Native vegetation in reclamation:

Improving habitat and ecosystem function through using prairie species in mine land reclamation

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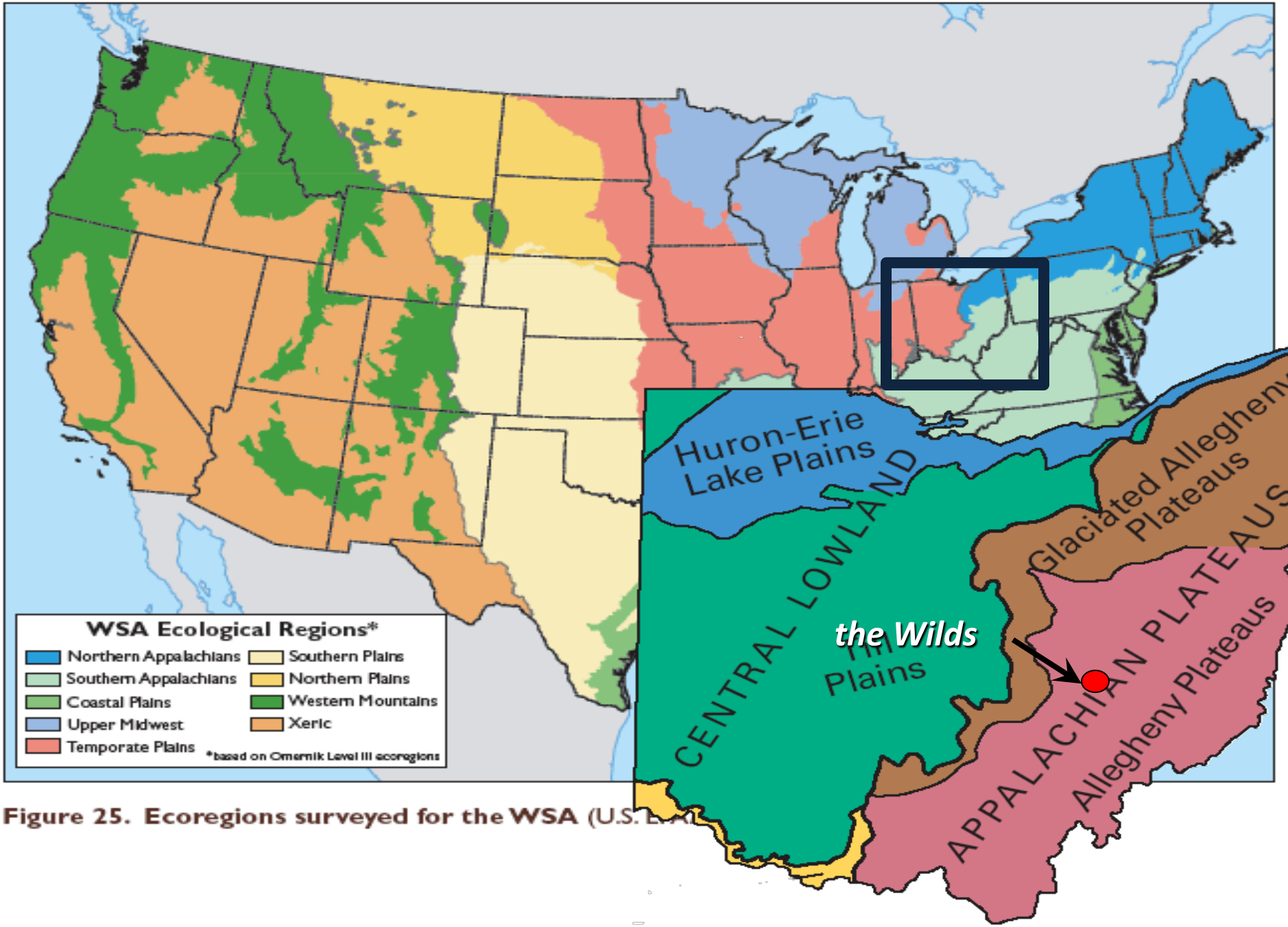


Figure 25. Ecoregions surveyed for the WSA (U.S. EPA

How The Wilds was born…

- Land donated by AEP
- 10,000 acres of reclaimed surface-mined land in southeast Ohio

- Non-profit (1984)
- Open to public (1994)

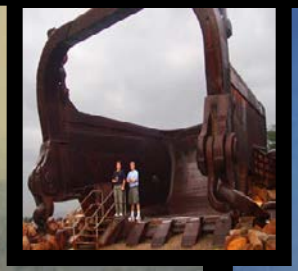
- Today we are one of the largest conservation research & education center in North America







The Wilds Mining Legacy
~ 1940-1984 ~



The Wilds Past

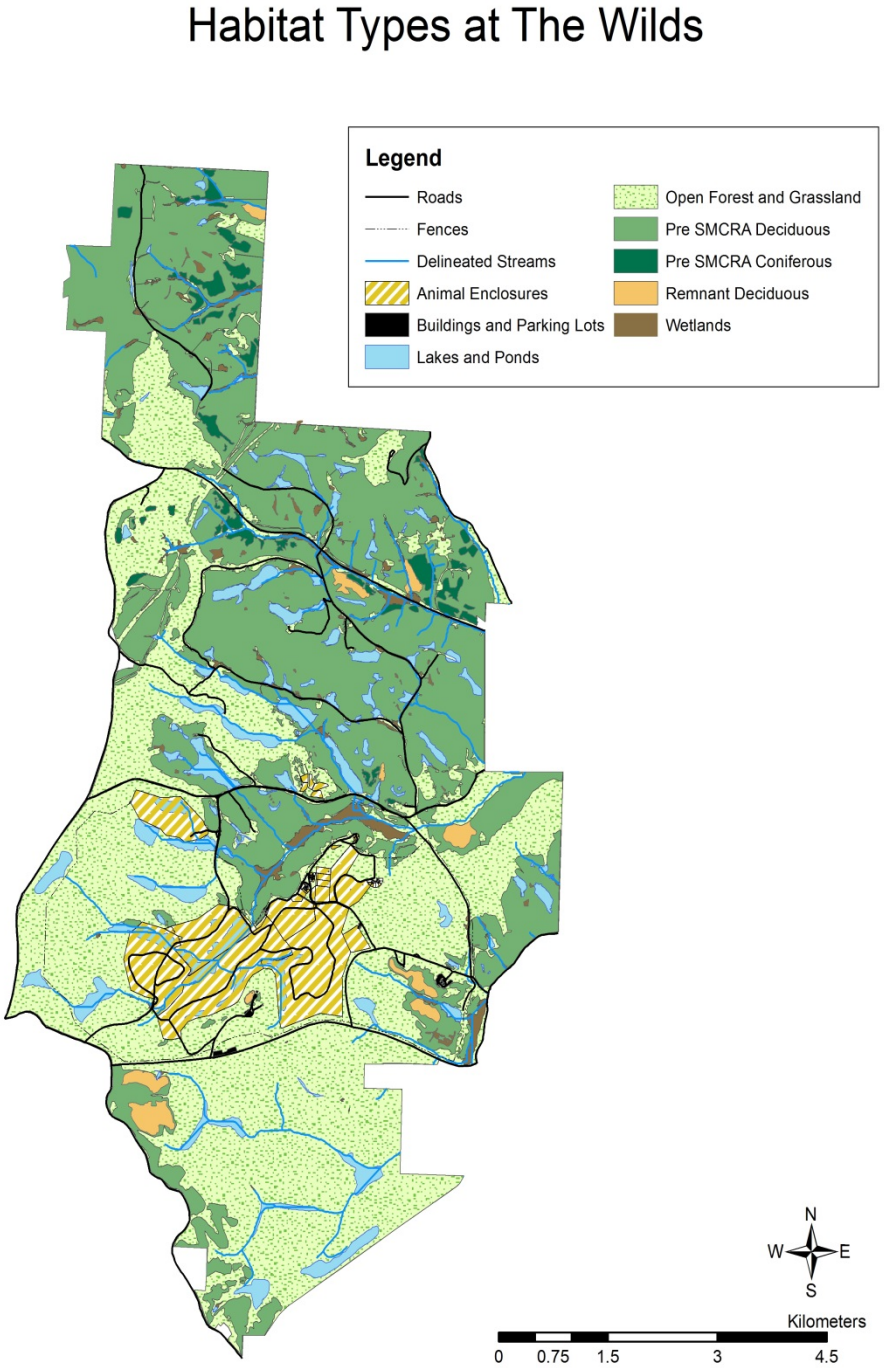
The Big Muskie – Largest Dragline on EARTH During Operation

Mining & Reclamation:

- **Over 90% of the landscape was mined & reclaimed**

Wilds Habitats:

- **Grassland 4,655 ac**
  - **Prairie 672 acres**
- **Forests 3,832 ac**
- **Lakes / Ponds 497 ac**
  - **(125 on site)**
- **Wetlands 165 ac**
- **Animal Pastures 1,200 ac**

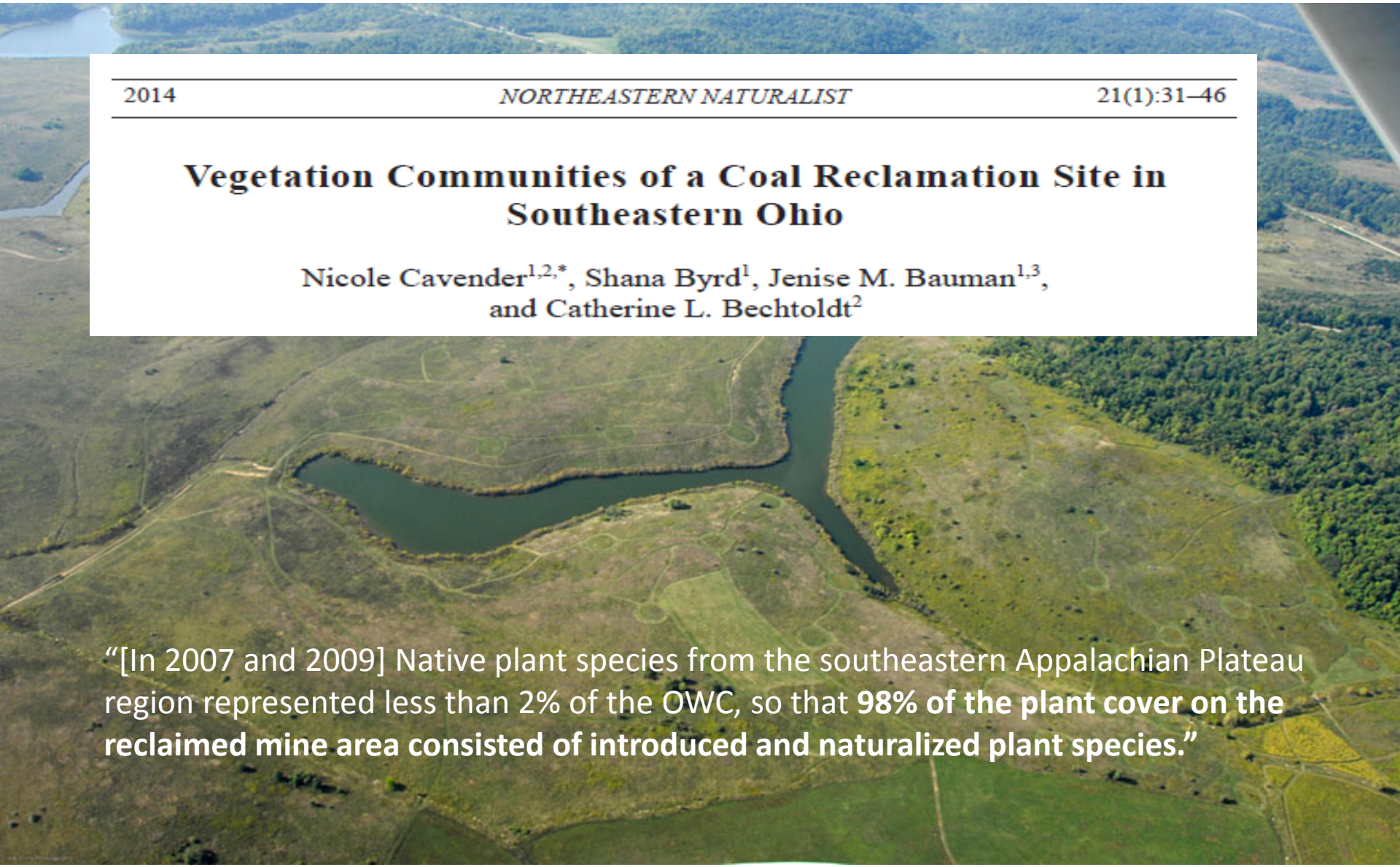


SPECIES PLANTED (lbs/acre)	
KY 31 Fescue	
Orchard Grass	10
Perrenial Rye	10
Ranger Alfalfa	8
Red Clover	5
Blue Grass	8
Ladino Clover	
Sericea Lespedeza	
Mammoth Clover	3
Red Top	
Alsike Clover	2
Timothy	5
Meidan Clover	
Birds foot Trefoil	5


Final product ….
Lush competition on
heavily compacted clay top soil medium

Reclamation

Reclamation



2014 *NORTHEASTERN NATURALIST* 21(1):31–46

Vegetation Communities of a Coal Reclamation Site in Southeastern Ohio

Nicole Cavender[1,2,*], Shana Byrd[1], Jenise M. Bauman[1,3], and Catherine L. Bechtoldt[2]

"[In 2007 and 2009] Native plant species from the southeastern Appalachian Plateau region represented less than 2% of the OWC, so that **98% of the plant cover on the reclaimed mine area consisted of introduced and naturalized plant species.**"

Restoration

- Reforestation

Restoration

- Reforestation

Restoration

- Native Prairies

~~Restoration~~ Ecological Engineering

- Native Prairies

Mitsch (1996) "the design of sustainable ecosystems intends to integrate human society with its natural environment for the benefit of both".


Vegetation removal

No-Till Seed Drill

Ecological Engineering

- Native Prairies

Ecological Engineering

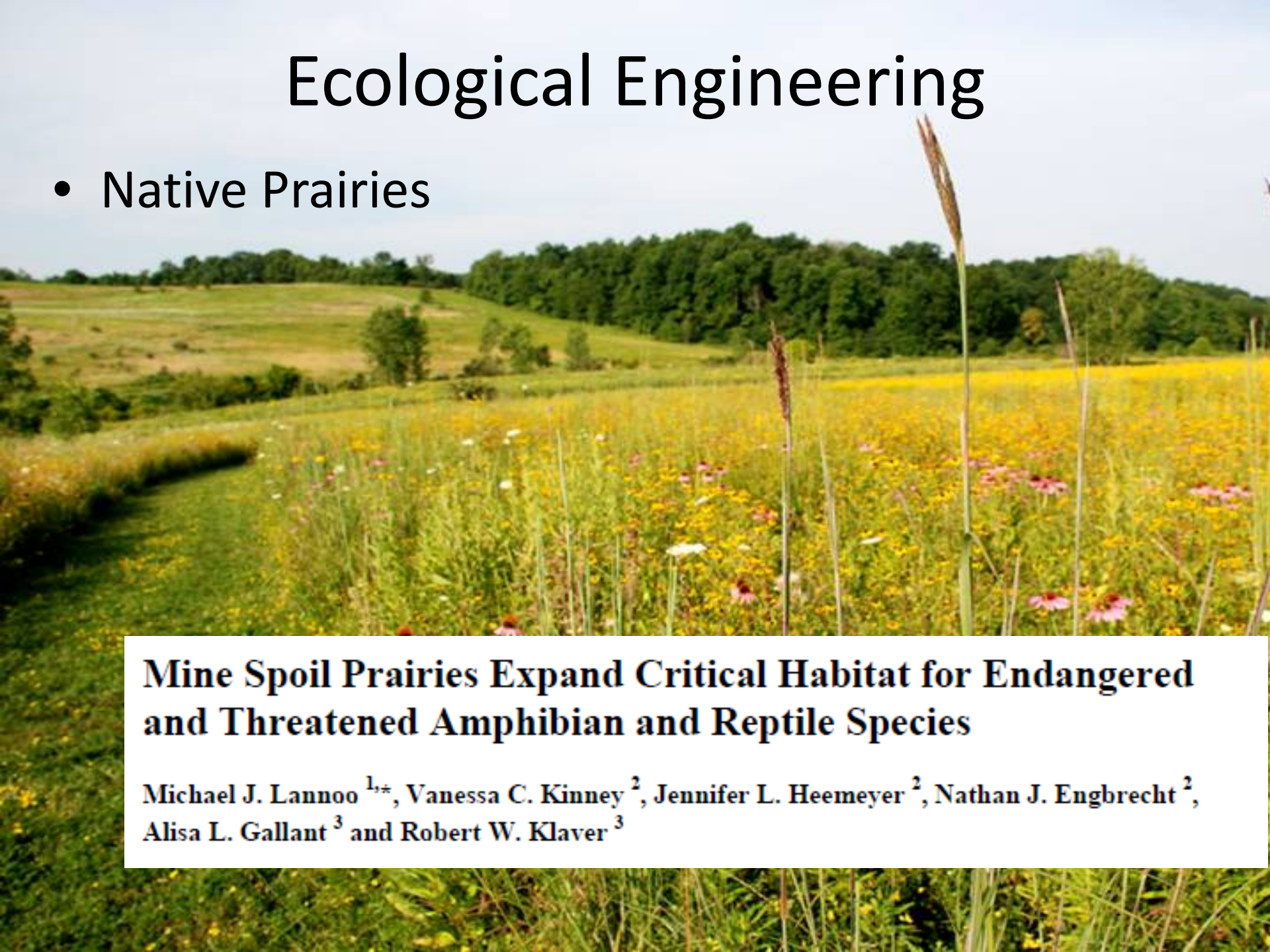
- Invasive grasslands

Ecological Engineering

- Native Prairies

Ecological Engineering

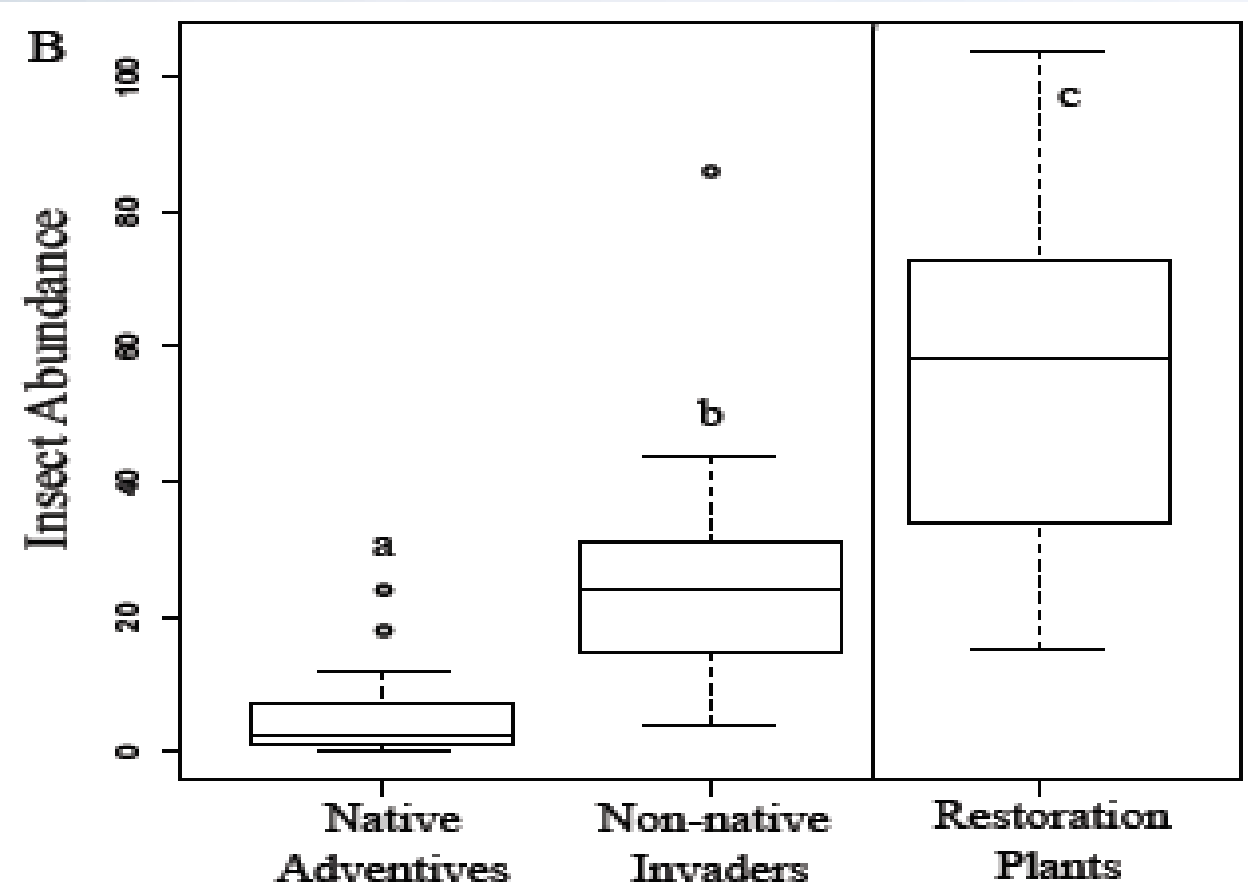
- Native Prairies



Mine Spoil Prairies Expand Critical Habitat for Endangered and Threatened Amphibian and Reptile Species

Michael J. Lannoo [1,*], Vanessa C. Kinney [2], Jennifer L. Heemeyer [2], Nathan J. Engbrecht [2], Alisa L. Gallant [3] and Robert W. Klaver [3]

Ecological Engineering

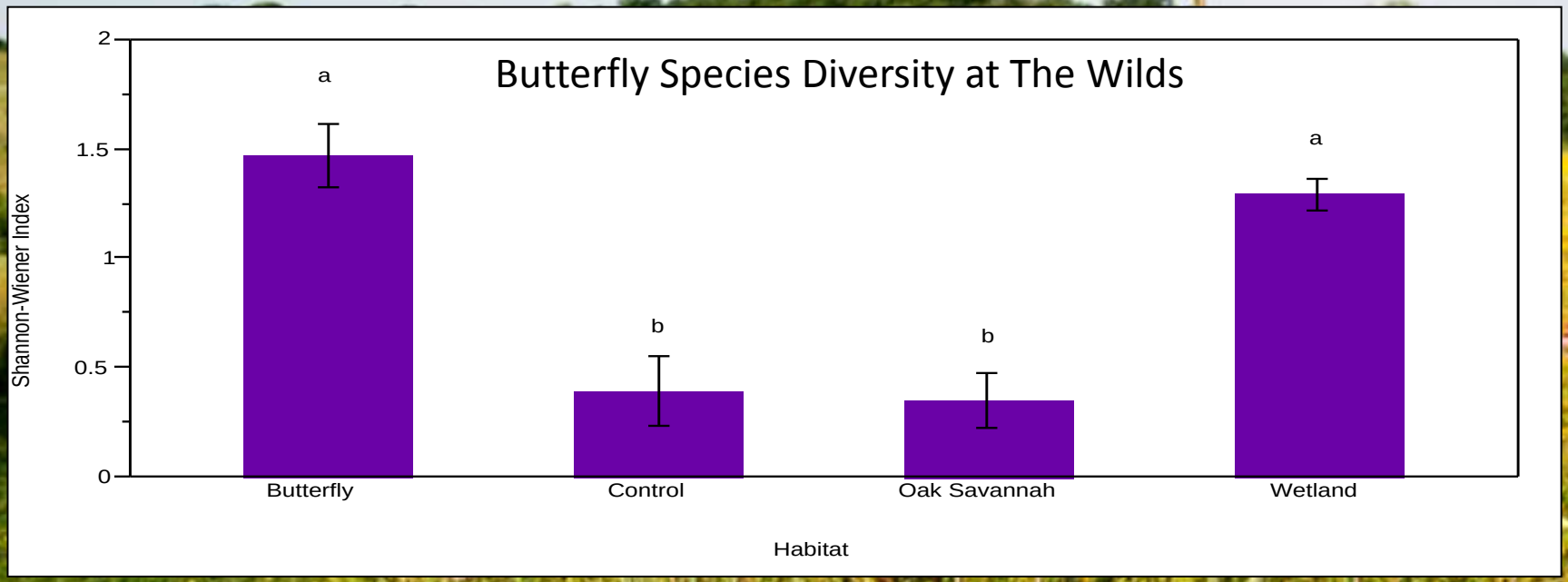


Using a Centrality Index to Determine the Contribution of Restored and Volunteer Plants in the Restoration of Plant-Pollinator Mutualisms on a Reclaimed Strip Mine

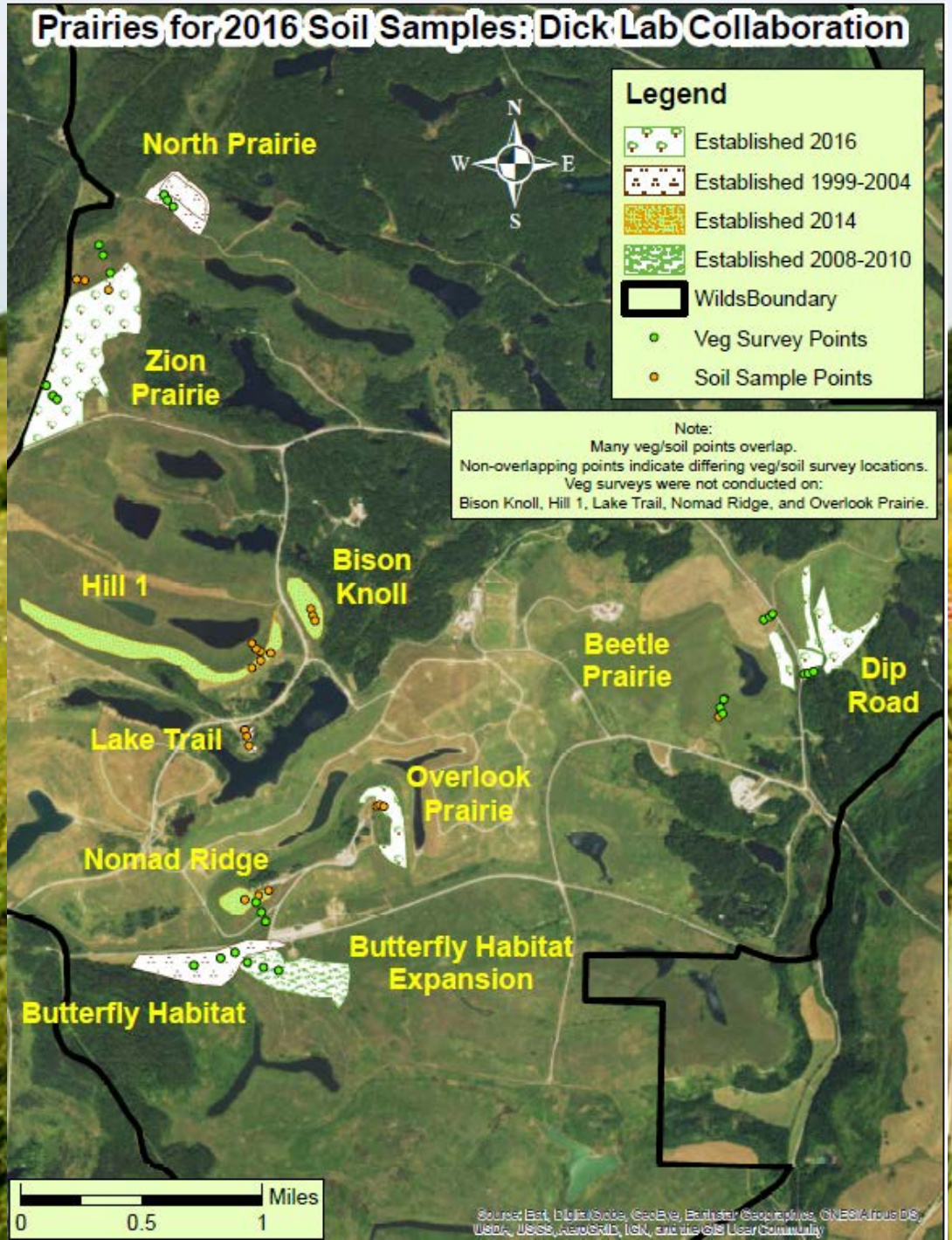
Sarah Cusser and Karen Goodell

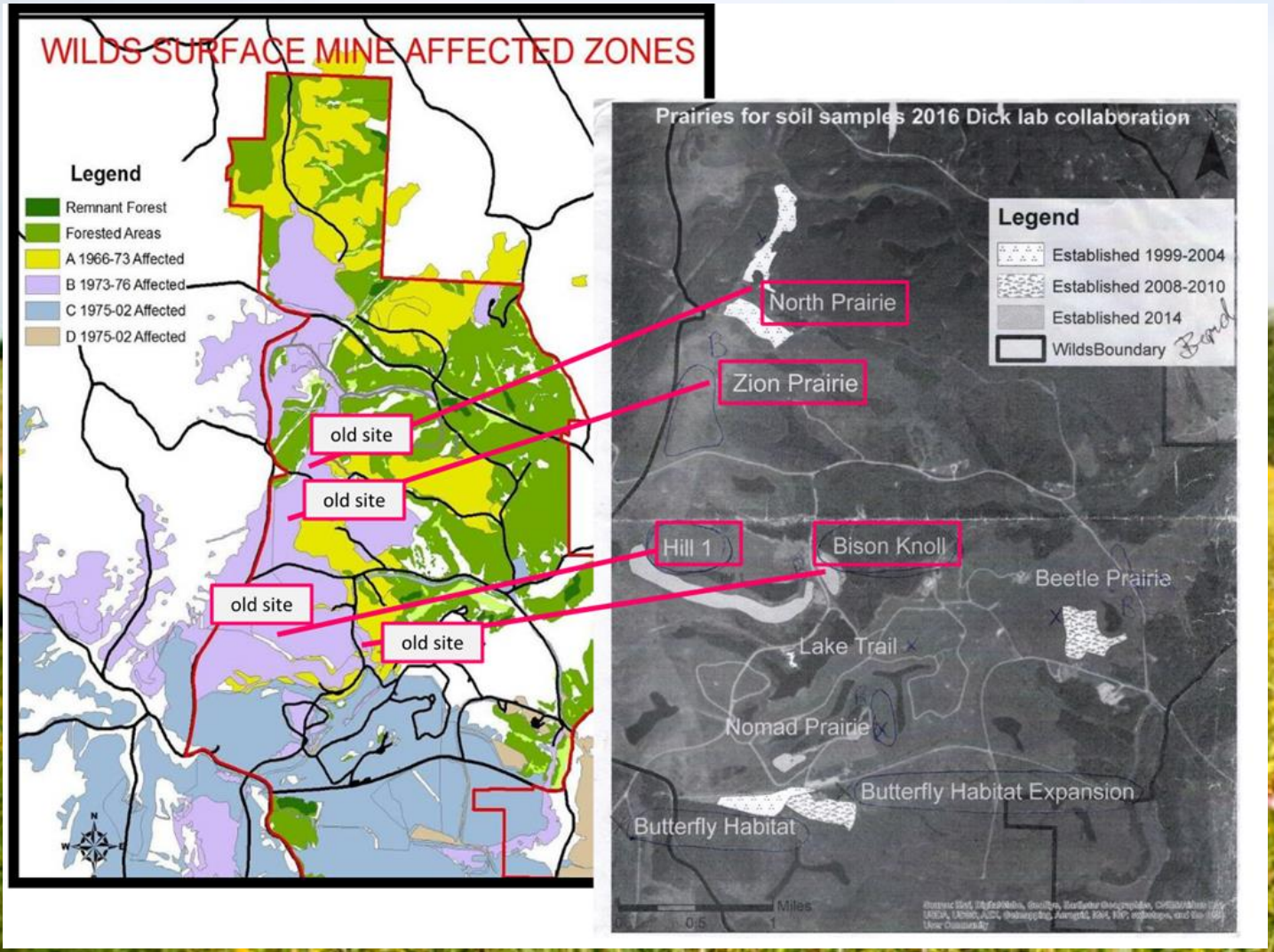
Ecological Engineering

- Native Prairies



Significant increases in butterfly species diversity among restored habitats (*P* = 0.03)

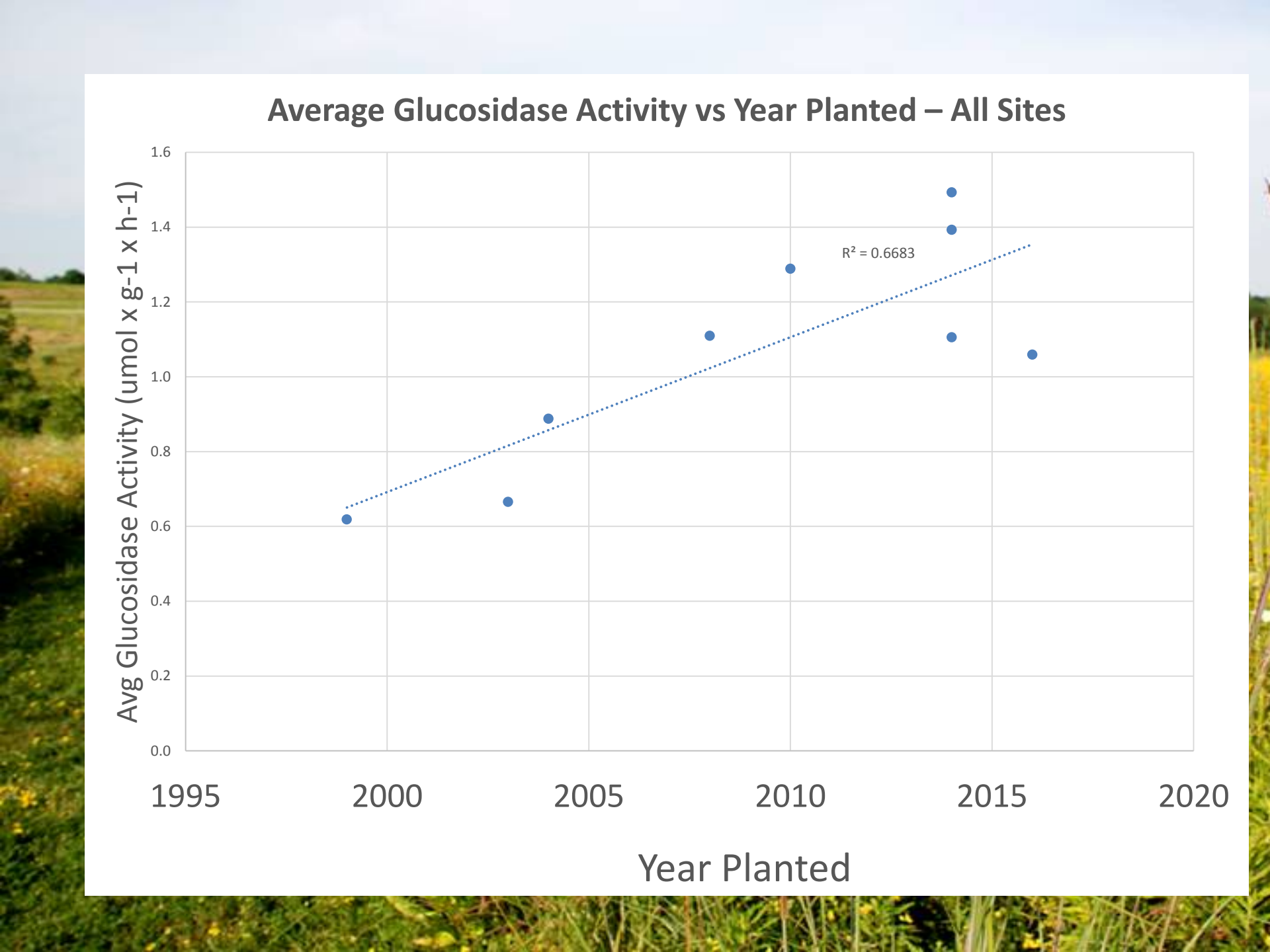

Prairies for 2016 Soil Samples: Dick Lab Collaboration
Legend
Established 2016
Established 1999-2004
Established 2014
Established 2008-2010
WildsBoundary
Veg Survey Points
Soil Sample Points
N
W
E
S
Note:
Many veg/soil points overlap.
Non-overlapping points indicate differing veg/soil survey locations.
Veg surveys were not conducted on:
Bison Knoll, Hill 1, Lake Trail, Nomad Ridge, and Overlook Prairie.
North Prairie
Zion Prairie
Hill 1
Bison Knoll
Beetle Prairie
Dip Road
Lake Trail
Overlook Prairie
Nomad Ridge
Butterfly Habitat Expansion
Butterfly Habitat
Miles
0
0.5
1

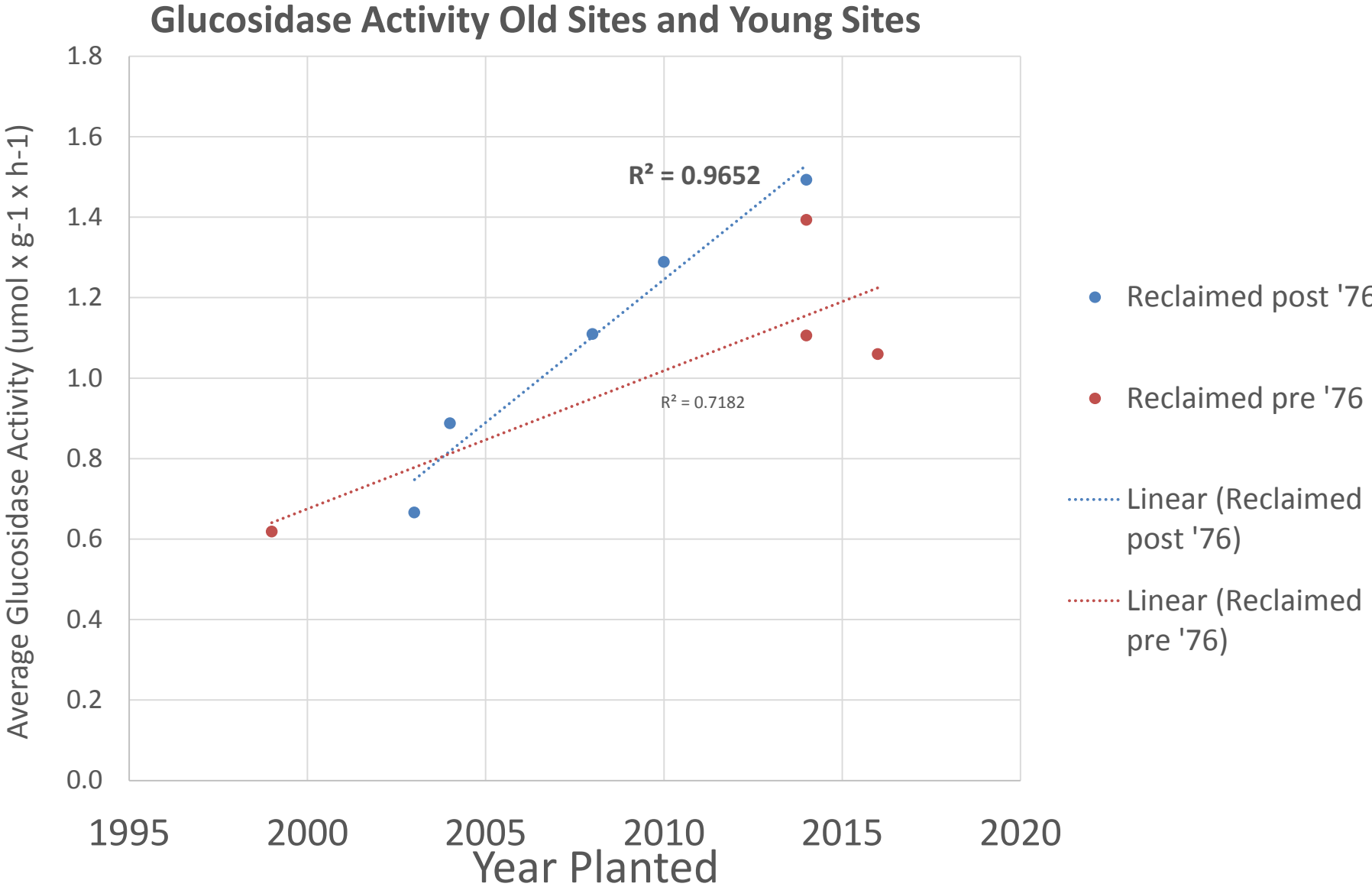


Factors to consider:

Prairie age

Date of reclamation


Average Glucosidase Activity vs Year Planted – All Sites
Avg Glucosidase Activity (umol x g-1 x h-1)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
R² = 0.6683
1995
2000
2005
2010
2015
2020
Year Planted


Glucosidase Activity Old Sites and Young Sites
Average Glucosidase Activity (umol x g-1 x h-1)
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
R² = 0.9652
R² = 0.7182
1995
2000
2005
2010
2015
2020
Year Planted
Reclaimed post '76
Reclaimed pre '76
Linear (Reclaimed post '76)
Linear (Reclaimed pre '76)

Natives in Reclamation

Traditional seed mix for reclamation

Common Name	Scientific Name	Percent of Mix
Orchard Grass	*Dactylis glomerata*	25
Perennial Ryegrass	*Lolium perenne*	20
Timothy	*Phleum pretense*	18
Birdsfoot Trefoil	*Lotus corniculatus*	16
Annual Ryegrass	*Lolium multiflorum*	15
Red clover	*Trifolium pretense*	6

Trial seed mix for reclamation of abandoned mine lands, combining both native and non-native species.

Common Name	Scientific Name	Percent of Mix
Switchgrass	*Panicum virgatum*	18
Indiangrass	*Sorghastrum nutans*	14
Orchard Grass	*Dactylis glomerata*	18
Perennial Ryegrass	*Lolium perenne*	18
Browneyed Susan	*Rudbekia triloba*	>2
Maximillian Sunflower	*Helianthus maximillani*	>1
Common Milkweed	*Asclepias syriaca*	>1
Birdsfoot Trefoil	*Lotus corniculatus*	10
Partridge pea	*Chamechrista fasciculata*	18
Plains Coreopsis	*Coreopsis tinctoria*	>1

Natives in Reclamation

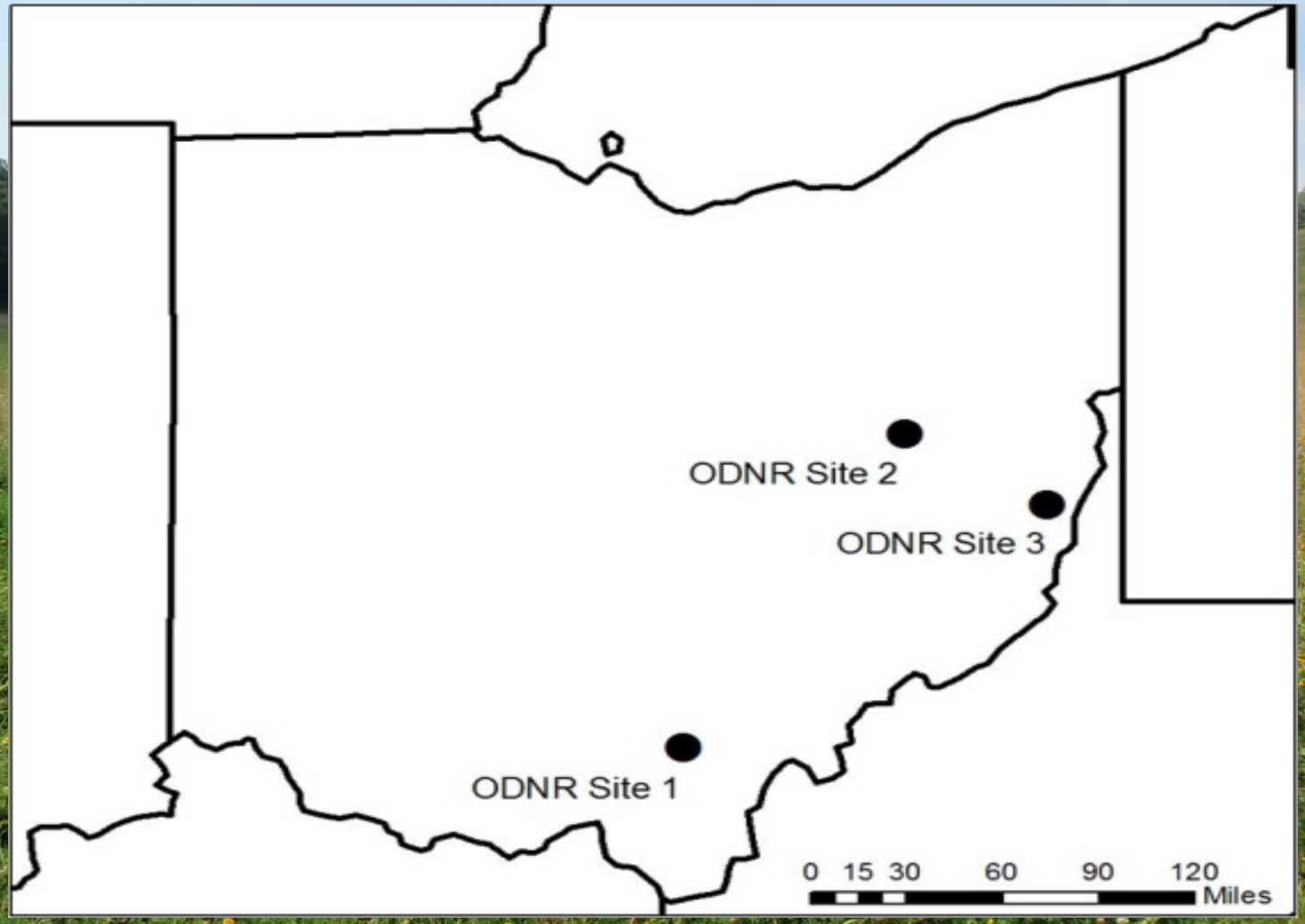


Table 1. Experimental seed trial site information.
Fertilizer rates are all expressed in kg ha^{-1}

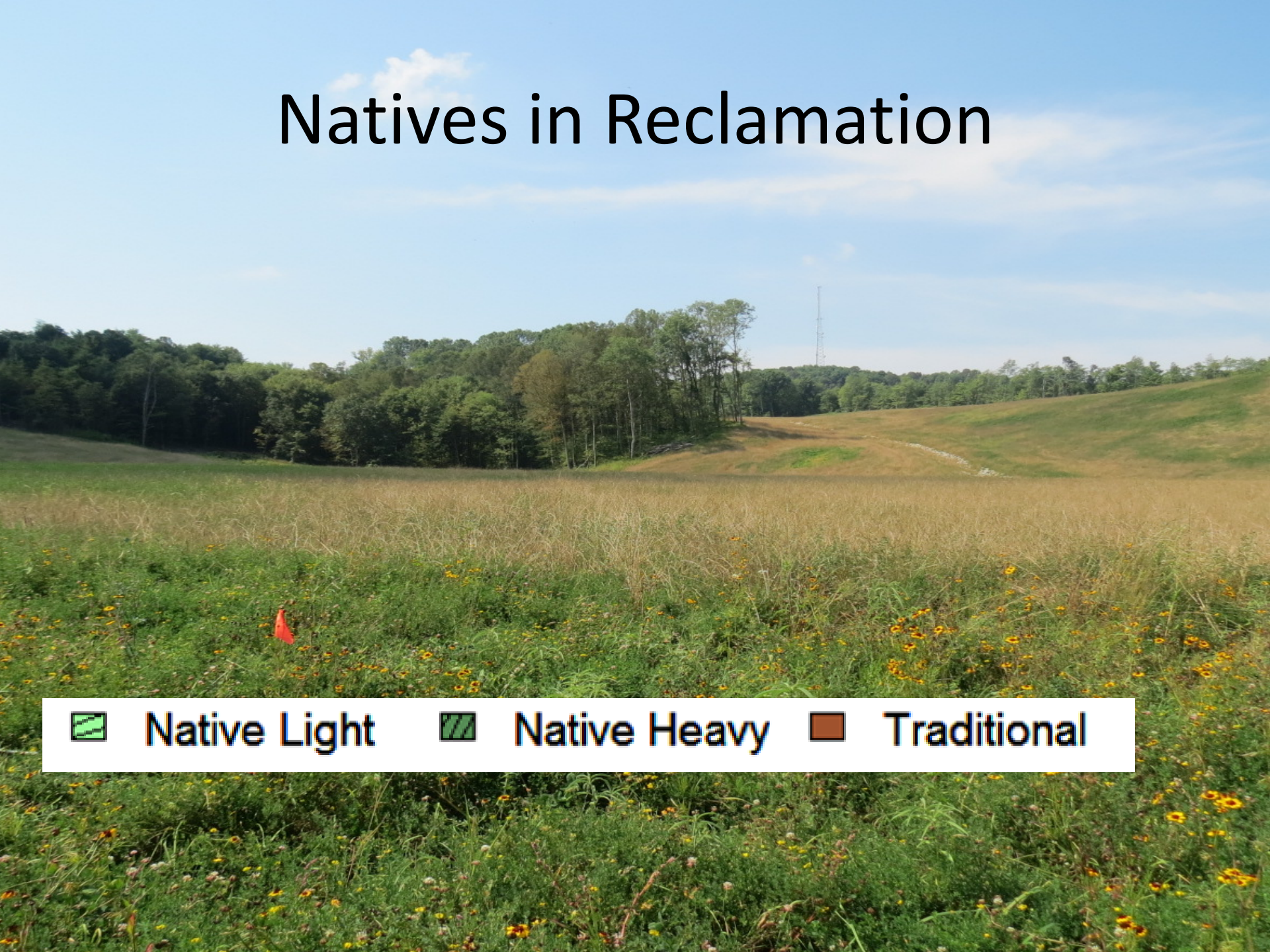
Site	App. size	Seeding Date(s) for native plots	Fertilizer rate- Trad	Fertilizer rate- Native	Years mined	Avg. depth of soil
Middleton Run	16 ha (40 ac)	5/14/15	N-33.6 P-145.7 K-123.3	N-16.8 P-72.9 K-61.6	1950s	0.6m
Joyce Hill	18 ha (45 ac)	2/18/15	N-22.4 P-106.5 K-224.2	N-28.0 P-145.7 K-190.5	1950s	0.3m
Rose Valley	4 ha (10 ac)	12/19/14 (Native Heavy) 7/10/15 (Native Light)	N-44.8 P-184.9 K-168.1	Native Heavy N-71.7 P-183.8 K-168.1 Native Light N-70.6 P-34.7 K-91.9	Unknown	Unknown

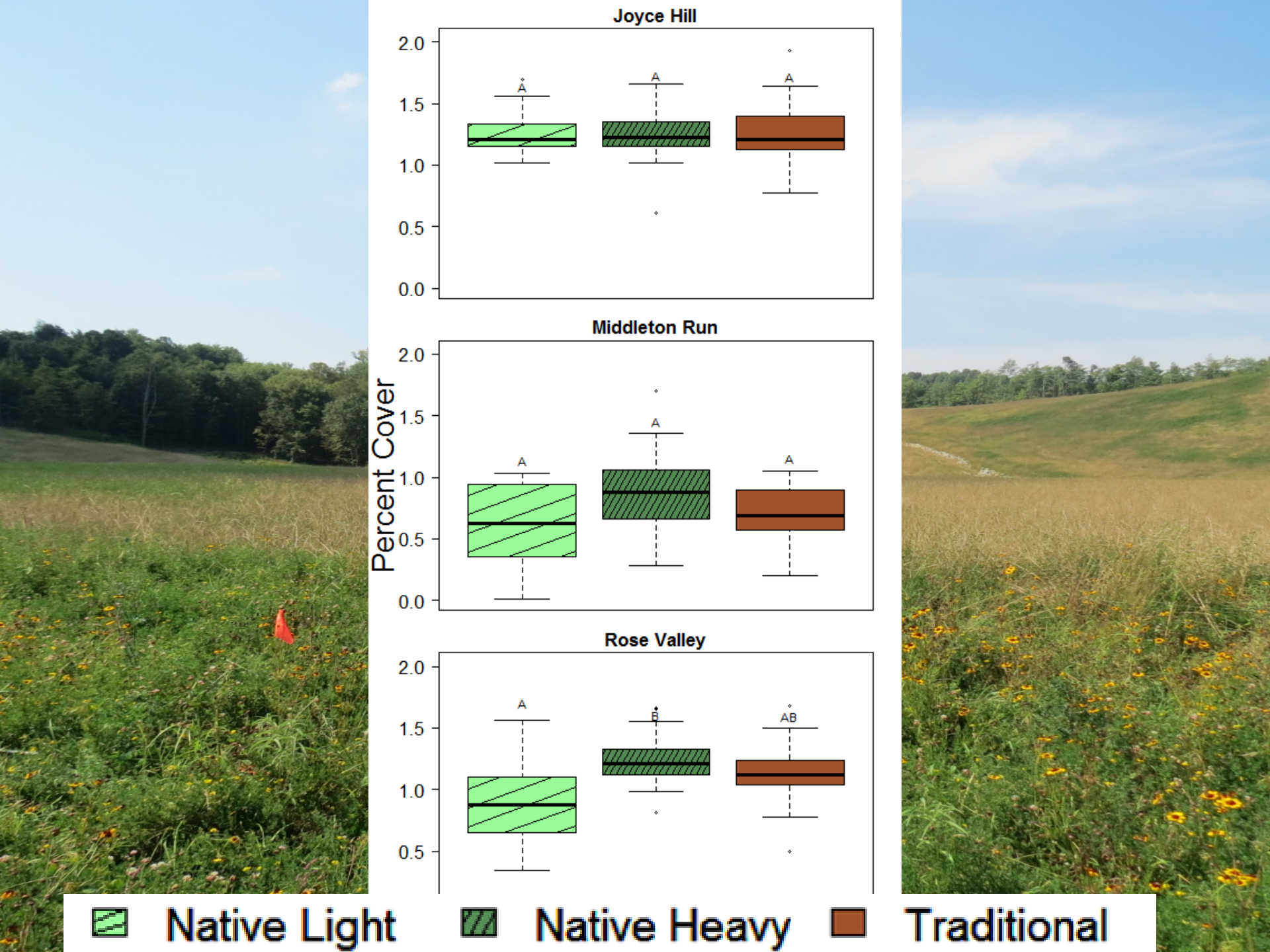
Table 3. Soil Properties between treatments at the three sites. Native Light- native mix at 16.8 kg ha^{-1} Native Heavy- native mix at 33.6 kg ha^{-1}. Traditional- Traditional reclamation mix at 56.04 kg ha^{-1}. Significant differences are marked by * (p value <0.05) or *** (p value <0.001)

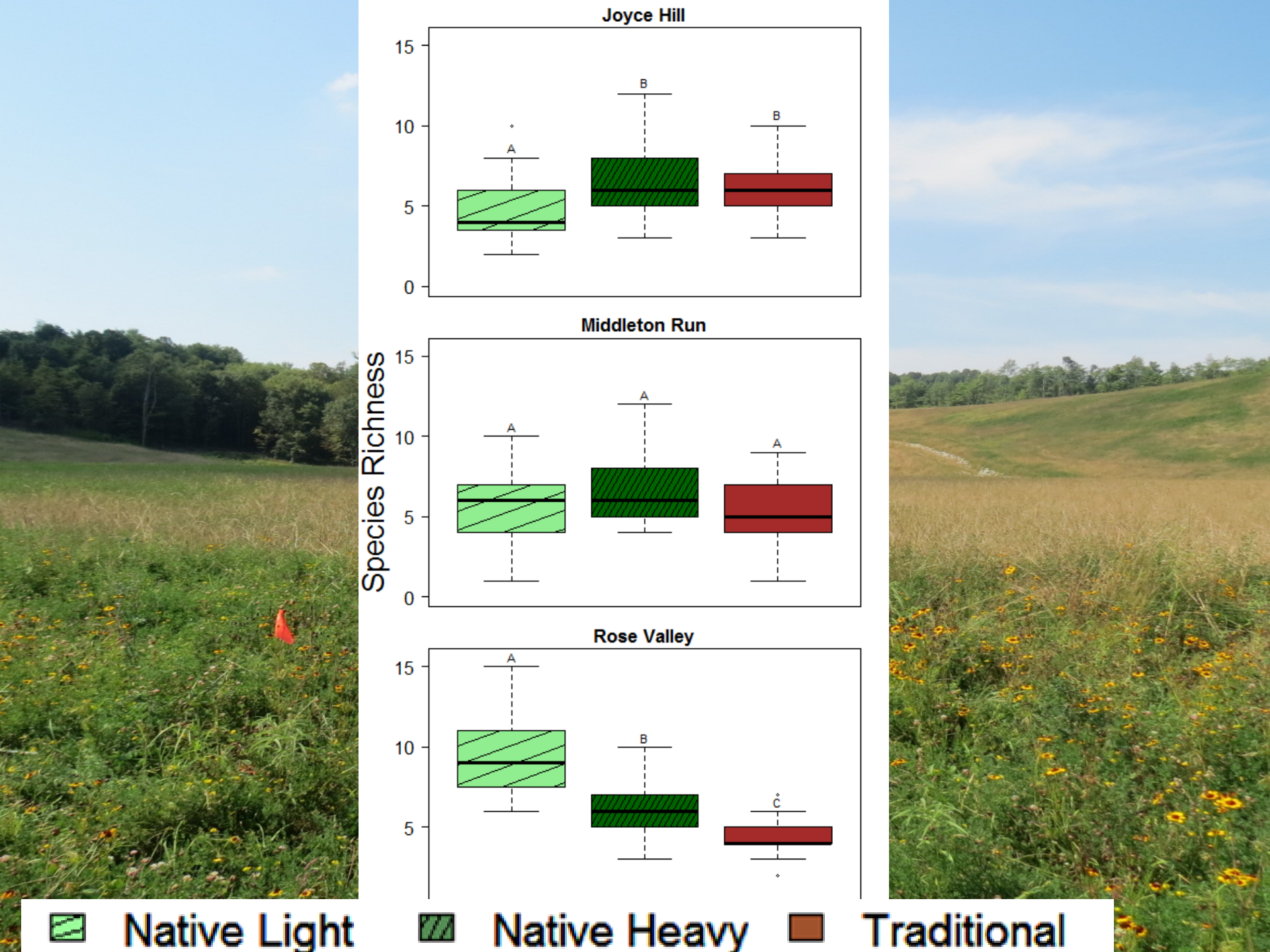
Joyce Hill	Native Light	Native Heavy	Traditional
Soil pH***	5.83^{A}±0.15	7.10^{B}±0.20	7.27^{B}±0.21
Organic Matter (%)	1.70 ±0.30	1.87 ±0.80	1.37 ±0.06
Phosphorus ppm/m^3*	12.00^{A}±2.65	7.33^{B}±1.53	7.67^{B}±0.58
Potassium ppm/m^3	99.33 ±5.13	86 ±5.57	82.00 ±3.61
Calcium ppm/m^3*	1335^{A} ±173	1791^{AB}±207	1870^{B}±174
Middleton Run	**Native Light**	**Native Heavy**	**Traditional**
Soil pH	5.50 ± 0.17	5.77 ± 0.15	6.17 ± 0.71
Organic Matter (%)	2.70 ± 1.22	2.23 ± 0.45	1.23 ± 0.75
Phosphorus ppm/m^3	28.00 ±15.13	24.67 ± 3.06	61.67±38.18
Potassium ppm/m^3	100.67 ± 6.66	141.67±63.22	98.67±25.15
Calcium ppm/m^3	1109 ± 210	988 ± 74	1030 ± 325
Rose Valley	**Native Light**	**Native Heavy**	**Traditional**
Soil pH	7.53 ± 0.15	7.43 ± 0.06	7.50 ± 0.10
Organic Matter (%)	2.23 ± 0.25	2.67 ± 0.60	2.53 ± 0.35
Phosphorus ppm/m^3	8.00 ± 5.29	9.33 ± 3.51	22.33 ± 8.50
Potassium ppm/m^3	195.67±31.94	193.33±28.01	199.67±15.95
Calcium ppm/m^3	8271 ± 1571	8547 ± 142	7726 ± 616

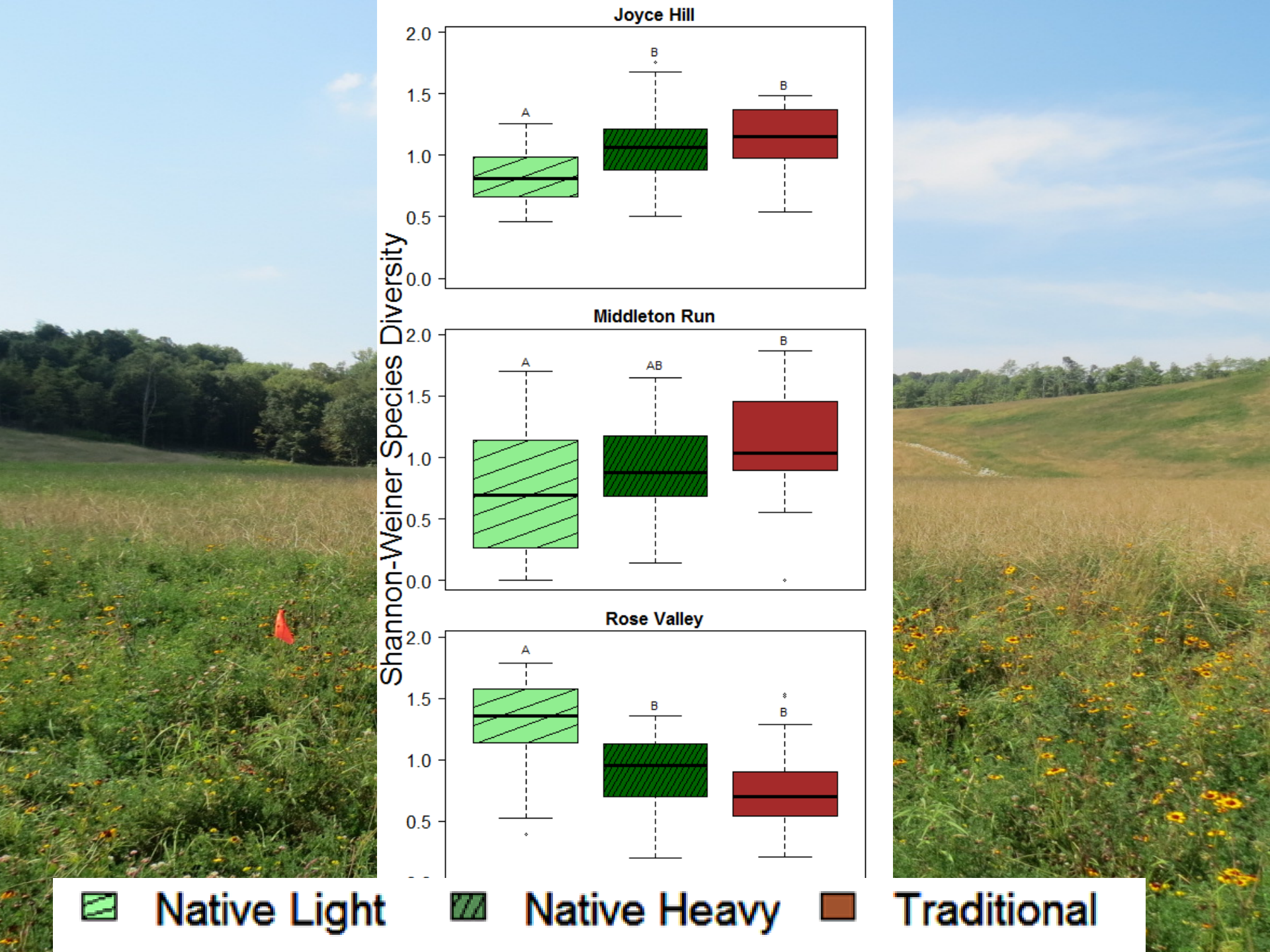
Natives in Reclamation

Natives in Reclamation

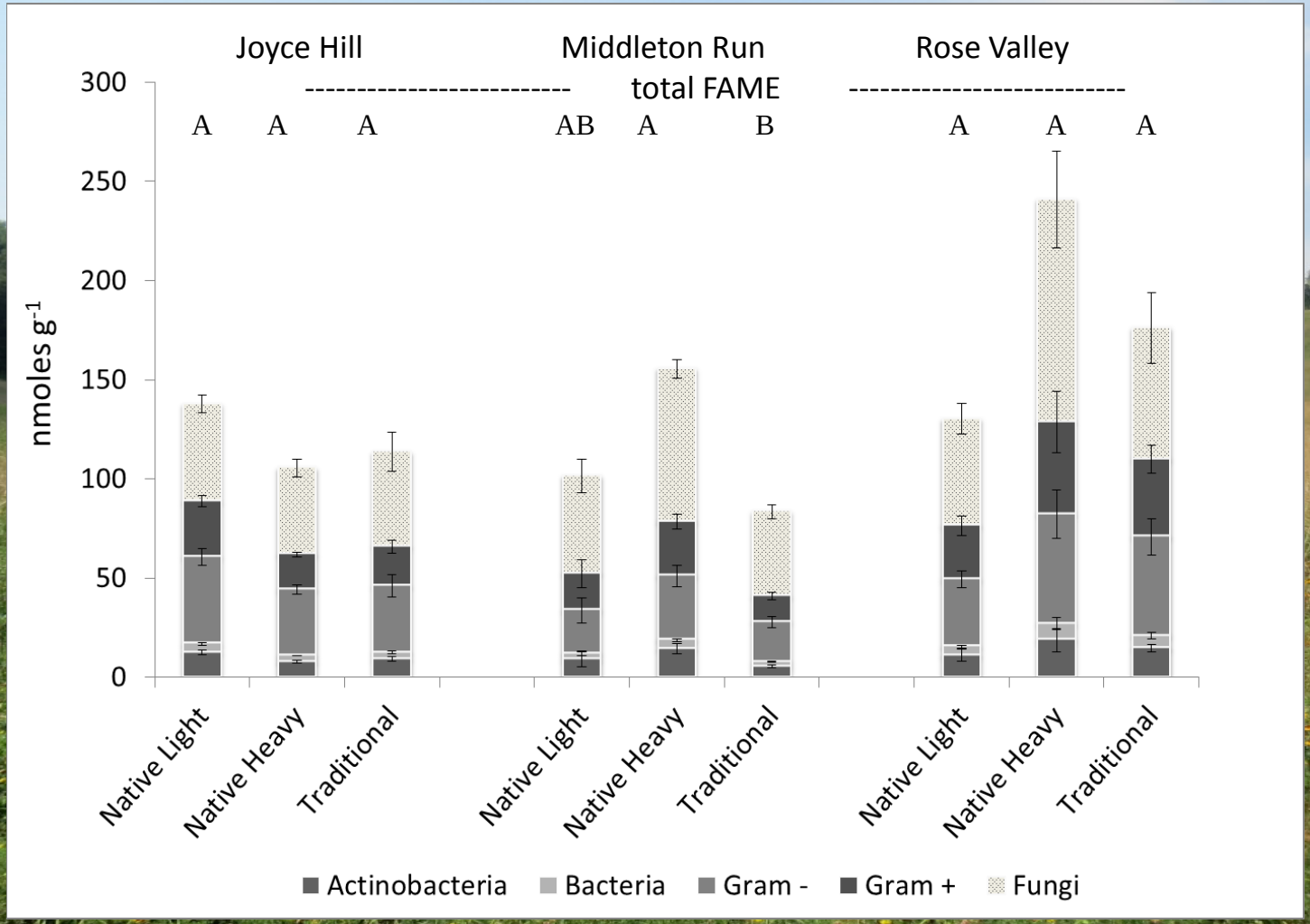



Joyce Hill
Middleton Run
Rose Valley
Percent Cover
2.0
1.5
1.0
0.5
0.0
A
A
A
A
A
A
A
B
AB
Native Light
Native Heavy
Traditional


Joyce Hill
Middleton Run
Rose Valley
Species Richness
15
10
5
0
A
B
B
A
A
A
A
B
C
Native Light
Native Heavy
Traditional


Joyce Hill
Middleton Run
Rose Valley
Shannon-Weiner Species Diversity
2.0
1.5
1.0
0.5
0.0
A
B
B
A
AB
B
A
B
B
Native Light
Native Heavy
Traditional

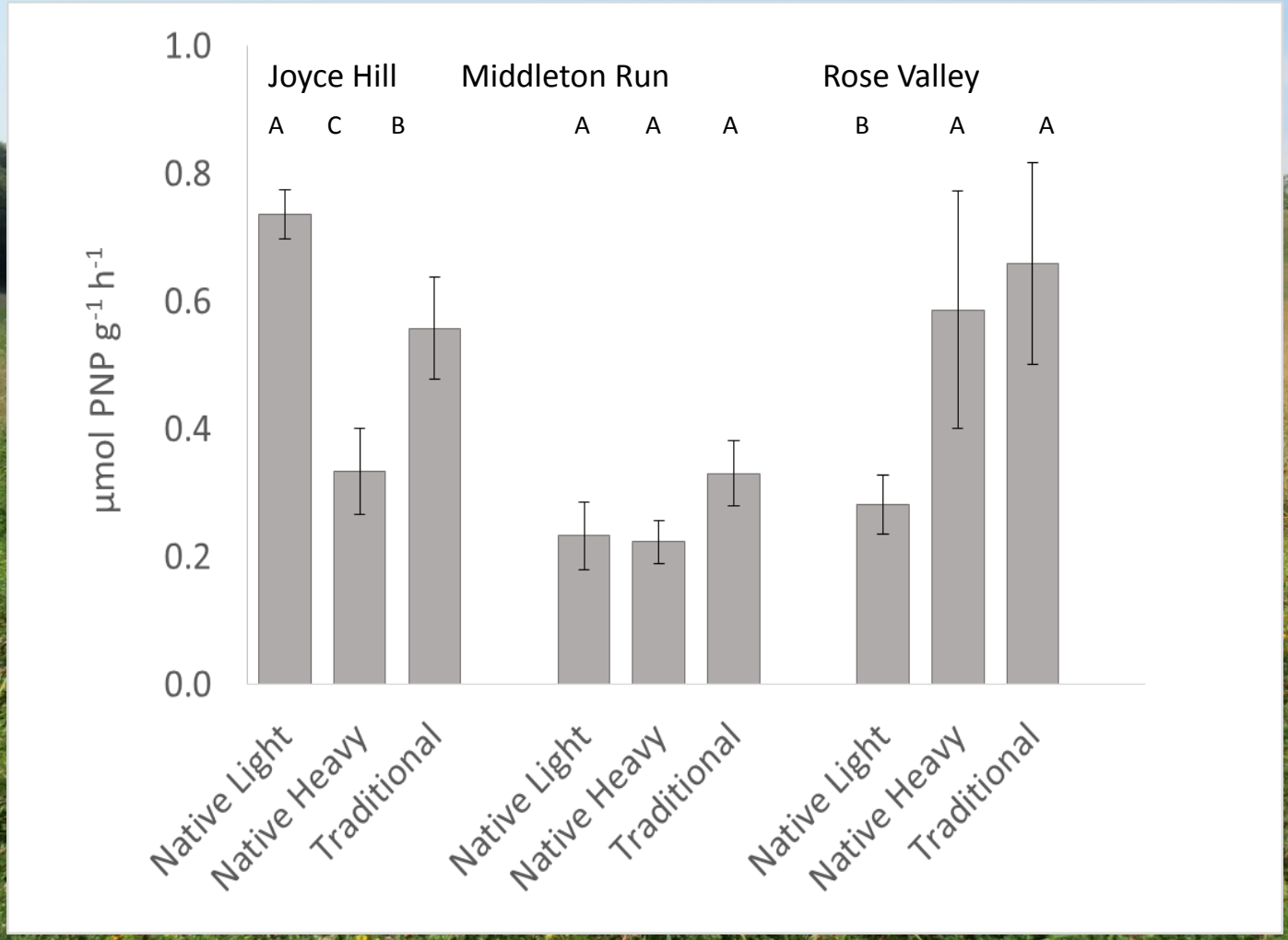
Soil Microbes



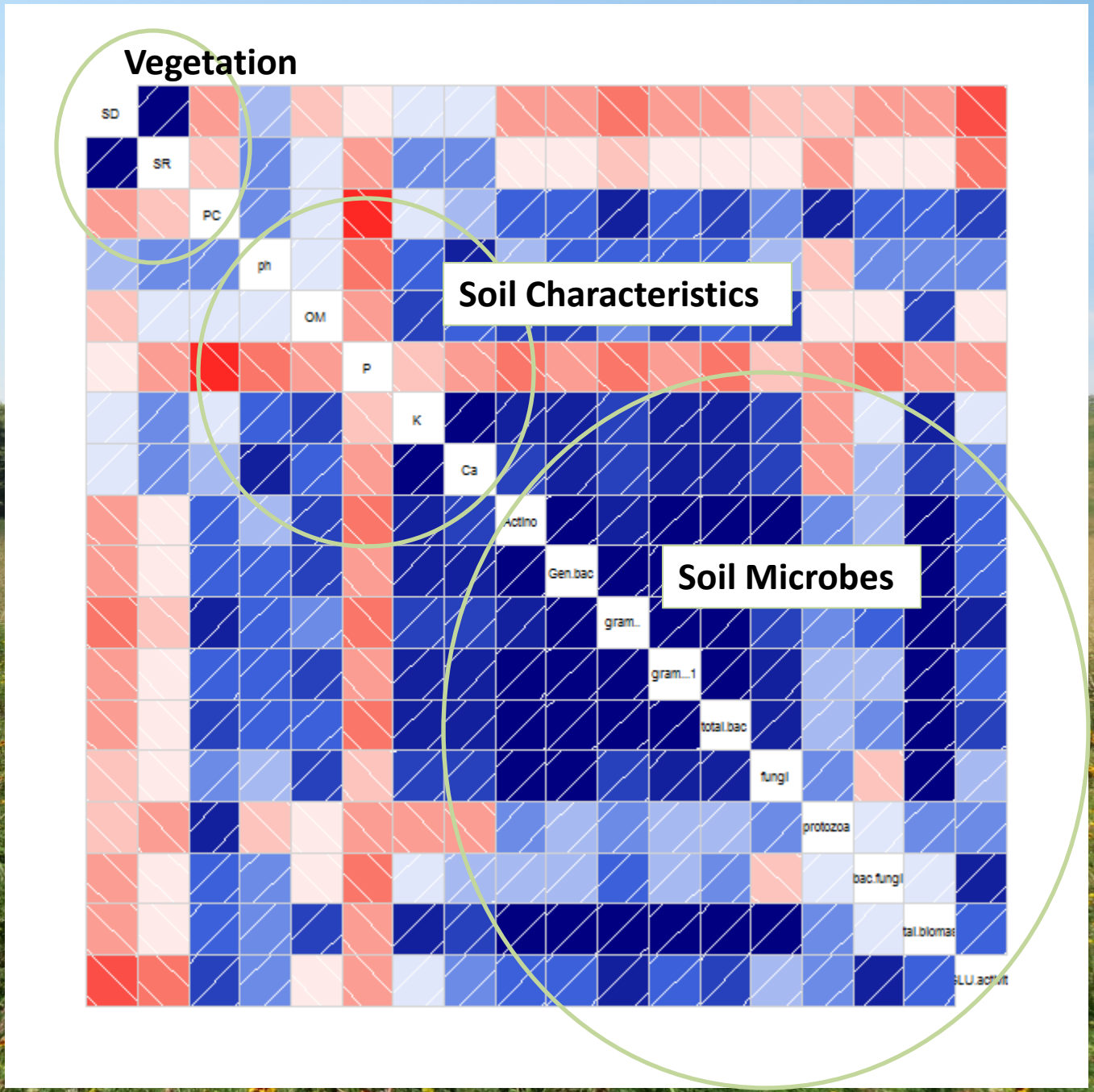
Ester-Linked Fatty Acid Methyl Ester (EL-FAME) biomarker concentrations in recently reclaimed mine soils seeded with native and non-native grasses (Traditional)

Soil Enzyme Activity

Beta-Glucosidase enzyme activities



Correlation between vegetation factors:
SD- species diversity,
SR-species richness,
PC- Percent cover,
Soil factors: ph,
OM-Organic matter,
P-Phosphorous,
K-Potassium,
Ca-Calcium.,
And Soil microbial activity



Engineering native landscapes

Success?

-Percent cover: Yes!

-Species Diversity, Richness: No.

-Soil Microbial Community: No.

-Natives: Yes!

Engineering native landscapes

Recovering from mining:

Initial conditions key

- Soil
- Compaction
- Seeding

  -Use natives!

  -Plant trees?

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Emma Lord

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Kaabe Shaw
Kevin Bratcher
Michael Gosnell
Ben McCammet

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A) 2015	JH Native Light	JH Native Heavy	MR Native Light	MR Native Heavy	RV Native Heavy	Native seed mix	JH Trad	MR Trad	RV Trad	Traditional seed mix
Panicum virginatum Switchgrass	0.001	0.000	0.200	0.222	0.003	**0.180**	0.000	0.000	0.000	
Sorghastrum nutans Indiangrass	0.000	0.000	0.000	0.000	0.011	**0.140**	0.000	0.000	0.000	
Chamechrista fasciculate Partridge pea	0.006	0.005	0.105	0.101	0.029	**0.180**	0.000	0.000	0.000	
Coreopsis tinctoria Plains coreopsis	0.039	0.057	0.006	0.114	0.018	**0.010**	0.003	0.000	0.000	
Rudbeckia triloba Browneyed susan	0.000	0.005	0.017	0.017	0.012	**0.020**	0.000	0.026	0.000	
Helianthus maximiliani Maximillian sunflower	0.005	0.005	0.000	0.012	0.006	**0.010**	0.000	0.000	0.000	
Asclepias syriaca Common milkweed	0.000	0.000	0.000	0.000	0.000	**0.010**	0.000	0.000	0.000	
Lolium perenne Perennial Ryegrass	0.000	0.000	0.123	0.001	0.001	**0.180**	0.000	0.432	0.000	**0.2**
Lotus corniculatus Birdsfoot trefoil	0.628	0.677	0.125	0.075	0.596	**0.100**	0.725	0.128	0.285	**0.16**
Dactylis glomerata Orchardgrass	0.206	0.095	0.125	0.151	0.119	**0.180**	0.017	0.185	0.045	**0.25**
Phleum pretense Timothy	0.000	0.000	0.000	0.000	0.001		0.000	0.000	0.011	**0.18**
Trifolium pretense Red clover	0.062	0.062	0.024	0.000	0.041		0.028	0.031	0.069	**0.06**
Lolium multiflorum Annual ryegrass	0.000	0.002	0.000	0.000	0.029		0.203	0.008	0.468	**0.15**
Volunteer	0.051	0.093	0.275	0.308	0.132		0.024	0.189	0.122	

- Much lower proportions than planted
- Lower proportions than planted
- Approximately equal
- Slightly higher
- Much higher proportions than planted

B) 2016

	JH Native Light	JH Native Heavy	MR Native Light	MR Native Heavy	RV Native Light	RV Native Heavy	Native seed mix	JH Trad	MR Trad	RV Trad	Traditional seed mix
Panicum virginatum Switchgrass	0.004	0.024	0.286	0.221	0.028	0.011	**0.180**	0.000	0.000	0.000	
Sorghastrum nutans Indiangrass	0.001	0.004	0.025	0.113	0.002	0.000	**0.140**	0.000	0.000	0.000	
Chamechrista fasciculate Partridge pea	0.000	0.000	0.008	0.110	0.006	0.002	**0.180**	0.000	0.000	0.000	
Coreopsis tinctoria Plains coreopsis	0.000	0.001	0.000	0.003	0.034	0.001	**0.010**	0.000	0.000	0.000	
Rudbeckia triloba Browneyed susan	0.001	0.011	0.000	0.001	0.017	0.019	**0.020**	0.000	0.002	0.000	
Helianthus maximiliani Maximillian sunflower	0.039	0.027	0.000	0.002	0.005	0.020	**0.010**	0.000	0.000	0.000	
Asclepias syriaca Common milkweed	0.000	0.000	0.000	0.000	0.000	0.000	**0.010**	0.000	0.000	0.000	
Lolium perenne Perennial Ryegrass	0.000	0.000	0.000	0.000	0.004	0.000	**0.180**	0.000	0.000	0.010	**0.2**
Lotus corniculatus Birdsfoot trefoil	0.716	0.645	0.437	0.435	0.501	0.694	**0.100**	0.588	0.365	0.750	**0.16**
Dactylis glomerata Orchardgrass	0.185	0.167	0.031	0.029	0.051	0.131	**0.180**	0.077	0.325	0.082	**0.25**
Phleum pretense Timothy	0.005	0.005	0.000	0.000	0.002	0.007		0.022	0.000	0.022	**0.18**
Trifolium pretense Red clover	0.004	0.008	0.008	0.001	0.014	0.031		0.062	0.080	0.088	**0.06**
Lolium multiflorum Annual ryegrass	0.000	0.000	0.007	0.000	0.000	0.000		0.000	0.003	0.000	**0.15**
Volunteer	0.045	0.108	0.197	0.086	0.337	0.083		0.250	0.225	0.049	

- Much lower proportions than planted
- Lower proportions than planted
- Approximately equal
- Slightly higher
- Much higher proportions than planted