Forest Composition and Growth After 9 Years on a Virginia Mine Site

C.E. Zipper, J.A. Burger, D.M. Evans, P. Donovan

Departments of
Crop and Soil Environmental Sciences
and Forest Resources and Environmental Conservation

Virginia Tech. Blacksburg VA 24061

The eastern USA's Appalachian region contains abundant coal resources and supports extensive deciduous forests. Appalachia's forests provide ecosystem services, including carbon storage, watershed and water quality protection, and habitat for diverse flora and fauna; and they supply high-quality hardwood timber to the world economy.

Since 2006, some mining firms have been using a reclamation method known as the "Forestry Reclamation Approach" or FRA, for the purpose of restoring native hardwood forests on reclaimed coal mine sites (Burger et al. 2005).

In 2001-2002, a prototype version of the Forestry Reclamation Approach was applied by Rapoca Energy Co. at a mine site in Buchanan County, Virginia. Company personnel worked with the authors to apply Virginia Tech's mine reforestation guidelines (Burger and Zipper 2002) while remining and reclaiming an older mine site. Reclamation grading operations were conducted with the intent of avoiding surface compaction. A tree-compatible groundcover seeding mix was applied, and trees of species native to Appalachian forests were planted. Due to limited spoil availability and prior mining effects, a wide variety of mine soil types and conditions were left on the surface. Most of the site was bounded by unmined forest, providing opportunity for "seeding in" by volunteer species.

Here, we report results of a site assessment conducted in summer and fall 2010, after nine growing seasons. Specific goals are to assess species composition and growth of the young forest, and to evaluate how community composition and tree growth responded to soil and site conditions.

Methods

<u>*General Site Description*</u>

Most of the reclaimed site is comprised of steep slopes that drain into a flat area . The site's eastern area is a ridgeline that also includes some relatively flat areas created by reclamation grading. The site's far eastern edge drains from that ridgeline to the east (Figures 1 and 2).

Spoil types used to construct mine soils varied over the site. Most areas were reclaimed with weathered sandstones, often mixed with unweathered sandstones, siltstones, and shales; in some areas, unweathered rocks were used without being mixed with weathered spoils. Reclamation grading was minimized on slopes, but many near-level areas were compacted by equipment operations. A tree-compatible herbaceous seeding was applied over the site by a hydroseeding contractor (Showalter 2005).

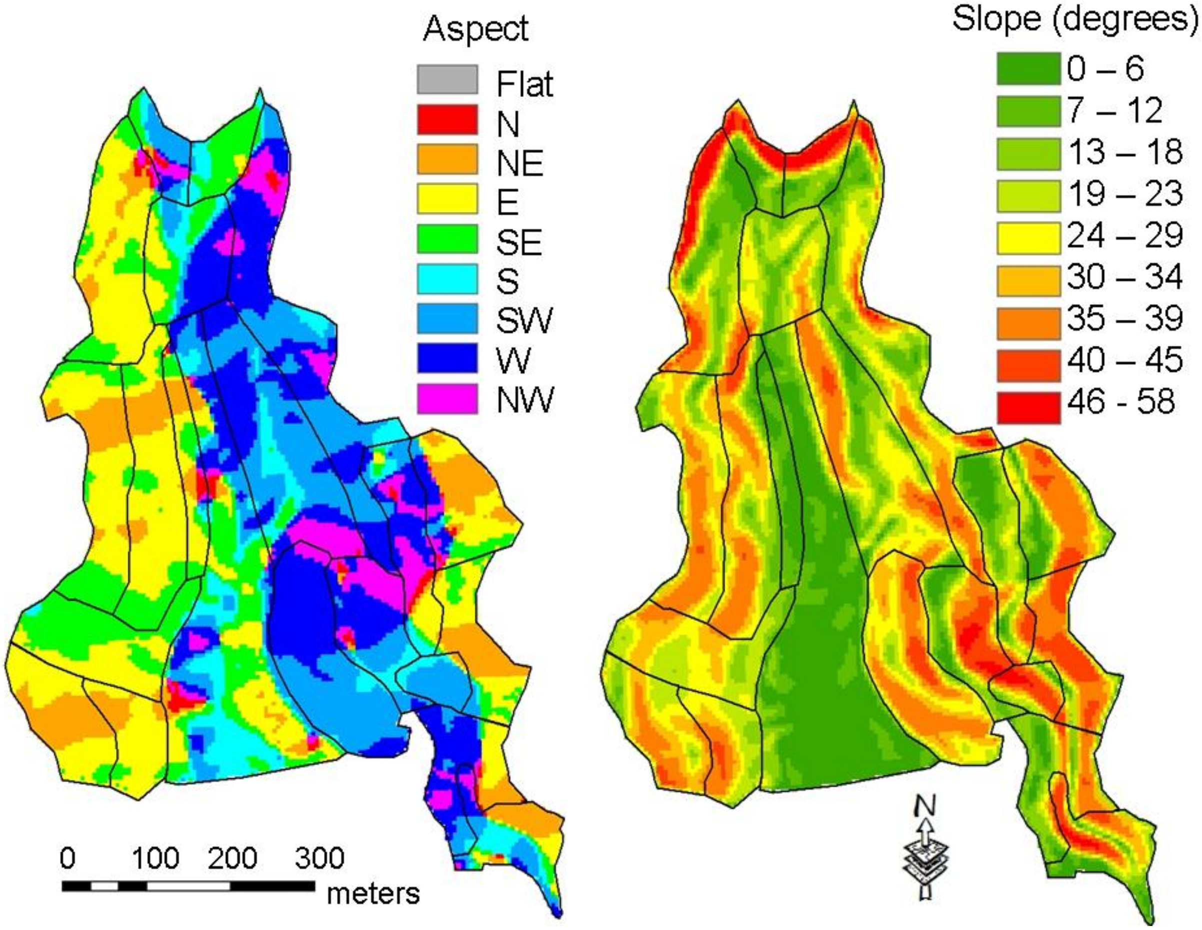

Figure 1. Physiography of the Rapoca Mine Site.

Pre-Reforestation Site Assessment

In late 2001 after reclamation grading, the site was assessed for reforestation potentials. The site was divided into soil mapping units, each of which was judged to have similar characteristics for reforestation (Figure 3), and a mine soil quality classification model (Burger et al. 2002) was applied to characterize each mapping unit. That model included three criteria: rock type, compaction, and aspect (Figure 4). Each three factor was evaluated, classified, and scored on a scale of 1 (best) to 5 (worst), and a weighting factor (WF) was assigned to each criterion to reflect estimated relative importance. Within each mapping unit, soils were evaluated and scored for each of the three criteria; and criteria scores were multiplied by their respective WFs and summed to obtain a soil quality index value. Those values were rounded to integers, as needed to classify each mapping unit as a Soil Site Quality Class, with Class Values ranging from I to V (Table 1; Figure 3 right).

The site was planted in 2002 with native trees and shrubs at a density of 1,792 ha^{-1} using species mixes specified for each soil mapping unit's properties (Table 2, Figure 5).

Figure 2. The mine site viewed from southeast in early 2002 (from Showalter 2005).

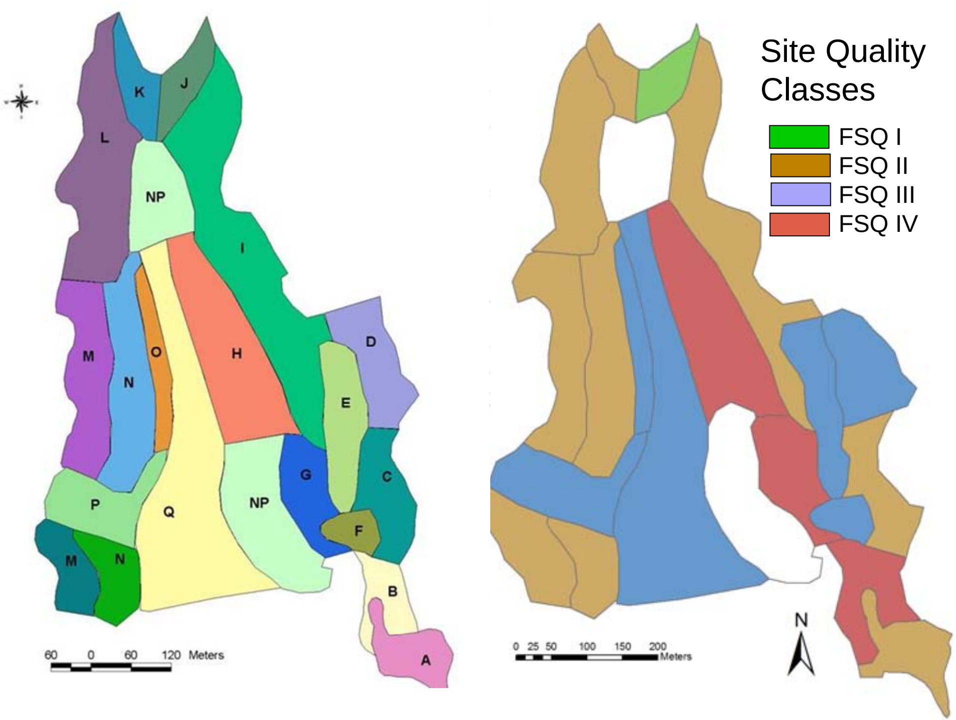

Figure 3. Soil mapping units (left) and forest site quality (right), as determined by applying the site quality classifications (Figure 4) to soil mapping units.

Table 1. Mapping unit areas, characteristics, and site quality ratings and classes.

Mapping Unit	Area (hectares)	Rock Type	Compaction	Aspect	Site Quality Rating	Site Quality Class	Planting Mix
A	1.0	2	2	3	2.2	II	2
B	1.1	4	3	3	3.5	IV	2
C	1.1	3	1	2	2.2	II	1
D	1.3	4	2	2	3	III	1
E	1.2	2	4	3	2.8	III	1
F	0.4	3	2	4	2.9	III	2
G	1.2	4	4	5	4.2	IV	2
H	2.7	5	3	4	4.2	IV	3
I	2.9	1	1	5	1.8	II	2
J	0.6	1	1	2	1.2	I	2
K	0.5	1	1	5	1.8	II	2
L	2.0	3	1	2	2.2	II	3
M	3.0	2	1	1	1.5	II	1
N	2.8	2	1	1	1.5	II	1
O	0.7	4	3	2	3.3	III	4
P	1.6	4	2	1	2.8	III	1
Q	4.8	2	5	3	3	III	4
Total	29.1						
Area-weighted Average		2.7	2.4	2.7	2.6	III	

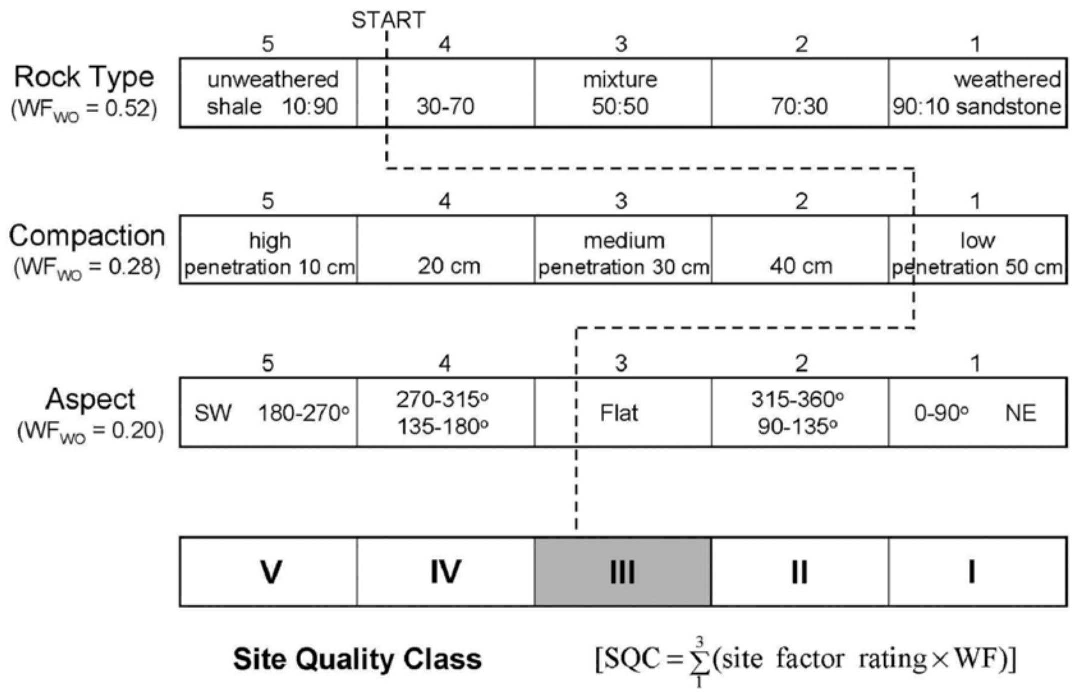

Figure 4. Site factor gradients used to determine site quality classifications (SQCs). Three field mapping criteria -- rock type, level of compaction, and aspect -- are scored, each on a scale of 1 (best to 5 (poor). The SQC score is calculated by multiplying each score by its weighting factor, summing those totals, and rounding that sum to an integer.. The word “start” shows an example culminating in an SQC III. (Figure from Burger et al. 2002).

Table 2. Tree planting mixes prescribed for planting on the four delineated site types

Site Type / Tree Planting Mix	Role	Moist, sandstone 1	Dry, sandstone 2	Siltstone/ Shale 3	Com-pacted 4 †	Total
TREES						
white ash	Crop	371	494	297		395
white oak	Crop	371	494	297		395
sycamore	Crop	-	-	297		65
burr oak	Crop	-	-	297		65
n. red oak	Crop	371	-	-		168
white pine	Nurse	124	124	124		124
chestnut oak	Crop	-	494	-		162
dog wood	Nurse	62	62	62		62
red maple	Crop	-	-	297		65
sugar maple	Crop	371	-	-		168
Total TREES ‡		1668	1668	1668		1668
SHRUBS						
bristly locust	Nurse	124	124	124		124
Total TREES and SHRUBS ‡		1792	1792	1792	1792	1792

† Mix number 4 prescribed as "Plant mixture of all remaining trees and shrubs."

‡ Some totals do not add correctly due to independent rounding. Original prescription was per-acre.

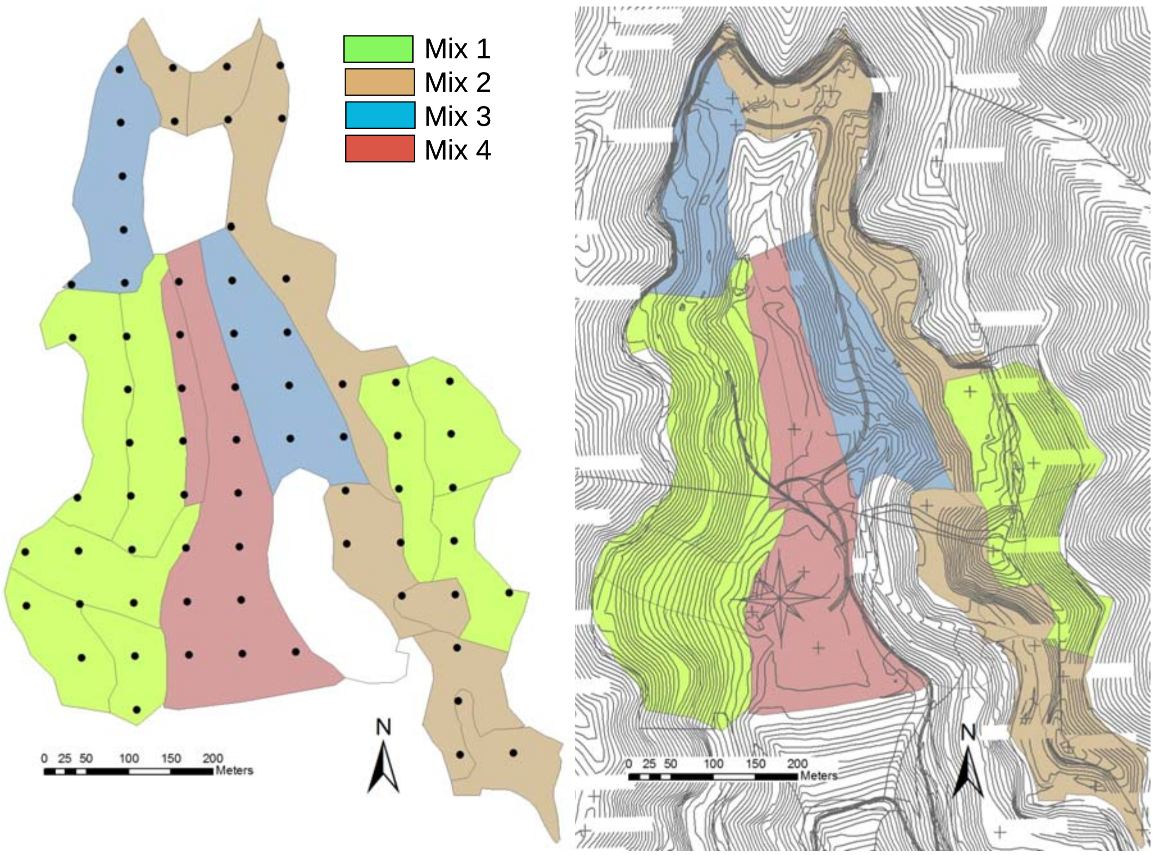

Figure 5. Tree planting mixes applied to various areas of the site, with 2010 sampling point locations (left) and site contours (right).

<u>Measurement Methods in 2010</u>

Measurement plot center plots were laid out on a 1-acre (0.4 hectare) gridded pattern (Figure 5). Soils were sampled from each of the 68 measurement plots on June 24 and 25, 2010. The soil samples were taken with a sharpshooter spade from the top 15 cm at 4 locations within each measurement plot, each about 3m and in a cardinal direction from the plot center, and aggregated.

Soil densities were estimated using the “shovel method” (Sweigard et al. 2007) applied with a sharpshooter spade. About 50 lbs. of foot pressure was applied to the spade. The spade was gently levered back and forth, allowing it to penetrate until refusal, and the depth of penetration was noted. Soils were categorized for density based on depth of penetration:

0-1 inch:	1. very dense	6-9 inches:	4. slightly compacted
1-3 inches:	2. dense	9-12 inches:	5. loose
3-6 inches:	3. moderately compacted		

The procedure was applied in at least 4 locations within each plot, avoiding large rocks and boulders, and the most frequently encountered category was recorded.

In the laboratory, soil samples were air dried and weighed, and coarse fragments were separated from fines using a 2mm sieve. The fraction of the original sample comprised of coarse fragment particles (>2mm), by weight, was recorded. The coarse fragments were compared visually to samples of 5 rock types (siltstone, weathered sandstone, unweathered sandstone, black shale, and coal or coal-like). Using a combination of physical separation and visual estimation, approximate fractional composition for each fragment type was recorded. A subsample of the fines was taken to Virginia Tech Soil Testing Laboratory and analyzed for extractable nutrients, soluble salts (electrical conductivity in a 2:1 water:soil mixture), pH, and organic matter (weight loss on ignition).

Trees and shrubs were measured on October 8, 9, and 10, 2010. On each measurement plot, all trees taller than breast height within a 1/100th hectare (18.5 foot radius) area were measured for height (h) using an extendable height-pole and for diameter at breast height (dbh); the species was recorded for each. All shrubs within a 1/200th hectare radius were measured for height and for dbh, and species were recorded. Where shrubs of a single species occurred in dense clumps, an individual considered to be representative of that clump was measured for height and dbh; those dimensions were recorded along with a count of the number of shrubs within the clump. Only trees and shrubs taller than breast height (approx. 1.5 m) were recorded.

<u>Data Analysis:</u>

All trees were classified as either “planted” or “volunteer” based on the planting area prescriptions: if a living tree was found in an area where it was prescribed for planting, it was tallied as a planted tree; otherwise living trees of species known to be growing in the local area were tallied as volunteers. All burr oaks (*Quercus macrocarpa*) were tallied as planted, since that species is not known to be growing in the local area. White ash *(Fraxinus americana*) was planted at all sites, but green ash (*Fraxinus pennsylvanica*) and white ash could not be discriminated during site survey; therefore, all *Fraxinus* species were tallied as planted. All trees of non-planted species were tallied as volunteers.

A biomass index was calculated for each living tree as h*dbh^2. Living shrubs and trees were summed to estimate stocking, and per-shrub/tree biomass indices within measurement plots were both averaged and summed to calculate measurement plot totals. These metrics are extrapolated and expressed on a per-ha basis. Site area and soil mapping unit characteristics were estimated by extrapolating from measurement plot totals. The influence of selected soil and site characteristics for each measurement plot on tree stocking and biomass metrics was evaluated through correlation analysis; because stocking and biomass metrics are non-normally distributed, the Spearman correlation procedure was used.

We evaluated associations between soil quality class, tree planting mix, soil pH and site characteristics, with forest establishment, composition, and growth.. Mean stocking and growth metrics were calculated for each class from measurement plot data. These class values were evaluated for significant differences ($p<0.05$) using Wilcoxon signed-rank procedures.

Importance values for all recorded tree and shrub species were calculated using the methods of Kuers (2010). An importance value is a measure of the relative dominance of species in a forest community. Importance values rank species within a site based upon three criteria: the frequency at which the species is recorded within measurement units; the total number of individuals of the species recorded; and the total amount of forest area occupied as basal area by the species. Importance Values were calculated for the site as a whole; they were also calculated and compared for soil quality class, tree planting mixes, and soil pH measurement-plot groupings.

Statistical comparisons for forest site quality class ("FSQ Class") were conducted by combining Classes I & II for comparison to combined Classes III & IV, as these combinations produced groups with comparable numbers of measurement plots. Despite the fact that forest site quality was determined on a soil mapping unit basis, comparisons were performed considering individual measurement plots as independent observations. This decision was made because the alternative procedure – calculating mapping unit means as a first step, followed by calculation of FSQ Class means based on mapping unit means – gave results that did not accurately represent the reality on the ground, in some cases, because of the unequal numbers of measurement points within mapping units (*i.e.*, means calculated from grouped mapping-unit means gave results quite different from similarly grouped means the measurement plots themselves).

Results and Discussion

Soil and Site Properties

Site soils are high in coarse fragments with a mean value of 57% (Table 3), as is common in mine soils. Coarse fragments are positively correlated with slope.

Soils are predominantly acidic, with a pH mean of 5.0, but pH ranges from 3.1 to 7.4. Pyritic minerals are likely associated with shale and siltstone rock materials, as the coarse fragment compositions of both are negatively correlated with pH.

Table 3. Mean values of soil and site properties (± Standard Deviation), including rock type composition, at 68 sampling points

Siltstone (% of CF)	38 ± 25	Coarse fragments (%)	57 ± 12
Weathered sandstone (% of CF)	34 ± 22	pH	5.0 ± 1.1
Unweathered sand-stone (% of CF)	24 ± 22	Soluble salts (ppm)	169 ± 187
Black Shale (% of CF)	3 ± 9	Organic Matter (%)	2.8 ± 1.1
Coal (% of CF)	2 ± 7	Slope (%)	37 ± 26
		Treeline distance (m)	48 ± 34

Twenty-four tree species and three shrub species were recorded (Table 4). Trees tallied as volunteers were more numerous than surviving planted trees. Three non-native invasives (autumn olive, *Elaeagnus umbellate*; *Ailanthus altissima*; and *Paulownia tomentosa*) were observed, all in small numbers; two species that are native to eastern US but do not occur commonly within as natives of the local area were observed: burr oak (*Quercus macrocarpa*), which was planted within mapping units with alkaline soils, and eastern cottonwood (*Populus deltoides*). All other species occur as natives in the local area.

Of all tree species observed, the volunteer black locust (*Robinia pseudoacacia*) was most common and had the highest importance value (Figure 6), and was responsible for ~30% of all woody biomass observed at the site. Like the most commonly observed shrub, the planted bristly locust (*Robinia hispida*), black locust is an N-fixing legume; it is well known for its ability to proliferate on coal surface mines where soils are often N deficient. The volunteer black locust occurred commonly in association with other planted and volunteer tree species. Sourwood (*Oxydendrum arboretum*), also a volunteer, was the second-most commonly observed tree species, although its occurrence was concentrated within only 15 of the 68 measurement plots.

Table 4. Mean tree and woody plant stocking and growth at the Rapoca reforestation site. Tree species are listed in order of importance value (See Figure 5).

	Fre-quency	Stocking - Planted	Stocking Volunteer	Stocking - All	Hei-ght	DBH	Basal Area	Avg BI	Total BI
	(plots)	(n/ha)	(n/ha)	(n/ha)	(cm)	(cm)	(m^2/ha)	(cm^3)	(m^3/ha)
Shrubs									
bristly locust	33	2,815	-	2,815	256	2.1	1.09	1,318	3.71
autumn olive	5	-	62	62	401	5.7	0.18	15,287	0.94
sumac	7	-	112	112	260	2.7	0.07	2,432	0.27
Total		2,815	174	2,988	259	2.2	1.35	1,649	4.93
Trees									
black locust	41	-	326	326	432	4.1	0.64	16,274	5.31
fraxinus	53	222	-	222	349	3.0	0.22	5,903	1.31
sourwood	15	-	231	231	273	1.9	0.1	1,444	0.33
white oak	38	104	-	104	343	3.4	0.13	6,186	0.65
sycamore	19	25	21	46	604	6.4	0.19	41,248	1.88
burr oak	17	44	-	44	428	5.9	0.14	19,115	0.84
n. red oak	22	38	32	71	345	3.2	0.07	5,226	0.37
sweet birch	18	-	51	51	333	2.5	0.04	3,952	0.20
white pine	12	22	-	22	372	4.9	0.05	13,610	0.30
chestnut oak	13	16	10	26	433	3.9	0.04	8,688	0.23
tulip poplar	13	-	25	25	343	2.5	0.02	7,067	0.18
dog wood	9	53	-	53	217	0.9	0	190	0.01
red maple	12	15	10	25	368	2.4	0.01	3,516	0.09
sugar maple	11	12	9	21	300	1.7	0.01	1,153	0.02
ailanthus	2	-	3	3	553	14.8	0.05	150,134	0.44
pitch pine	4	-	15	15	192	1.6	<0.01	641	0.01
black cherry	3	-	15	15	291	1.9	0.01	2,333	0.03
paulownia	1	-	1	1	329	12.7	0.02	53,094	0.08
red bud	2	-	4	4	219	1.6	<0.01	599	<0.01
cottonwood	1	-	1	1	732	7.0	0.01	35,844	0.05
scarlet oak	1	-	1	1	418	4.8	<0.01	9,621	0.01
virginia pine	1	-	1	1	204	1.3	<0.01	345	<0.01
sassafras	1	-	1	1	213	0.9	<0.01	173	<0.01
serviceberry	1	-	1	1	198	0.4	<0.01	32	<0.01
Planted Trees		551			357	3.3	0.71	8,093	4.47
Volunteer Trees			762		363	3.2	1.03	10,368	7.89
All Trees	310			1,313	360	3.2	1.74	9,413	12.36
Trees + Shrubs		3,366	936	4,301	306	2.7	3.09	4,019	17.29

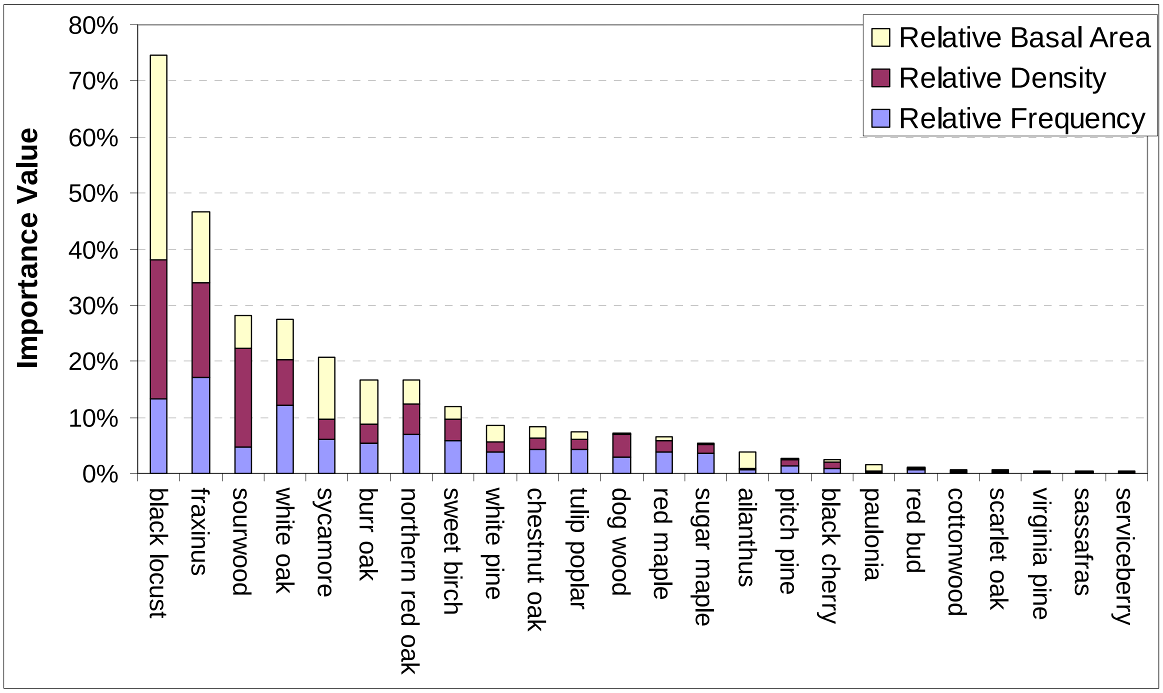

Figure 6. Importance value metrics for all tree species recorded at the measurement plots. The 24 tree species recorded as growing on the site are ordered from greatest to least importance value.

Overall survival of planted species is calculated at 33% (Table 5), although this is likely an overestimate of true survival as some species that were planted may also have volunteered. Two planted trees – ash (*Fraxinus)* sp. and white oak (*Quercus alba*) were also among the 4 species with highest importance values. However, both species were observed within some measurement plots at higher stockings than would have been expected based on average planting densities. Dogwood (*Cornus sp.*), also a planted species throughout the site, also occurred at some measurement plots at greater than average planting densities, indicating that it also became established as a volunteer.

The highest survival rates are calculated for dogwood and *Fraxinus*. American sycamore (*Platanus occidentalis*) and burr oak, which were planted only within Planting Mixes 3 and 4, also survived at high rates, relative to other species. Sycamore was recorded on 6, and burr oak on 9, of the 12 planting mix 3 measurement plots, indicating that they were able to establish with some success on areas with soil characteristics poorly suited for most native tree species. Red maple (*Acer rubrum*) and dogwood also survived in significant numbers within the areas designated for planting mixes 3 and 4. Of the planted species, sugar maple (*Acer saccharum*) and chestnut oak (*Quercus prinus*) exhibited the lowest survival rates.

All measurement plots had at least 1 tree, either planted or volunteer. Stocking by both planted and volunteer trees was highly variable, ranging from 100 to 5800 trees per hectare (Figure 7).

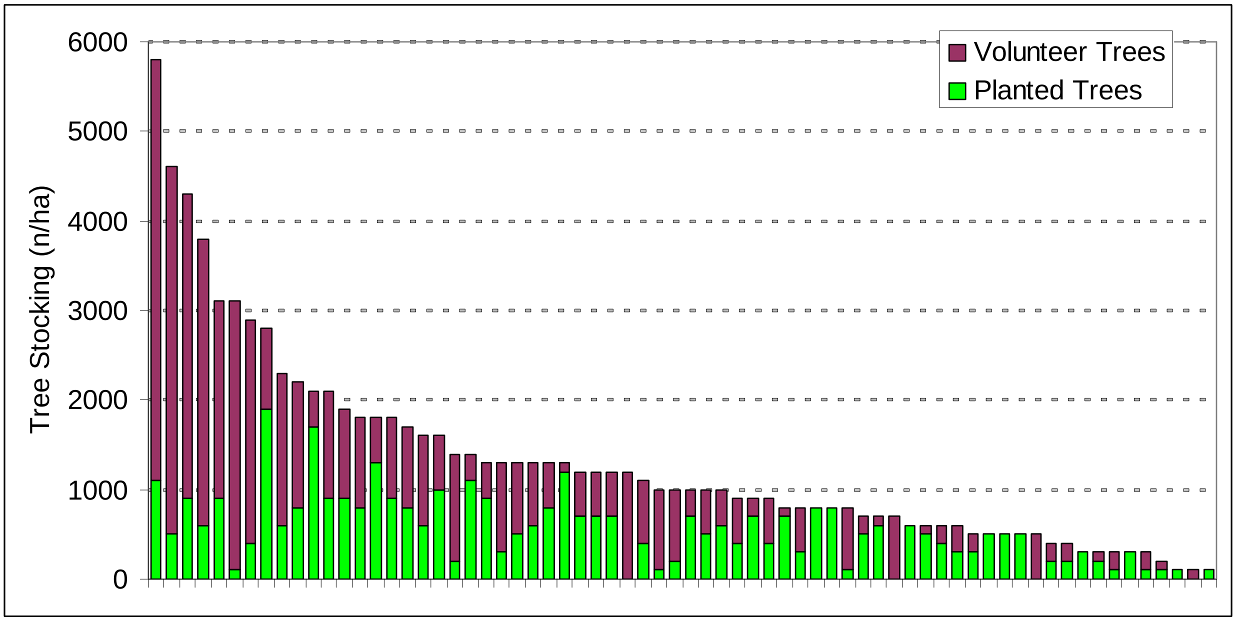

Figure 7. Stocking (number of trees per hectare) for the 68 plots, ordered from most to least.

The volunteer black locust was responsible for ~30% of all woody biomass recorded, by far the largest fraction accounted for by any single species. Three planted trees -- American sycamore, *Fraxinus*, and burr oak – and the planted shrub bristly locust were also prolific biomass producers. Of the common species, American sycamore, black locust, and burr oak also produced the largest amounts of biomass per-tree. Nine individual trees were recorded with biomass exceeding 100,000 cm^3: 4 black locust, 3 sycamore, one *Fraxinus*, and one *Ailanthus*. Within the upper 10^{th} percentile of individual-tree biomass, more than half were black locust.

The most common native volunteer (black locust), planted shrub (bristly locust), and non-native invasive woody species (autumn olive) are nitrogen fixers; no nitrogen fixing trees were planted.

Forest site-quality Class affected both planted and volunteer tree stocking, as expected, but it had a more dramatic effect on stocking by volunteers (Table 6). Per-tree and total biomass did not differ statistically among FSQ Class groupings for planted trees. One reason for this result is that tree species selected for use only within Tree Planting Mix 3 – American sycamore, burr oak, and red maple – survived well on Class IV soils, where Mix 3 was predominant and where survival by other planted species was poor; thus, sycamore and burr oak – both of which were among the fastest growing species – made up a larger fraction of planted trees on Class III&IV sites, compared to Class I&II. On a total biomass basis, both volunteer and combined biomass for Classes I&II exceeded Class III&IV, as expected. Average biomass by volunteers did not differ, statistically, by Class because small-statured volunteer species (including sourwood) were more prolific on Class I&II than on Class III&IV lands.

Table 5. Survival of planted trees, by planting mix and overall.

	Living Trees (n/ha) by Planting Mix					Survival Rates by Planting Mix				
	1	2	3	4	Avg	1	2	3	4	Avg
Fraxinus sp.	208	217	242	238	222	56%	44%	82%		56%
white oak	120	156	67	38	104	32%	31%	22%		26%
sycamore			108	31	25	-	-	37%		39%
burr oak	16	28	158	15	44	-	-	53%		68%
n. red oak	100			8	38	27%	-	-		23%
white pine	36	28		8	22	29%	22%	0%		18%
chestnut oak		50		15	16	-	10%	-		10%
dog wood	24	128	58		53	39%	207%	94%		86%
red maple			58	23	15	-	-	20%		23%
sugar maple	32				12	9%	-	-		7%
Total	536	606	692	377	551	32%	36%	41%	23%	33%

Note: Species survival rates are not calculated for mix 4, but Mix 4 trees are considered in calculating site averages.

Table 6. Variation of tree stocking and biomass metrics with forest site quality class.

	- - Forest Site Quality Class† - -			
	I	II	III	IV
Number of Mapping Units	1	7	6	3
Number of Measurement Plots	2	31	24	11
P Stocking (n/ha)	1,400	613	417	518
V Stocking (n/ha)	1,050	1,068	467	491
P + V Stocking (n/ha)	2,450	1,681	883	1,009
P Bio Index Avg (cm^3 / tree)	4,167	7,480	6,464	12,804
V Bio Index Avg (cm^3 / tree)	2,601	15,107	7,556	4,342
P+V Bio Index Avg (cm3 / tree)	6,351	10,738	0,653	8,003
P Bio Index (m^3 / ha)	5.0	4.6	2.7	7.8
V Bio Index (m^3 / ha)	11.6	11.1	5.8	2.7
P + V Bio Index (m^3 / ha)	16.6	15.7	8.5	10.5

† site quality class means are calculated from measurement plots.

Although Class I&II average per-tree biomass was nominally greater than Class III&IV for a number species (including chestnut oak, northern red oak, sweet birch, sugar maple, sourwood, sycamore, tulip poplar, and white pine), that difference was statistically significant only for black locust. The opposite pattern (greater nominal growth on Class III&IV sites) was present for pitch pine and burr oak.

Species' Importance Values also varied by FSQ Class, although these differences cannot be evaluated statistically. Black locust did well on all FSQ Classes, while ash, sycamore, and burr oak were more important as stand components, and white oak was slightly more important, on FSQ III&IV sites. In contrast, sourwood was a far more prolific and important stand component on Class I&II sites. Northern red oak, sweet birch, and tulip poplar were also more prolific and important on the better sites, with northern red oak's differences evident on where it was planted as well as where it volunteered. A variety of minor volunteer species also played more important roles in forest stand development on the Class I&II sites.

Conclusions

A mine site in Buchanan County, Virginia, was reclaimed and reforested using a prototype version of the Forestry Reclamation Approach in 2002. Because soil and site conditions varied, prescribed tree planting mixes were also varied in response to soil and site conditions. Reclamation produced excellent forest establishment and growth over most of the site, but species composition and biomass varied with site features. Twenty four species of living trees (22 natives and 2 invasives) and 3 shrub species (including 1 invasive) were recorded, with invasives occurring in small numbers. Stocking of planted trees (numbers of living trees hectare), and both stocking and growth of volunteer trees, were greatest on areas with higher site qualities; and were generally low in areas with compacted soils. Varying the tree planting mix in response to site features aided forest establishment.

Acknowledgements

The authors express sincere thanks to parties who helped the project. Bill Wampler and Duane Beggs, both formerly of Rapoca Energy Co., were instrumental to the original reclamation and reforestation. Rick Williams planted the trees. Thanks to Tad Nunley and Bob Brendlinger, of United Coal Metinvest, for providing access to the site in 2010. Thanks to Chris Fields-Johnson for assistance with soil sampling, and to Zach Addington and Travis Stanley for assistance tree measuring. Amy Allamong and Cameron Daniels processed soils in the lab, under supervision by Julie Burger. Brian Strahm assisted with locating plot centers.

References

Burger, J.A, and J.L. Torbert. 1992. Restoring Forests on Surface-Mined Land. Virginia Cooperative Extension publication 460-123.

Burger, J.A., D.O. Mitchem, and D.A. Scott. 2002. Field assessment of mine site quality for establishing hardwoods in the Appalachians . p. 226-240, in: Proceedings, 2002 National Meeting of the American Society of Mining and Reclamation. Lexington, KY.

Burger, J.A., D. Graves, P. Angel, V. Davis, C. Zipper. 2005. The Forestry Reclamation Approach. U.S. Office of Surface Mining, Department of Interior, Washington. Forest Reclamation Advisory 2.

Burger, J.A., C.E. Zipper. 2002. How to restore forests on surface-mined land. Powell River Project, Virginia Cooperative Extension Publication 460-123 (revised).

Kuers, K. 2010. Ranking Species Contribution to Forest Community Composition: Calculation of Importance Values. http://www.sewanee.edu/Forestry_Geology/watershed_web/Emanuel/ImportanceValues/ImpVal_SET.html

Showalter, J. 2005. Evaluation of Topsoil Substitutes for Restoration of Appalachian Hardwoods on Strip Mined Land. M.S. Thesis, Virginia Tech, Blacksburg

Showalter, J., J. Burger, C. Zipper, J. Galbraith, P. Donovan. 2007. Physical, chemical, and biological mine soil properties influence white oak seedling growth: A proposed mine soil classification model. South. J. Appl. For. 31:99-107.

Sweigard R., J. Burger, D. Graves, C. Zipper, C. Barton, J. Skousen, P. Angel. 2007. Loosening Compacted Soils on Mined Sites. Appalachian Regional Reforestation Initiative, Forest Reclamation Advisory Number 4.