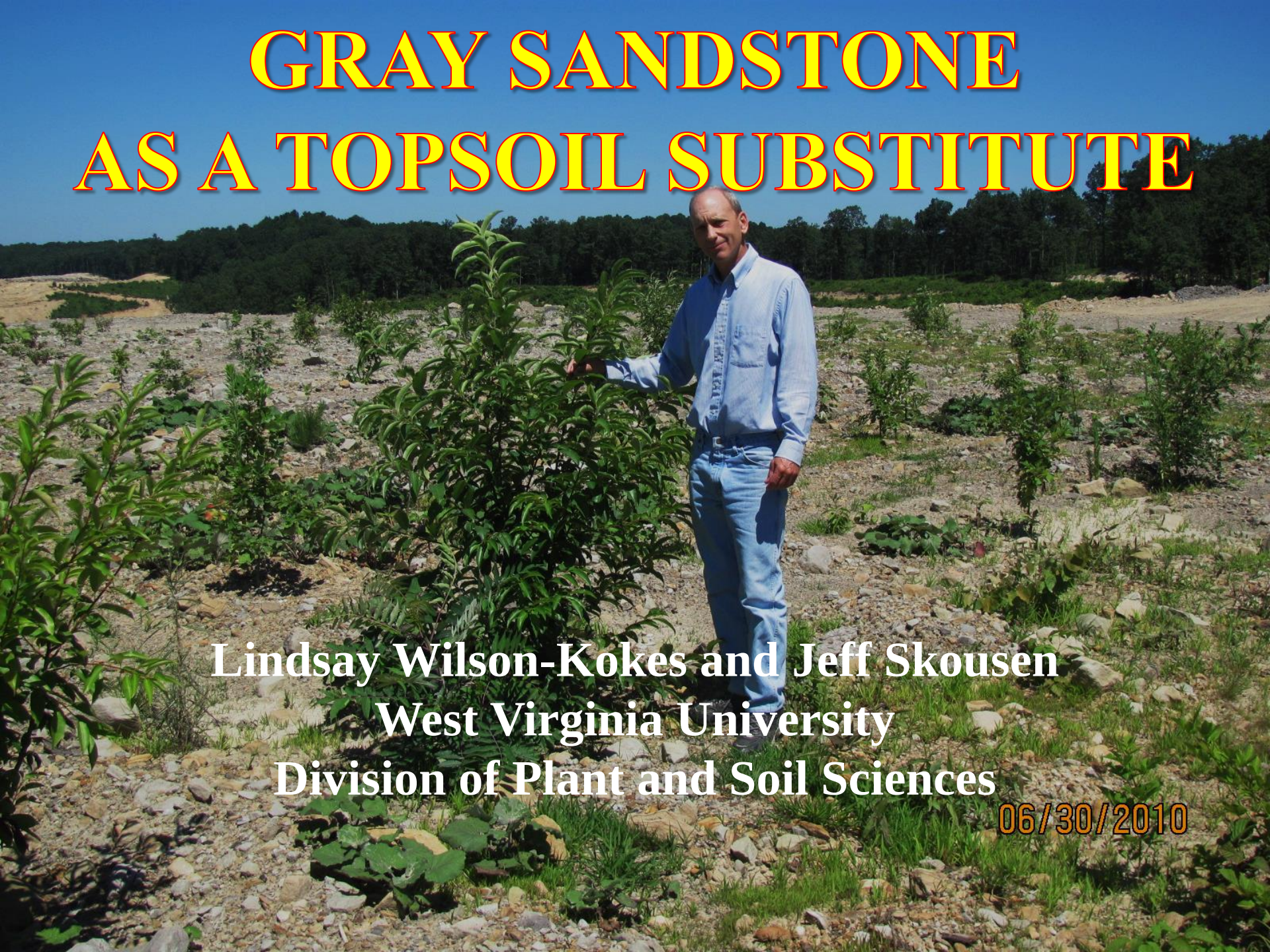
GRAY SANDSTONE AS A TOPSOIL SUBSTITUTE



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Coal Mining in Appalachia for decades
Appalachia primarily forested
1950s dragline

Early mining methods were suitable for tree re-colonization

Good Substrate
No Grading
No Competing Vegetation


Some of these old mined sites have the best tree growth!


Old uncompacted contour jobs…


…readily reverted back to trees!

1977 - Surface Mining Control and Reclamation Act (SMCRA)

Act was intended to:

- Enhance human safety
- Control erosion
- Improve water quality
- Return the land to AOC

Land was largely put back to pasture and hay land with soil compaction and heavy seeding rates to meet regulations


SMCRA interpretation led to most post mined land being reclaimed to pasture and hayland
Economic benefit from grazing and hay production

Reclamation evolved into large tracts of pasture


But if the land is not managed in a pasture or hayland use ..
Heavy groundcover and Compaction
resulted in
Grass and Invasive Shrub Wasteland


Unmanaged Hay land or Pasture
Post Mining Land Use
Good for What?
How long to go back to Forest?

Develop Forests on Mined Lands!

Benefits of reforestation include:

- **wildlife habitat**
- **commercial wood production**
- **improve ecosystem diversity**
- **ecosystem services**

ARRI!
Reforestation Initiative
Forestry Reclamation Approach

The 5 Steps of FRA

1. Create a suitable rooting medium...
2. Loosely grade the rooting medium...
3. Use compatible ground covers...
4. Plant two types of trees…
5. Use proper tree planting techniques.

Demonstration Plots

Brown Sandstone

Gray Sandstone


Gray Plot
7 acres each
Brown Plots

RESULTS: Trees

2012 (8th Yr) average tree growth and survival

Treatment	Volume Index	Survival
	-----cm^3-----	------%------
1.5-m BC	3556 a	84
1.5-m BNC	5182 a	75
GC	449 b	83
GNC	309 b	31

Growth after 2 years – Brown

Growth after 2 years - Gray

Growth after 5 years – Brown

Growth after 5 years - Gray

Growth after 6 years - Brown

Growth after 6 years - Gray


Growth after 8 years - Brown
08/08/2012

Growth after 8 years - Gray

RESULTS: Soil

	1.5 BC	1.5 BNC	GC	GNC
Property	---------- su ----------			
pH	5.6 a	5.7 a	7.9 b	8.0 b
	---------- dS/m ----------			
EC	0.05	0.03	0.04	0.06
	---------- % ----------			
Fines	69 a	68 a	41 b	36 b

*Means within row with the same letter are not significantly different at $P < 0.05$

RESEARCH OBJECTIVE

- **Determine tree growth on three gray sandstone plots with varying compaction and compare them to tree growth on a brown sandstone plot.**

- **Soil chemical properties.**

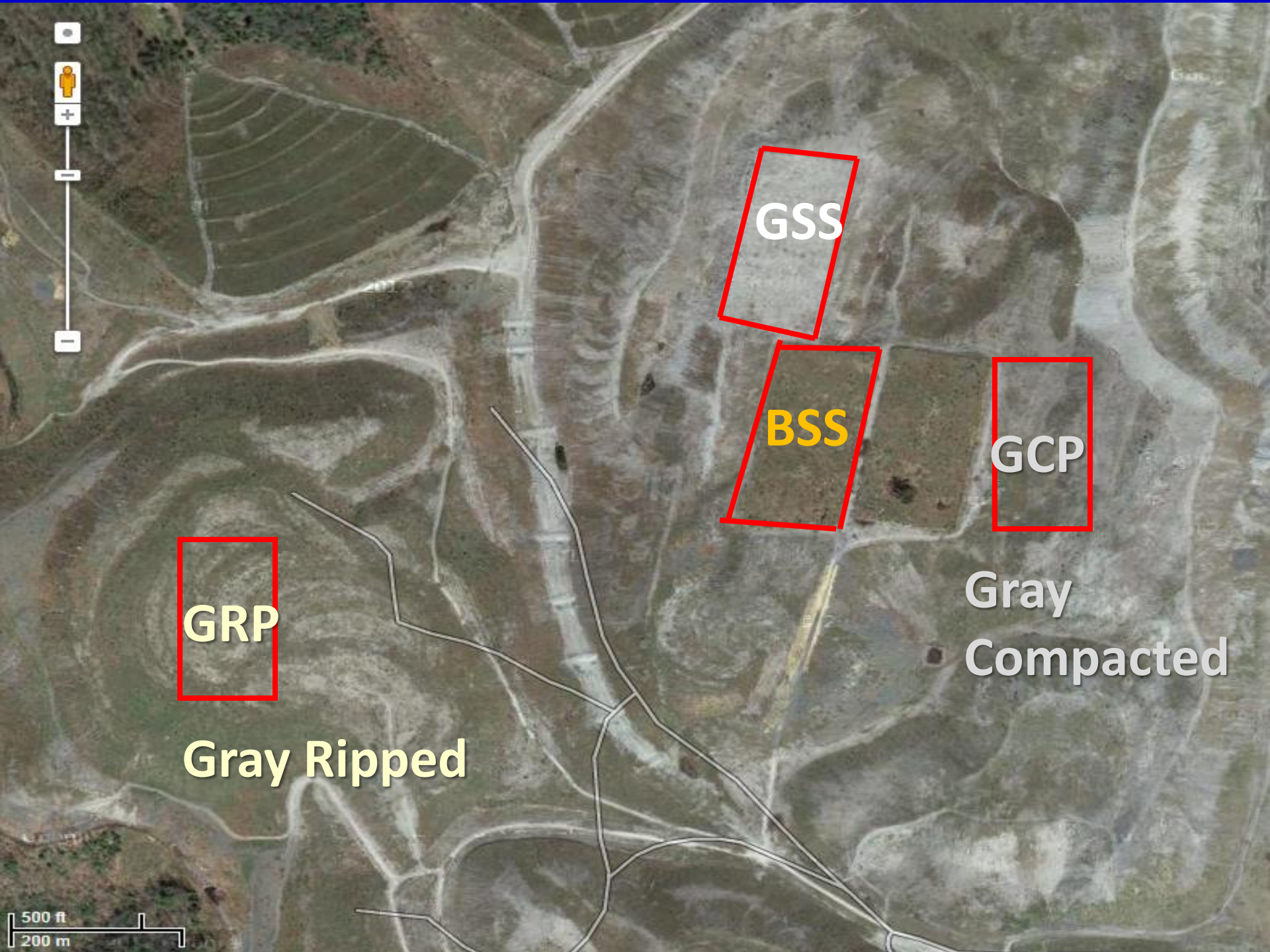
STUDY SITE


Morgantown
Charleston
Samples Mine
Beckley
50 KM
50 Miles
geology.com

Demonstration Plots

Brown Sandstone

Gray Sandstone


GSS
BSS
GCP
GRP
Gray
Compacted
Gray Ripped
500 ft
200 m

EXPERIMENTAL DESIGN

2005:

- Four 2.8-ha plots established.
  - Brown sandstone (BSS) with native topsoil and compacted with a bulldozer.
  - Two compacted gray sandstone plots; one more than the other (GSS and GCP).
  - One gray sandstone plot that was compacted and then ripped (GRP).

- Eleven 2-year-old tree seedlings planted.

EXPERIMENTAL DESIGN

2007:

- **Plots hydroseeded with tree compatible ground cover at a rate of 15.4 kg ha^{-1}.**

- **Plots fertilized with 10-10-10 N-P_2O_5-K_2O at a rate of 440 kg ha^{-1}.**

Tree Species Planted

Species	Total # Planted	% of total planted
Red Oak	3,400	22
White Oak	2,500	16
White Ash	2,500	16
Sugar Maple	1,500	10
Chestnut Oak	1,250	8
Tulip-Poplar	1,250	8
White Pine	1,250	8
Black Locust	465	3
Black Cherry	465	3
Redbud	465	3
Dogwood	465	3
Total	15,510	100 %

EXPERIMENTAL DESIGN

Hydroseeding rate by forage species

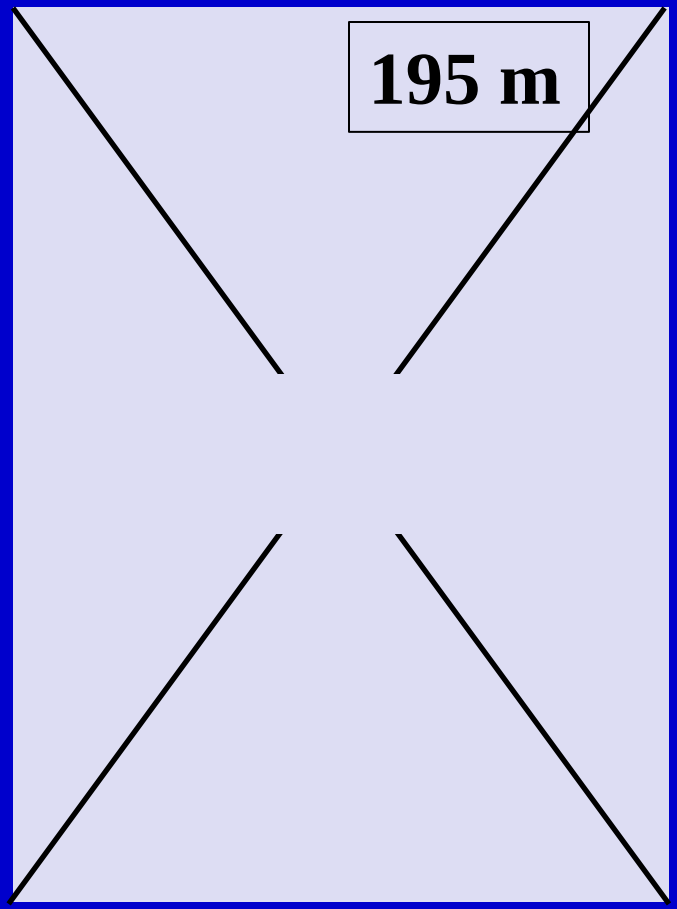
Rate of Application	
Species	**Rate (kg/ha)**
Birdsfoot trefoil	11.0
Perennial ryegrass	2.2
Redtop	2.2
Total	15.4

EXPERIMENTAL DESIGN

➢ Tree sampling method:

- Two, 2.7-m wide by 195-m long transects.

- Species, height, and diameter recorded.



SOIL CHEMICAL ANALYSIS

- Top 15 cm of the soil was collected
- Five randomly selected points along each transect within each plot.
- pH, extractable nutrients, and electrical conductivity

STATISTICAL ANALYSIS

- One-way ANOVA was used to compare…
  - tree growth by plot.
  - soil pH, EC, extractable nutrients, and % fines by plot.
- Tukey's HSD test used to determine significant difference at $p<0.05$ level.

RESULTS: Soil

	GSS	GCP	GRP	BSS
	su			
pH	7.9 a*	7.4 a	7.3 a	5.4 b
	dS m^{-1}			
EC	0.05	0.12	0.08	0.04
	%			
Fines	39 a	30 a	76 b	73 b

*Means within row with the same letter are not significantly different at $P < 0.05$

Brown Sandstone

Gray Sandstone

RESULTS: Trees

	GSS	GCP	GRP	BSS
	---------- cm^3 ----------			
Volume Index	407 a*	909 a	885 a	3108 b
	---------- cm ----------			
Height	70 b	83 ab	91 a	137 c

*Means within row with the same letter are not significantly different at $P < 0.05$

GCP – 8th Year

GRP – 8th Year

GSS – 8th Year

BSS – 8th Year

White oak on GCP

White pine and white oak on GRP

White pine and white oak on GSS

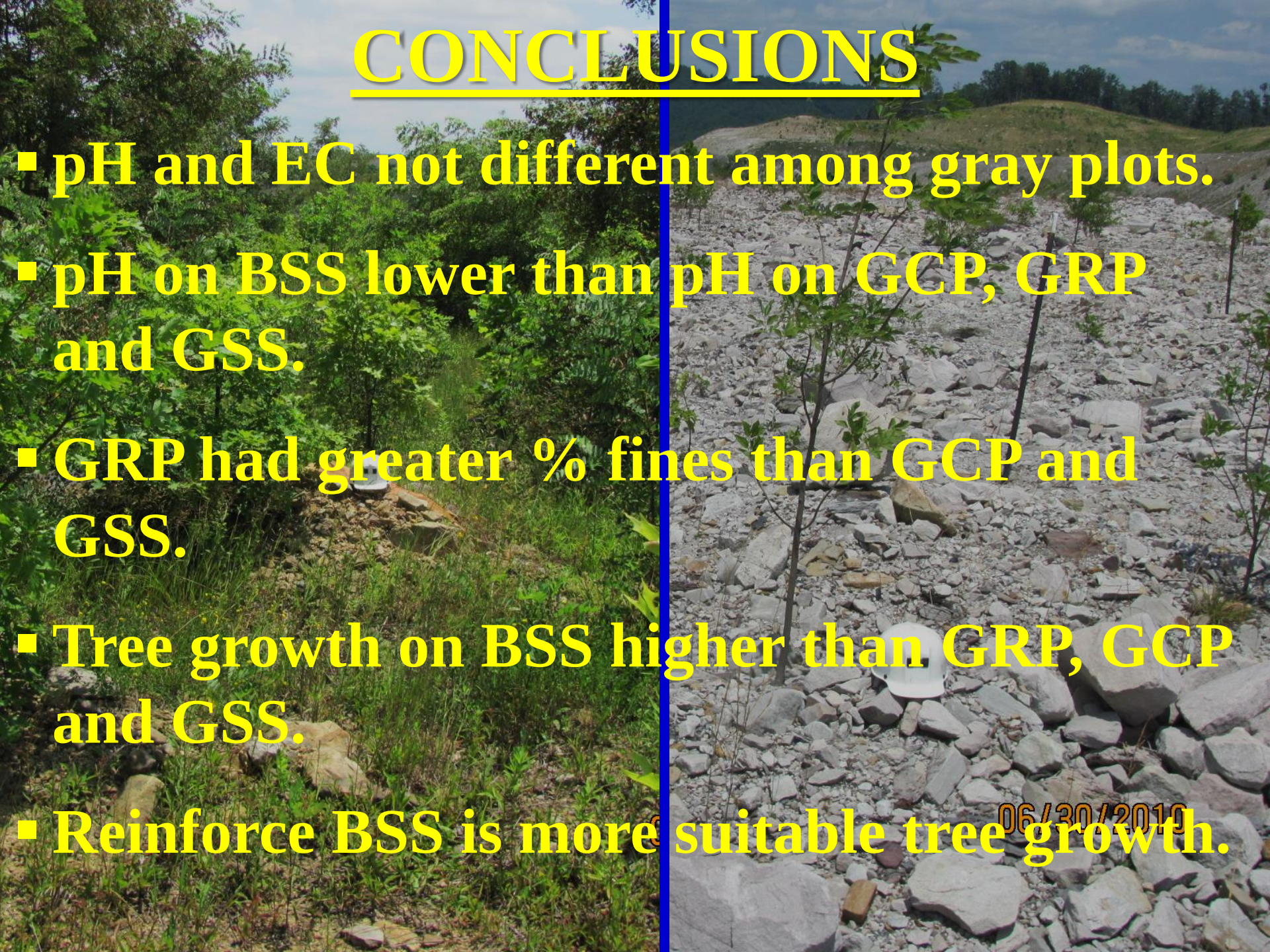
White oak

BSS

GSS

CONCLUSIONS

- pH and EC not different among gray plots.
- pH on BSS lower than pH on GCP, GRP and GSS.
- GRP had greater % fines than GCP and GSS.
- Tree growth on BSS higher than GRP, GCP and GSS.
- Reinforce BSS is more suitable tree growth.



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QUESTIONS???