Long-Term Studies Identify Avenues for Improving Revegetation Efforts

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Two Studies

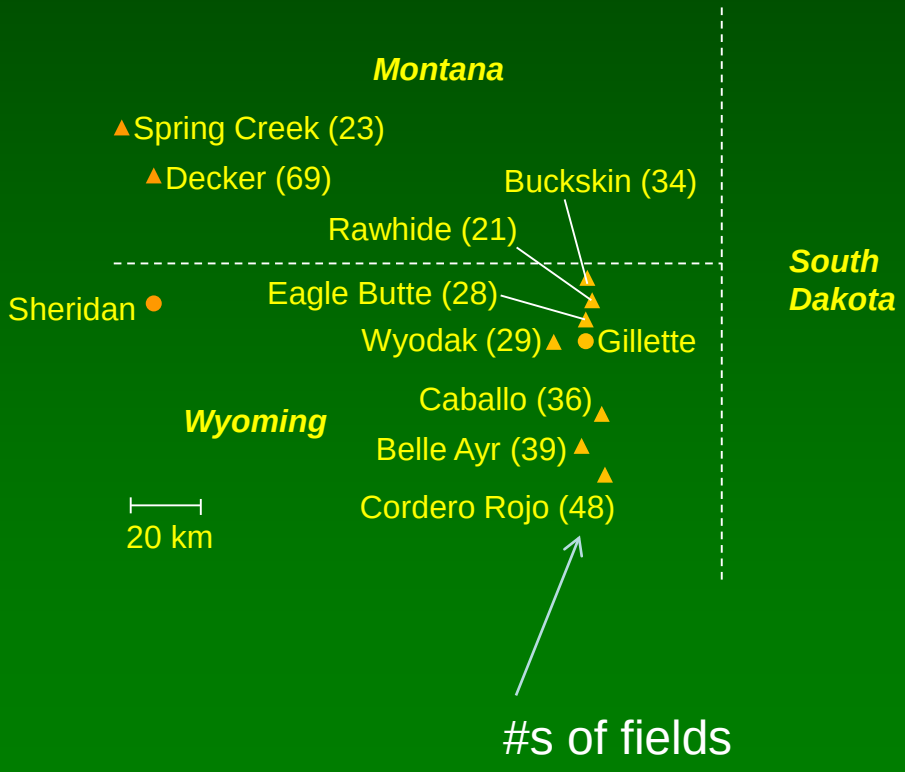
Office of Surface Mining (OSM)-funded study focused on constraining annual weeds, preventing crested wheatgrass invasion and increasing shrubs (i.e. winterfat, four-wing saltbrush, big sage, fringed sage) on surface-mined lands of the Great Plains. Shrubs are the most difficult plant group to establish on these lands.

Journal of Applied Ecology. (Accepted).

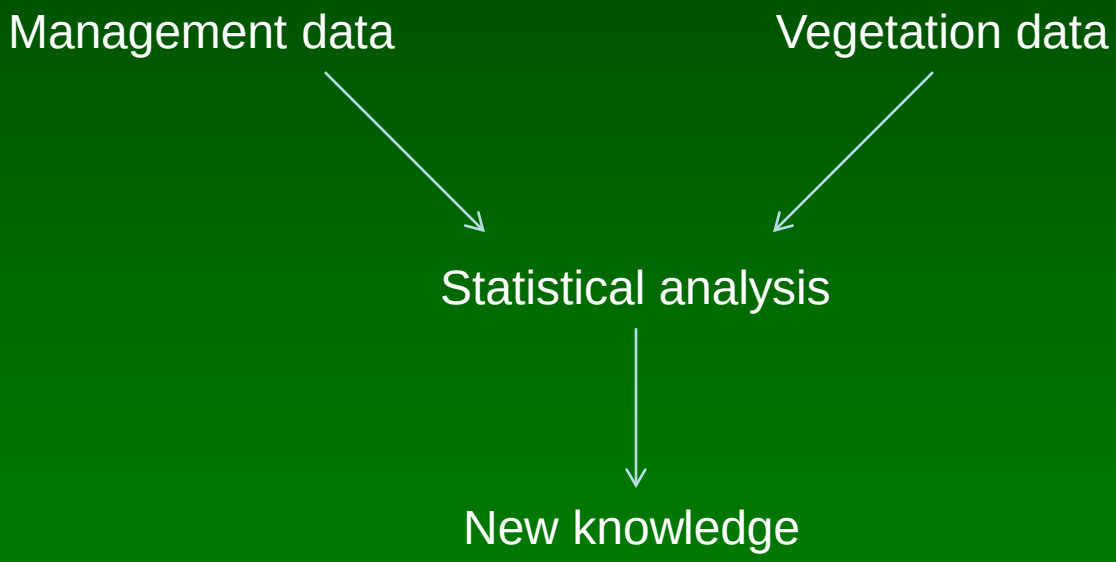
Montana Department of Environmental Quality (DEQ)-funded study investigating factors regulating shrub abundances.

Ecological Applications. 2015. 25:1044-1053.

Sites


Montana
Spring Creek (23)
Decker (69)
Buckskin (34)
Rawhide (21)
South Dakota
Sheridan
Eagle Butte (28)
Wyodak (29)
Gillette
Wyoming
Caballo (36)
Belle Ayr (39)
Cordero Rojo (48)
20 km
#s of fields

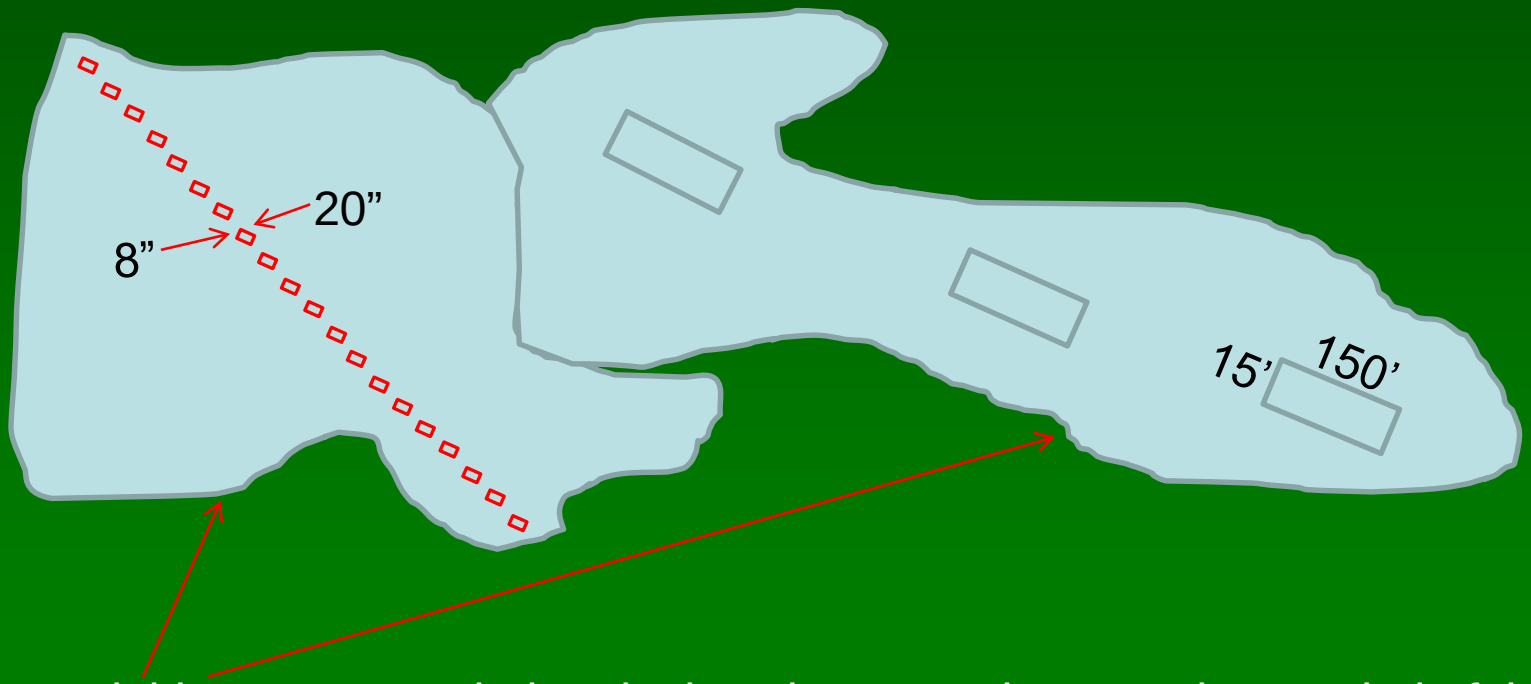
Approach


Management data
Vegetation data
Statistical analysis
New knowledge

Sampling Designs

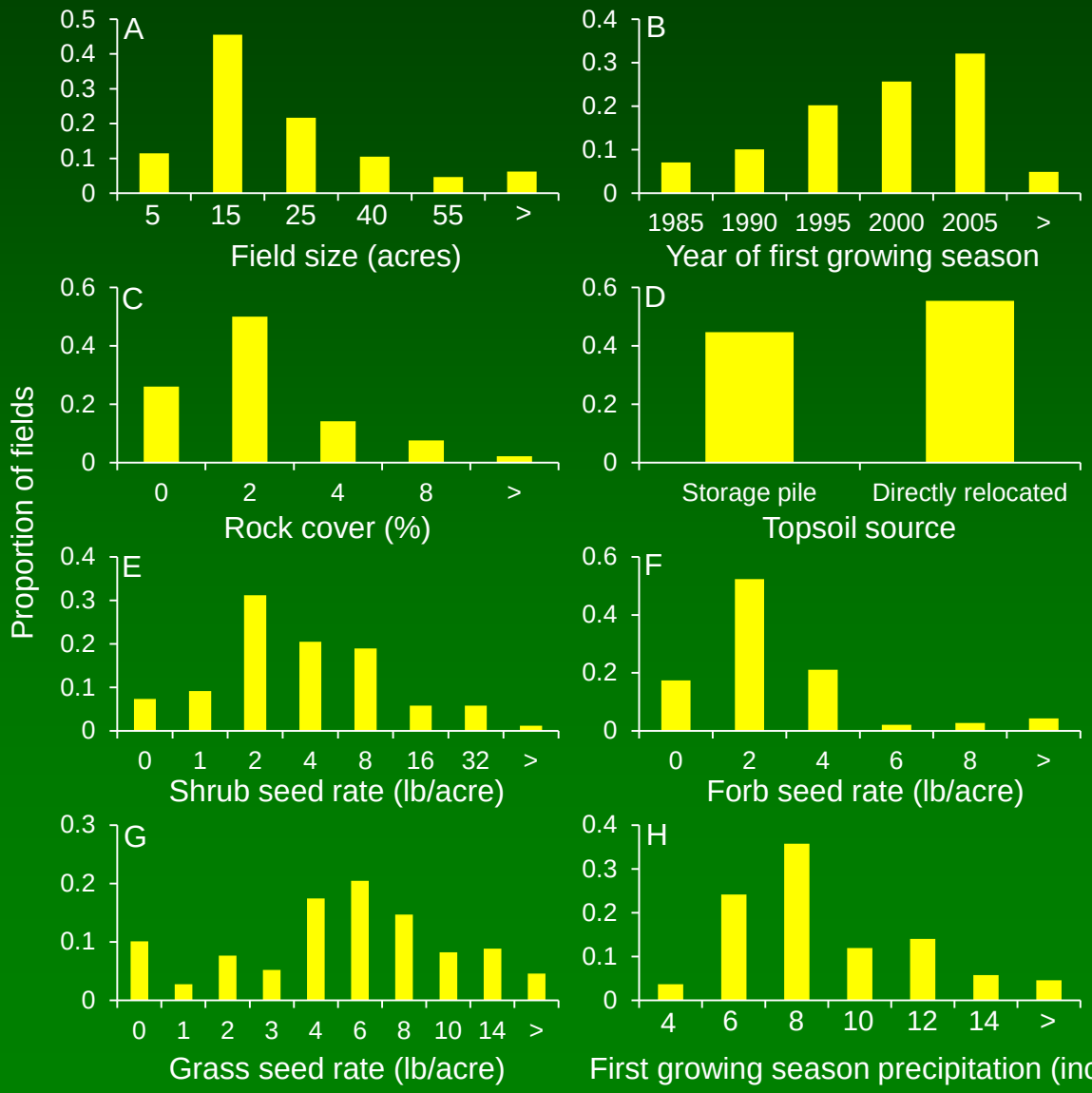
OSM project: 327 fields

DEQ project: 169 fields



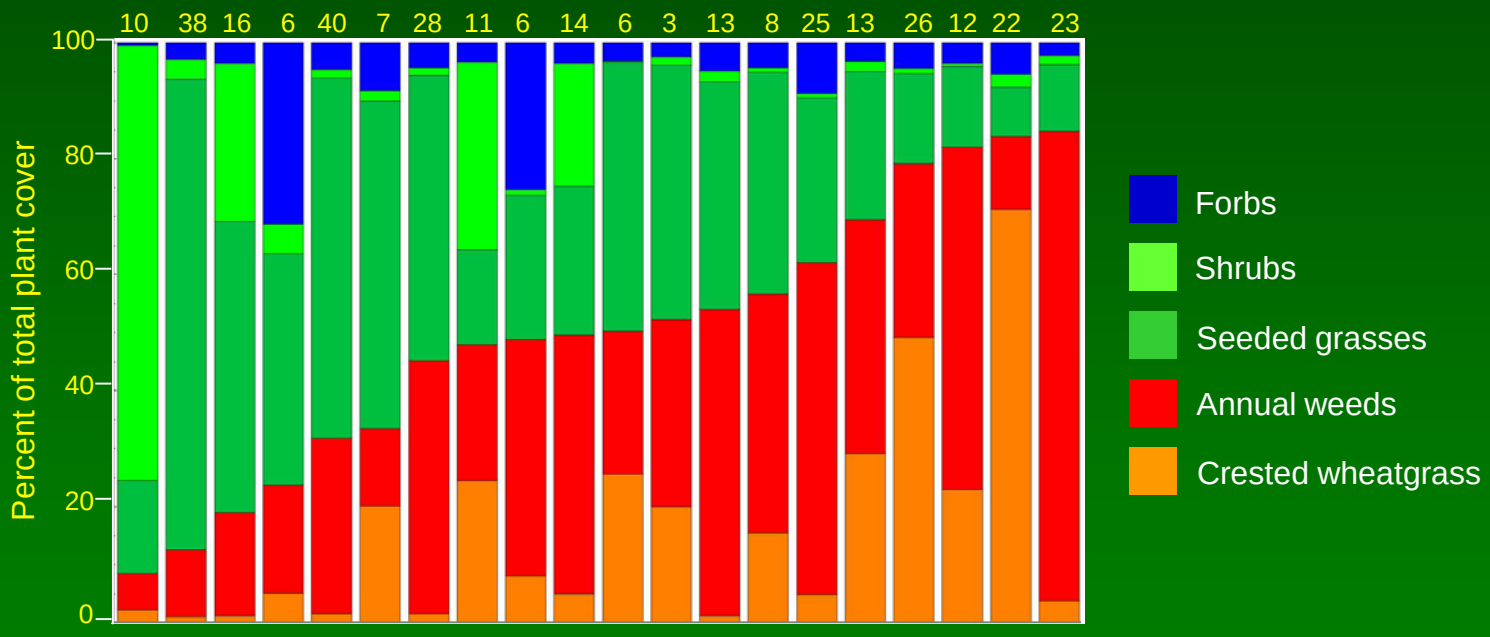
“Field” or area seeded and otherwise treated over a short period of time

Reclamation Variables

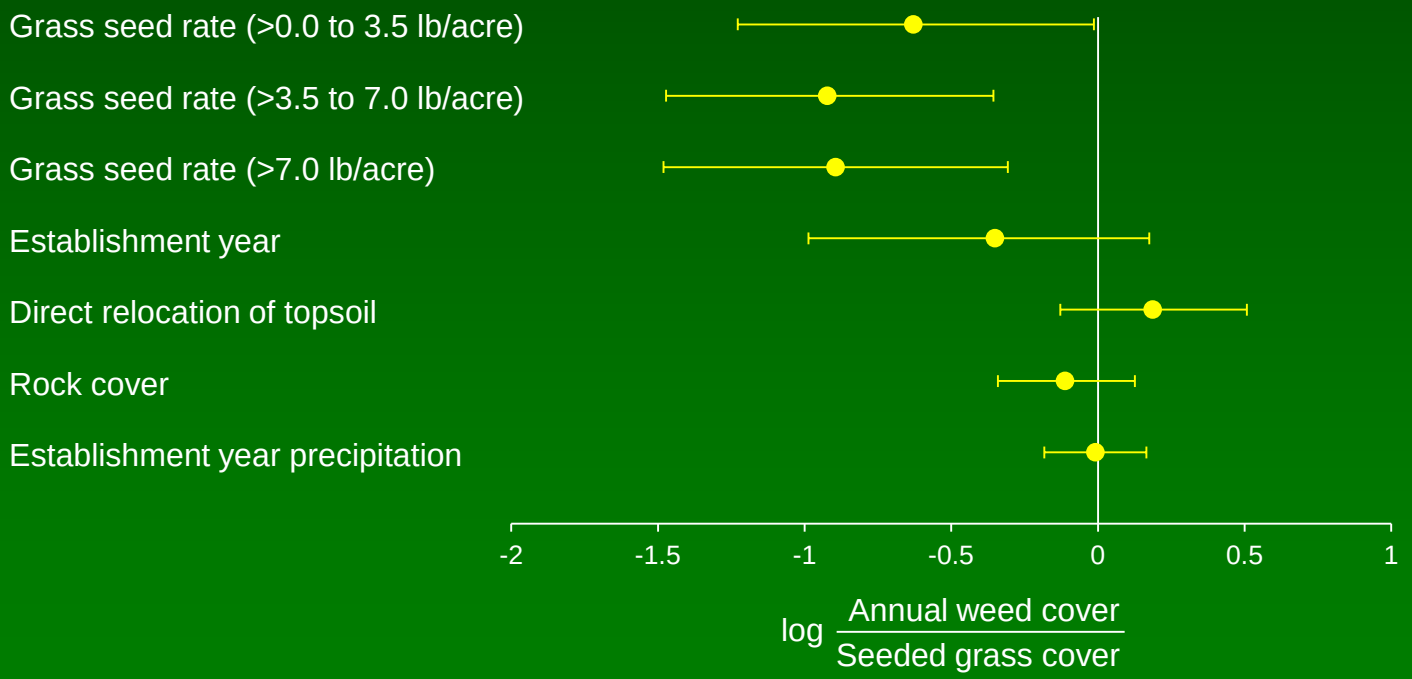


-Western wheatgrass
-Thickspike wheatgrass
-Slender wheatgrass
-Green needlegrass
-Non-native grasses (15% of fields)

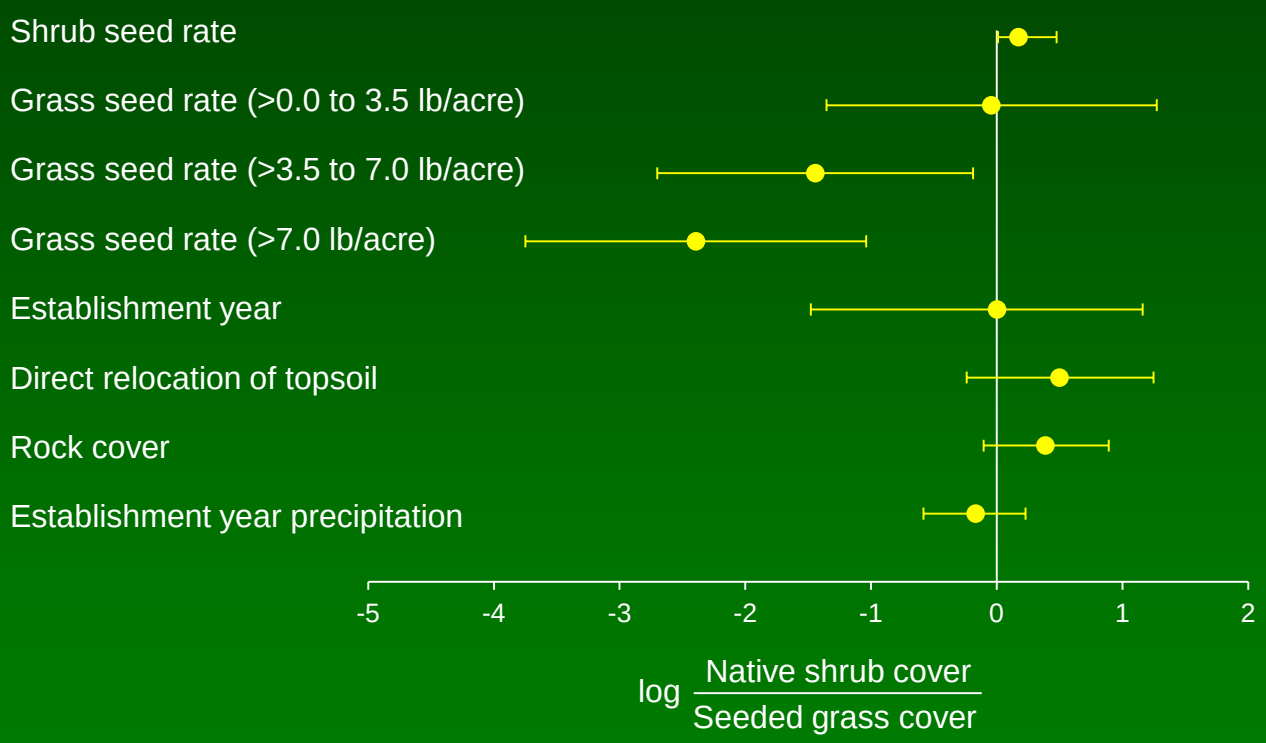
Plant Cover


10 38 16 6 40 7 28 11 6 14 6 3 13 8 25 13 26 12 22 23
100
80
60
40
20
0
Percent of total plant cover
Forbs
Shrubs
Seeded grasses
Annual weeds
Crested wheatgrass

Annual Weeds: Cheatgrass, Japanese brome, Mustards, Etc.



Shrubs

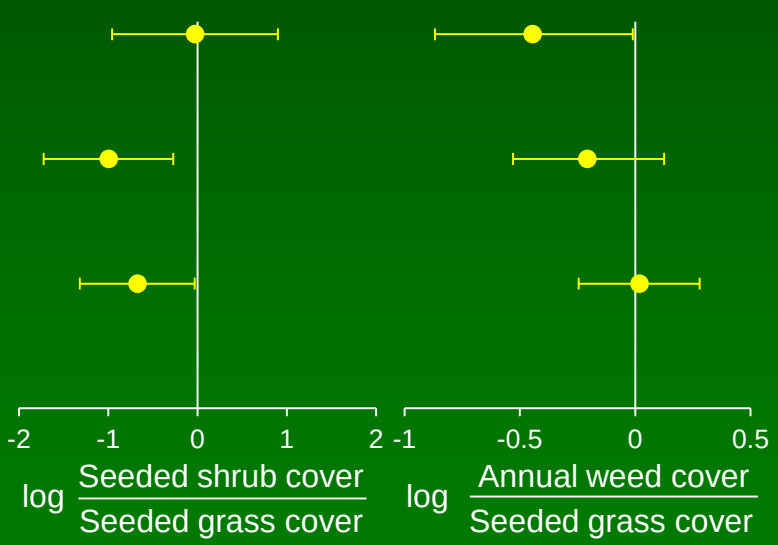

Shrub seed rate
Grass seed rate (>0.0 to 3.5 lb/acre)
Grass seed rate (>3.5 to 7.0 lb/acre)
Grass seed rate (>7.0 lb/acre)
Establishment year
Direct relocation of topsoil
Rock cover
Establishment year precipitation
-5
-4
-3
-2
-1
0
1
2
log Native shrub cover / Seeded grass cover

Effects of Grass Seed Rates on Plant Cover

Difference between 0.0 and low (>0.0 to 3.5 lb/acre)

Difference between low and medium (>3.5 to 7.0 lb/acre)

Difference between medium and high (>7.0 lb/acre)

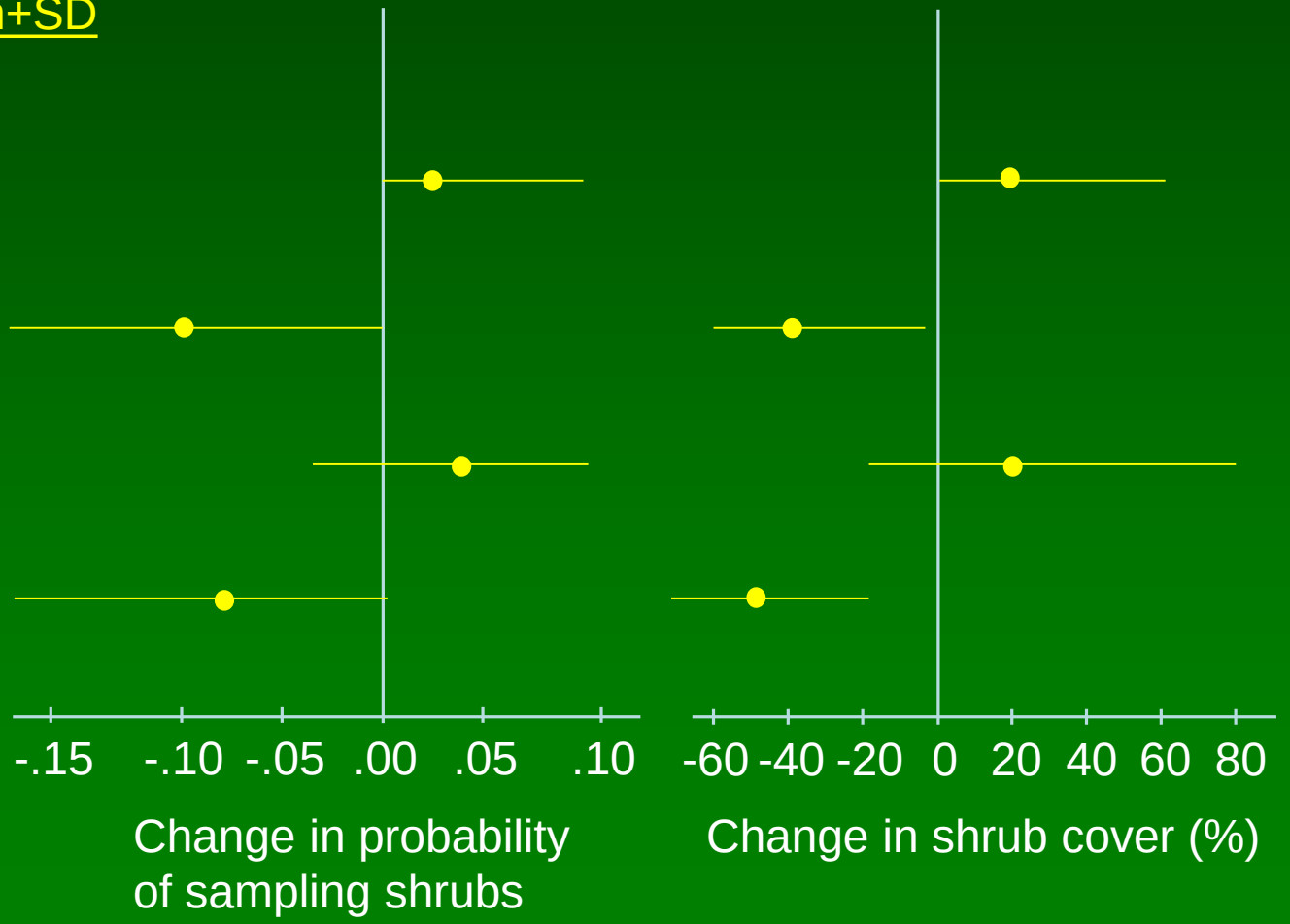


Effects of Grass Seed Rates on Plant Cover

Grass seed rate	Seeded shrubs / Seeded grasses	Annual weeds / Seeded grasses
0.0 lb/acre	0.10(0.02, 0.53)	2.8(1.1,6.7)
<0.0 to 3.5 lb/acre	0.10(0.03, 0.41)	1.5(0.7,3.3)
>3.5 to 7.0 lb/acre	0.02(0.007, 0.09)	1.1(0.5,2.4)
>7.0 lb/acre	0.009(0.002,0.04)	1.1(0.5,2.4)

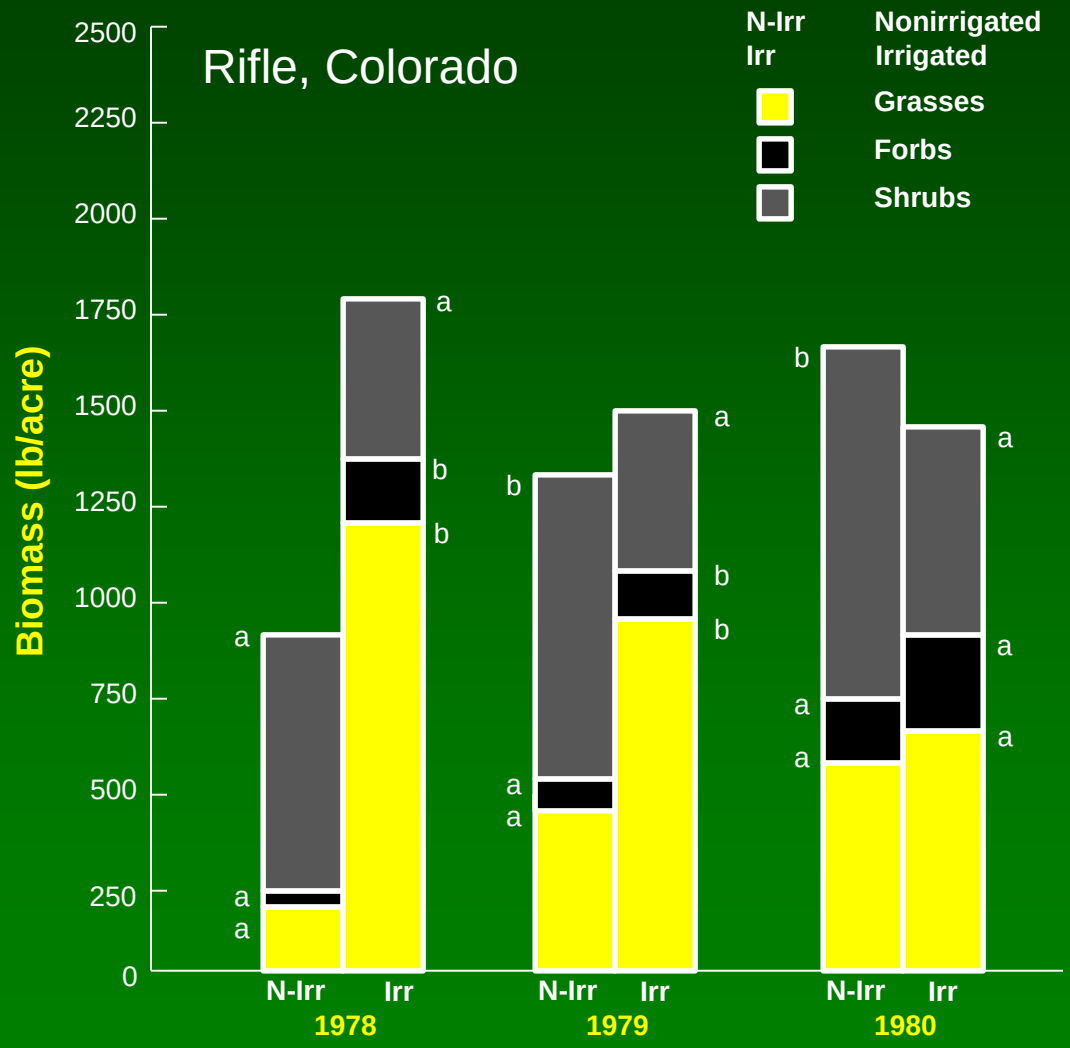
Shrubs-DEQ Study

Variable	Mean	Mean+SD
Shrub (lb/acre)	0.9	2.1
Grass (lb/acre)	23	39
Rock cover (%)	9	30
Precip. (Inches)	6.6	8.7



Why the Negative Precipitation Effect?

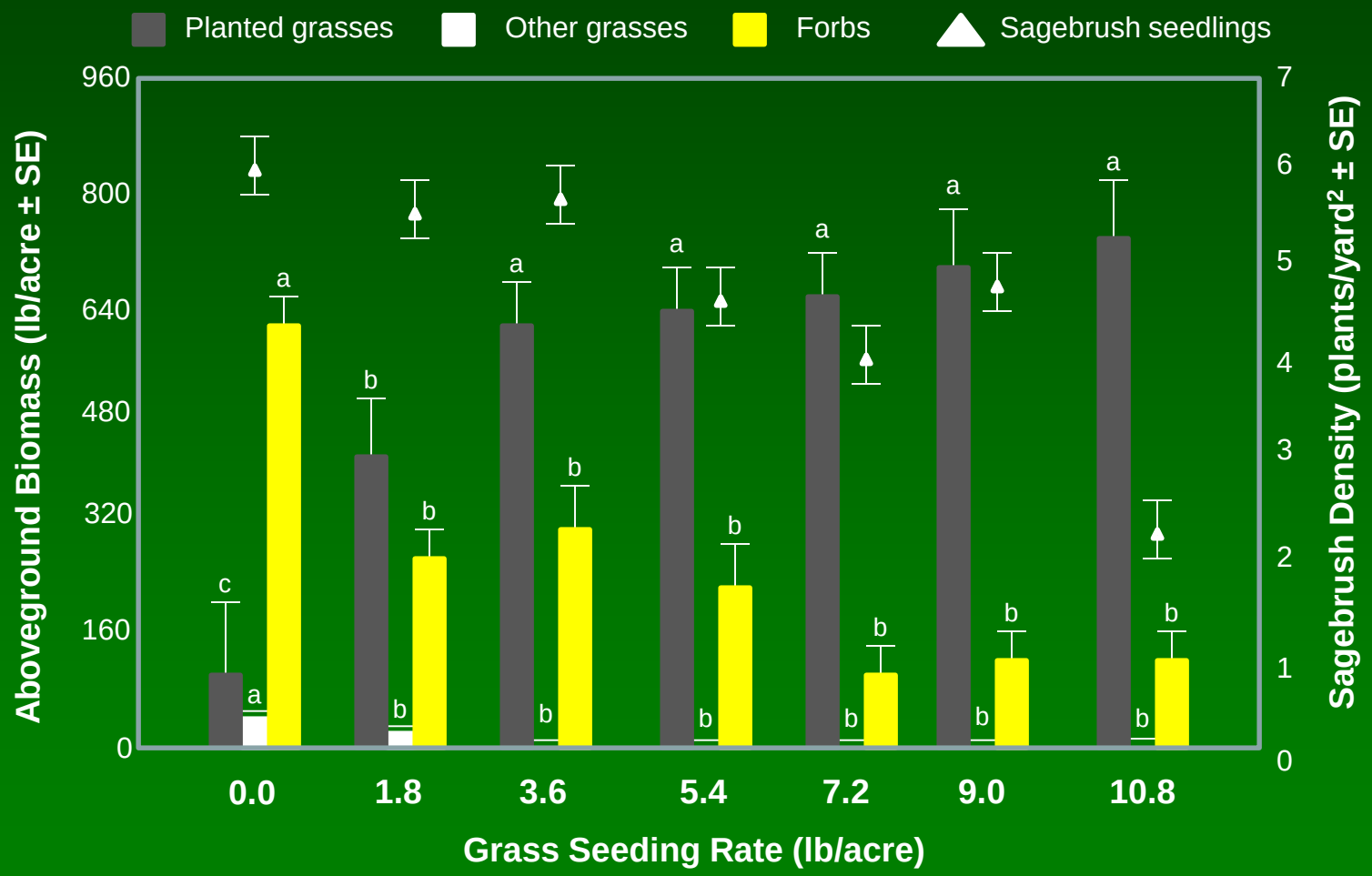
Why Negative Precip. Effect?



Doerr et al. 1983. *Journal of Range Management*. 36:423-428

Grass Competition

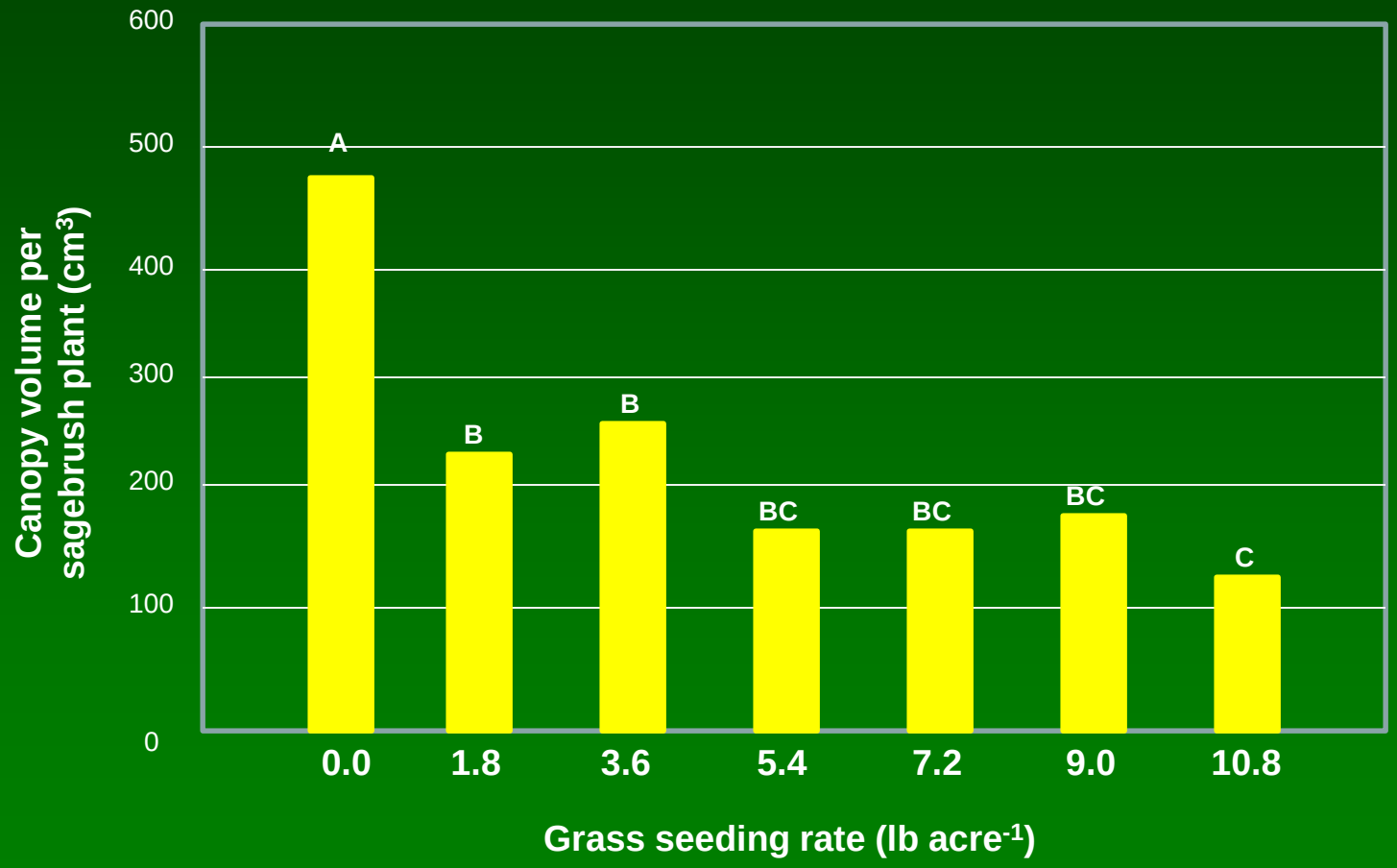
Belle Ayr Coal Mine. 2nd growing season after seeding.



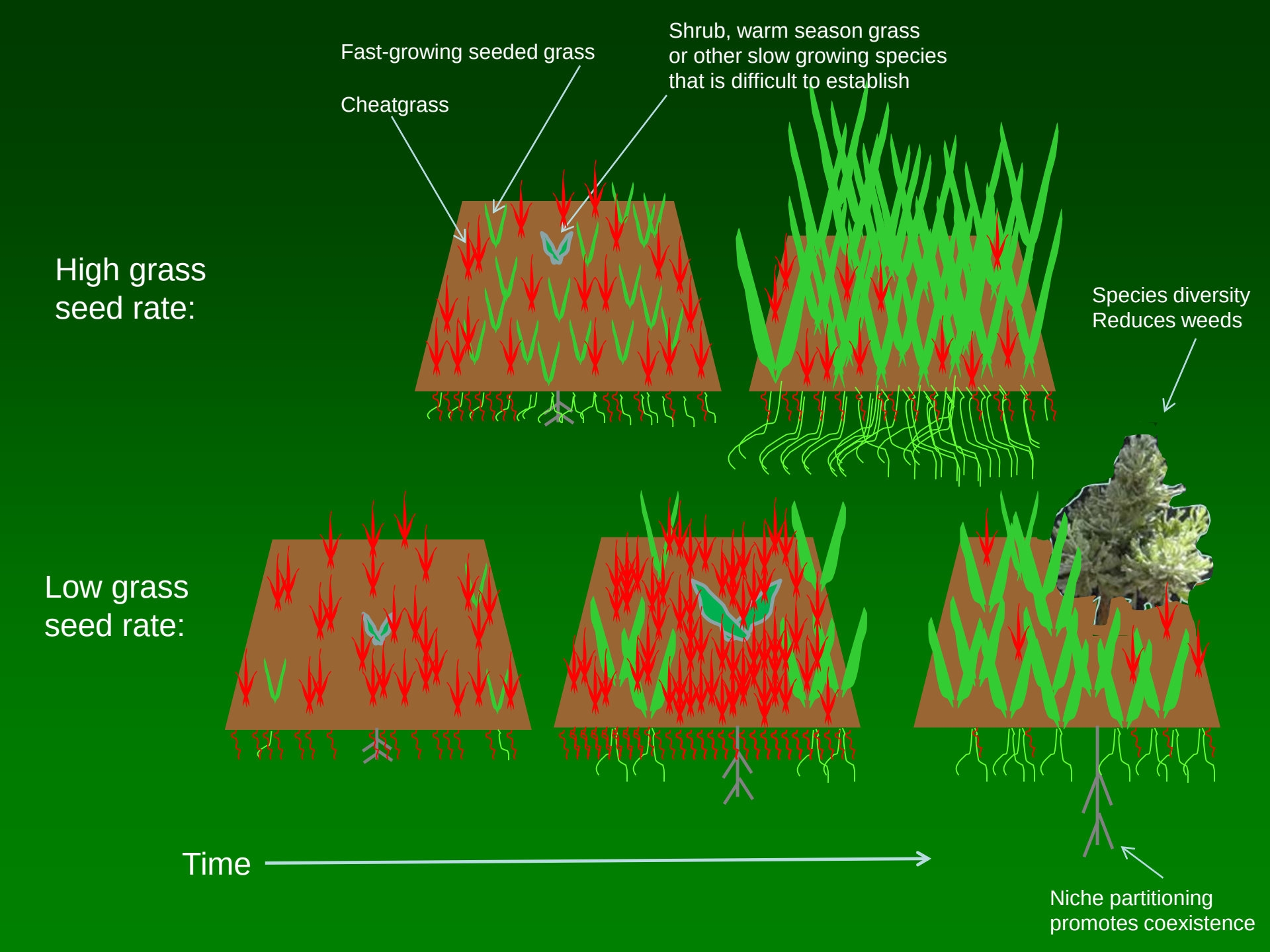
Williams et al. 2002. *Restoration Ecology.* 10: 385-391

Grass Competition

Belle Ayr Coal Mine. 6th growing season after seeding.

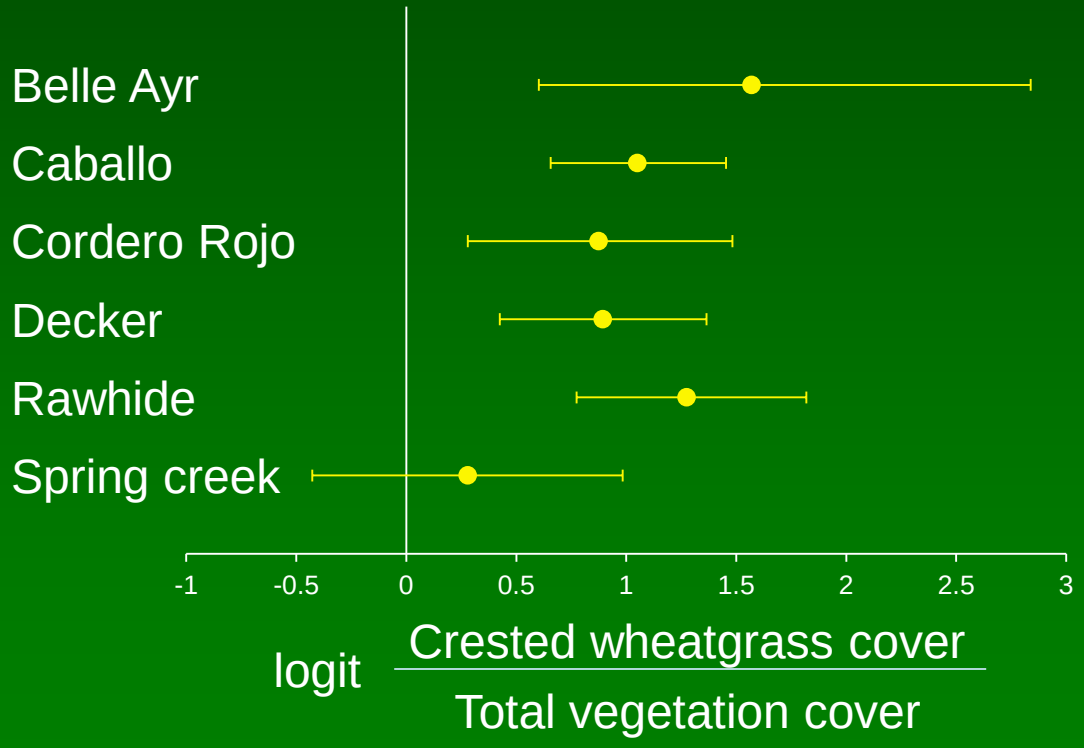


Hild et al. 2006. *Arid Land Research and Management.* 20:183-194

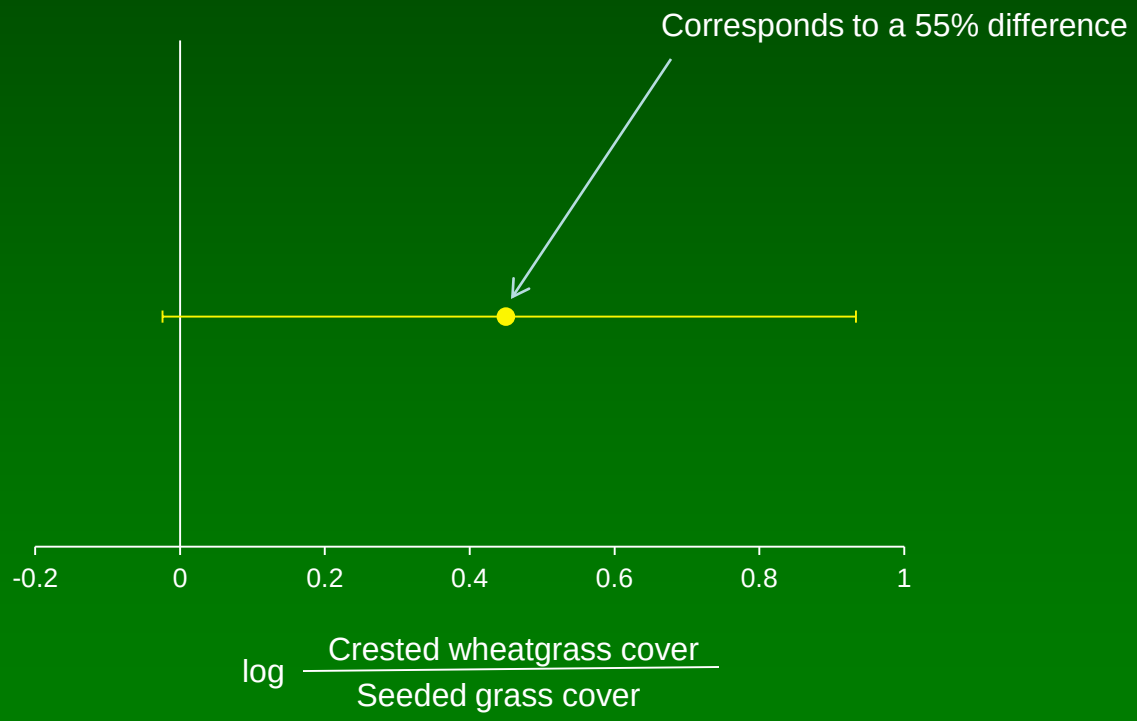

Fast-growing seeded grass
Cheatgrass
Shrub, warm season grass
or other slow growing species
that is difficult to establish
High grass
seed rate:
Species diversity
Reduces weeds
Low grass
seed rate:
Time
Niche partitioning
promotes coexistence

Crested Wheatgrass Time Trends

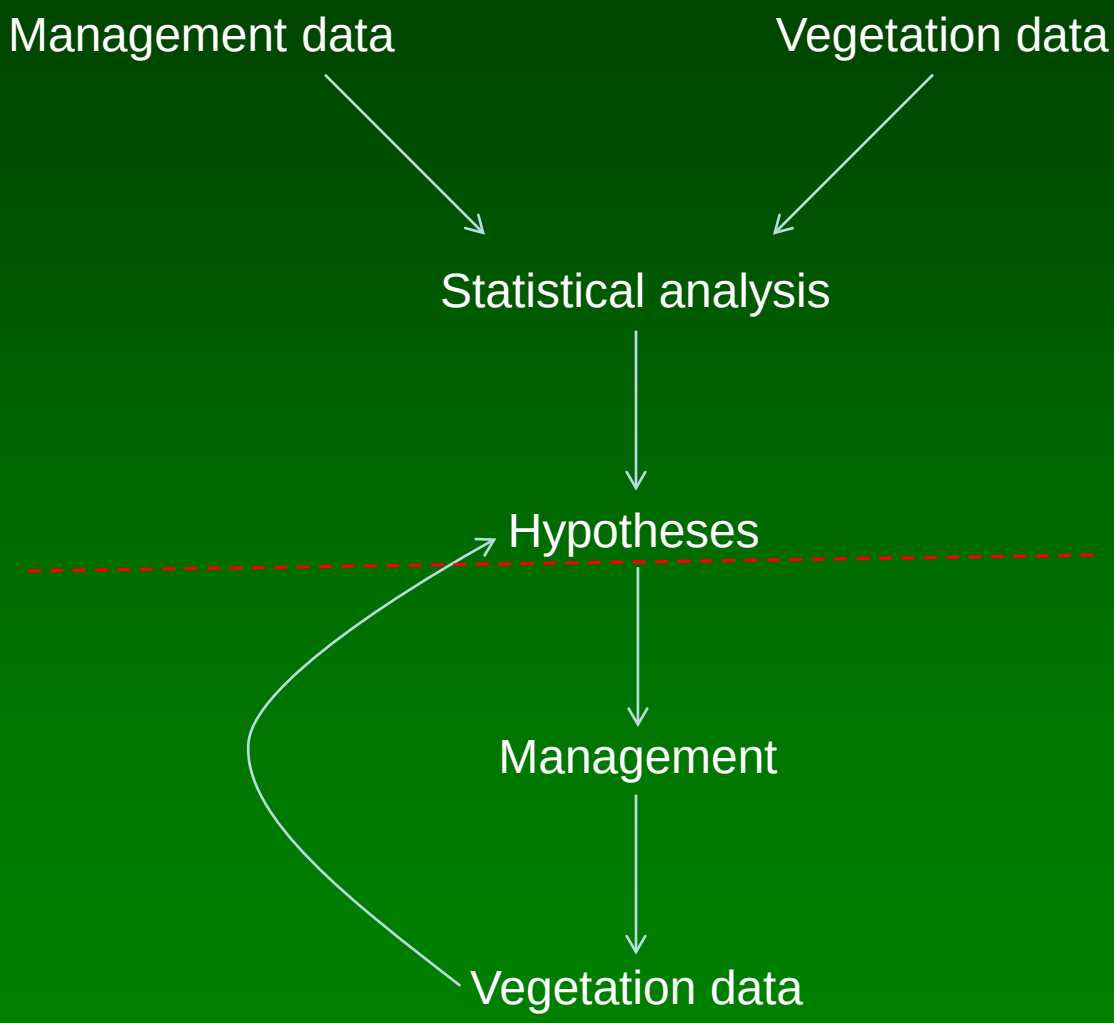
Not all fields had crested wheatgrass



Direct Haul Effect on Crested Wheatgrass



Adaptive Management



Adaptive Management

Project evaluating aggressive grass seed rates well below rates commonly used (i.e. 0.2, 0.4, 1.0, 2.0 lb acre^{-1})

Project spatially segregating difficult-to-establish shrubs from aggressive grasses

Final Thoughts

I believe this research has relevance outside our Great Plains study system

If you see any potential for applying the research and have questions, please look me up today or feel free to contact me:

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406-874-8232