095 - A  Site recon. no.  1223

State: Ky.  County:  Harlan  Subwatershed:  Crummies

Coal seam name  Darby  Approx. elevation MSL  2000

Last known mining disturbance  1966

Plot aspect  north  Plot slope in degrees  33

Plot size  80' x 30'

Original planting date  3/27/78

Seedlings at time of planting:  size  6 - 12”  age in years  2

Approximate spacing  6' x 6'

Original number of plants within plot  55

Number of plants living at  11/1/78  was  55  =  100  %

Spoil pH from lab test:  water  5.1  buffer  6.0

Plot location  highwall

Spoil color  light - medium brown

Rock fragments  many to 24” D.

Parent material of surface spoil  shale and sandstone

Degree of erosion  severe, extensive sheet erosion plus several small
gullies to 1' deep & 3' wide

Existing vegetation:  % cover  25  description  g. moss is majority,
blackberry, c. fern, l f. dogwood to 7', l n.r. oak to 10'

Vegetation of adjacent areas  K. 31 t. fescue, cattails, t. sedge,
s. lespedeza, c. fern, blackberry, pokeberry, n.r. oak to 65', t. poplar
to 75', w. ash to 60', sassafras to 30'
THESIS PLOT DATA

Plant name, common scotch pine

Plant name, scientific Pinus sylvestris

Mine no. 0095 - A Site recon. no. 1223

State: Ky. County: Harlan Subwatershed: Crummies

Coal seam name Darby Approx. elevation MSL 2000

Last known mining disturbance 1966

Plot aspect northwest Plot slope in degrees 34

Plot size 100' x 15'

Original planting date 3/27/78

Seedlings at time of planting: size 6 - 12" age in years 2

Approximate spacing 6' x 6'

Original number of plants within plot 34

Number of plants living at 11/1/78 was 34 = 100 %

Spoil pH from lab test: water 5.3 buffer 6.4

Plot location lower edge of highwall

Spoil color light brown

Rock fragments many to 12" D. (many eroded from above)

Parent material of surface spoil shale and sandstone

Degree of erosion severe; much sheet erosion; several gullies to 18"

deep & 5' wide

Existing vegetation: % cover 10 description blackberry, ironweed,
K. 31 t. fescue

Vegetation of adjacent areas K. 31 t. fescue, blackberry, ironweed, A.

beech to 90', t. poplar to 70', w. ash to 70', b. gum to 60', f. dogwood
to 6', r. maple to 10', r. paulownia to 45', sg. hickory to 55'
**THESIS PLOT DATA**

- **Plant name, common**: Virginia pine
- **Plant name, scientific**: *Pinus virginiana*
- **Mine no.**: 0098 - A  **Site recon. no.**: 667
- **State**: Ky.  **County**: Clay  **Subwatershed**: Goose Creek
- **Coal seam name**: Horse Creek  **Approx. elevation MSL**: 950 - 1150
- **Last known mining disturbance**: 1955 - 1962
- **Plot aspect**: southeast  **Plot slope in degrees**: 19
- **Plot size**: 55' x 45'
- **Original planting date**: 5/19/78
- **Seedlings at time of planting**: size 6 - 12"  **age in years**: 1
- **Approximate spacing**: 6' x 6'
- **Original number of plants within plot**: 101
- **Number of plants living at**: 10/25/78  **was**: 76  **=**: 75
- **Spoil pH from lab test**: water 5.4  buffer 6.4
- **Plot location**: on slope adjacent to highwall
- **Spoil color**: light brown
- **Rock fragments**: many to 12" D.
- **Parent material of surface spoil**: shale majority
- **Degree of erosion**: severe; much sheet erosion leaving very rocky surface; several small gullies to 1' deep
- **Existing vegetation**: % cover 30  description w. grass is majority, kr. lespedeza, blackberry, broomedge, V. pine to 4'
- **Vegetation of adjacent areas**: broomedge, ironweed, blackberry, t. sedge, g. brier, s. lespedeza, st. sumac to 10', sycamore to 35', n.r. oak to 50', E. r. cedar to 8', f. dogwood to 10', n. alder, r. maple to 10', A. holly to 6', pt. oak to 30', tree of heaven to 25'
THESIS PLOT DATA

Plant name, common          autumn olive
Plant name, scientific       Elaeagnus umbellata
Mine no.                  0104 - A    Site recon. no.        759
State: Ky.  County: Clay    Subwatershed: Little Goose
Coal seam name Horse Creek  Approx. elevation MSL  1100 - 1150
Last known mining disturbance                  1955 - 1962
Plot aspect northeast    Plot slope in degrees  0 - 2
Plot size                  60' x 30'
Original planting date       5/12/78
Seedlings at time of planting: size 6 - 12" age in years 1
Approximate spacing          4' x 4'
Original number of plants within plot            70
Number of plants living at 8/25/78 was 67 = 95 %
Spoil pH from lab test: water 3.8    buffer 5.1
Plot location     top of berm on fill bench
Spoil color                light brown
Rock fragments many small fragments 1" - 12" D., mostly coal
Parent material of surface spoil    shale majority, some sandstone
Degree of erosion very little; no gullying but some depressions caused by previous erosion and weathering
Existing vegetation: % cover 80 description broomsedge to 3', w. grass is majority, sourwood to 3', t. sedge to 3', ironweed to 2', blackberry to 1'
Vegetation of adjacent areas V. pine and sh. pine to 20', s. lespedeza, b. locust to 8', n.r., w., b. oaks to 70', t. poplar to 30', r. maple to 30', p. hickory to 55'
THESIS PLOT DATA

Plant name, common: autumn olive

Plant name, scientific: Elaeagnus umbellata

Mine no.: 0104 - A  Site recon. no.: 759

State: Ky.  County: Clay  Subwatershed: Little Goose

Coal seam name: Horse Creek  Approx. elevation MSL: 1100 - 1150

Last known mining disturbance: 1955 - 1962

Plot aspect: southeast  Plot slope in degrees: 2

Plot size: 90' x 35'

Original planting date: 5/12/78

Seedlings at time of planting: size: 6 - 12"  age in years: 1

Approximate spacing: 5' x 5'

Original number of plants within plot: 130

Number of plants living at 8/25/78 was 68 = 52 %

Spoil pH from lab test: water 3.7  buffer 4.4

Plot location: top of berm on fill bench

Spoil color: mixed; light brown to medium gray

Rock fragments: many, from 1 - 6" D., mostly shale and coal fragments

Parent material of surface spoil: shale majority

Degree of erosion: slight; 1 gully runs through plot to 6" deep and 3' wide

Existing vegetation: % cover 15  description: V. pine to 10', broomsedge to 2'

Vegetation of adjacent areas: b. locust to 15', t. poplar to 70', e. redbud to 6', sycamore to 35', ironweed to 4', t. sedge to 5', goldenrod to 3', blackberry to 3', s. lespedeza to 3', V. pine to 30', p. hickory to 45', n.r. oak to 40'
**THESIS PLOT DATA**

<table>
<thead>
<tr>
<th>Plant name, common</th>
<th>black locust</th>
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<tr>
<td>Plant name, scientific</td>
<td>Robinia pseudoacacia</td>
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<tr>
<td>Mine no.</td>
<td>0104 - A</td>
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<td>Site recon. no.</td>
<td>759</td>
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<td>State: Ky. County: Clay Subwatershed: Little Goose</td>
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<td>Coal seam name</td>
<td>Horse Creek</td>
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<td>Approx. elevation MSL</td>
<td>1100 - 1150</td>
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<td>Last known mining disturbance</td>
<td>1955 - 1962</td>
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<tr>
<td>Plot aspect</td>
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<td>Plot slope in degrees</td>
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<td>Plot size</td>
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<tr>
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<td>8 - 16&quot;</td>
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<tr>
<td>age in years</td>
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<td>Approximate spacing</td>
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<td>Original number of plants within plot</td>
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<td>Number of plants living at</td>
<td>8/25/78</td>
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<tr>
<td>was</td>
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</tr>
<tr>
<td>%</td>
<td>50</td>
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<tr>
<td>Spoil pH from lab test: water</td>
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<td>buffer</td>
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<td>Plot location</td>
<td>outslope</td>
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<tr>
<td>Spoil color</td>
<td>variable; light brown to light gray</td>
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<td>Rock fragments</td>
<td>many from 1&quot; D. - 6' D. sandstone and shale</td>
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<tr>
<td>Parent material of surface spoil</td>
<td>sandstone and shale</td>
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<tr>
<td>Degree of erosion</td>
<td>severely eroded; deeply gullied; gullies range from 18&quot; - 6' deep and 3' - 12' wide</td>
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<tr>
<td>Existing vegetation: % cover</td>
<td>0</td>
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<td>description</td>
<td>none (extremely hot and rocky)</td>
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<tr>
<td>Vegetation of adjacent areas</td>
<td>w. oak to 30', sycamore to 45', t. poplar to 35', b. locust to 8', sh. pine to 20', V. pine to 10', pokeberry to 4', sourwood to 7', s. birch to 15'</td>
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<tr>
<td><strong>THESIS PLOT DATA</strong></td>
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<td>----------------------</td>
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<tr>
<td>Plant name, common</td>
<td>Virginia pine</td>
</tr>
<tr>
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<td>Pinus virginiana</td>
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<tr>
<td>State:</td>
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<td>Coal seam name</td>
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<td>Approx. elevation MSL</td>
<td>1100 - 1150</td>
</tr>
<tr>
<td>Last known mining disturbance</td>
<td>1955 - 1962</td>
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<td>Plot aspect</td>
<td>east</td>
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<tr>
<td>Plot slope in degrees</td>
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<td>Plot size</td>
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<tr>
<td>Original planting date</td>
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<tr>
<td>Seedlings at time of planting:</td>
<td>size 6 - 12'' age in years 1</td>
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<tr>
<td>Approximate spacing</td>
<td>6' x 6'</td>
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<tr>
<td>Original number of plants within plot</td>
<td>104</td>
</tr>
<tr>
<td>Number of plants living at 8/25/78 was 27 = 25 %</td>
<td></td>
</tr>
<tr>
<td>Spoil pH from lab test:</td>
<td>water 3.8 buffer 5.1</td>
</tr>
<tr>
<td>Plot location</td>
<td>Water, berm on fill bench</td>
</tr>
<tr>
<td>Spoil color</td>
<td>Medium gray</td>
</tr>
<tr>
<td>Rock fragments</td>
<td>Many small fragments 1 - 5'' D.; no large ones</td>
</tr>
<tr>
<td>Parent material of surface spoil</td>
<td>Shale majority</td>
</tr>
<tr>
<td>Degree of erosion</td>
<td>Very slight; plot bordered on one end by gully which drains back onto bench</td>
</tr>
<tr>
<td>Existing vegetation:</td>
<td>% cover 25 description majority is V. pine to 10', deerontgue to 1', broomsedge to 3', w. grass</td>
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<tr>
<td>Vegetation of adjacent areas t. poplar to 45', sycamore to 30', sh. &amp; V. pine to 30', st. sumac to 5', goldenrod to 4', ironweed to 5', t. sedge to 4', deerontgue to 2', b. locust to 6', w. oak to 60', n.r. oak to 60', r. maple to 25', b. gum to 8', p. hickory to 60'</td>
<td></td>
</tr>
</tbody>
</table>
THESIS PLOT DATA

Plant name, common Virginia pine

Plant name, scientific Pinus virginiana

Mine no. 0104 - A Site recon. no. 759

State: Ky. County: Clay Subwatershed: Little Goose

Coal seam name Horse Creek Approx. elevation MSL 1100 - 1150

Last known mining disturbance 1955 - 1962

Plot aspect east Plot slope in degrees 30

Plot size 60' x 50'

Original planting date 5/12/78

Seedlings at time of planting: size 6 - 12" age in years 1

Approximate spacing 4' x 4'

Original number of plants within plot 100

Number of plants living at 8/25/78 was 15 = 15 %

Spoil pH from lab test: water 3.6 buffer . 5.2

Plot location steep outslope

Spoil color light brown

Rock fragments many small 1 - 3" D. shale fragments

Parent material of surface spoil shale mostly

Degree of erosion severely gullied across entire plot; gullies from 3 - 6' deep and 2 - 8' wide

Existing vegetation: % cover 0 - 5 description t. sedge to 3', blackberry to 2', sourwood to 5', l s. birch to 10'

Vegetation of adjacent areas sourwood to 10', w. oak to 30', sycamore to 35', t. poplar to 25', sh. pine to 10', n.r. oak to 45', b. locust to 10', ironweed to 5'
THESIS PLOT DATA

Plant name, common Virginia pine
Plant name, scientific Pinus Virginiana
Mine no. 0037 - A Site recon. no. 695
State: Ky. County: Clay Subwatershed: Gray's Fork
Coal seam name Horse Creek Approx. elevation MSL 1100 - 1150
Last known mining disturbance 1955 - 1962
Plot aspect south Plot slope in degrees 4
Plot size 60' x 45'
Original planting date 4/14/78
Seedlings at time of planting: size 6 - 12" age in years 1
Approximate spacing 6' x 6'
Original number of plants within plot 60
Number of plants living at 8/10/78 was 58 = 96 %
Spoil pH from lab test: water 3.6 buffer 4.9
Plot location fill bench
Spoil color light gray
Rock fragments few between 1" and 4" D. (sandstone)
Parent material of surface spoil shale majority
Degree of erosion slight; no gullies in plot

Existing vegetation: % cover 25 description blackberry to 3' and
broomsedge to 3' majority, w. grass, V. pine to 2'

Vegetation of adjacent areas s. oak to 15', V. pine to 20', t. poplar
to 45', m. hickory to 40', w. oak to 40', n.r. oak to 75', blackberry
to 4', s. lespedeza to 3', sassafras to 6'
THESIS PLOT DATA

Plant name, common autumn olive

Plant name, scientific Elaeagnus umbellata

Mine no. 0040 - B Site recon. no. 696

State: Ky. County: Clay Subwatershed: Little Goose

Coal seam name Horse Creek Approx. elevation MSL 1100 - 1150

Last known mining disturbance 1955 - 1962

Plot aspect north Plot slope in degrees 0 - 2

Plot size 50' x 45'

Original planting date 4/6/78

Seedlings at time of planting: size 6 - 12" age in years 1

Approximate spacing 6' x 6'

Original number of plants within plot 60

Number of plants living at 8/10/78 was 17 = 28 %

Spoil pH from lab test: water 3.6 buffer 4.9

Plot location bench

Spoil color light gray

Rock fragments several to 4" D.; most less than 1" D.

Parent material of surface spoil shale; spoil very shallow

Degree of erosion very slight; no gullies

Existing vegetation: % cover 0 - 5 description w. grass

Vegetation of adjacent areas sh. pine and V. pine to 15' high, daertongue to 1', goldenrod to 2', sh. sumac to 5', ironweed to 6', c. thistle to 4', sourwood to 15', sassafras to 10', w. and n.r. oak to 40', t. poplar to 25'
THESIS PLOT DATA

Plant name, common __________________ white pine

Plant name, scientific ___________________ Pinus strobus

Mine no. _______ 0049 - A _______ Site recon. no. _______ 1214

State: Ky. County: Harlan Subwatershed: Cranks Creek

Coal seam name __________ Creech _______ Approx. elevation MSL _______ 1900

Last known mining disturbance ___________________ 1964

Plot aspect ___________ south _______ Plot slope in degrees _______ 13

Plot size _______ 120' x 30'

Original planting date _______ 4/7/78

Seedlings at time of planting: size ___________ 6 - 12" _______ age in years _______ 2

Approximate spacing _______ 6' x 6'

Original number of plants within plot _______ 160

Number of plants living at 11/1/78 was _______ 143 _______ = _______ 89 _______ %

Spoil pH from lab test: water _______ 5.3 _______ buffer _______ 6.1

Plot location _______ lower edge of highwall

Spoil color _______ light brown & light gray

Rock fragments _______ many to 36" D.; larger fragments are sandstone

Parent material of surface spoil _______ shale and sandstone

Degree of erosion _______ slight; only shallow surface erosion has occurred; no gullies present

Existing vegetation: % cover _______ 70 _______ description w. lovegrass, K. 31 t. fescue, kb. lespezea

Vegetation of adjacent areas _______ pokeberry, w. lovegrass, K. 31 t. fescue, blackberry, w. oak to 25', u.r. oak to 50', t. poplar to 80', s. maple to 15', w. ash to 30', m. hickory to 30', sg. hickory to 60', b. cherry to 45', b. locust to 40', A. beech to 40', r. paulownia to 65', w. grape
THESIS PLOT DATA

Plant name, common

Plant name, scientific

Mine no. 0049 - A Site recon. no. 1214

State: Ky. County: Harlan Subwatershed: Cranks Creek

Coal seam name Creech Approx. elevation MSL 1900

Last known mining disturbance 1954

Plot aspect south Plot slope in degrees 35

Plot size 75' x 25'

Original planting date 4/7/78

Seedlings at time of planting: size 6 - 12" age in years 2

Approximate spacing 8' x 8'

Original number of plants within plot 93

Number of plants living at 11/1/78 was 86 = 92 %

Spoil pH from lab test: water 4.9 buffer 6.1

Plot location highwall

Spoil color tan - light brown

Rock fragments many to 36" D.

Parent material of surface spoil shale majority

Degree of erosion severe; several small gullies to 6" deep; much material on surface has eroded from above

Existing vegetation: % cover 30 description K. 31 t. fescue, broomsedge to 3', 1 tree of heaven to 7', 1 t. sedge, 1 pokeberry

Vegetation of adjacent areas broomsedge, K. 31 t. fescue, t. sedge, goldenrod, p. grass, E. r. cedar, l. pine to 40', r. paulownia to 25', tree of heaven to 30', b. locust to 35', A. elm to 10', t. poplar to 60', m. hickory to 60'
THESIS PLOT DATA

Plant name, common: autumn olive

Plant name, scientific: Elaeagnus umbellata

Mine no.: 0104 - A
Site recon. no.: 759

State: Ky., County: Clay
Subwatershed: Little Goose

Coal seam name: Horse Creek
Approx. elevation MSL: 1100 - 1150

Last known mining disturbance: 1955 - 1962

Plot aspect: south
Plot slope in degrees: 0 - 5

Plot size: 85' x 35'

Original planting date: 5/12/78

Seedlings at time of planting: size 6 - 12" age in years 1

Approximate spacing: 4' x 4'

Original number of plants within plot: 211

Number of plants living at 8/10/78 was 74 = 35 %

Spoil pH from lab test: water 4.1 buffer 5.4

Plot location: top of fill bench berm

Spoil color: medium gray

Rock fragments: few from 1 - 6" D.

Parent material of surface spoil: shale, well weathered

Degree of erosion: moderate; several small gullies eroding near ends of plot to 18" deep and 6' wide

Existing vegetation: % cover 0 - 5 description s. sorrel to 3", w. grass is majority, 2 b. locust to 3' high, 1 deertongue clump to 1'

Vegetation of adjacent areas: b. gum to 5', b. locust to 10', sh. and l. pines to 35', sycamore to 15', t. poplar to 15', b. oak to 45', m. hickory to 70'
THESIS PLOT DATA

Plant name, common European black alder

Plant name, scientific Alnus glutinosa

Mine no. 0104 - A Site recon. no. 759

State: Ky. County: Clay Subwatershed: Little Goose

Coal seam name Horse Creek Approx. elevation MSL 1100 - 1150

Last known mining disturbance 1955 - 1962

Plot aspect south Plot slope in degrees 0 - 5

Plot size 115' x 20'

Original planting date 5/12/78

Seedlings at time of planting: size 6 - 12" age in years 1

Approximate spacing 5' x 5'

Original number of plants within plot 122

Number of plants living at 8/10/78 was 111 = 90 %

Spoil pH from lab test: water 4.2 buffer 5.2

Plot location bench

Spoil color medium gray

Rock fragments few black fragments 1 - 4" D.

Parent material of surface spoil shale, eroded from highwall and berm

Degree of erosion slight active gullying through center of bench where water drains

Existing vegetation: % cover 25 description mostly o. grass to 2' high in clumps, 1 sh. pine to 4', 1 b. gum

Vegetation of adjacent areas b. gum to 5', b. locust to 10', sh. and l. pines to 35', sycamore to 15', t. poplar to 15', b. oak to 45', m. hickory to 70'
WOODY PLANT SEEDLING SURVIVAL AS RELATED TO SITE CONDITIONS ON SOUTHEASTERN KENTUCKY ORPHAN LANDS

by

LARRY JOE LEACH

B.S. in Agriculture
University of Kentucky, 1971

AN ABSTRACT OF A MASTER'S THESIS

submitted in partial fulfillment of the requirements for the degree

MASTER OF LANDSCAPE ARCHITECTURE

Department of Landscape Architecture

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1980
ABSTRACT

Field research was conducted over a seventeen month period in 1977 and 1978 to collect site condition data on southeastern Kentucky orphan mines that had only partially revegetated twelve to twenty-four years after mining. The mines studied had been planted with woody plant seedlings under a Tennessee Valley Authority funded demonstration project. They were located on the Lily coal seam in Laurel County, the Horse Creek coal seam in Clay County, the Creech and the Darby coal seams in Harlan County.


Seedling survival showed considerable variation. Average survival for species with three or more test plots showed European black alder most successful, at 92%; shortleaf pine next, at 85%; black locust, 79%; Virginia pine, 73%; loblolly pine, 66%; autumn olive, 61%.

Research data showed that water pH was the most reliable predictor of seedling survival, of those site conditions measured and considered alone. Buffer pH was the next most reliable predictor, followed by the percentage of existing plant cover found on the plot.
Spoil color was found to be less reliable as were the individual plant invaders. Aspect, plot position on the mine, slope, degree of erosion, and occurrence of rock fragments were found to be unreliable predictors of seedling survival.

Relationships between the site conditions and seedling survival were individually analyzed, except for bicolor lespedeza, Chinese chestnut, Scotch pine, tulip poplar, and white pine, which did not have large enough data samples. When a 70% seedling survival standard was established, a relative comparison of tolerance to all site conditions was obtained. This comparison rated shortleaf pine, at 100, as the best plant species used; European black alder, 97; black locust, 81; Virginia pine, 69; loblolly pine, 55; and autumn olive, 29.