Reforestation and Biomass Production on Coal-Mined Lands: Research Application, Technology Transfer, Improving the Process

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Powell River Project 2011-2012 Progress Report

The Powell River Project mined land reforestation research and outreach program has developed prescriptions for re-establishing hardwood forests through reclamation that are being applied by many coal-mining firms to satisfy SMCRA standards. This is a major change in mining practices that applies the results of scientific research to improve environmental outcomes. Despite this change, additional research needs remain. Unanswered questions concern soil development and long-term productivity of post-mining forests, nutrition (e.g. N and P) in mine soils and effects on long-term productivity, forest restoration effects on surface hydrology, and similar issues.

This project conducted activities intended to aid continued improvement of forest restoration by the coal industry, maintenance and monitoring of long-term experiments including woody biomass plantings, and technology transfer that communicates the "how to" of forest restoration to the coal industry and agencies.

Accomplishments during the 2011-2012 Fiscal Year:

Taggart Bench Herbicide Trail

A primary demonstration of the Forestry Reclamation Approach at Powell River Project Research and Education Center is the hardwood planting that was established on about 10 acres at the base of the Red River Coal mining operation (Burger et al. 2008). This is a primary demonstration of the FRA's capability to restore native hardwoods on coal mines, and many visitor groups are taken to this area. The site was planted in spring, 2002, and completed its 10th year of growth in 2011.

This reforestation study was measured by Daniel Evans and graduate student Sean Allen in September of 2011. The project addresses reforestation of native hardwoods on mine spoils using herbicide treatments to control competing vegetation. Data are being analyzed by Mr. Allen for his master's thesis project under the direction of Brian Strahm.

Chestnut 1

Genetically improved American Chestnuts were planted in early 2008 on reforestation research plots used by Mr. Chris Fields-Johnson for his M.S. degree research. These trees were planted over 9 acres reclaimed by Red River Coal and by Paramont Coal using low-

compaction grading techniques and different herbaceous seeding treatments. Second-year results were published by Fields-Johnson et al. (2012).

Trees were tallied and measured in September of 2011 after four years of growth. Tree tubes were removed from trees and each tree was tagged using pre-stamped aluminum tags for future tree and plot identification. The tags were placed in numerical order in each treatment plot and were tied around the remaining rebar post from the tree tube. Each tree was also flagged for easier relocation at future measurement periods. These data, including tree ID numbers, were provided to C. Zipper for archiving.

Chestnut 2

This trial was installed at 4 locations on Powell River Project and Red River Coal mining operations in early 2009. First-year results were published by Fields-Johnson et al. (2009). The trial is addressing growth and survival of hybrid chestnut trees planted as seedlings or nuts on recently mined lands; it was measured in November of 2011. Each tree was flagged for easier relocation at future measurement periods. Tree tubes were left in place, but should be removed at future measurement periods to avoid damage to trees as they grow. This project data was provided to Carl Zipper for archiving.

Biomass

Under-utilized, previously mined lands may be used to produce woody biomass materials for energy production and C sequestration. Past research trials have shown that tree growth on mined lands can be highly productive if suitable reclamation practices are used. This study tests the productivity of woody biomass plantations on previously mined lands after ripping to reduce soil compaction, using four species and two planting densities. Species being tested are black locust, hybrid poplar, American sycamore, and northern red oak interplanted with eastern cottonwood. The experiment was established at three locations (Evans et al. 2010). Third-year results were published by Zipper et al. (2011).

This intensive biomass plantation trial on past-mined lands was measured after its fourth year of growth by Dan Evans and graduate student Maura Leveroos in March 2012. The boundary for each measurement plot was flagged and trees were measured for height and ground line diameter. The data were provided to Maura Leveroos for analysis in her master's thesis project being conducted under the direction of Dr. Jay Sullivan. Maura Leveroos will return after the 2012 growing season to re-measure the trial.

Black Locust

Biomass production on mined lands may become an economically viable method for producing relatively carbon neutral fuel stock for energy production or for carbon sequestration. Previous research trials at the Powell River Project (Wise, VA) have indicated that black locust (*Robinia pseudoacacia*) is a species of interest for production of biomass on mined lands, because of its high planting success, rapid growth, and relatively dense wood compared to other more commonly grown biomass species such as hybrid poplar (*Populus trichocarpa* L. x *Populus deltoides*).

Black locust's generally poor stem form is a disadvantage when using it for biomass production. In open growing conditions it can grow multiple stems and could be more costly to harvest or transport compared to single stem trees. This study is intended to test if improved stem form can be achieved through nursery selection. Treatments include black locust

seedlings that were culturally selected from parents with superior stem form vs. standard seedlings. We also included an additional fertilizer treatment on half of each of these seedling types to test for limitations due to soil quality.

This trial addressing growth and survival of black locust, with tree nursery based cultural selection treatments for improved stem form, was measured in March 2012. Each tree was measured for height and ground line diameter and was flagged to aid in finding trees during future visits. The data were provided to Carl Zipper for archiving.

Flint Gap

This trial addressing restoration of past-mined lands using brush removal, deep ripping, fertilization, native hardwood planting, and herbicides on an older mine site was installed by The Nature Conservancy in early 2008. Results after two years were summarized by Burger et al. (2011). Tree stocking, survival, and growth were measured in November of 2011 after four years of growth. The data were compiled and analyzed by Dan Evans and utilized to produce a manuscript that is in review by Ecological Engineering (Evans et al. 2012).

Apogee Coal Trial

During winter of 2011-2012, Apogee Coal (an operating company of Patriot Coal) installed an experimental trial on their mining operations near Yolyn, West Virginia. A separate manuscript has been included in this volume to describe the experiment and preliminary results.

This study addresses effects of herbaceous seeding mixes and surface spoil type on tree growth and survival. An initial measurement of established trees was conducted in June of 2012 by Sara Koropchak with Daniel Evans providing assistance. In July of 2012, Sara Koropchak returned to the site, with assistance provided by Melanie Letalik, and conducted herbaceous vegetation measurements. Three tree plots were monumented with rebar in each treatment plot. At each tree plot, 4 herbaceous plots were also installed and measured. This study was established by Apogee Coal, an operating unit of Patriot Coal.

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Partial List of Outreach Presentations

Burger J.A. Ecosystem Restoration Approach. Appalachian Regional Reforestation Initiative Conference. 2-4 August 2011. Knoxville TN.

Burger J.A., C. Zipper. Mined Land Reforestation. Field Program at Powell River Project Research and Education Center. 9/2011 prior to Powell River Project Leadership Dinner.

Burger J.A., C. Zipper, B. Strahm, S. Allen. Mined Land Reforestation. Field Program at Powell River Project Research and Education Center. 5/2012, for Appalachian Regional Reforestation Initiative Annual Conference.

Burger J.A., C. Zipper, P. Angel, D. Evans, S. Eggerud. 2011. Reforestation guidelines for unused surface mined lands: Development, application, and adoption. Appalachian Regional Reforestation Initiative Conference. 23 May 2012. Big Stone Gap, VA.

Zipper C.E., C.W. Fields-Johnson, J.A. Burger, Daniel M. Evans. 2012. Forest Restoration after Surface Coal Mining: Reclamation Seeding Effects. Appalachian Regional Reforestation Initiative Conference. 23 May 2012. Big Stone Gap, VA.

Zipper, C.E., J.A. Burger. Reforestation of abandoned and mined sites. Erosion and Sedimentation Control Planning and Design Workshop, N.C. Dept. of Environment and Natural Resources. 11/2011, Hickory NC.

Zipper, C.E., J.A. Burger, D. Evans, P. Donovan. Young forest composition and growth after nine years on a reclaimed Appalachian coal mine. Appalachian Regional Reforestation Initiative Annual Conference. Aug. 2-4, Knoxville TN.

Zipper, C.E., J. Burger, D. Evans. 2012. Young forest composition and growth on an Appalachian coal surface mine. Ecological Society of America, Mid-Atlantic Chapter Annual Meeting. April 14 & 15, 2012, Blacksburg.

Publications over the Past Year

Burger, J.A. 2012. Ecosystem Restoration: A Critical Component of Sustainable Mining and Reclamation. P. 72, In: Proceedings, American Society of Mining and Reclamation Annual Meeting. 11-13 June 2012, Tupelo MS.

Evans, D., C. Zipper, J. Burger, B. Strahm. 2012. Reforestation practice for enhancement of ecosystem services on a compacted surface mine: Path toward ecosystem recovery. Ecological Engineering (in review).

Davis, V., J. Burger, R. Rathfon, C. Zipper, C. Miller. 2012. Selecting tree species for reforestation of Appalachian Mined Land. Forest Reclamation Advisory No. 9. Appalachian Regional Reforestation Initiative, US Office of Surface Mining. 6 p.

Fields-Johnson C.W., J.A. Burger, D.M. Evans, C.E. Zipper. 2012. American chestnut establishment techniques on reclaimed Appalachian surface mined lands. Ecological Restoration 30: 99-101.

Fields-Johnson C.W., C.E. Zipper, J.A. Burger, D.M. Evans. 2012. Forest restoration on steep slopes after coal surface mining in Appalachian USA: Soil grading and seeding effects. Forest Ecology and Management 270: 126-134.

Franklin, J.A., C.E. Zipper, J.A. Burger, J.G. Skousen, D.F. Jacobs. 2012. Influence of herbaceous ground cover on forest restoration of eastern US coal surface mines. New Forests DOI 10.1007/s11056-012-9342-8.

Skousen, J.G., C.E. Zipper, J.A. Burger, C. Barton, P. Angel. 2011. Selecting material for soil construction when establishing forest on coal surface mines. Forest Reclamation Advisory No. 8. Appalachian Regional Reforestation Initiative, US Office of Surface Mining. 6 p.

Strahm B.D., J.A. Burger, C.E. Zipper, R.S. Allen, Z.D. Addington. 2012. Groundcover Influences Hardwood Reforestation Success on Reclaimed Appalachian Mined Lands. Abstract, In: Proceedings, American Society of Mining and Reclamation Annual Meeting. 11-13 June 2012, Tupelo MS.

Zipper C.E., J.A. Burger, D.M. Evans, P. Donovan. Young forest composition and growth on a reclaimed Appalachian coal surface mine after nine years. P.557 – 585, in: Proceedings, American Society of Mining and Reclamation Annual Meeting. 11-13 June 2012, Tupelo MS.

Other References:

Burger J., D. Mitchem, C. Zipper, R. Williams. 2008. Native Hardwood Reforestation After Five Years for Phase III Bond Release. p. 192-205, in: Proceedings, National Meeting of the American Society of Mining and Reclamation.

Burger, J., C. Zipper, P. Angel, D. Evans, S. Eggerud. 2011. Reforestation guidelines for unused surface mined lands: Development, application, and adoption. p. 90-112, in: Proceedings, 2011 National Meeting of the American Society of Mining and Reclamation.

Evans, D.M., C.E Zipper, J.A. Burger, C. Fields-Johnson. 2010. Tree species and density effects on woody biomass production on unused mined lands: Establishment and two-year results. p. 276 -291, in: Proceedings, National Meeting of the American Society of Mining and Reclamation.

Zipper, C.E., D.M. Evans, J.A. Burger, C.W. Fields-Johnson, A. Brunner, B. Stanton. 2011. Woody biomass production on post-SMCRA mined lands over three years and comparisons with other studies. p. 768-786, in: Proceedings, 2011 National Meeting of the American Society of Mining and Reclamation.