

Factors influencing the Establishment of Volunteer Vegetation on Quarry Overburden

J.A. Franklin and D.S. Buckley



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Laramie, WY



Forestry Reclamation Approach

Recommends seeding tree-compatible ground cover, and creating soil conditions that promote the establishment of native volunteer vegetation.



Forestry Reclamation Approach

Tested extensively on reclaimed coal mines in the eastern US for establishing forest.

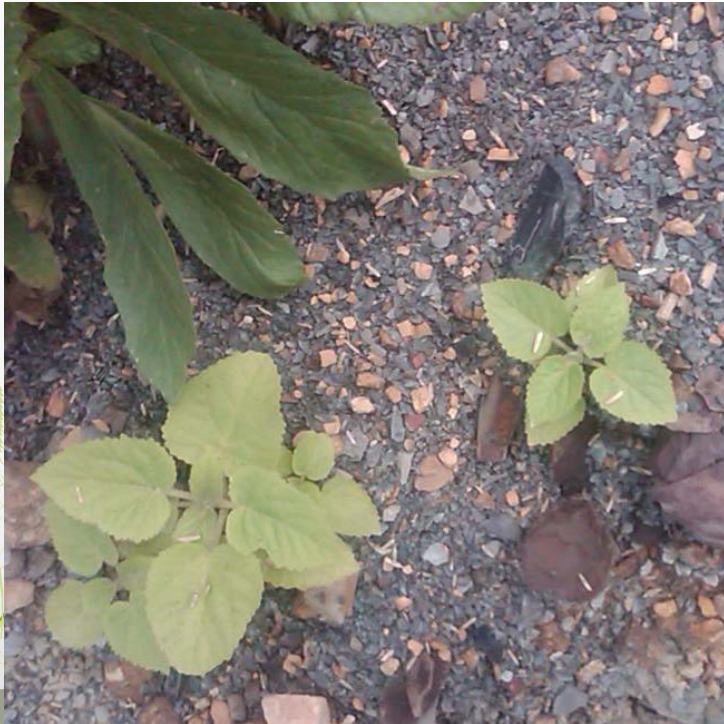
Challenges in the eastern US:

- Rapid development of vegetation can compete with tree seedlings



Forestry Reclamation Approach

Challenges in Tennessee:
Invasive species –
both woody and herbaceous



Rill development



Forestry Reclamation Approach

Challenges in Tennessee:

- Alkaline substrate – naturally occurring (pH 6.5- 7.5 is typical), due to overuse of lime, or both. Native soil pH is 3.5 – 6.
- Favorable for many agronomic species.



Forestry Reclamation Approach

Challenges in Tennessee:

Lack of topsoil. Nitrogen must be applied.



Unfertilized



200 lb./acre N

Project objectives:

- Demonstrate the use of the FRA outside of coal mine reclamation
- Test how the establishment of volunteer vegetation, both native and non-native, is related to:
 - 1) Macrotopography created by different overburden placement techniques
 - 2) Distance from intact forest
 - 3) Nitrogen fertilization
 - 4) Lime application



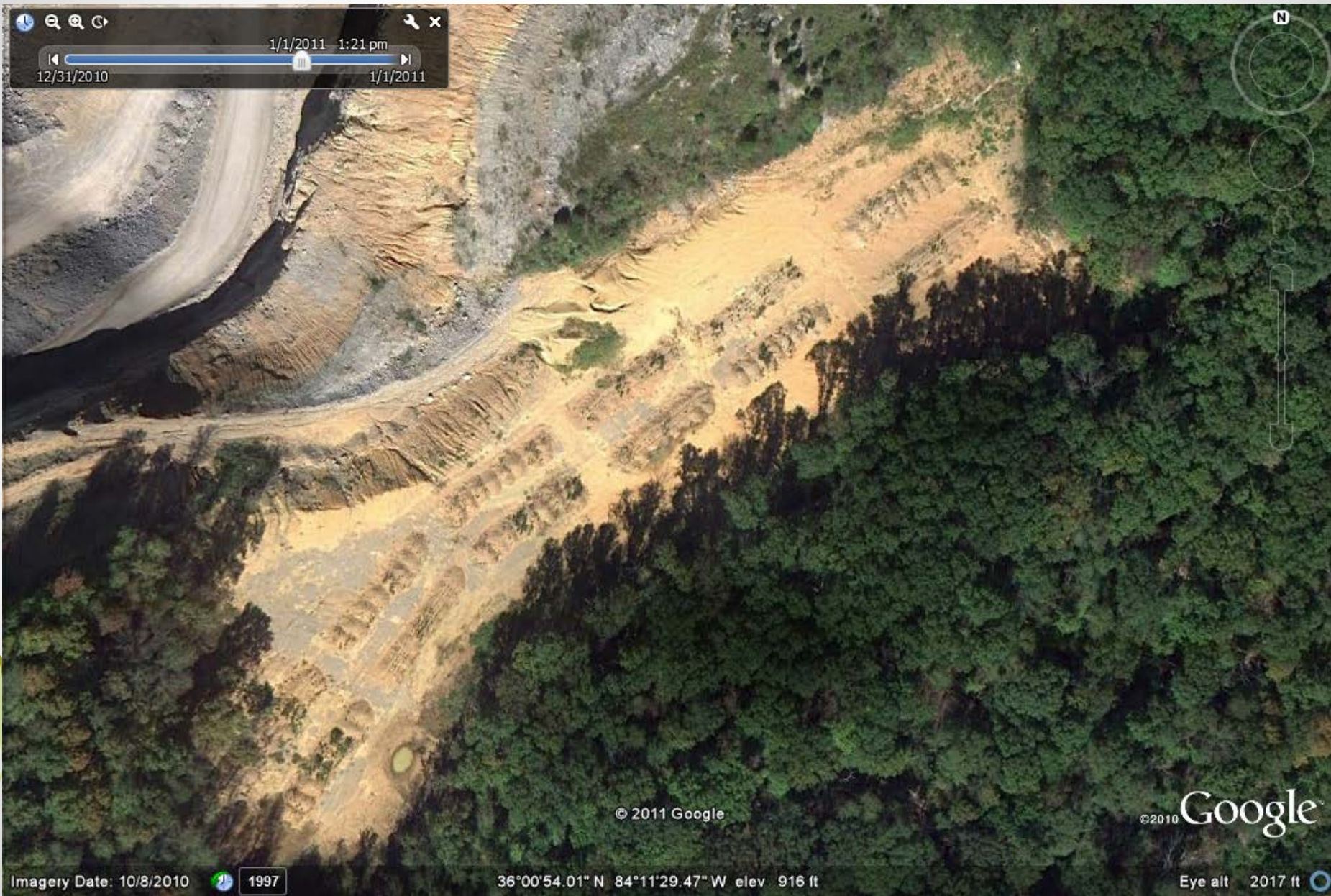
Study site: Roger's Quarry, Oak Ridge, TN





Image U.S. Geological Survey
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1/1/2011 1:21 pm
12/31/2010 1/1/2011

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Imagery Date: 10/8/2010 1997

36°00'54.01" N 84°11'29.47" W elev 916 ft

Eye alt 2017 ft

Overburden being removed from center background, valley fill in center foreground



End-dumped
overburden over
compacted base

Established in May
2009



Soil properties

P	0.4 %
K	54.2 ppm
Ca	3626
Mg	1854
Zn	17.3
Cu	0.4
Fe	3.7
Mn	29.5
Na	18.7
N	BDL



pH 5.1-5.6

66% > 2mm

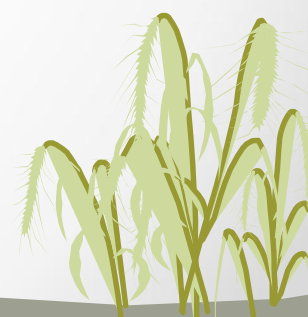
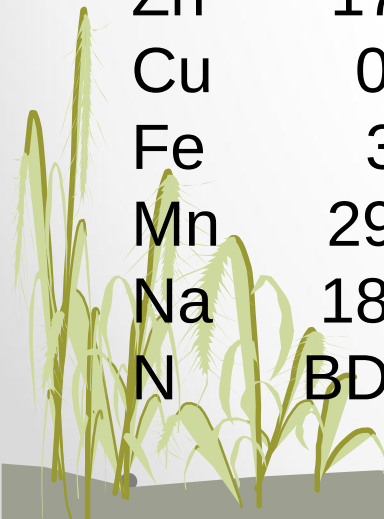
26% sand

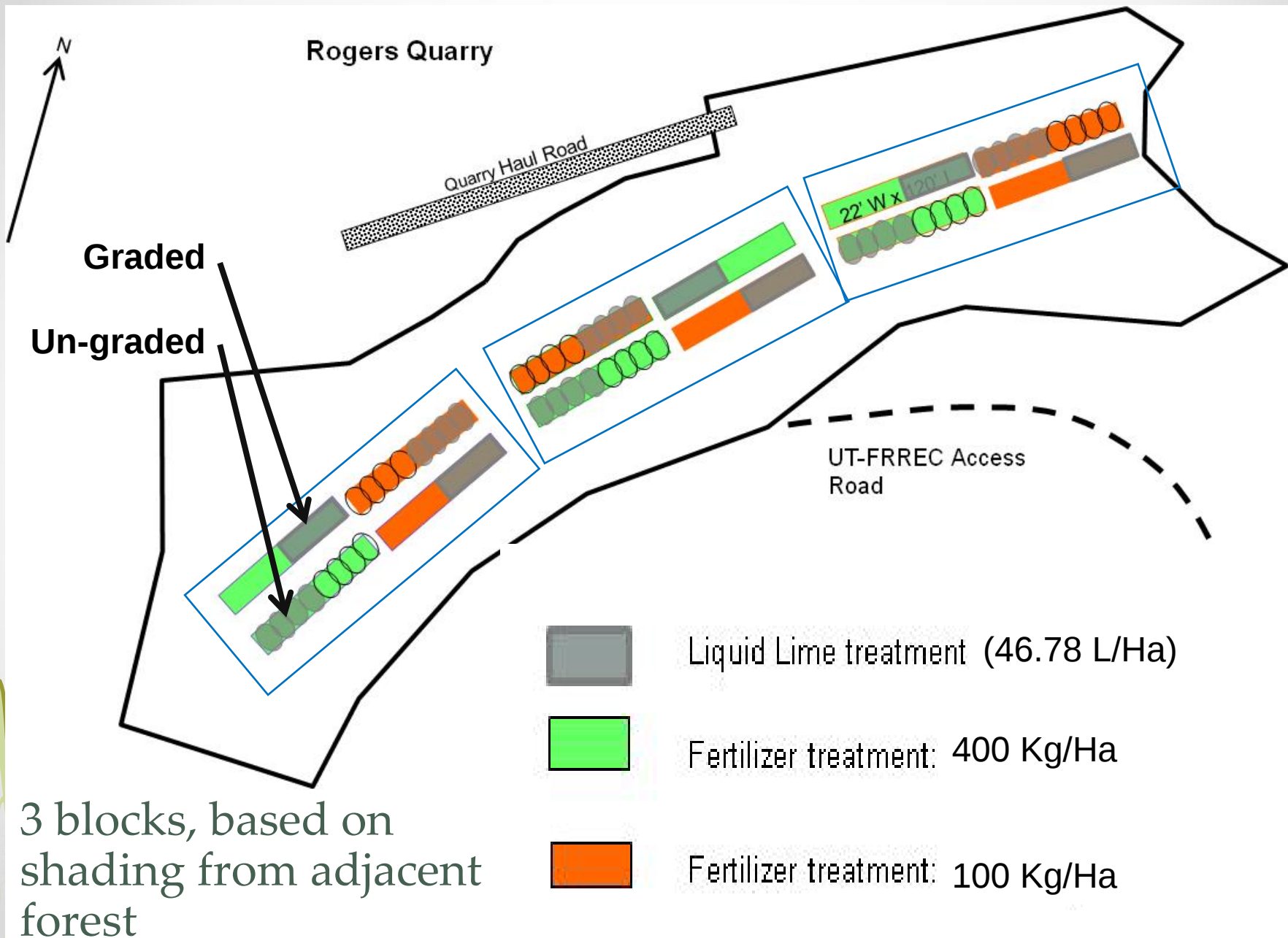
2% silt

6% clay

0.7% organic

Kg/ha





Trees were planted 1 species per sub-plot

white oak
(*Quercus alba*)

shortleaf pine
(*Pinus echinata*)

American Chestnut
(*Castanea dentata*)



No ground cover was seeded



Invasive woody species

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Imagery Date: 10/8/2010



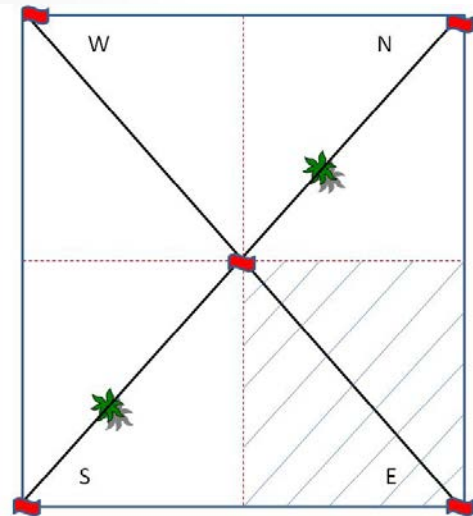
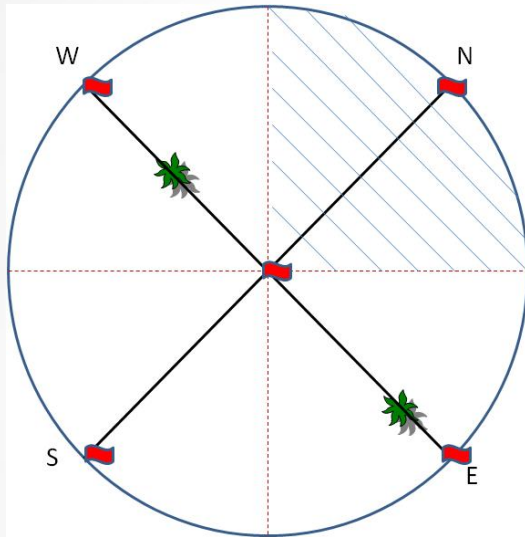
1997

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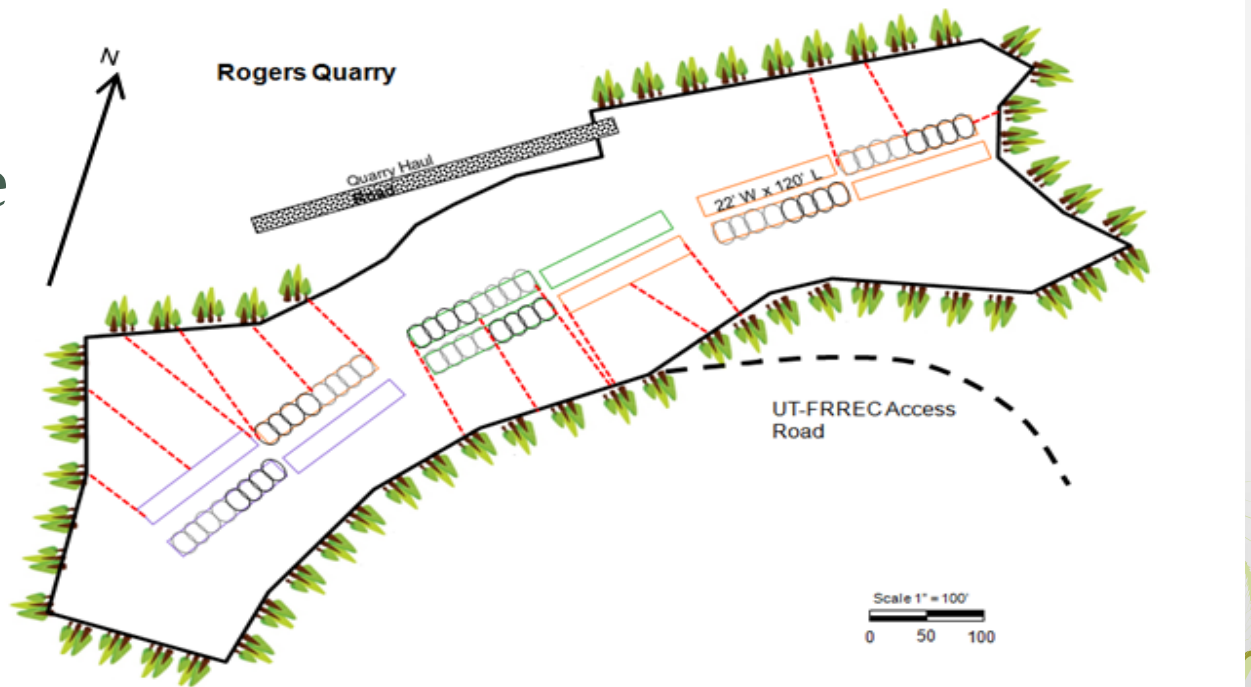
Measurements

Line transects to quantify cover in 2010 and 2011



Measurements

- Soil pH of each plot was tested two times per year. After 1 year there was no longer an effect of lime on pH, and it was re-applied in May 2010.
- Soil temperature and soil moisture at 15 mm depth were measured twice per month during the 2010 growing season
- The distance from each plot to forest edge was measured

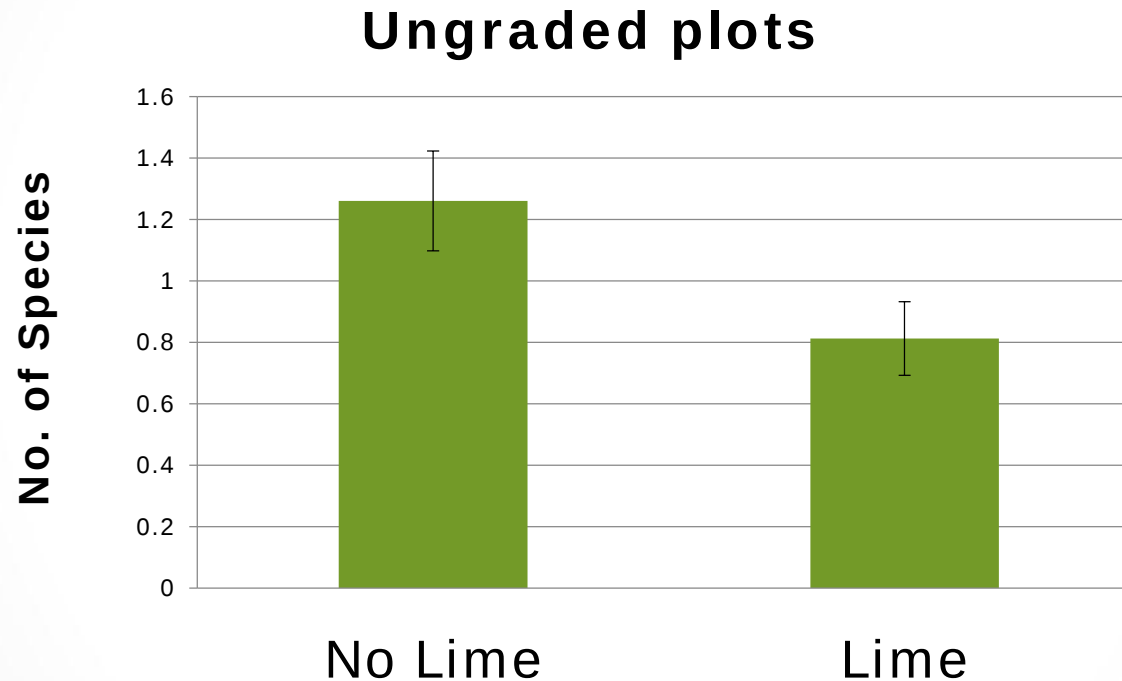


Analysis

- General linear model to test for main effects of lime treatment, fertilizer treatment, grading, and aspect (ungraded plots only), on the percentage of ground cover and number of colonizing species. Interactions were tested where main effects were significant.
- Linear regression was used to test the some of the parameters measured such as the number of colonizer species, microtopography and distance to the forest edge.

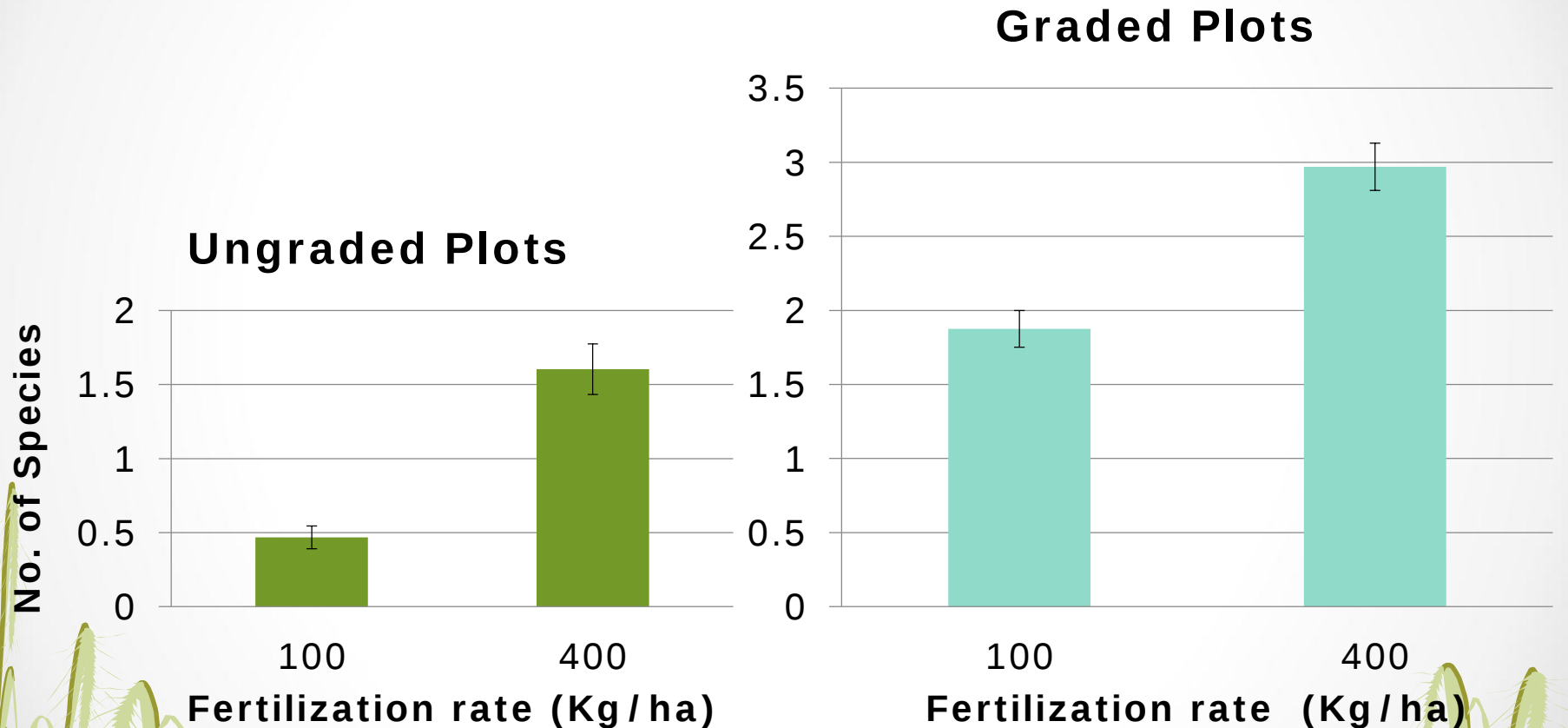


Effect of lime application on the number of volunteer species per plot after 1 growing season

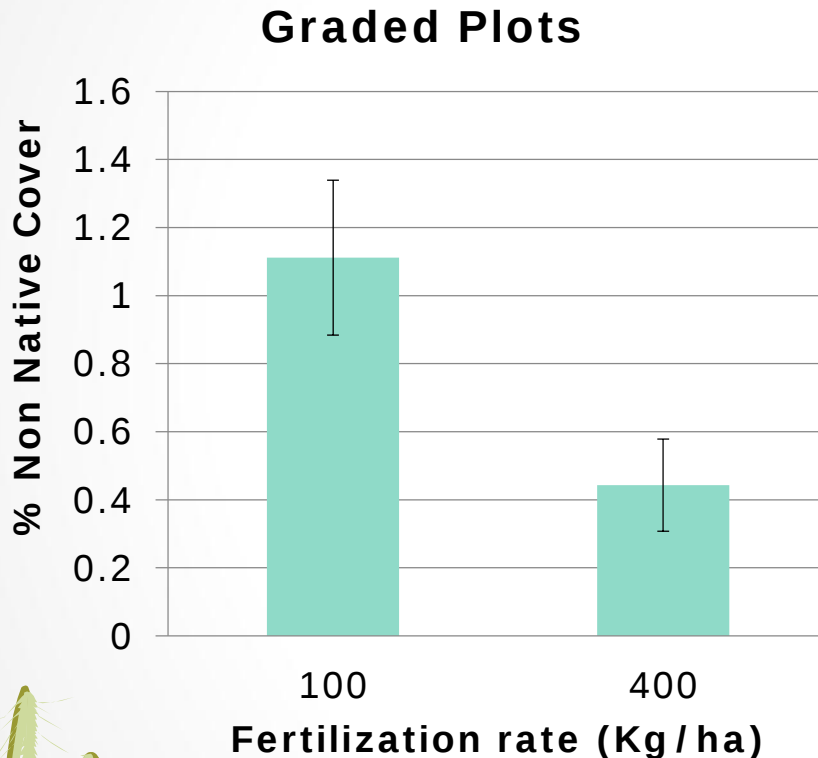


There was no effect of lime application on volunteer colonization of graded plots

Effect of lime application on the number of volunteer species per plot after 1 growing season



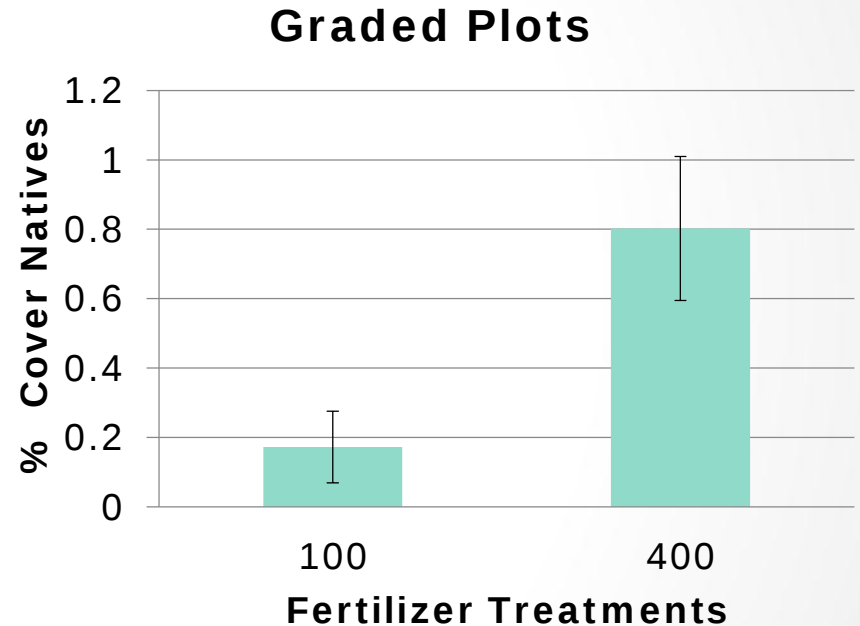
More non-native species were present on plots with a low fertilization rate



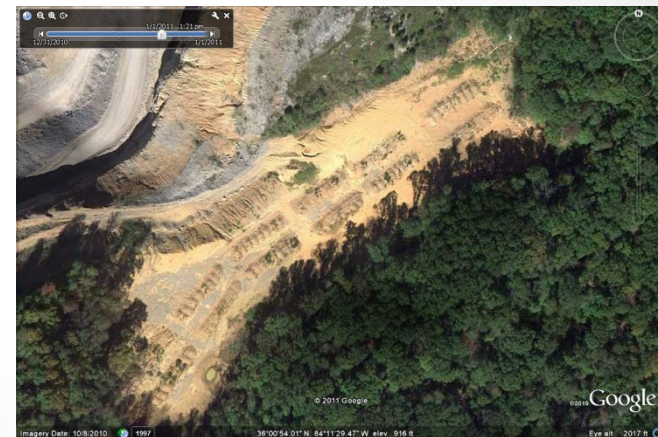
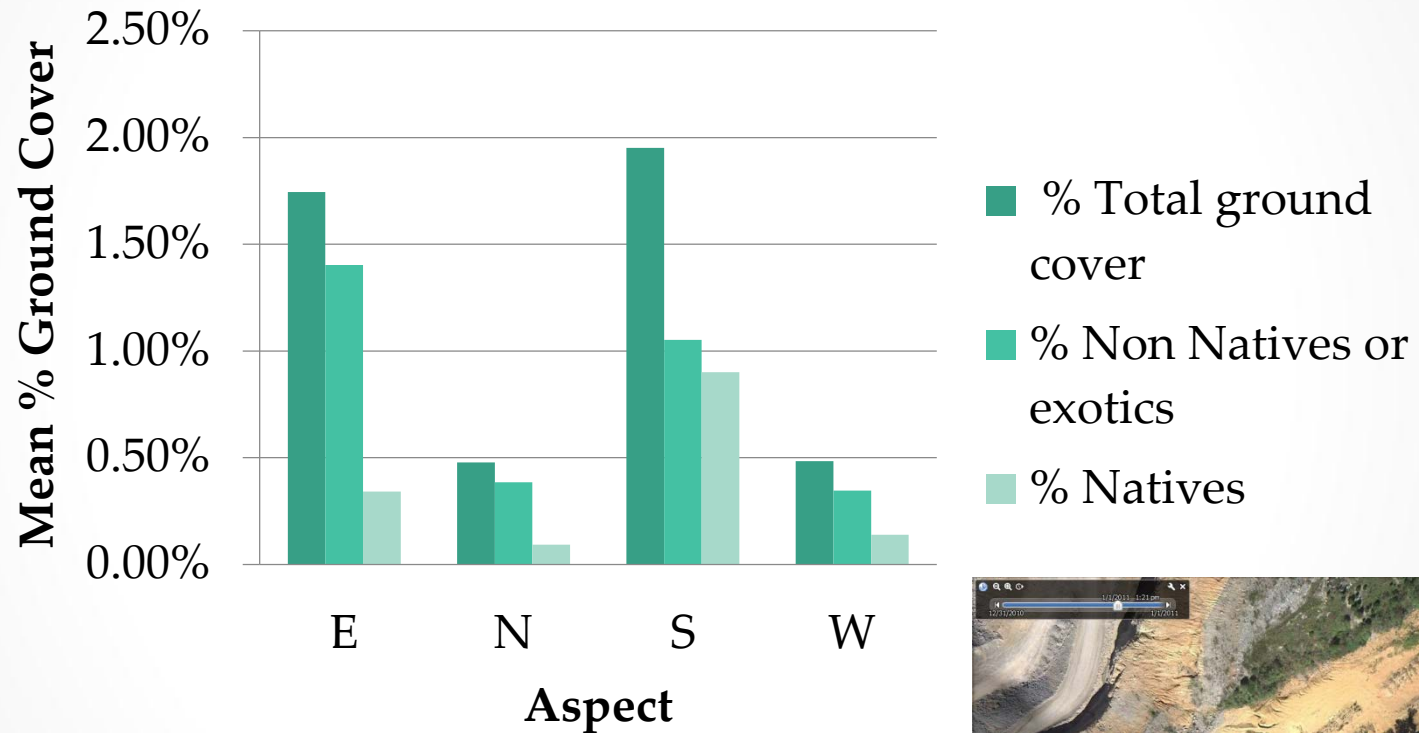
- Coltsfoot (*Tussilago farfara*)
- Tree of heaven (*Ailanthus altissima*)
- Sowthistle (*Sonchus arvensis*)
- Russian olive (*Elaeagnus angustifolia*)
- Green foxtail (*Setaria viridis*)

More native species were present on plots with a higher fertilization rate

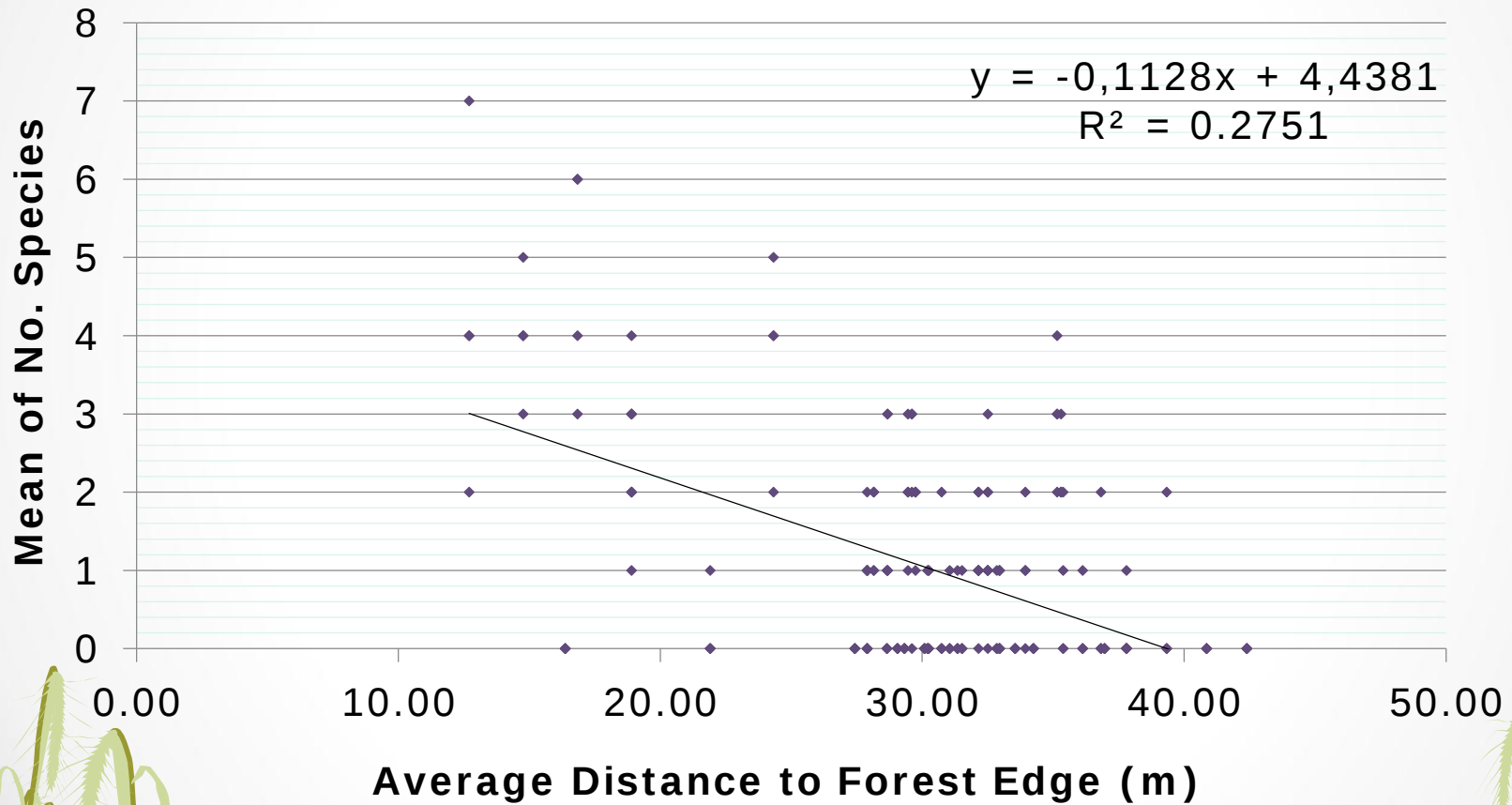
- Fireweed (*Erechtites hieracifolia*)
- Goldenrod (*Solidago* species)
- Yellow poplar (*Liriodendron tulipifera*)



Effect of aspect on volunteer establishment on un-graded plots



Colonization with respect to distance from intact forest, graded plots



Conclusions

Higher fertilization rates promote the establishment of native species.

Intact forest appears to be an important source of volunteer seeds of early successional species, even though the forest is dominated by later successional species.

The effect of the forest edge has become more pronounced over time.



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