Ripping Compacted Mine Soils: Does it Restore Pre-mining Forest Land Capability?

Jim Burger, Dan Evans, Tim Probert
Eighty-year+ History of Mined land Reforestation in the Appalachian and Midwestern Coalfields: 1928-2010

Tree planting Pre-SMCRA:
50 years: 1928-77

Grassland Reclamation Approach
Post-SMCRA hayland/pasture
15 years: 1978-92

Scrubland Approach
Post-SMCRA wildlife habitat/unmanaged forest
10 years: 1993-02

Forestry Reclamation Approach
Post-SMCRA forestland
8 years: 2003-10
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Goal: Restore native forest diversity and productivity
Mine soil quality affects:
Tree Growth, Value, and Carbon Sequestration

(Burger, 2002)
Mine soil quality affects on:
Tree Growth, Value, and Carbon Sequestration
(Burger, 2002)

Tree Height (ft)

Age (years)

Relative Stem Value/acre

- Poor site: $1x
- Average site: $5x
- Good site: $20x

Relative Stem Value/acre

- Poor site
- Average site
- Good site

Site Index

- Site Index 70 ft
- Site Index 56 ft
- Site Index 45 ft

Tree Growth, Value, and Carbon Sequestration

Mine soil quality and quantity

Poor

Average

Undisturbed

Relative Stem Value/acre

- Poor
- Average
- Good

Mine soil quality and quantity

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Average

Undisturbed
Mine soil quality affects on:
Tree Growth, Value, and Carbon Sequestration
(Burger, 2002)
Post-SMCRA forest land capability Wise Co., VA

Example of One of Three Sites

- Wise County, VA; surfaced-mined for coal and reclaimed in 1990.
- Seven hardwood species trees planted on a 10 ft by 14 ft spacing in plots on three sites in 1992 (randomized block design).
- Slopes ranged from 39% to 50%; shale/sandstone mix; typical compaction.
- Tree height and diameter measured in the early spring of 2007 at age 16.
Pre- versus post-mining capability:
Oak and poplar site index at age 50
(Burger and Fannon, 2008, ASMR Proc.)

![Bar chart showing site index for yellow poplar and red oak across different locations and project series.]

- Gilpin: Predominant Powell River Project Series
- Shelocta: Predominant Powell River Project Series
- Berks: Predominant Powell River Project Series
- Weighted Average for Wise County
- Mine Soil at Powell River Project

Legend:
- Yellow Poplar
- Red Oak
## Influence of mine site quality on commercial forest value

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<thead>
<tr>
<th>Mine Soil Quality</th>
<th>Very Poor</th>
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Martiki ripping effects study:

Established 1991: three ½-ac compacted and ripped plots each on sloped (40%) & flat (~3%) sites; split plot design

Ground cover seed mix

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<th>Application Rate</th>
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<tr>
<td></td>
<td>(lbs/ac)</td>
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<tr>
<td>Winter rye</td>
<td>10</td>
</tr>
<tr>
<td>Perennial ryegrass</td>
<td>5</td>
</tr>
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<td>Orchard grass</td>
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<tr>
<td>Kobe lespedeza</td>
<td>5</td>
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<td>Appalow lespedeza</td>
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<td>Birdsfoot trefoil</td>
<td>5</td>
</tr>
<tr>
<td>Redtop</td>
<td>3</td>
</tr>
<tr>
<td>Weeping lovegrass</td>
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<td>Ladino clover</td>
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<td>Crown vetch</td>
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Soil erosion & ground cover after 1st year

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<th>Treatment</th>
<th>Soil Loss from Slope (cm³)</th>
<th>Total Cover (%)</th>
<th>Legume Cover (%)</th>
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<tr>
<td>Compacted</td>
<td>1.83a</td>
<td>82a</td>
<td>28a</td>
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<td>Ripped</td>
<td>0.02b</td>
<td>82a</td>
<td>45a</td>
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Survival after 18 years on compacted and ripped mine soils in KY

- Sycamore
- Sweetgum
- Yellow Poplar
- Loblolly Pine
- White Pine

Survival on Slope (%)
Relative volume of trees on compacted and ripped mine soils on adjacent sloped (~40%) and flat sites (~3%).

[Graph showing the comparison of volume index for different tree species on compacted and ripped soils.]
Yellow poplar site index of compacted and ripped mine soils compared to pre-mining* conditions

*Pre-mining site index weighted for all soils in Martin and Lawrence Counties, KY
USDA National Cooperative Soil Survey
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Study Conclusions

- Ripping significantly improved tree survival of most species on both sloping and flat sites.
- Ripping had little effect on growth, site index, and pre-mining economic capability on the sloped site. Lack of tree response on the sloped site is likely due to other limiting factors in addition to compaction.
- Ripping on the flat site increased site index from 55 to 75, which restored 50% of the pre-mining economic capability.
General Take Home Messages

- Ripping almost always improves tree survival on compacted sites, but does not necessarily improve tree growth; other factors might be limiting (soil chemistry).
- Once compacted, it is not feasible to fluff up the entire soil volume to 4 feet.
- Growing trees in rips is like growing them in a big pot; they will eventually “hit a wall”
- This is why step 2 of the FRA is critical; avoid compaction in the first place; Keep it loose!
“Those who plant trees
love others besides
themselves”—Thomas Fuller
FRA Goal:
Restore native forest diversity and productivity
Mine soil quality affects:
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Age (years)

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poor
Average
Post-SMCRA Reclamation
Undisturbed

good
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Restore native forest diversity and productivity

Diverse FRA Mixed Hardwoods

Forest productivity

Non-mined Average

Post-SMCRA

Post-SMCRA FRA