Advances in Scientific Knowledge and the Forestry Reclamation Approach

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Purpose

- Present an overview of the Forestry Reclamation Approach (FRA) and how it is supported by research results.

Presentation Outline:

- Importance of forests in the Appalachian region of the U. S.
- History and evolution of the FRA
- Examples of research and practice that underpin the FRA
- Why the FRA and the ARRI is important
Figure 1. General location of study sites in the Midwestern and Appalachian coalfields.

Midwestern and Appalachian Coalfield Regions

Harrisburg, Illinois
Central City, Kentucky
Terre Haute, Indiana
Zanesville, Ohio
Grove City, Pennsylvania
Norton, Virginia
Morgantown, West Virginia

Surface Mining for Coal

Native Hardwood Forest

1.2 million acres disturbed by mining in the East
West Virginia Forestry Statistics

- 79% forested
- 9 million individual woodlot owners
- 271 manufacturing facilities
- Wood products is 3rd in manufacturing after metals and chemicals
- Annual payroll $430 Million
- Value of industry shipments: $1.8 Billion
Forest Products and Services

- **Products**
  - Wood, fiber and paper

- **Ecosystem Services**
  - Water quality
  - Flood control
  - Erosion control
  - Biodiversity
  - Wildlife habitat
  - Carbon sequestration
Land Use Change in the Midwestern and Appalachian Coalfields

Native forest
- Mixed mesophytic
- Appalachian oak

Scrub Land
- Robinia pseudoacacia
- Festuca arundinacea

Post-mining condition
- abandoned hayland/pasture
- abandoned wildlife habitat
- unmanaged forest land

Surface Mining Control and Reclamation Act
"All disturbed areas shall be restored to the uses and productivity they were capable of supporting before mining, or a higher or better use."

Our Reclamation Legacy
Which will it be

Reclaimed Managed Forest land
- Quercus alba
- Lirodendron tulipifera

- **1947-76**
  Pre-SMCRA: Tree planting

- **1977-96**
  Grassland Reclamation approach:

- **1997-04**
  Transition Period:

- **2004-07**
  Forestland Reclamation Approach:

1947-76
Pre-SMCRA: Tree planting
• Loose spoils
• Little or no competing cover
• Tree selection for variable spoils
• Tree planting & handling
• Very productive forests in many cases

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Grassland Reclamation approach:
• Few trees planted
• When planted, poor survival/growth
• Heavily graded, compacted mine soils
• Competing ground cover
• "Desperation" tree species

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Forestland Reclamation Approach:
Sixty-year History of Mined land
Reforestation in the Appalachian and
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Transition Period:
• Wildlife habitat & unmanaged forest land primary land uses
• Mine soils still compacted
• Competitive agricultural grasses/legumes
• Little or no forest value

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2004-07
Forestland Reclamation Approach:
• Top soil substitutes for trees
• Less grading, loose spoils
• Tree-compatible ground cover
• Valuable native tree mix
• Good Planting techniques
ARRI Forestland Reclamation Approach (“Best Practices”)  

1. Select and use specific top soil substitutes for trees  
2. Reduce grading, leave spoils loose and uncompacted  
3. Use a tree-compatible ground cover and reduce herbaceous cover as much as possible  
4. Use a valuable native tree mix consisting of crop and wildlife species  
5. Hire reputable tree planters who use good techniques
Step 1. Select a topsoil substitute for trees and place it 4-ft thick on surface.
Mine Soil Quality Model

- Climate
- Tree Growth
- Genetic Potential

Root Growth

Mine Soil

- Soil Depth
- Available Phosphorus
- Soil Density
- Adequate pH
- Soluble Salts

- Torbert et al., 1988
- Burger et al., 1994
- Andrews et al., 1998
- Rodrigue and Burger, 2006
Influence of mine site quality on commercial forest value

<table>
<thead>
<tr>
<th>Mine Soil Quality</th>
<th>Very Poor</th>
<th>Poor</th>
<th>Fair</th>
<th>Good</th>
<th>Very Good</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site Quality Class</td>
<td>V</td>
<td>IV</td>
<td>III</td>
<td>II</td>
<td>I</td>
</tr>
<tr>
<td>Oak Site Index (ft$_{50}$)</td>
<td>45</td>
<td>55</td>
<td>65</td>
<td>75</td>
<td>85</td>
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<tr>
<td>Potential Species</td>
<td>Black locust, Autumn olive, Chestnut oak, Scarlet oak</td>
<td>White oak, White ash</td>
<td>N. Red oak, Yellow poplar</td>
<td>Black cherry, Sugar maple</td>
<td></td>
</tr>
<tr>
<td>Potential Commercial Uses</td>
<td>None</td>
<td>Firewood OSB chips</td>
<td>R R Ties Small saw-timber</td>
<td>Large saw-timber</td>
<td>Large saw-timber Veneer</td>
</tr>
<tr>
<td>% Return on Investment (Probert, 1999)</td>
<td>-2</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>8</td>
</tr>
</tbody>
</table>

Post-SMCRA Mined Land

Average for Appalachian Region
Mine Soil Depth Wedge Study
Torbert and Burger, 1992

* Up slope > 5 ft
* Down slope < 2 ft
* > 5 ft
* < 2 ft
White pine site index (age 50) as a function of rooting depth
(Torbert et al. 1988 Jour. Environ. Qual.)
Step 2. Leave surfaces loose and un-compacted.
8-yr-old white pine; site class V

8-yr-old white pine; site class I

Torbert et al., 1988, J. Environ. Qual.
Yellow Poplar

Height (cm)

Survival

Compacted
Strike-Off
Loose Dump

Angel et al., 2006
Naturally seeded forest species after 8 years in loose dumped, rough graded, and conventionally graded areas of a Perry County, Kentucky, surface mine.

After 8 years, the woody canopy occupied more than half the area. In contrast, canopy cover was only 5% percent in the “Conventional Grade” areas of the mine site.

(Groninger et al., 2007; Data from Cook, 2007).
Another Influential Study: At Martiki Coal, Eastern KY

Treatments (all with D-9):

**Intensive Grading** - front- and backbladed, 1-3 three passes, + tracking in

**Ripping** - After standard grading: rip 3 ft deep and 10 ft apart running up- and down-slope with a subsoiling shank

**Moderate Grading** - backbladed downslope, 1-2 passes

Legend:

- Moderate (M)
- Intensive (I)
- Ripped (R)

1st Year Soil Erosion

- Less grading=
- Loose, rough surface=
- More water infiltration=
- Less erosion=
- Less sediment in ponds=
- Lower cost $$$$$

5th Year Ground Cover

Sediment Pond
3. Use non-competitive herbaceous species for erosion control.
4. Plant valuable native hardwoods and wildlife species.
Tree-compatible Re-vegetation Mix for Native Hardwood Reforestation
(examples of useful species)

- **Grasses**
  - Ryegrass
  - Foxtail millet
  - Timothy

- **Legumes**
  - Birdsfoot trefoil
  - White clover

- **Fertilizer**
  - High phosphorus
  - Low nitrogen

- **Wildlife Trees (100/ac)**
  - Shagbark hickory
  - Redbud
  - Dogwood
  - Crab apple

- **Crop Trees (600/ac)**
  - Red & white oaks
  - White ash
  - Sugar maple
  - Tulip poplar
  - Black cherry

No fescue or grains
No tall clovers

Torbert and Burger. 1998. ASA Monograph; Burger and Zipper, 2002 VCE 420-123
Ground cover development in Stages using the FRA re-vegetation mix for reforesting mined land

Stage 1: Grass
Stage 2: Legume
Stage 3: Wildlife Species
Stage 4: Crop Tree

Canopy Cover (\%)

Time (years)

Step 5. Use experienced, reputable planters who guarantee their work.
Refrigerated transport and storage

Proper seedling handling and treatment

Using high quality seedling stock and good handling and planting procedures are critical.

Proper planting
These 5 FRA steps produce:
Diverse, high-value, reclaimed forestland
ready for bond release after 5 seasons.
Step 6. All participants in the process must develop and execute the reclamation and re-vegetation plan for the permit.
Reclaimed forest land is very valuable for both wood products and landscape services.

On average, forest land capability has not been restored on post-SMCRA mined land, but research clearly shows that it can be restored at no extra cost.

Research shows that two reclamation approaches must be recognized:
- A grassland reclamation approach for Grassland
- A forestland reclamation approach Forestland

Research shows that Forestland capability and forests can be restored by:
- Using topsoil substitutes suitable for trees
- Light grading of deep, loose mine soil; ripping compacted soils
- Using tree-compatible ground cover at reduced rates
- Planting a mix of native hardwoods
- Using reputable tree planters

Forest land is less costly for operators to establish: less grading and less sediment pond cleanout.
Thanks to early industry, agency, and university researchers who pioneered most of this work:

Dr. Clark Ashby
Bill Plass
Willis Vogel
Many, many others