REFORESTATION OF MINED LAND FOR PRODUCTIVE LAND USES AND ENVIRONMENTAL QUALITY

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PROGRESS REPORT (2007-2008)

The Powell River Project Forestry Reclamation Approach

Most mined land in the Appalachian Coalfields that was previously forested is now being returned to forests. Forestry is a logical land use because of its traditional economic importance to the region, and because of the many services it provides the public such as flood control, water quality, habitat, carbon sequestration, and aesthetic environments. After the implementation of the SMCRA in 1978, highly-graded mined landscapes covered with agricultural grasses and legumes were common. However, landowners and coal operators are now commonly reclaiming with trees for forestry post-mining land uses. To reclaim mined land with trees, a Forestry Reclamation Approach (FRA) is needed to ensure tree survival and productivity. The approach requires five straightforward steps: (1) select the best soil or mine spoil for trees and apply about 4 feet for the final surface material; (2) grade it lightly or not at all to leave it loose and uncompacted; (3) employ a professional tree planter who guarantees his work; (4) have him plant a mix of commercially valuable native hardwoods (oaks, black cherry, sugar maple, ash, etc., at a rate of 600 trees/acre) along with a lesser amount of wildlife or nurse trees (dogwood, redbud, hawthorn, hickory, crabapple, etc., at a rate of 100 trees/acre); (5) after the trees are planted in winter, hydroseed a tree-compatible ground cover the following spring. More specific recommendations for the FRA can be found in Virginia Cooperative Extension Bulletin 460-123 at http://www.ext.vt.edu/pubs/mines/460-123/460-123.html.

The foundation for the Forestry Reclamation Approach is our ongoing Powell River Project reforestation research program consisting of many forestry research sites in Virginia and adjacent states. The results from these research sites allow us to develop reforestation guidelines for reclaiming mined land, and they allow us to demonstrate the value of reclaimed forests. Because forestry is a long-term enterprise, we maintain and monitor our field sites over time. The older these research sites become, the more valuable they are, because they show how reclamation treatments will ultimately affect the success and value of the restored forest. As we collect data from these older sites, we adjust our guidelines and recommendations in ways that will improve reclamation for better long-term forestry land uses.

Research Reports

This year we did research on several steps of the Forestry Reclamation Approach. Herbaceous ground covers used for erosion control can be very competitive and detrimental to tree survival and growth. This was demonstrated in a six-year study that showed that native hardwoods can grow at three times the rate when ground cover is reduced to 60 to 80% while still controlling erosion. We summarized the results of this and other long-term studies in a Powell River Project Virginia Cooperative Extension Publication that is currently available from the Powell River Project website: http://www.ext.vt.edu/pubs/mines/460-124/460-124.html

Another major mined land reforestation research effort this year was determining the reforestation potential of bond released compacted mined land. Many lands reclaimed since the passage of the Surface Mining Control and Reclamation Act of 1977 (SMCRA) have dense ground covers and compacted soil materials, in some cases associated with unfavorable soil chemical properties. To address these concerns, three previously reclaimed mined sites were located in Ohio, Virginia, and West Virginia. At each site, eastern white pine, hybrid poplar, and mixed Appalachian hardwoods were planted at three levels of silvicultural intensity (weed control only, weed control with subsoil ripping, and weed control with subsoil ripping and fertilization). Each combination of species and treatment was repeated three times in each of the three states. All species achieved their highest biomass values for this study on the West Virginia shale-based spoils and their highest survival rates on the Virginia sandstone-dominated spoils. When restoring forest vegetation to previously reclaimed mine sites with unfavorable soil and vegetation properties, the use of weed control and subsoil ripping, with or without fertilization, greatly improves survival and growth.

The full paper presenting the results of this work is attached to this report.

Ongoing Research Activities

Our ongoing Powell River Project reforestation research program is dedicated to: (1) helping coal operators meet their reclamation requirements; (2) helping landowners maximize the value of their reclaimed mined land; and (3) helping mining communities meet their socio-economic needs. The following studies are being conducted to meet these goals:

1. Use of herbicides for weed control to improve native hardwood establishment.

- This PRP project is in its seventh growing season. The results after three years were published this year in the proceedings of the American Society for Mining and Reclamation.

Burger, J. A., D. O. Mitchem, C. E. Zipper, and R. Williams. 2008. Hardwood reforestation for Phase III bond release: Need for reduced ground cover. In: R. I. Barnhisel (ed.). Proc., 25th Mtg., Amer. Soc. for Mining and Reclamation. July 14-19, 2008, Richmond, VA. ASMR, 3234 Montavesta Rd., Lexington, KY.

2. Hardwood establishment field trials:

- This is a large study with 10 three-acre sites located in three states. We completed tree, ground cover, and site measurements for eight continuous years. A preliminary analysis of this project was presented and published at the annual meeting of the American Society of Mining and Reclamation in Breckenridge, Colorado, in June, 2005. A final report will be completed winter, 2009.

Auch, W. T., J. A. Burger, and D. O. Mitchem. 2005. Hardwood stocking after five years on reclaimed mined land in the Central Appalachians. In: R. I. Barnhisel (ed.). Proc., 22nd Mtg., Amer. Soc. for Mining and Reclamation. June 18-24, 2005, Breckenridge, CO. ASMR, 3234 Montavesta Rd., Lexington, KY.

3. White oak response to different mine soil types:

- We continue to monitor an 80-acre native hardwood planting on Rapoca Coal Company land. This cooperative effort between Rapoca, Virginia Tech, and the Virginia DMME serves as a model for the application of Powell River Project reforestation guidelines.

We recently completed a study of white oak response to mine soil types on this field site. The results of this work were published in Spring, 2007.

Showalter, J. M., J. A. Burger, C. E. Zipper, J. M. Galbraith, and P. F. Donovan. 2007. Influence of mine soil properties on white oak seedling growth: A proposed mine soil classification model. *Southern Journal of Applied Forestry* 31(2):99-107.

4. Reforestation and carbon sequestration by forests and soils on mined land:

- This project was funded by the Appalachian Regional Commission, Virginia Department of Mines, Minerals and Energy, The Nature Conservancy, the U.S. Department of Energy, and the Powell River Project. The project is directed toward reforestation of compacted mined land reclaimed prior to the implementation of the Forestry Reclamation Approach. It compares survival and growth of three forest types (hybrid poplar plantations, white pine plantations, and mixed native hardwoods) growing on mined land subjected to forest practices (weed control, tillage, and fertilization). This 3x3 factorial experiment is replicated three times in each of three states (Virginia, West Virginia, and Ohio). As part of the requirements for an undergraduate research project, fourth-year survival and growth was measured and presented by Chris Fields-Johnson, a forestry senior, at the annual meeting of the American Society for Mining and Reclamation in June, 2008 (Chris received a best paper award for his presentation). His published paper is attached to this progress report.

- The second objective of this study is to measure the potential of restored forests to sequester large amounts of atmospheric carbon, which is associated with the greenhouse effect and climate change. Much of the elevated level of CO_2 in the atmosphere is attributed to land use change and the burning of coal and other fossil fuels. This project will help determine the benefits of reforesting mined land for sequestering carbon from the atmosphere. Beyhan Amichev recently completed his Ph.D. dissertation in 2007 and published one of his papers in the journal *Forest Ecology and Management*.

Amichev, Beyhan Y. 2007. Biogeochemistry of carbon on disturbed forest landscapes. Ph.D. Dissertation. Virginia Polytechnic Institute and State University. 371 p.

Amichev, B., J. A. Burger, and J. A. Rodrigue. 2008. Carbon sequestration empirical models for forests and soils on mined lands in the eastern U. S. coalfields. *Forest Ecology and Management*. In press.

5. Establishing hardwood forests with American chestnut using the Forestry Reclamation Approach: Effects of grading practices and ground cover:

- This project compares the relative success of reforestation established using three different types of ground covers on both compacted and uncompacted mined soils. In the winter of 2008, a native hardwood mix was planted across all sites along with 5 varieties of American chestnut hybrids. This project will demonstrate the benefits of using the Forestry Reclamation Approach, and it will test the viability of American chestnut hybrids as a species component in reclaimed native forests. This research trial was established with the cooperation of Red River Coal Co. (two study sites) and Paramont Coal Co. (one study site). It was funded by an OSM Applied Science Grant and the Powell River Project.

6. Bioenergy feedstock production potentials of reclaimed coal mines:

- This project was installed with co-PI Carl Zipper in winter 2008 on three sites in Virginia. The purpose of this project is to determine the feasibility of using otherwise unproductive, reclaimed mined land for feedstock production for raw materials for conversion to biobased fuels and biobased products. We will determine the response of hybrid poplar planted on mined land of different quality to a range of silvicultural treatments, including weed control, tillage, and fertilization; determine biomass production and optimum harvest cycles of short rotation woody trees, including hybrid poplar, tulip poplar, and black locust; and we will conduct an economic analysis of the biomass system to both optimize the silvicutural system and provide feedstock costs to make comparisons with other current energy sources. The project was funded by Alpha Natural Resources.

Outreach Activities

We conducted a tour of forestry research sites during the Powell River Project field day in September, 2007, and supported Arbor Day events conducted by DMME.

Two Extension Bulletins on forestry topics were published:

Burger, J. A., C. E. Zipper, and J. Skousen. 2008. Establishing ground cover for forestry post-mining land uses. Virginia Cooperative Extension Bull. 460-124.

Zipper, C. E., and J. A. Burger. 2008. Coal-resource contracting terms for productive postmining forests. Virginia Cooperative Extension Bull. 460-143.

We participated in the 2nd Annual Appalachian Regional Reforestation Conference in Logan, West Virginia, August 4-6, 2008, and made the following presentations at the conference:

Zipper, C. E. "Overview of ARRI-Forestry Reclamation Approach advisory update."

Burger, J. A. "Forestry Reclamation Approach Step 2: Grading and compaction."

What Are the Benefits of This Reforestation Research?

Our work has provided the foundation for the Forestry Reclamation Approach used by many coal operators in Virginia and adjacent states. It is currently being promoted by the Office of Surface Mining's Appalachian Regional Reforestation Initiative. Economic analyses have shown that the return on mined land reclaimed according to guidelines based on PRP research can be several times higher than on land currently reclaimed to unmanaged land uses. While improving the value of mined land for the landowner, coal operators benefit through more timely and successful recovery of performance bonds, and local communities benefit from land reclamation that improves water quality, reduces flooding potential, is more aesthetically pleasing, and is more valuable for a diversifying economy.