

Case Study to Assess the Costs of the Appalachian Regional Reforestation Initiative's (ARRI) Forest Reclamation Approach



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Outline

- I. Introduction
 - A. Background of Conventional Reclamation
 - B. ARRI and the FRA
- II. Study Objectives
- III. Methods
- IV. Preliminary Results
- V. Potential Study Impacts

Background

Forestry in Pennsylvania:

- 60% of land area is forest
- Annual contribution of \$19 billion to the state's economy
- Most revenue comes from high quality hardwoods

Coal Mining in Pennsylvania:

- Contribution of \$4 billion (2014)
- Often occurs on Forestlands



Background

Conventional forest and wildland reclamation involves

- Rough grade backfilling and grading with a dozer
- Shallow rooting zone (1 – 1.5 ft)
- Heavy seeding of fast-growing groundcovers to control erosion

Poor tree growth results from:

- Excessive compaction
- Competition from grasses



Background

The Appalachian Region Reforestation Initiative (ARRI)

- Coalition of citizens, the coal industry, and government

Forest Reclamation Approach (FRA)

- Requires quality soil material and loose grading



The Five Steps of the FRA

1. Suitable rooting medium:
 - No less than 4 ft deep
 - Topsoil, weathered sandstone
2. Loosely grade to create a noncompacted growth medium.



The Five Steps of the FRA

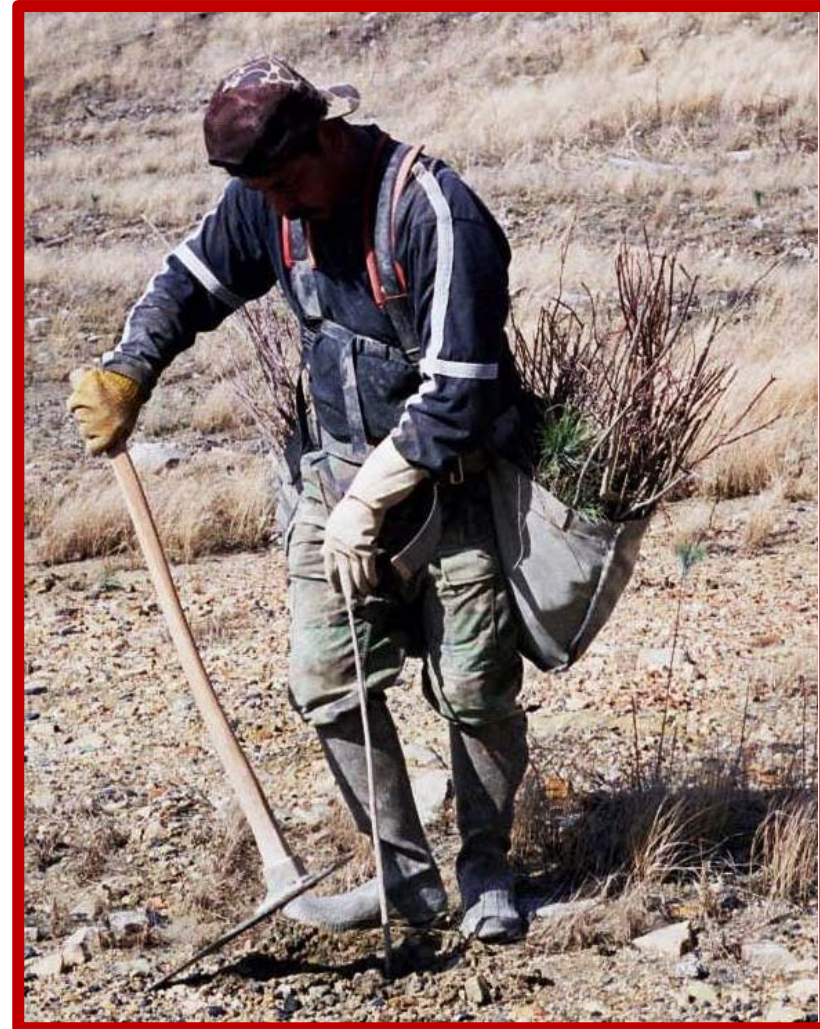
3. Use ground covers that are compatible with growing trees
 - Slow-growing
 - Low density planting rates

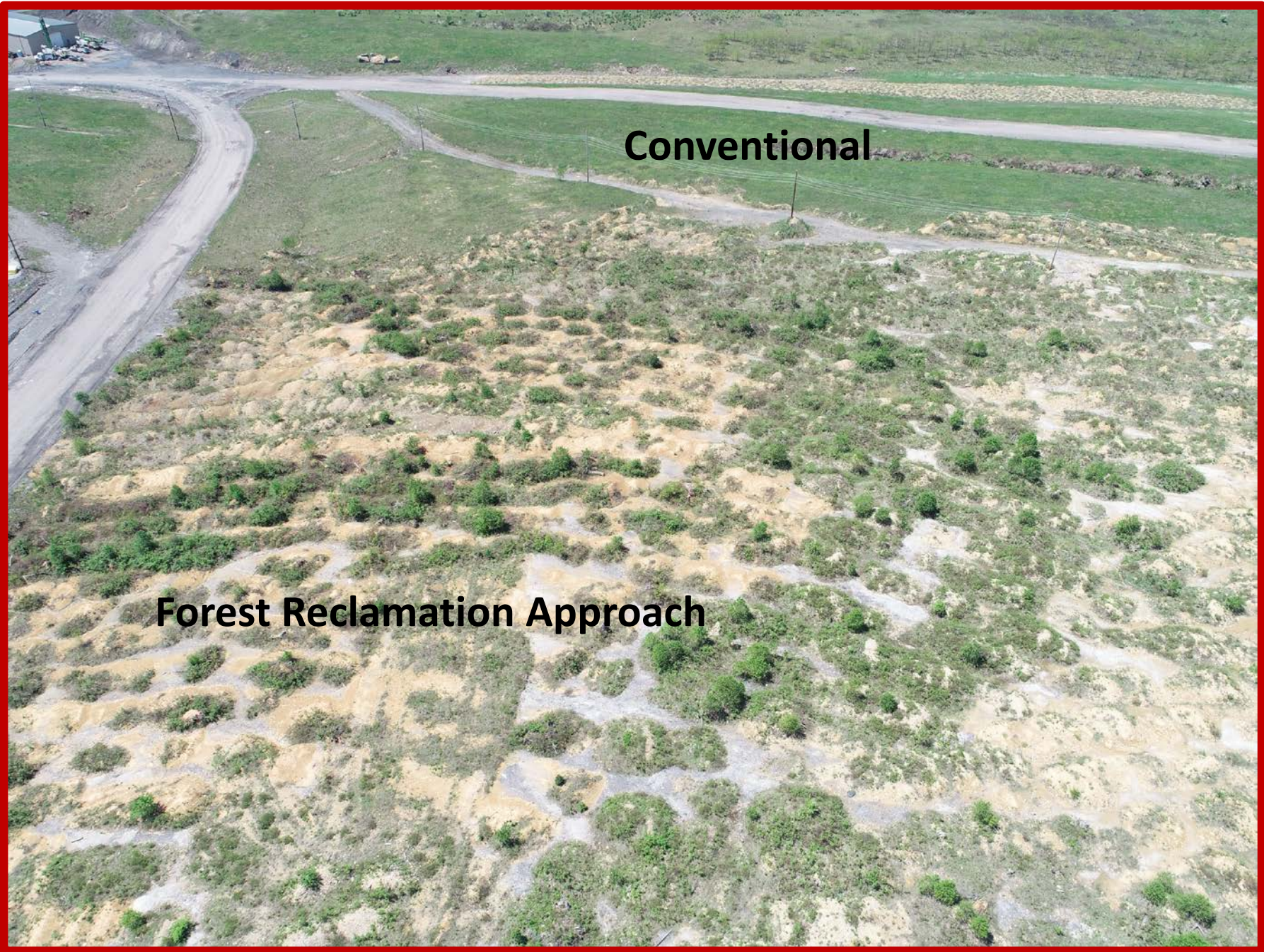
4. Tree types:
 - Early succession species for wildlife and soil stability
 - Commercially valuable crop trees



The Five Steps of the FRA

5. Use proper tree planting techniques (hand planting)





Conventional

Forest Reclamation Approach

Background

Many studies have characterized the ecological successes of the FRA:

- Timber
- Carbon sequestration
- Wildlife and Biodiversity

But, no single study has presented economic and financial analyses to compare the FRA to conventional post-SMCRA reclamation.

Study Objectives

1. Assess FRA and conventional reclamation methods, land uses, management, and regulations across the surface mining regions of the Eastern United States
2. Determine economic costs of reclamation operations by assessing mine spoils, grading, seeding/planting, and erosion control costs

Hypothesis:

The FRA will result in lower costs and greater benefits to operators and landowners compared to conventional reclamation practices.

Methods: Case Study by State

A state by state review of industry reports, literature, and mining permits over the last 10 years

- State regulations
- Reclamation land-uses
- Spoil material characteristics
- Soil amendments
- Seeding and planting techniques
- Species selection (trees and groundcovers)
- Topography

Methods

Collaboration with state regulators and mine operators to collect available cost data from former reclamation sites.

Identify variation in costs across regions:

Northern Appalachia

- Small truck operations in PA

Central Appalachia

- Mountain Top Removal operations in WV and KY

Southern Appalachia

- Conventional Contour Mining in TN and VA



Methods: Cost Analysis on Active Mine Sites

Reclamation methods on active sites in Pennsylvania and Kentucky:

- Grading and machine costs
- Costs associated with appropriate topsoil substitutes
- Amendments
- Seeding/planting costs



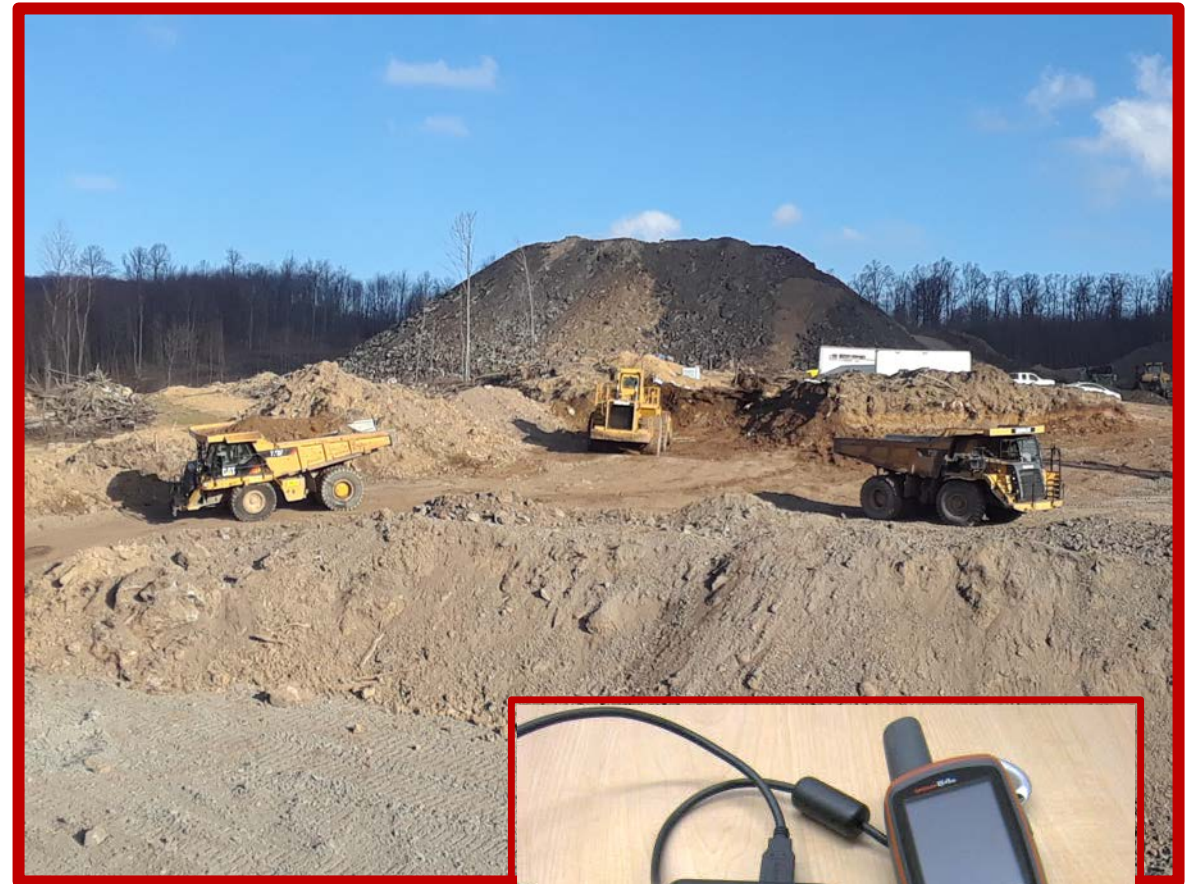
Time-Motion Tracking

GPS units installed in truck and dozer cabs during active reclamation

- Garmin GPSMAP® 64s
- 10 ft. accuracy and 10 sec. intervals
- Verified by on-site observation/ photos

Delay-free machine utilization rates determined by measuring:

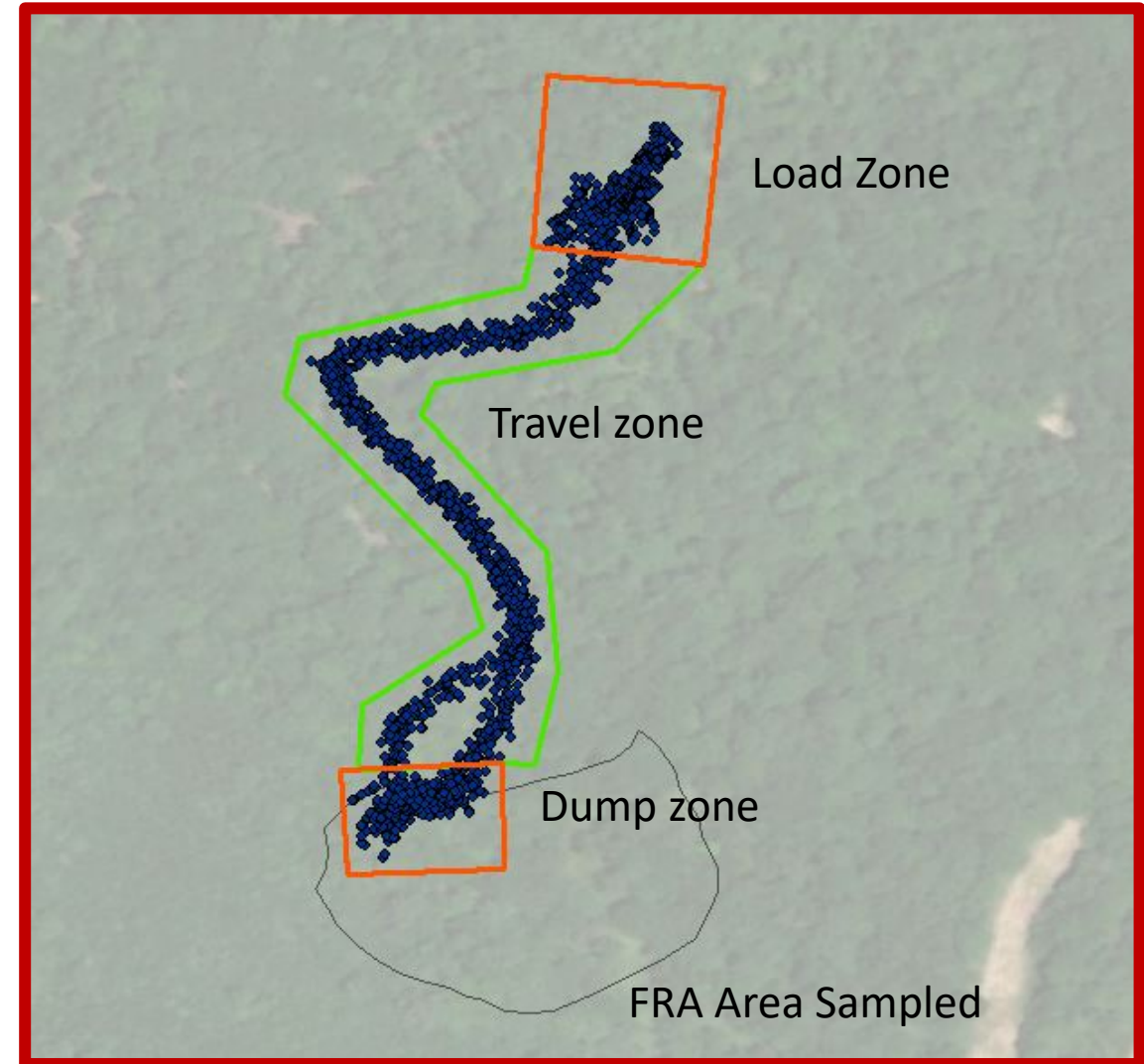
- Time
- Activity cycles
- Distance and velocity
- Delays (types and lengths)



Time-Motion Tracking

ArcMap™ and ArcGIS® software (ESRI)

- Dump and Load zones delineated from areas of zero velocity (<0.5mph)
- Load, travel, dump data for each activity cycle summarized within zones





Preliminary Results

Machine Cycles for Forest Reclamation Approach Pennsylvania Site 1

	Travel Distance (ft)		Travel Speed (mph)		Time (min)							
					Loading		Travel (2-way)		Dump		Total (Delay-free)	
Average	882	± 283	6.09	± 0.93	3.21	± 1.40	3.15	± 1.29	1.60	± 0.49	7.95	± 1.23
Min	312		2.13		1.20		0.83		0.67		5.50	
Max	1268		8.38		8.67		6.00		3.67		13.33	

Preliminary Results

Machine Cycles for Forest Reclamation Approach Pennsylvania Site 1

Machine	Cost/Hour †	Time (sample hours)			Utilization Rate (%)
		Total Scheduled	Operational Delay	Total Productive (Delay-free)‡	
Cat 773f Rock Truck (1)	144.33	25.60	2.34	23.26	90.8
Cat 773f Rock Truck (2)	144.33	33.17	3.54	29.63	89.3
Cat. 992 with Bucket Loader	150.31	~	~	29.63	~
† Determined from interviews with mine operator					
‡ Assumed that Cat. 992 with Bucket Loader works whenever a Cat 773f Rock Truck is running					

Reclamation Study Area: 2.74 acres

Preliminary Results

Reclamation Cost Summary for Pennsylvania Site 1		
Activity	FRA (\$/acre)	Conventional (\$/acre)
Placement of Topsoil †	4411.13	~
Ground Preparation ‡	0.00	818.00
Tree Planting ‡	512.00	512.00
Groundcover Establishment ‡	0.00	150.00
Total:	4923.13	~
† Determined from machine cycle times and reclamation sample areas		
‡ Determined from mining permits, interviews with mine operator and contractor estimates		

Potential Study Impacts

Provide regional guidelines for costs and economics of FRA

Regression analysis using machine cycle rates and site-characterization data to more accurately predict FRA costs



Potential Study Impacts

Show landowners and operators they have options, other than conventional reclamation, that result in productive long-term benefits and sustainable forests which once covered the coal mining regions.



Questions?

