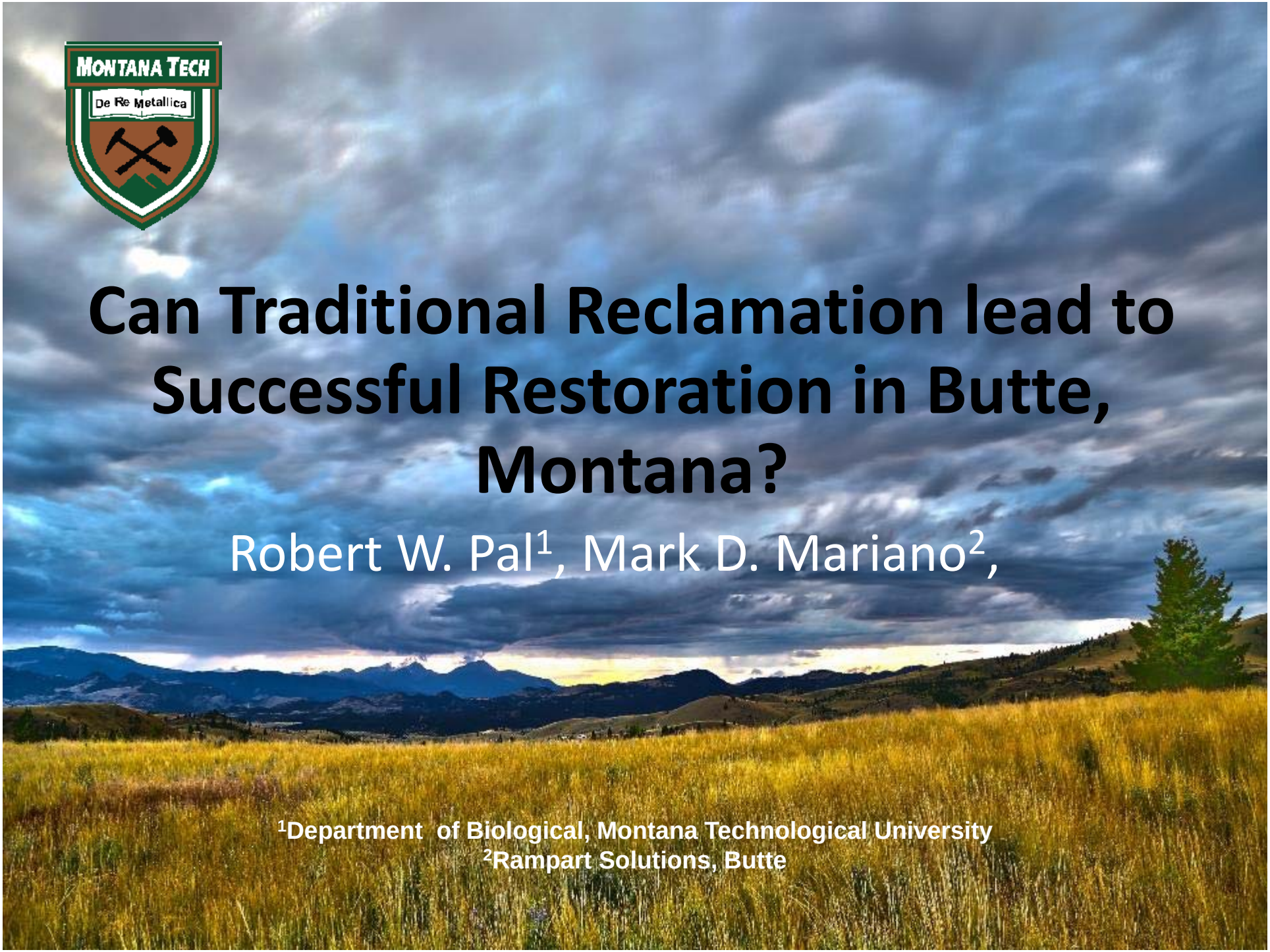
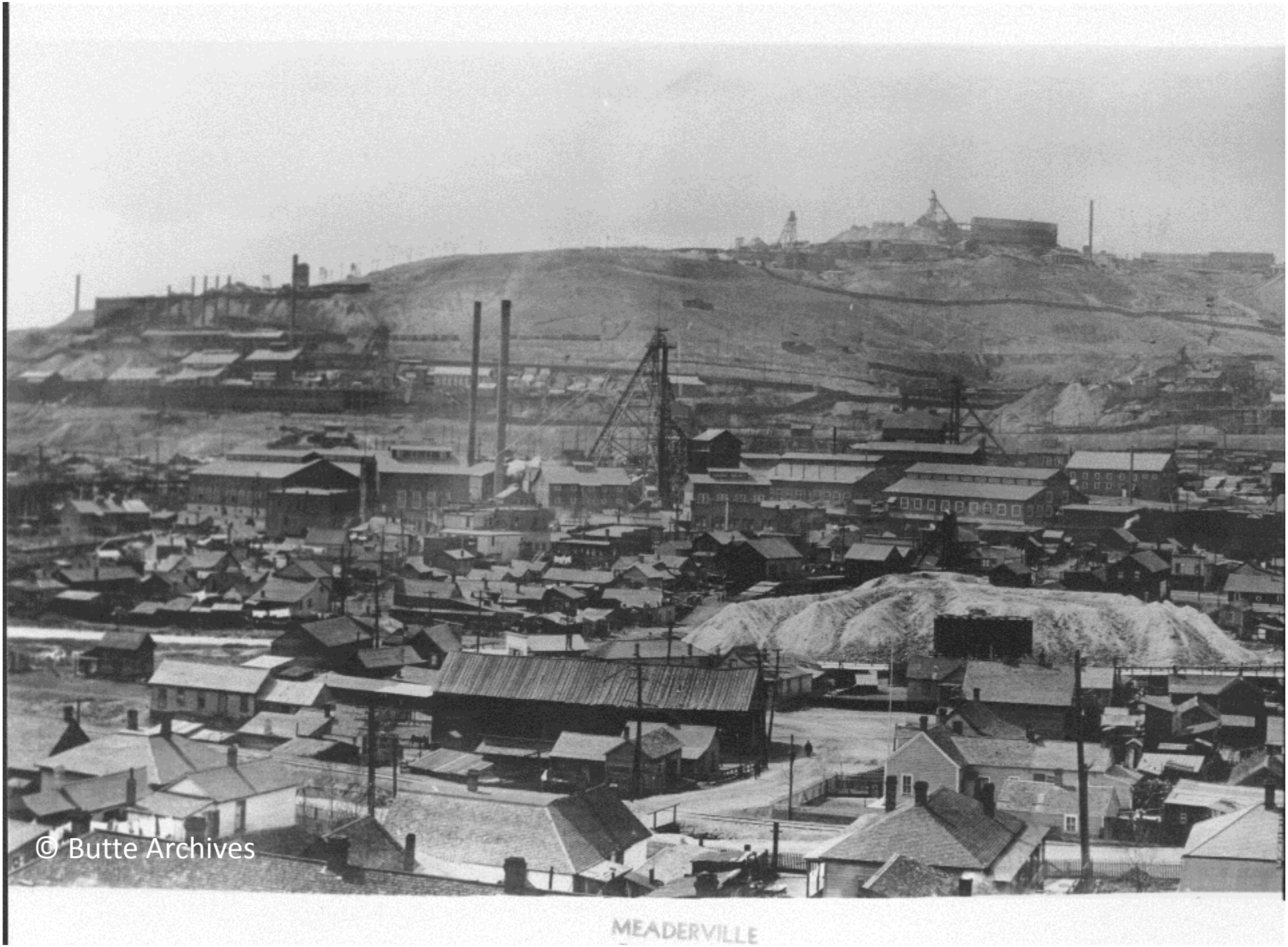


Can Traditional Reclamation lead to Successful Restoration in Butte, Montana?

Robert W. Pal[1], Mark D. Mariano[2],

[1]Department of Biological, Montana Technological University
[2]Rampart Solutions, Butte


© Butte Archives
MEADERVILLE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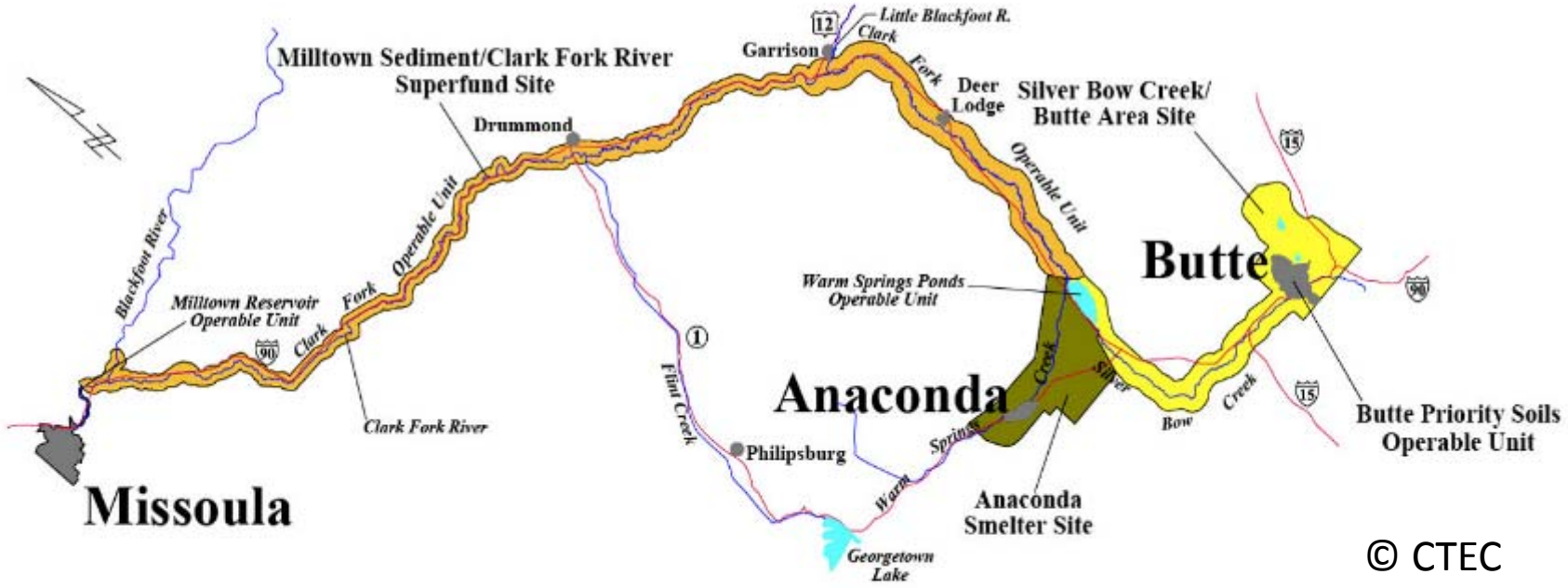
CuO

Clark Fork Superfund Complex (1983) - 400 mi^2

The goal was to protect human health and initially get things done quickly.

Location in State



Traditional Reclamation Practices


Traditional Reclamation Practices
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Most frequently applied species
Crested wheatgrass

- Decrease in amount of available soil N, P, and C

- Increased bare ground and erosion in the long term

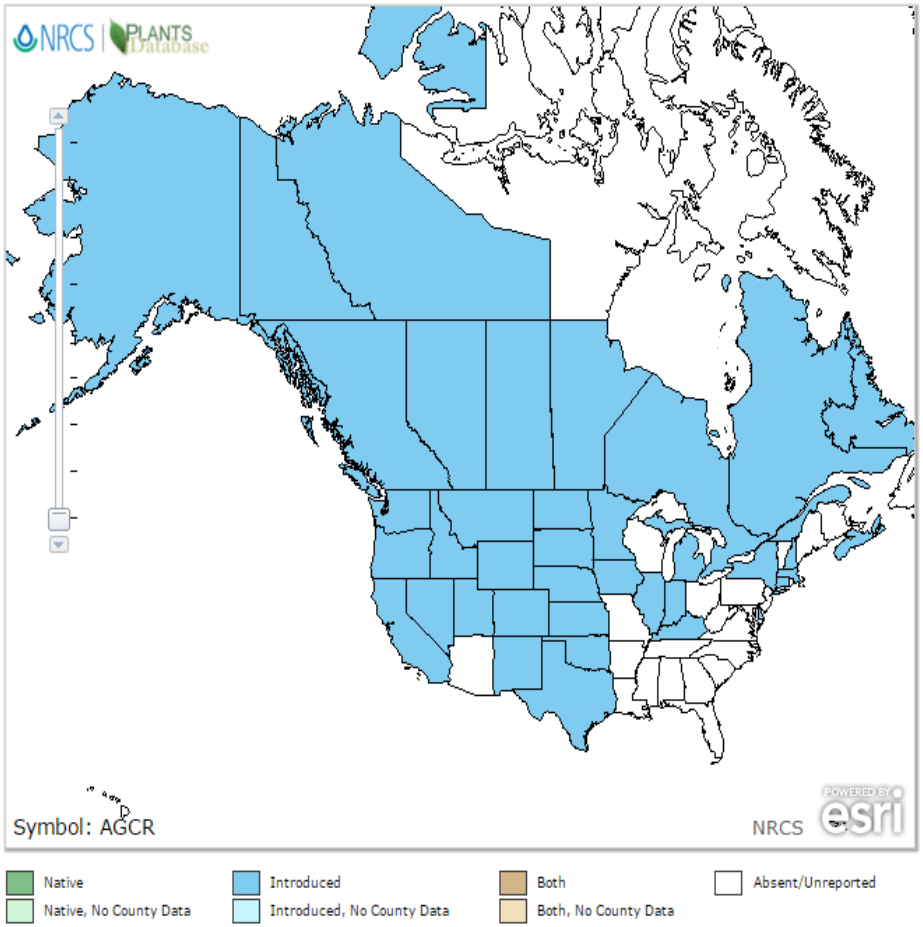
Dormaar et al. 1995, Sutter and Brigham 1998

Lesica and DeLuca 1996,

Soil conservation – The Dust Bowl

- Large portions of the American prairie plowed for crop production in early 1900's
- Government utilized crested wheatgrass as a cover crop

Crested wheatgrass in North America



- "Most commonly planted exotic grass in *Western* North America"
  - (Lesica and DeLuca 1996)
- Over 5 million acres of pasture land alone!
  - (Grant-Hoffman et al. 2012)


The Butte Hill 1995
Since 1983, over 600 acres of land have been remediated and reclaimed
West Side Reservoir
Google earth
2000 ft
N


The Butte Hill 2015
West Side Reservoir
Google earth
© 2015 Google
2000 ft
N

Administrative Rules of Montana

ARAR = Applicable or Relevant and Appropriate Requirement Under CERCLA 1980 – Comprehensive Environmental Response Compensation, and Liability Act

ARM 17.24.711

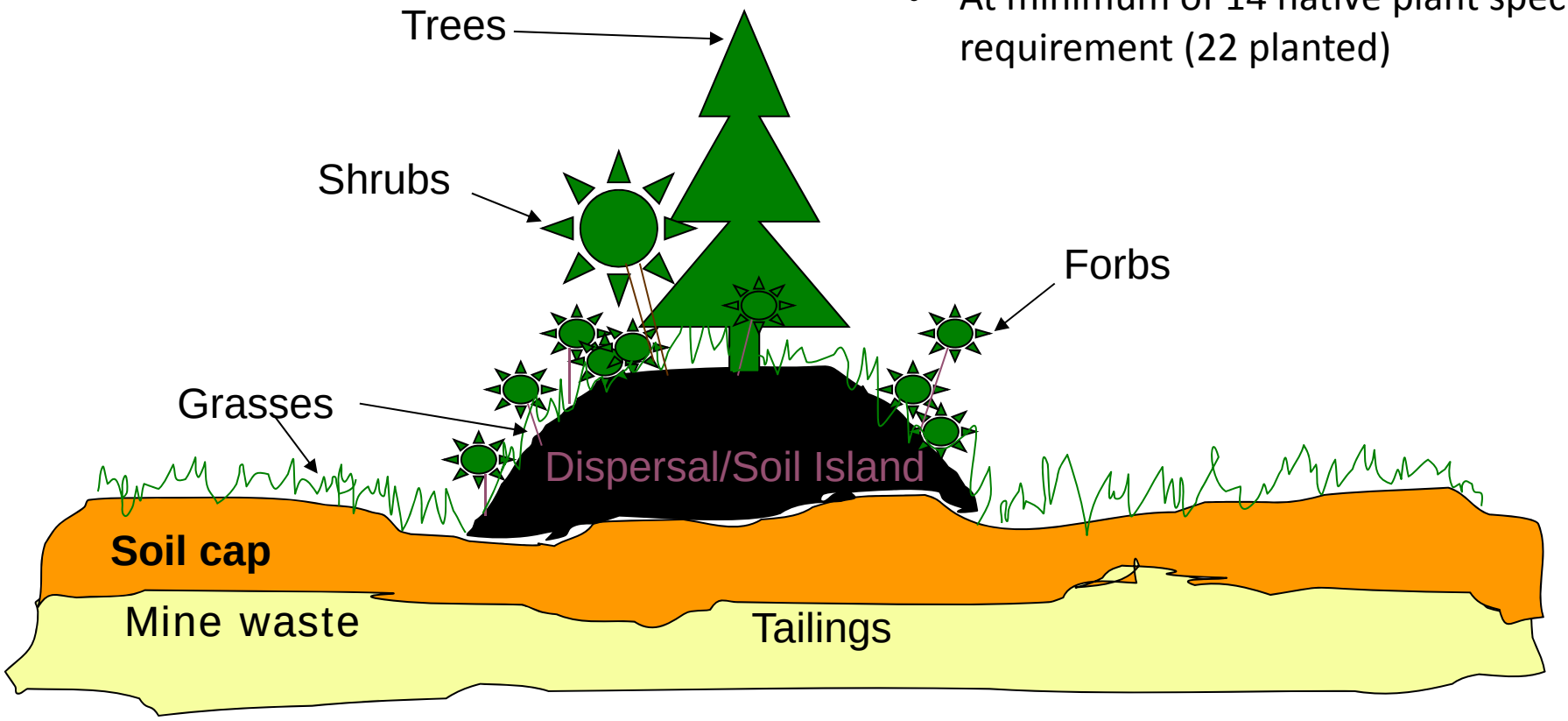
…requires that a diverse, effective, and permanent vegetative cover of the same seasonal variety native to the area of land to be affected shall be established…

…relates to the planting of trees and other woody species… capable of self-regeneration and plant succession at least equal to the natural vegetation of the area…

…specifies that re-vegetation success must be measured against approved unmined reference areas…

DISPERSAL ISLANDS

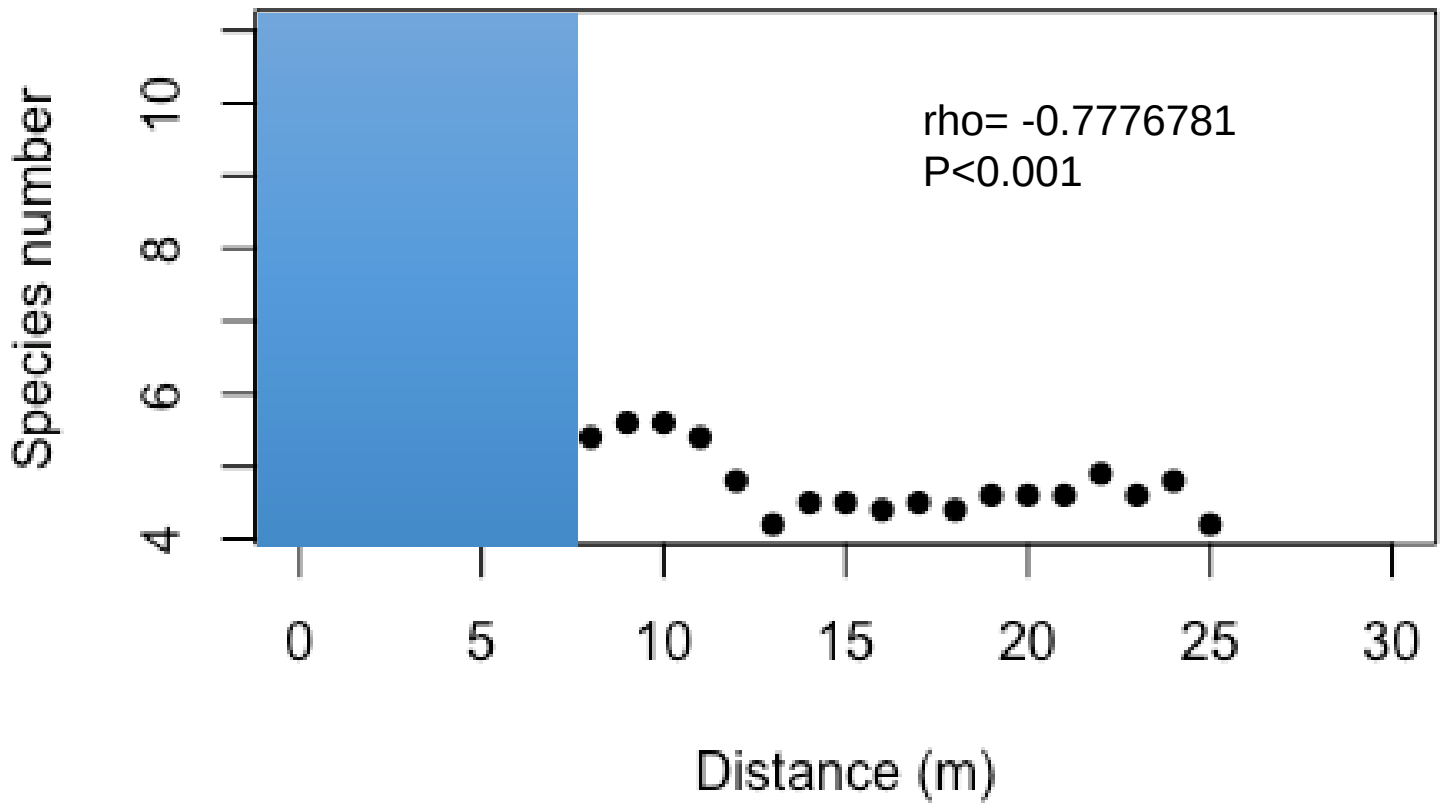
- Planting 2008-2012
- Sites 50 m2
- At minimum of 14 native plant species requirement (22 planted)

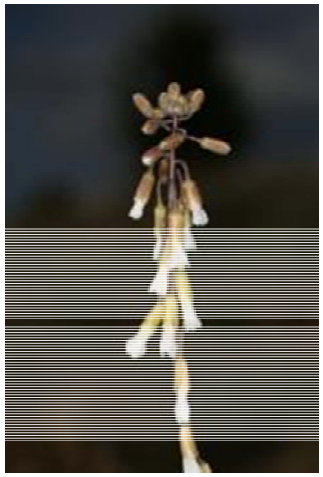


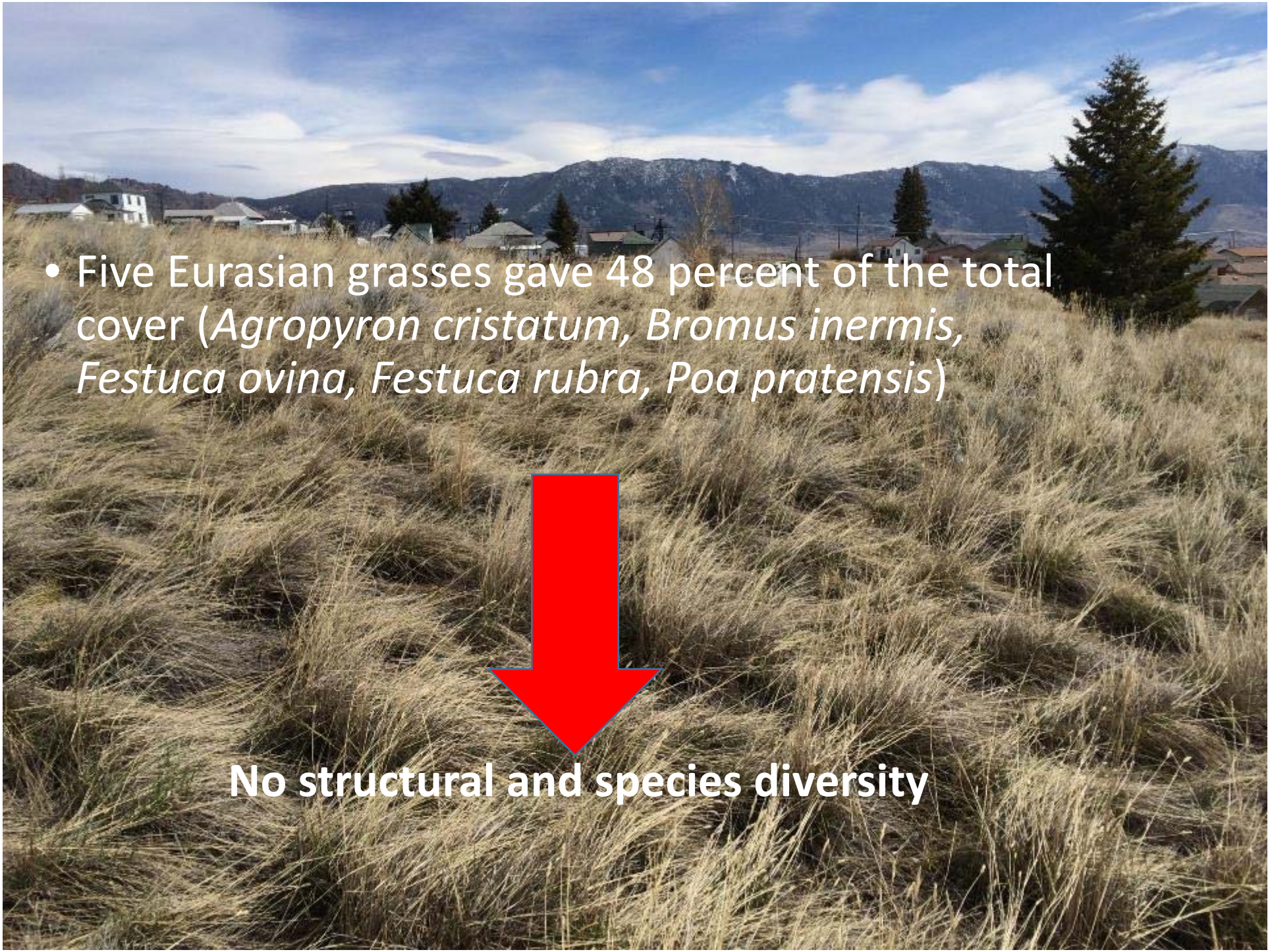
Monitor the survival and spread – Transect method

100x40=**4000**

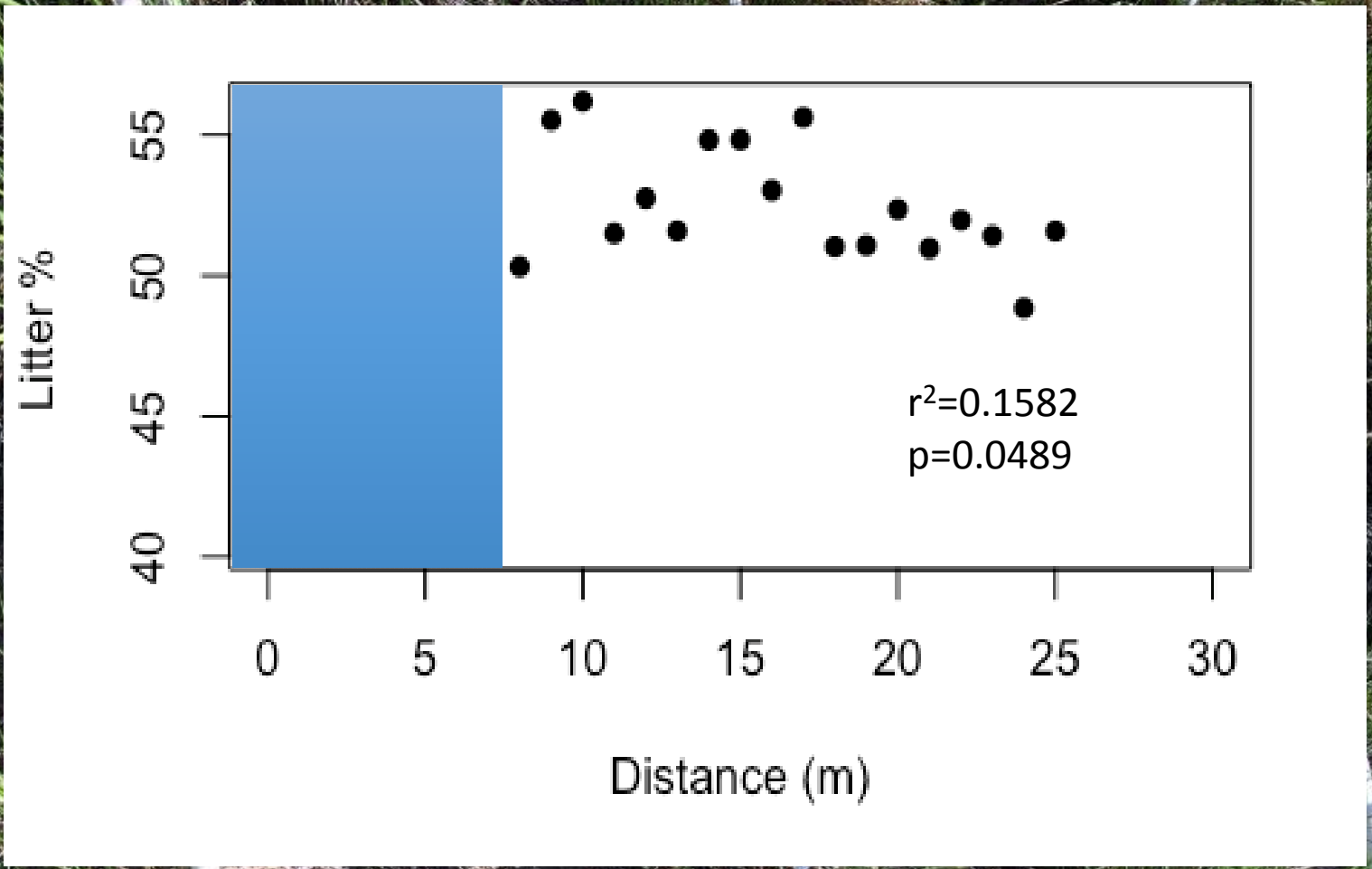
Effects on species number






• Five Eurasian grasses gave 48 percent of the total cover (*Agropyron cristatum, Bromus inermis, Festuca ovina, Festuca rubra, Poa pratensis*)
No structural and species diversity

Change in litter cover



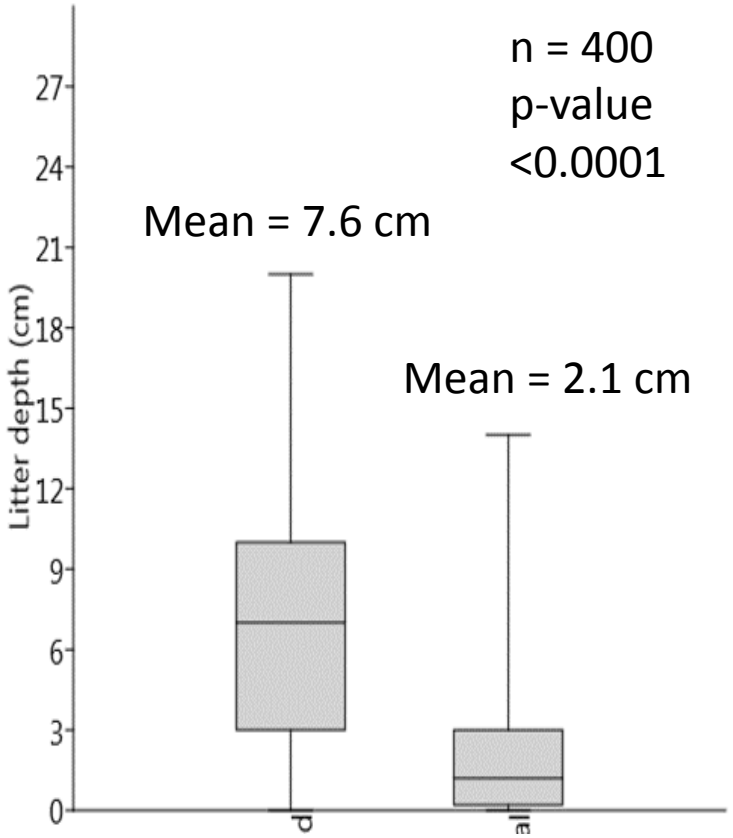
Hypothesis

Agropryon cristatum exhibits **physical** and/or **allelopathic** traits which limit the natural dispersal, germination rates and thus, the establishment of desired native species in our study area.

Test the effect of crested wheatgrass

- **Compare leaf litter depth** in *A. cristatum* and natives dominated grasslands
- Greenhouse experiment to **test the effect of litter depth**
- Petri dish experiment to **test the nature of leaf litter**
- Petri dish experiment to **test leaf litter extract**
- Greenhouse experiment to test **soils for crested wheatgrass impact**

Compare litter depth of crested stands vs. contemporary wild grassland nearby



Litter depth experiment

- Deposit seeds onto pots containing average leaf litter depth. Use pots with no litter as a control

- 2 types of litter
  - Crested wheatgrass (*A. cristatum*)
  - Great Basin wildrye (*L. cinereus*)

- 4 native species
  - *Boechera holboellii*
  - *Artemisia ludoviciana*
  - *Pseudoroegenaria spicata*
  - *Koeleria macrantha*

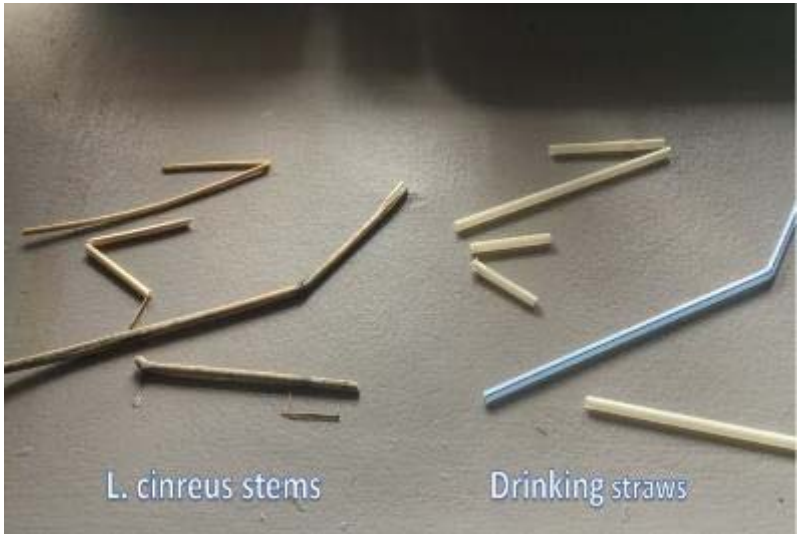
Litter depth experiment

Results

	Native Test Species				
Litter Species	***A. ludoviciana***	***B. holboellii***	***K. macrantha***	***P. spicata***	**Total**
A. cristatum	1	3	0	2	6
L. cinereus	3	0	0	2	5
Control (no litter)	31	11	25	18	85

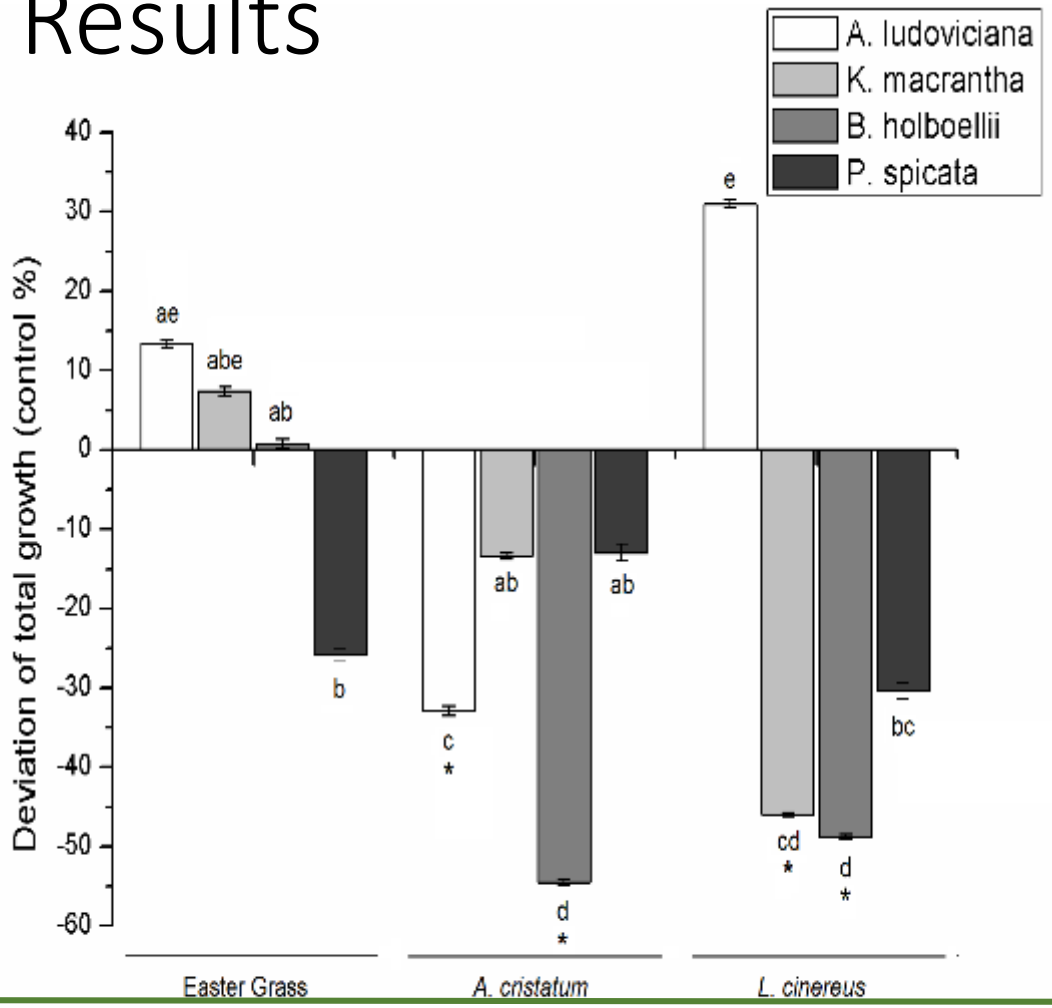
Litter type experiment

- Effects of leaf litter on germination rates when grown in a Petri dish in a controlled environment



Litter type experiment

Results



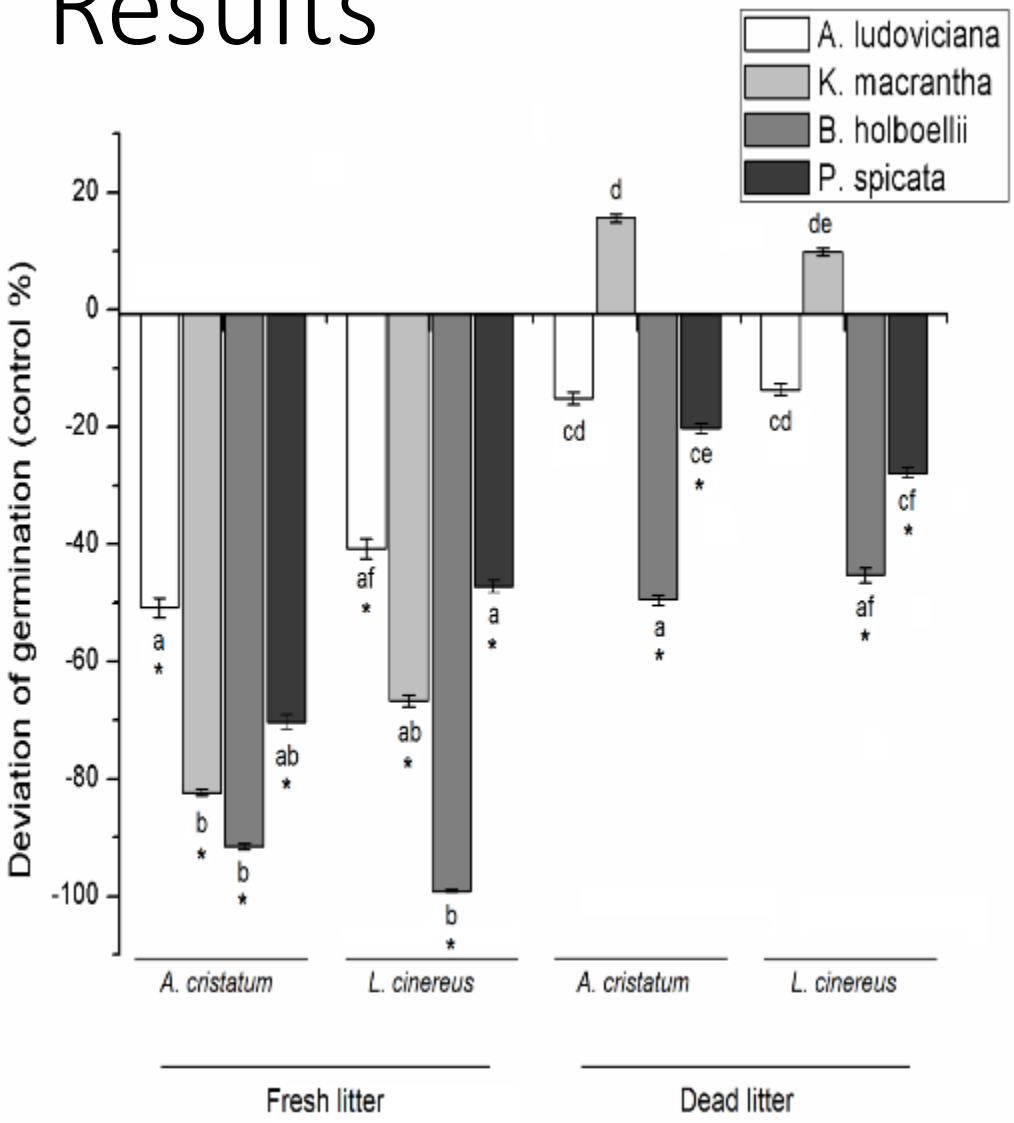
- Easter grass not different from control
- Both litter species negatively effected test species
- Mold

Leachate experiment

- Aqueous extract of leaf litter effect on germination rates, growth and biomass

- Fresh and dead litter

Leachate experiment Results



- Dead litter of both species had less effect than fresh.
- Both litter species negatively effected test species

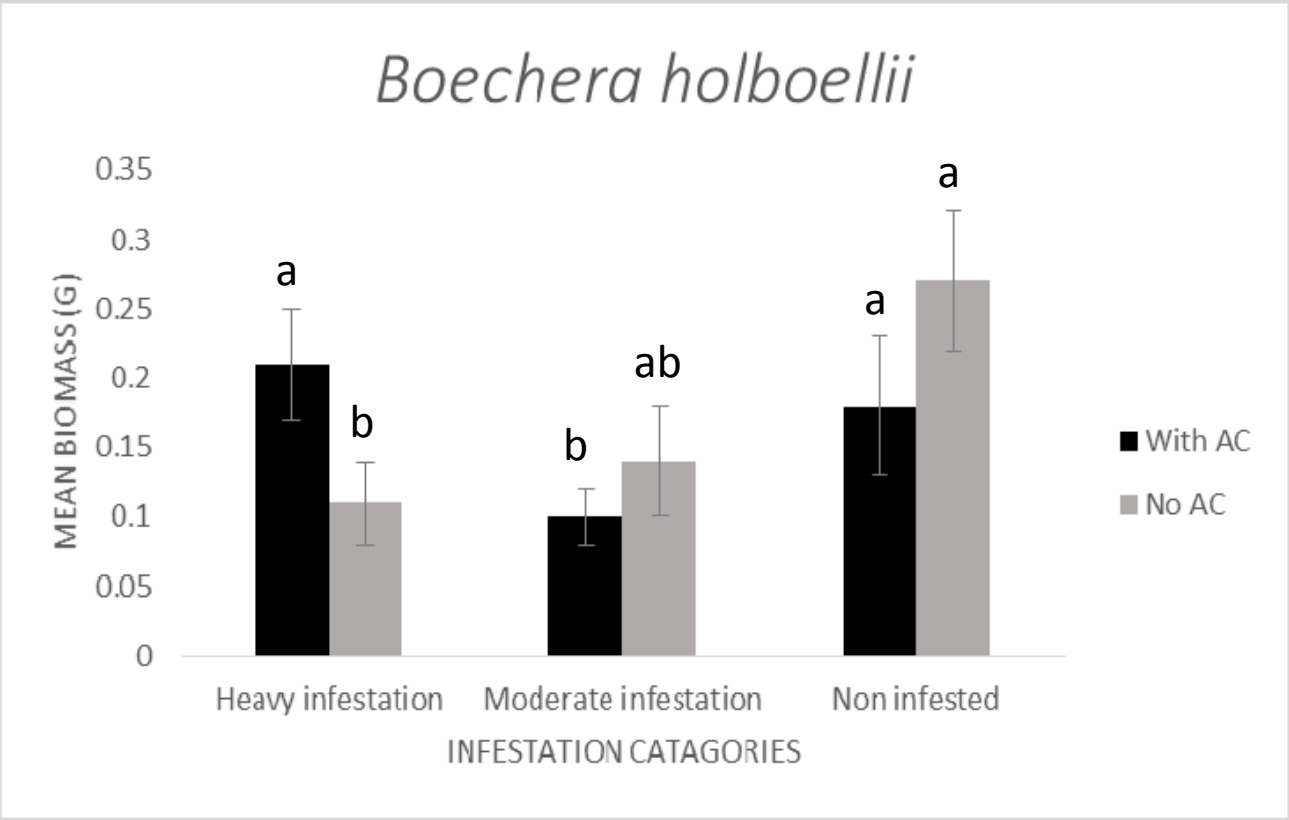
Soil experiment

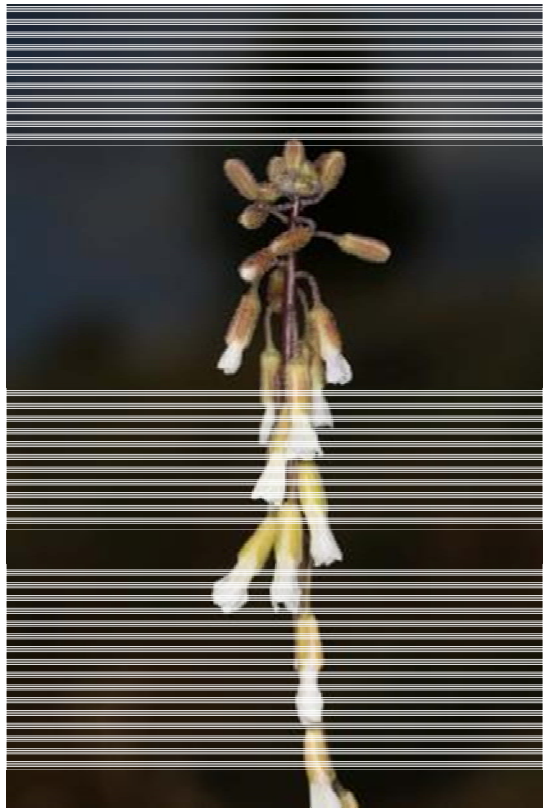
Allelochemicals in the soil may be inhibiting native plant growth

- 2 native species
  - *B. holboellii*
  - *P. spicata*
- 3 soil types
  - Heavily (<75%), moderately (25-50%), and non infested (0%)
- Activated carbon as a control

Soil experiment

Results





Conclusions

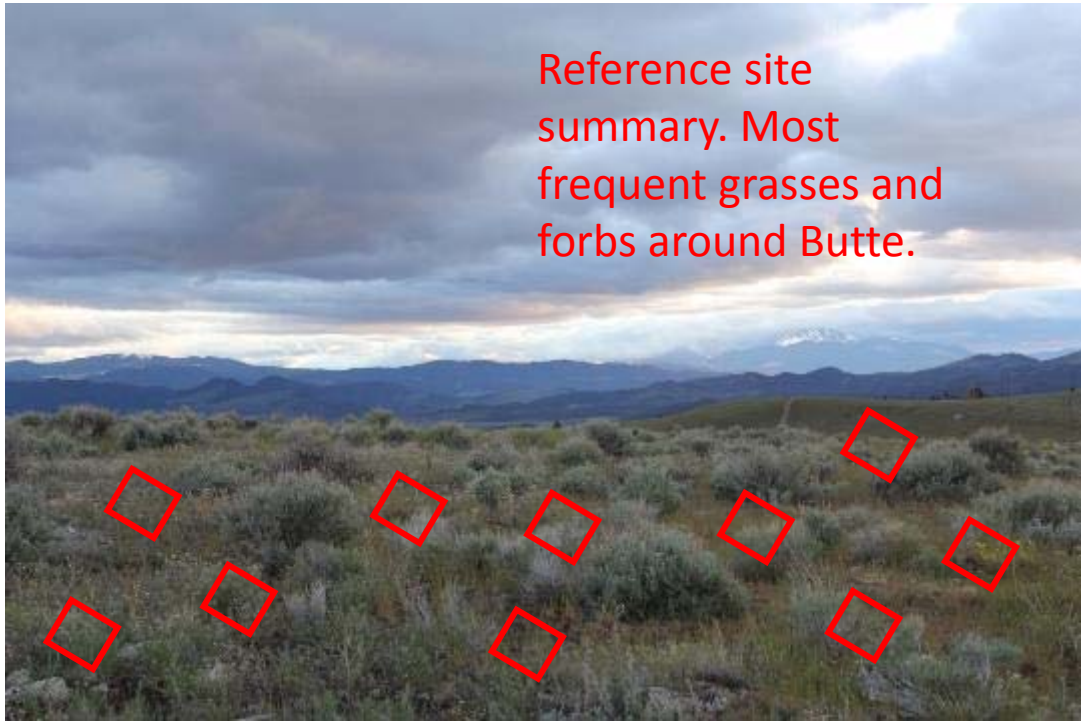
- Significant differences in mean litter depth between natural and reclaimed grasslands
- 7.6 cm litter layer is a serious physical barrier for native plants
- Both the native and exotic test litter had negative effects on test species however, less native litter exists in natural systems
- Any potential allelopathic chemical from *A. cristatum* does not persist in the soils we tested, but high infestation effects native plant germination
- Fresh litter effects the native species more than the old litter
- ***Agropyron cristatum* exerts a physical and also a chemical barrier for native plant colonization**

Future Directions

Survey reference sites for more appropriate site tailoring in future plantings

Plateau example

Common name	Scientific name	Presence %
Silky lupine	*Lupinus sericeus*	60
Prairie Junegrass	*Koeleria cristata*	53
Bluebunch wheatgrass	*Pseudoroegneria spicata*	47
Sulphur buckwheat	*Eriogonum umbellatum*	40
Common yarrow	*Achillea millefolium*	33
Idaho fescue	*Festuca idahoensis*	33
Longleaf phlox	*Phlox longifolia*	33
Sagebrush	*Artemisia tridentata*	33
Slender cinquefoil	*Potentilla gracilis*	33



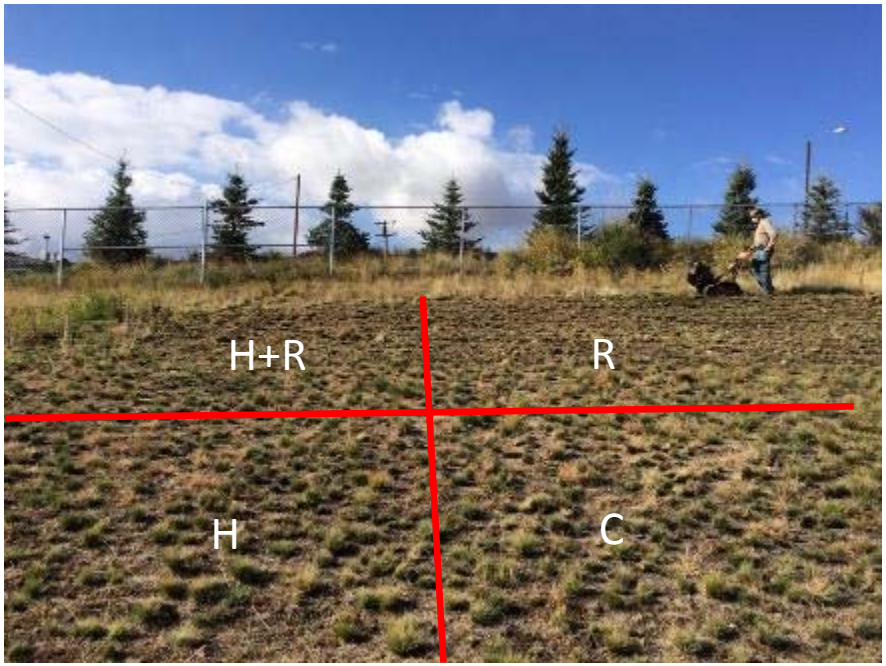
Survey reference sites for more appropriate site tailoring in future plantings

Based on these results a new EPA approved native seedmix was designed

Common Name	Species	% mix	Desired Seeds/SF	Seeds/lb.	lbs PLS/acre
Bluebunch wheatgrass	*Pseudoroegneria spicata*	30%	30	117,500	11.12
Idaho fescue	*Festuca idahoensis*	37%	37	450,000	3.58
Rough fescue	*Festuca scabrella*	9%	9	200,000	1.96
Prairie junegrass	*Koeleria macrantha*	9%	9	2,300,000	0.17
Sandberg bluegrass	*Poa sandbergii*	10%	10	925,000	0.47
Quick guard (sterile triticale)	*Triticale*	3%	3	22,700	5.76
Blue flax	*Linum lewisii*	1%	1	233,750	0.19
Rubber rabbitbrush	*Ericameria nauseosa*	1%	1	693,000	0.06
	Grand Totals	**100.0%**	**100**		**23.3**

Lessons learnt – New approaches

Apply methods for knocking back Eurasian grasses

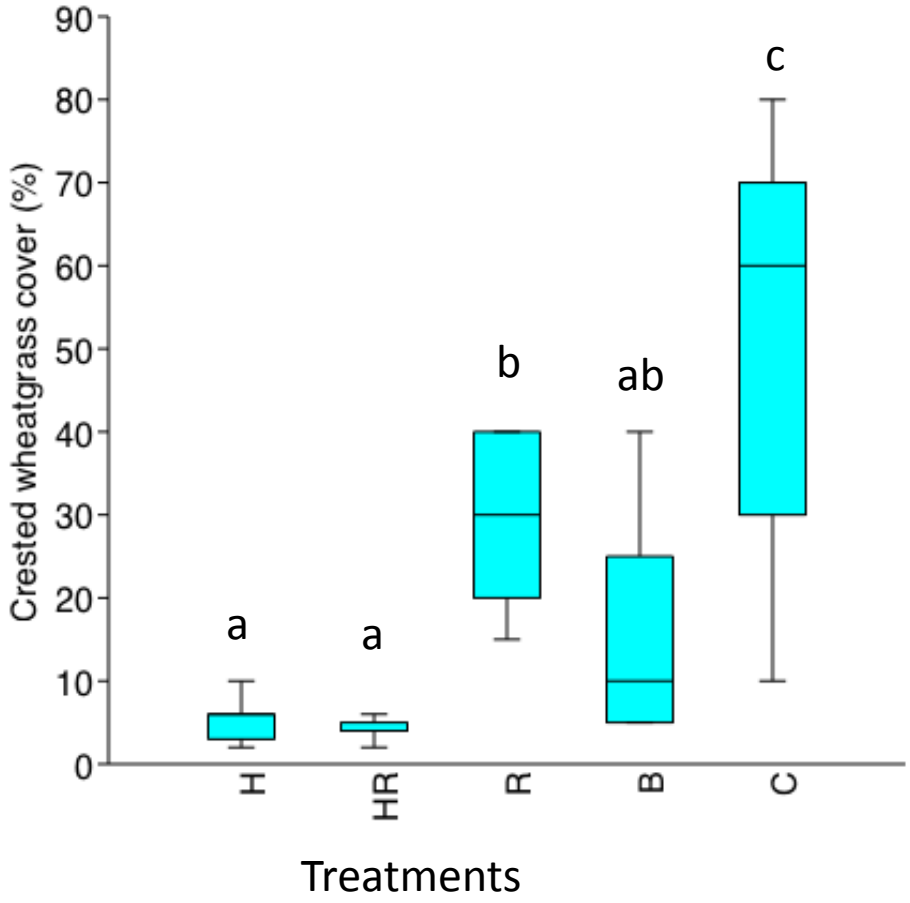


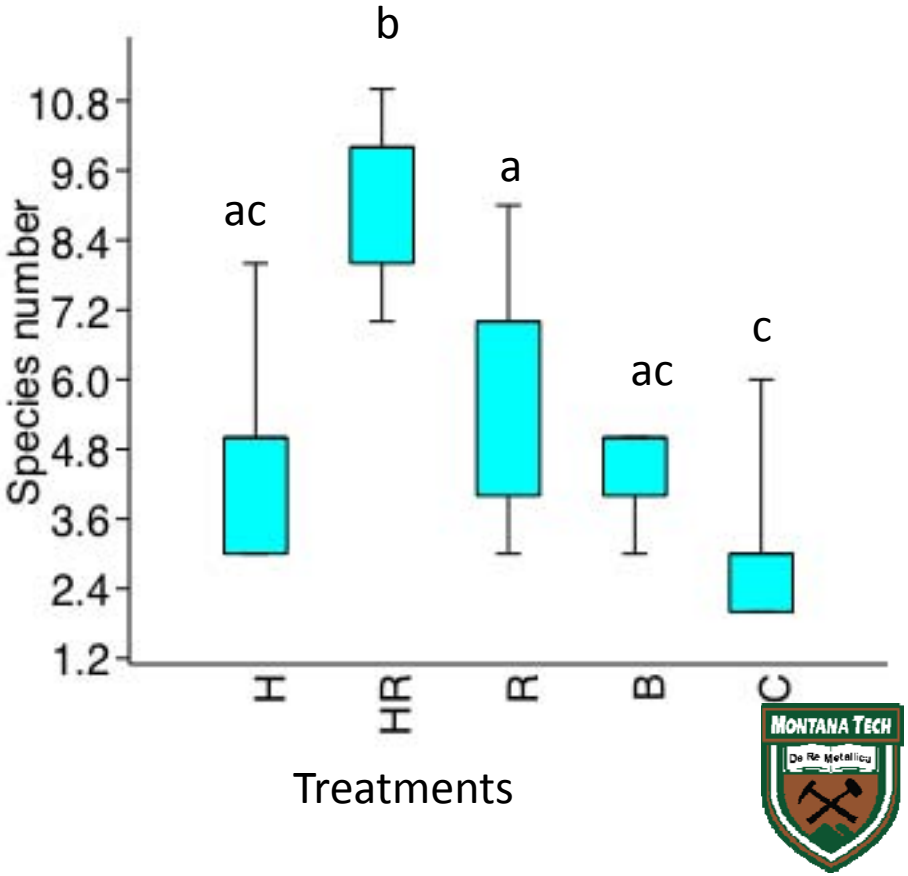
Seed in 6 grass species

Syndicate Pit

Lessons learnt – New approaches

Apply methods for knocking back Eurasian grasses





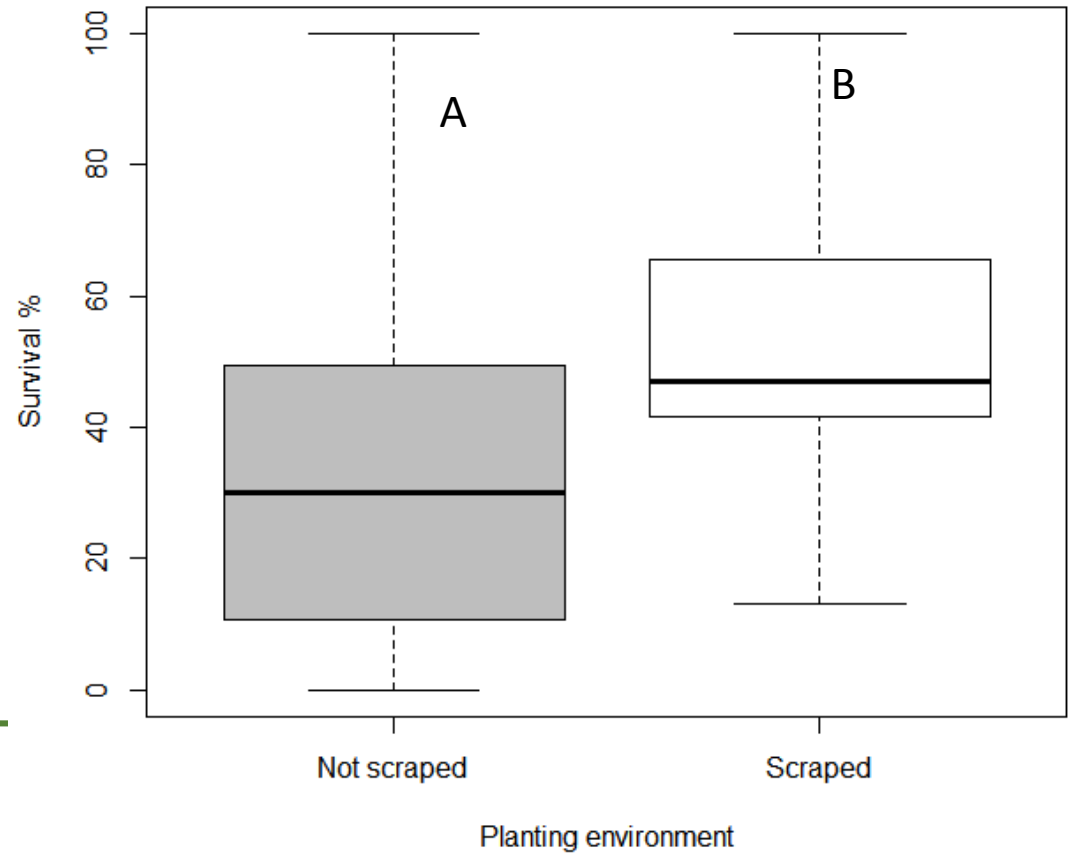
Lessons learnt – New approaches

Apply methods for knocking back Eurasian grasses

Lessons learnt – New approaches

Apply methods for knocking back Eurasian grasses

- Planting technique lessons learned
  - Site preparation (scraping vs. non-scraping)



Locally adapted pioneer species

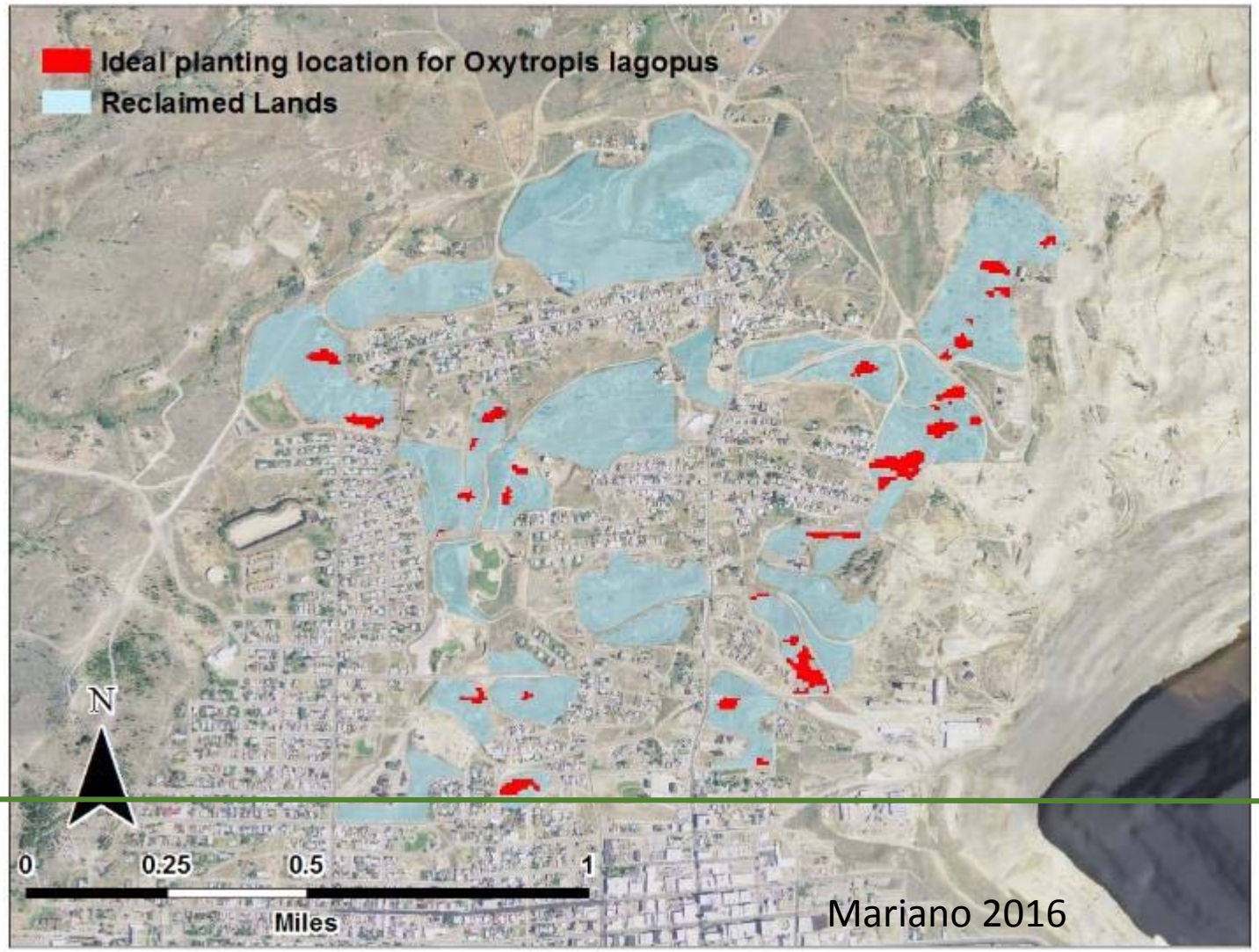






Lessons learnt – New approaches

GIS model for best planting locations



Mariano 2016


Thank you !
and
DO NOT PLANT
A. cristatum !!!!

Thanks