RIPPING AND NATIVE SEEDING TREATMENTS INFLUENCE ON VEGETATION COMPOSTION OF COMPACTED TAILINGS

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Introduction

- From the 1970's - recently, soil compaction and planting with non-native pasture grasses was common practice in reclamation of eastern coal mines.
- The lack of tree growth prompted the development of the Forestry Reclamation Approach, which is successful in restoring forests on these sites.
- But vast areas of previously reclaimed land, "Legacy mine sites", remain.

Introduction

Methods for remediation outlined in Forest Reclamation Advisory No. 11

ESTABLISHING NATIVE TREES ON LEGACY SURFACE MINES J.A. Burger, C.E. Zipper , P.N. Angel, N. Hall, J.G. Skousen, C.D. Barton, S. Eggerud

http://arri.osmre.gov/FRA/Advisories/FRA-11-LegacyLands-Nov2013.pdf

THE APPALACHIAN REGIONAL REFORESTATION INITIATIVE (ARRI)

FOREST RECLAMATION ADVISORY

Forest Reclamation Advisory No. 11 November 2013

ESTABLISHING NATIVE TREES ON LEGACY SURFACE MINES

J.A. Burger, C.E. Zipper , P.N. Angel, N. Hall, J.G. Skousen, C.D. Barton, S. Eggerud

More than one million acres have been surface mined for coal in Appalachia. Today, much of this land is unmanaged, unproductive, and covered with non-native plants. Establishing productive forests on such lands will aid restoration of ecosystem services provided by forests – services such as watershed protection, water quality enhancement, carbon storage and native wildlife habitat – and will enable mined lands to produce valued products such as commercial timber.

This Advisory describes practices for establishing native forest trees on lands that were surface mined for coal and reclaimed to meet legal standards, and where the mine operator no longer has any legal responsibilities ("legacy surface mines." Photo 1). These lands often differ from their pre-mining condition with respect to topography, soils, water resource influences, and vegetation.

Photo 1. This legacy surface mine is covered with non-forest vegetation despite the passage of about 18 years since mining and reclamation in the late 1990s.

Successful establishment of native forest trees on legacy mines typically requires a sequence of steps or procedures over several years. Here, we describe those steps as the "four P's": Plan, Prepare, Plant, and Protect. All four steps are needed to ensure success. Some project managers may desire more technical detail than we have provided here. Hence, we reference other Forest Reclamation Advisories that provide detail and suggest that reforestation experts be consulted if necessary.

PLAN: Assess the Site and Develop a Plan

The first step is to develop a reforestation plan or strategy by assessing site conditions. Preparing a written plan will aid the reforestation process.

Survey Existing Vegetation

Herbaceous plants and woody shrubs, including non-native and invasive species, often dominate legacy surface mines. Herbaceous plants that are common on mine sites, such as non-native grasses and sericea lespedeza, will outcompete young planted trees if not controlled. Non-native invasive woody plants also require control because they often grow rapidly and, if present, will out-compete native tree seedlings.

First, visit the site, assess vegetation and site conditions, and develop a vegetation management strategy that will enable planted trees to survive. A site map or aerial photo will aid this task. On the map, delineate and mark areas with 1) different types and amounts of vegetation (e.g., good growth of native trees, dominance of invasive species, complete herbaceous cover, extensive bare soil, etc.), 2) land slope, 3) aspect (direction the slopes are facing), 4) soil sampling locations, 5) property lines, 6) roads and access, and other information that will aid planning.

Areas with a thick cover of non-native shrubs and trees will require clearing prior to replanting. Because the non-native shrubs and trees that proliferate on Appalachian coal mines – including autumn olive, tree of heaven, and Paulownia – will re-sprout from living roots even if their tops are cut, they should be killed with an herbicide.

When mine sites are dominated by non-native herbaceous species such as tall fescue and sericea lespedeza, we also advise killing them with an herbicide. This control will be temporary as seeds in the soil will germinate. However, this temporary control will allow tree seedlings to get a good growing start before competing plants emerge from the soil seedbank. Successful reforestation

Remediation methods

- Survey existing vegetation, assess soil chemical and physical properties
- Control competing vegetation
  - Removal of invasive species
  - Herbicide non-native grasses
- Loosen soil
  - Deep ripping to 1m depth
  - Grid pattern 2.4 m spacing
- Improve soil chemistry
  - Fertilizer and OM

Remediation methods

- Plant native trees
  - 1480 – 1730 per ha
  - Plant at intersection of rips
  - Usually 1-0 bareroot seedlings
- **Protect seedlings**
  - **Tree tubes to protect from browsers**
  - **Herbicide to control non-native grasses**

Approach

Seed with native species that establish quickly, to increase diversity of herbaceous vegetation and replace non-native species that were originally seeded.

Goals:

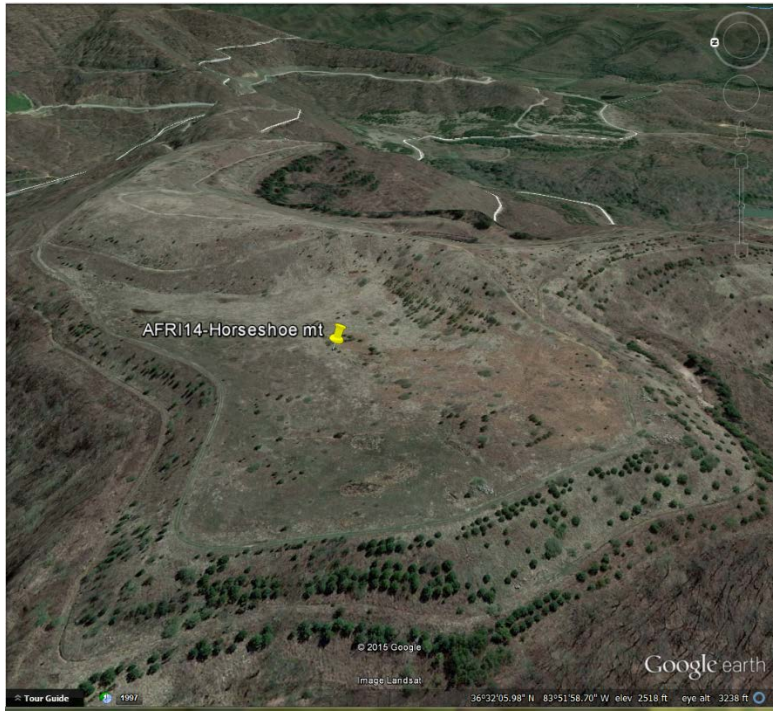
- Improve value of early successional habitat
- Native, diverse vegetation is less likely to inhibit tree growth and establishment
- Soil biota associated with native plants differs from that of invasive plants, may be more compatible with native trees.

Objectives

Compare 4 seeding and herbicide treatments to determine how they influence:

1. Composition of vegetation
2. Browsing damage to tree seedlings
3. Early tree seedling establishment
4. Tree survival and growth

Study site 1



Reclaimed ~10 years prior

10 ha total

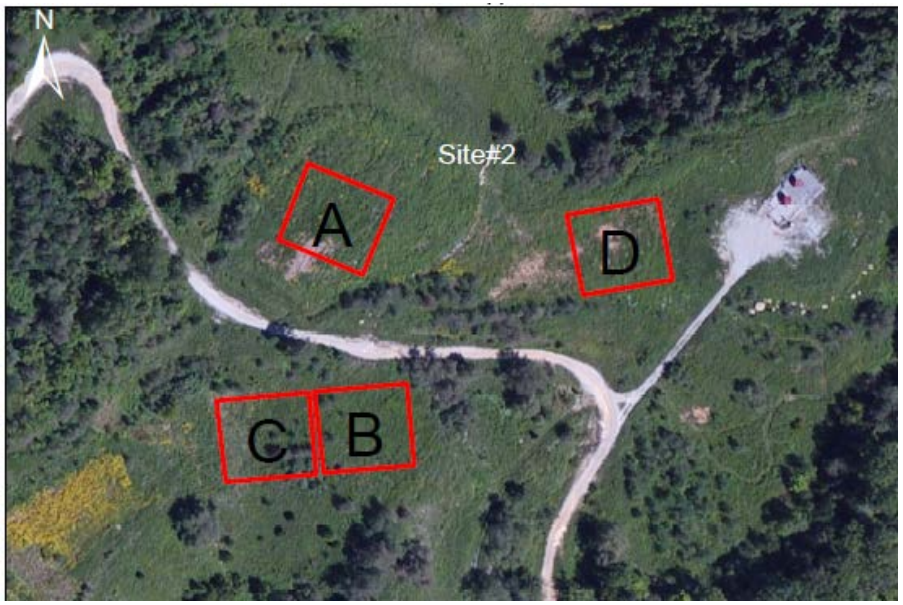
Elev. 770 m (2500 ft.)

Soil sandstone/shale pH 6.5

3 blocks

4 treatment plots 0.81 ha each

Study site 2



Reclaimed ~20 years prior
4 ha total
Elev. 625m (block1),
320m (block2)
Soil sandstone/shale pH 6.5

2 rep blocks
4 plots 0.4 ha each (block1) or
0.2 ha each (block2)

Site prep

- Autumn olive and Paulownia: Foliar spray of Arsenal in Aug. (80% mortality)
- Glyphosate on kudzu, Japanese knotweed, mimosa.
- Cross-ripped to 1.2m depth on 2.4m grid in Nov.

Treatments

1. Control
2. Glyphosate applied in 0.5m radius around each seedling in

4.	**Deer (-) mix**		seeding rate (lb/ac)
Cool season annuals	Winter wheat	*Triticum aestivale*	49
	Mustard	*Brassica juncea*	3.2
Legumes	Maryland senna	*Senna marylandica*	0.8
	Blue false indigo	*Baptisia australis*	0.8
Perennials	Big bluestem	*Andropogon gerardii*	0.8
	Indian grass	*Sorghastrum nutans*	0.4
	Switchgrass	*Panicum virgatum*	0.4
	Wild quinine	*Parthinium integrifolium*	0.3
	Bergamot	*Monarda fistulosa*	0.1
	Butterfly milkweed	*Asclepias tuberosa*	0.4
	Yarrow	*Achillea millefolium*	0.05

Tree planting – April 2015

species	total	% of total	per ha
northern red oak	2000	12	203
chinkapin oak	2000	12	203
yellow poplar	2000	12	203
white oak	2000	12	203
pin oak	1000	6	101
silky dogwood	1000	6	101
sweetgum	1000	6	101
ninebark	1000	6	101
American plum	1000	6	101
southern red oak	1000	6	101
buttonbush	1000	6	101
beautyberry	500	3	50
hazel	500	3	50
eastern white pine	300	2	35
chestnut	200	1	17
pawpaw	200	1	35
total	**16700**	**100**	**690**

Plus 268 American chestnut on site 1

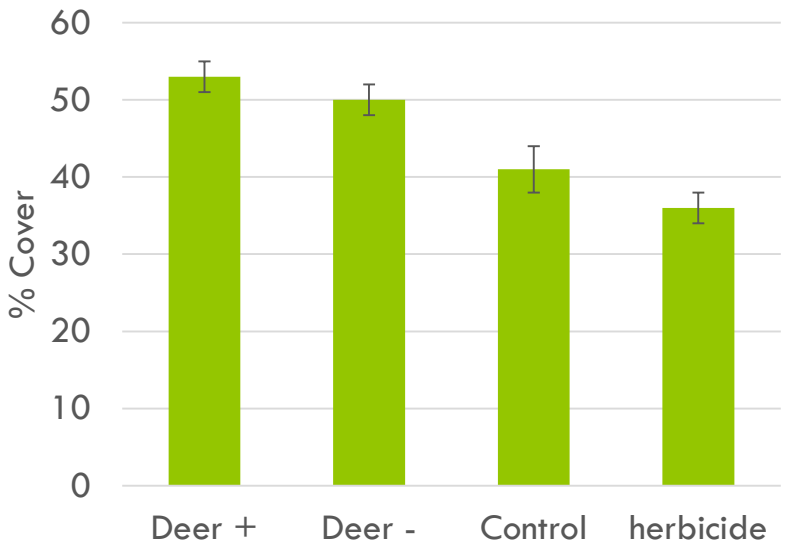
Measurements

- Trees: 5 permanent plots (0.04 ha) established on each treatment plot (3 on smallest trt. plots) following USFS-FIA methods.
  - July 2015 – Height, RCD, vigor class, browse damage
- Vegetation surveys: visual ranking method (Scott, 1989) using 1m^2 quadrats
  - Aug. 2014 (pre-treatment)
  - May 2015
  - Aug. 2015

Pre-treatment vegetation

- Average cover (including senescent) 93%
- Site 1 dominated by:
  - Red clover (Trifolium pratense)
  - Tall fescue (Schedonorus arundinaceus)
  - Lespedeza cunata
  - Birdsfoot trefoil (Lotus corniculatus)
- Site 2 dominated by:
  - Ambrosia artemisiifolia, A. trifoliate
  - Lespedeza cunata
  - Chamaecrista fasciculata
  - Solidago canadensis

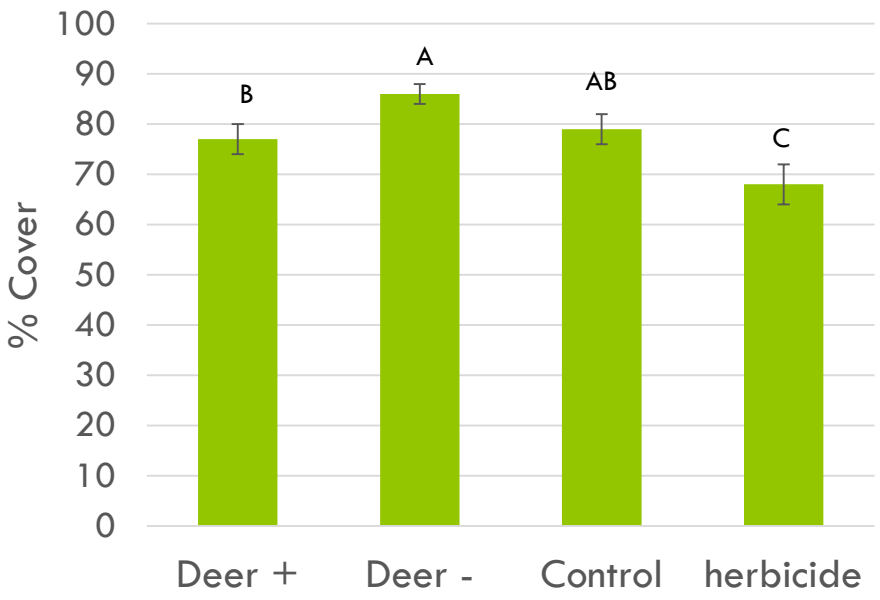
April 2015



Un-seeded plots

Seeded plots

Aug. 2015



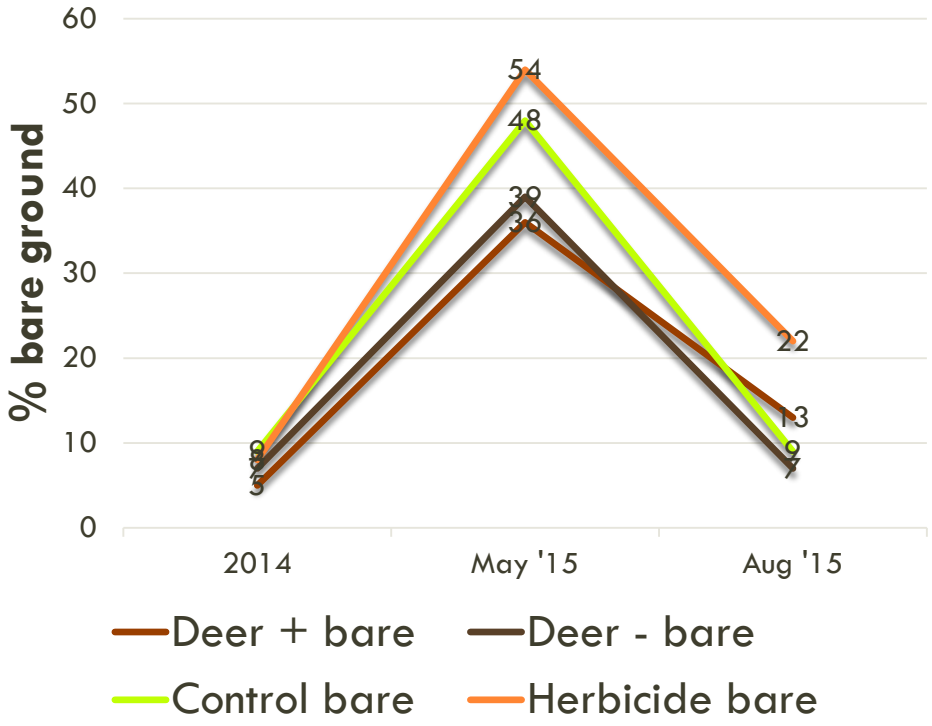
Deer+

Deer-

Control

herbicide

Aug. 2015



Deer+

Deer-

Control

Herbicide

Post-treatment vegetation

- Average cover (including senescent) 78%
- Site 1 dominated by:

	% plots 2014	% plots 2015
Red clover (*Trifolium pratense*)	61	76
Tall fescue (*Schedonorus arundinaceus*)	55	3
Lespedeza cunata	47	28
Birdsfoot trefoil (*Lotus corniculatus*)	53	91
Ragweed (*Ambrosia artemisiifolia*)	13	58

Site 2: reduction in Lespedeza

No sig. effect of seeding treatment on dominant vegetation

Browse damage– April to July 2015

species	per ha
northern red oak	64
chinkapin oak	39
yellow poplar	9
white oak	16
pin oak	48
silky dogwood	43
sweetgum	13
ninebark	40
American plum	24
southern red oak	35
buttonbush	53
beautyberry	40
hazel	35
eastern white pine	4
chestnut	56
pawpaw	---

Analyzed by binary logistic regression. Probability of browse damage depends on species and treatment:

Probability of browse:

Deer +	33%
Deer -	45%
Control	37%
Herbicide	43%

Conclusion

- Ripping reduced the frequency of Lespedeza and tall fescue, with new space being taken by other existing species.
- Seeding treatments did not have a major influence on dominant vegetation over the first year, but did influence browsing.
- The occurrence of browsing damage was higher with herbicidal control of ground cover, and where herbaceous cover is less palatable.

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