Mechanisms of Competition with KR Bluestem (*Bothriochloa ischaemum*)

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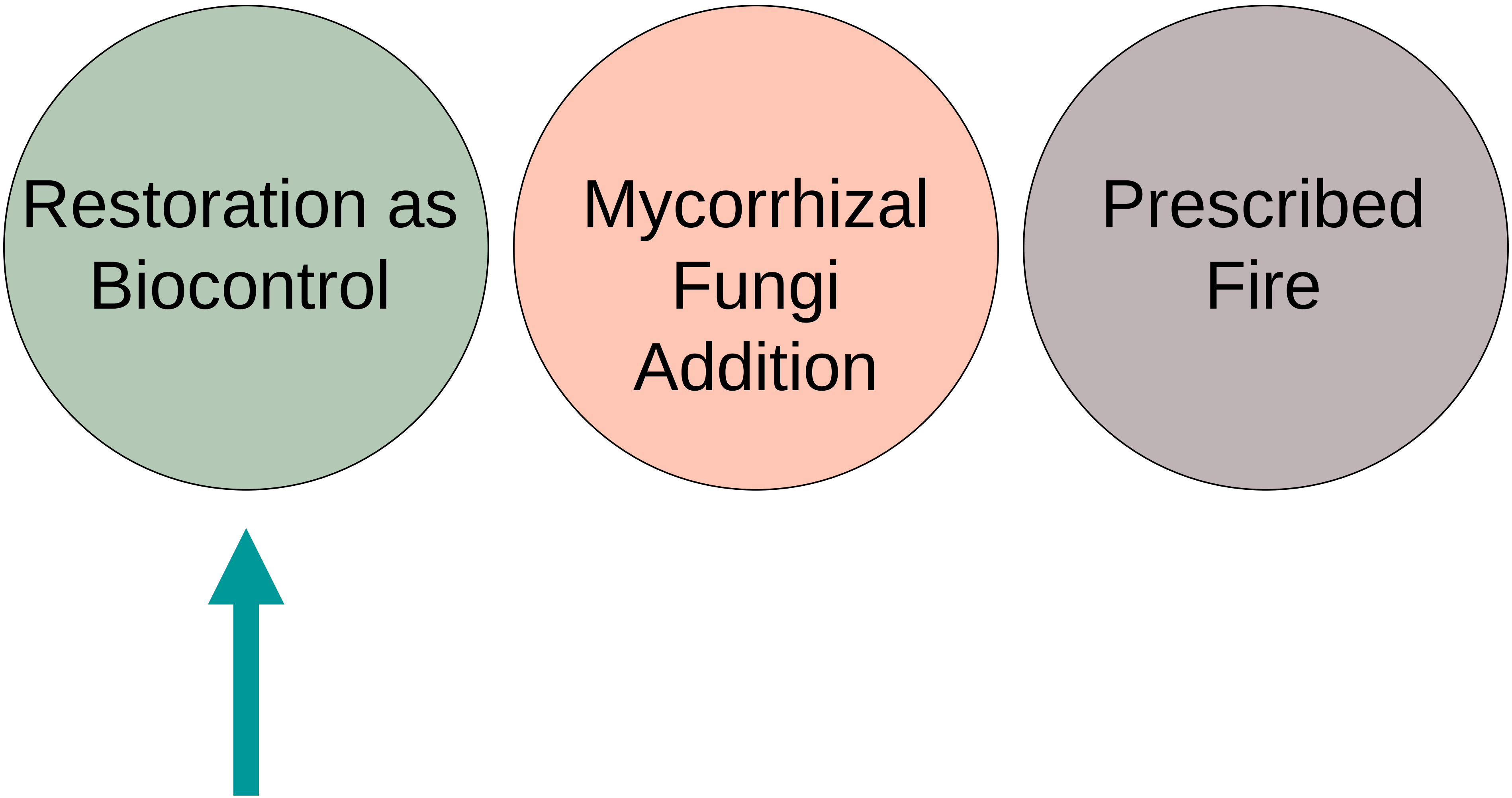
KR Bluestem (*Bothriochloa ischaemum*)

- Perennial, C4 bunchgrass
- Management of C4 in C4 grassland

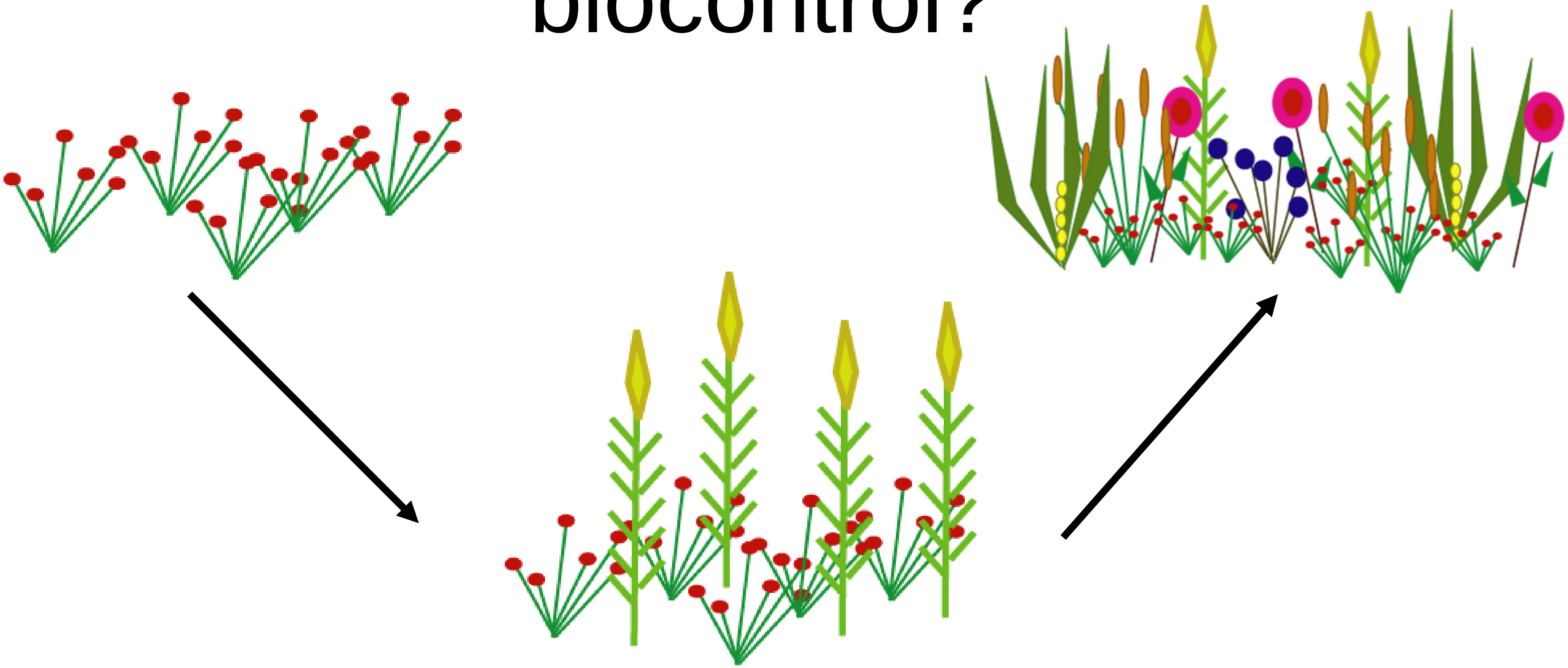
Project Goals

- Increase presence and productivity of high-value forage species
- Increase native grass diversity for wildlife

Mediating Competition Through Management



Can rangeland restoration serve as biocontrol?



Which species?

How many species?

What combinations of species?

Experimental Design

- Four perennial grass species of high forage value.

- Richness: 1, 2, 3, 4 with all possible combinations at 2 and 3.

- Randomized, complete block design.

- 16 individuals per plot, substitutive design.

- KR removal - prescribed burn.

KR Removal – Prescribed Burn, Growing-Season, October 2009

Restored Species – Diversity Study

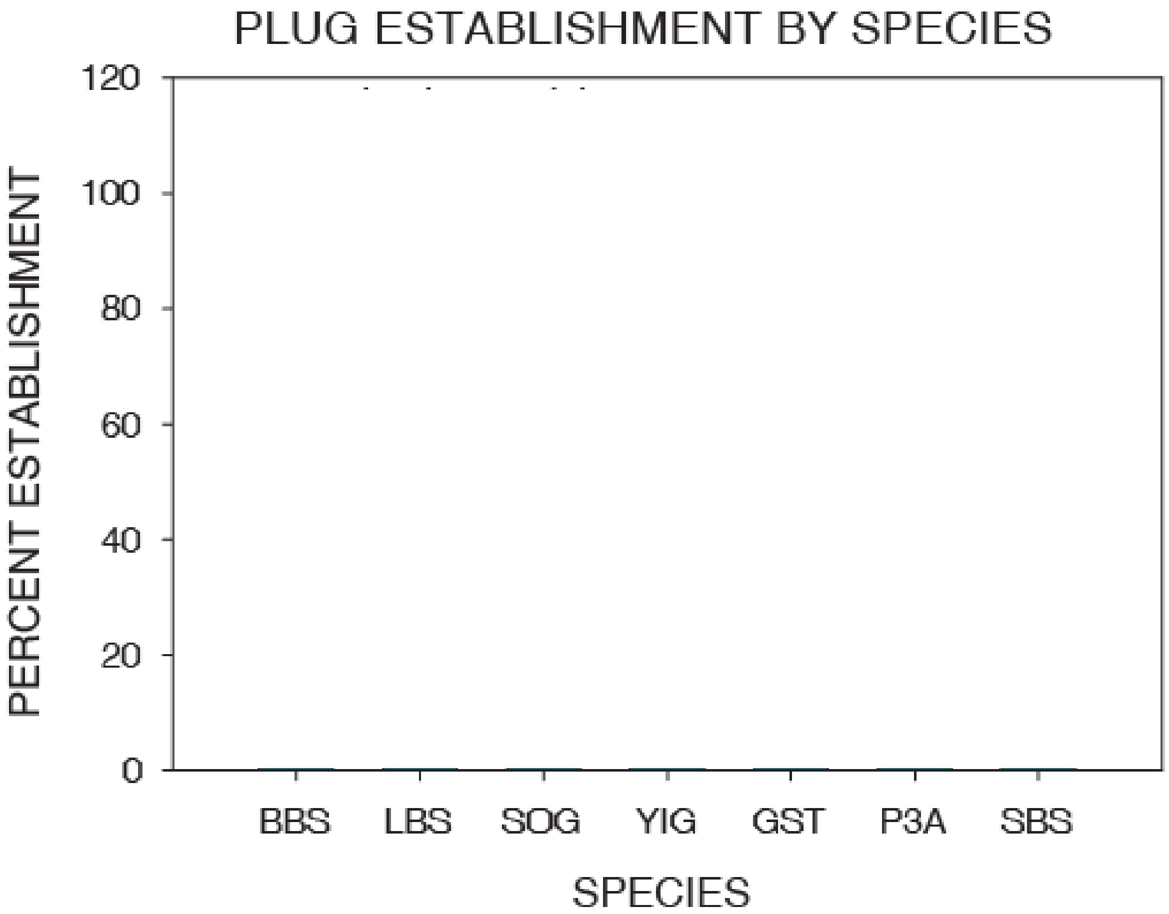
- Big bluestem (BBS, *Andropogon gerardii*)
- Little bluestem (LBS, *Schizachyrium scoparium*)
- Sideoats grama (SOG, *Bouteloua curtipendula*)
- Yellow Indian grass (YIG, *Sorghastrum nutans*)



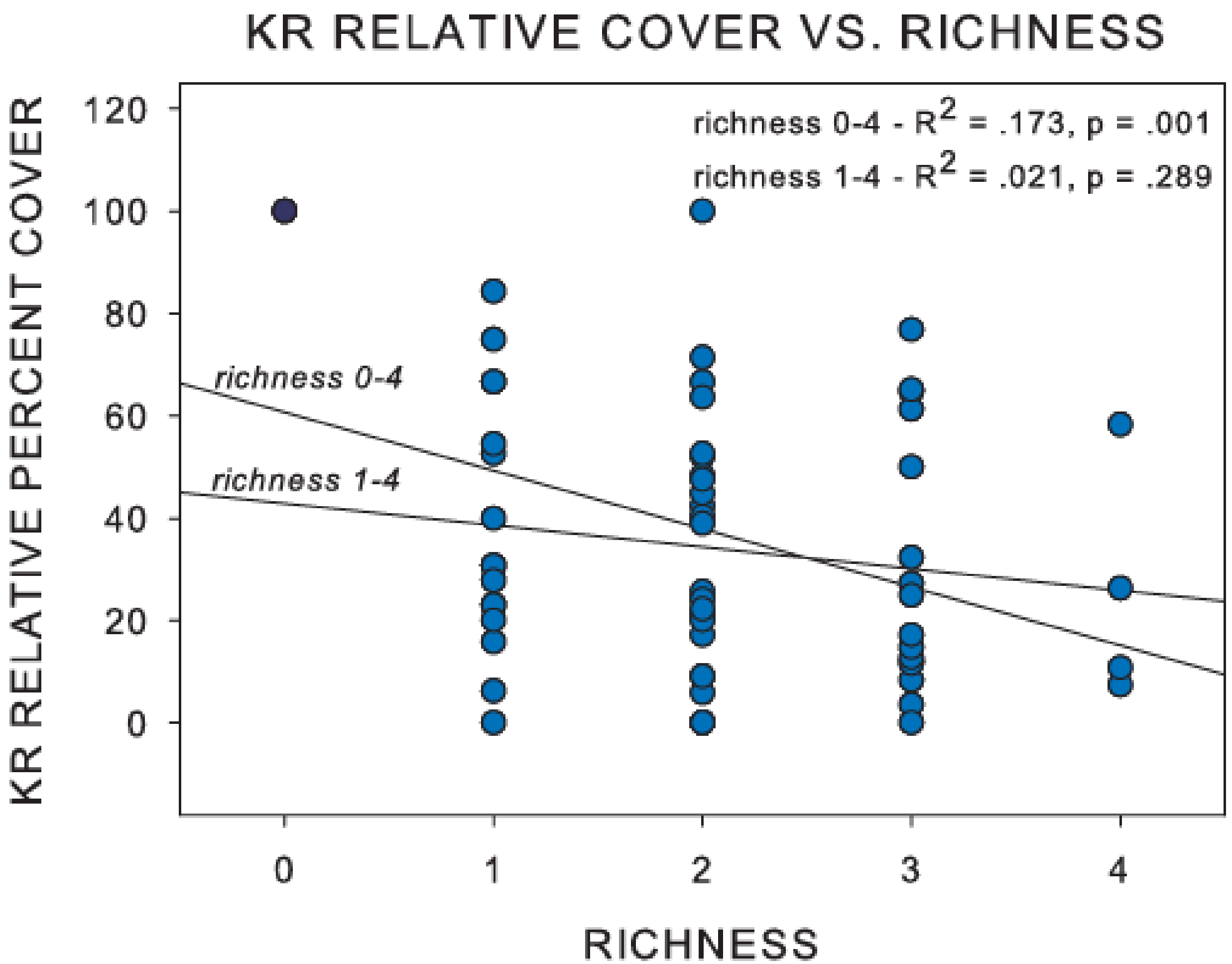

Other Restored Species - Monoculture only

- Green sprangletop (GST, *Leptochloa dubia*)
- Purple threeawn (P3A, *Aristida purpurea*)
- Silver bluestem (SBS, *Bothriochloa laguroides)*

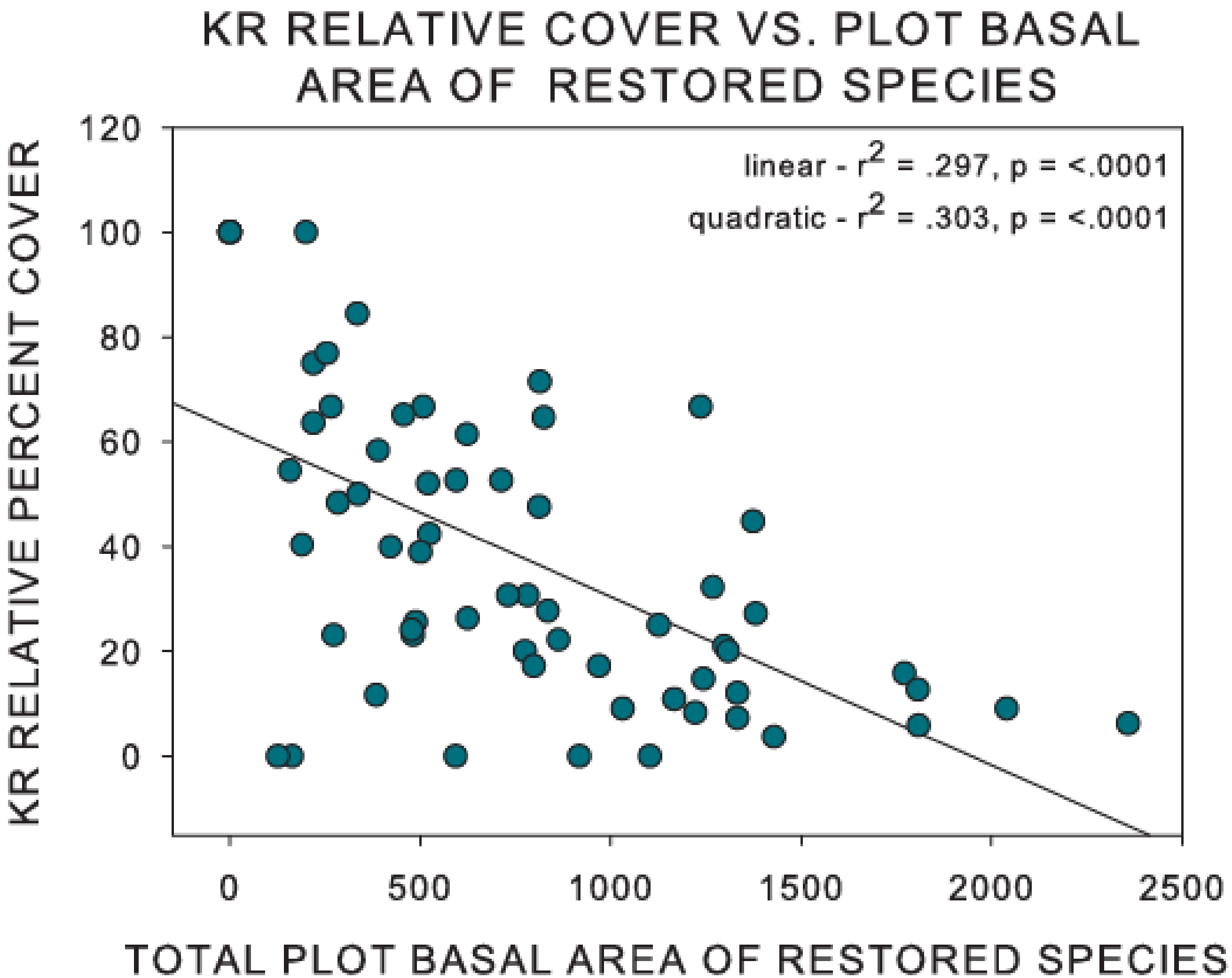
Restored Species Establishment Summer 2010 (pre-drought)



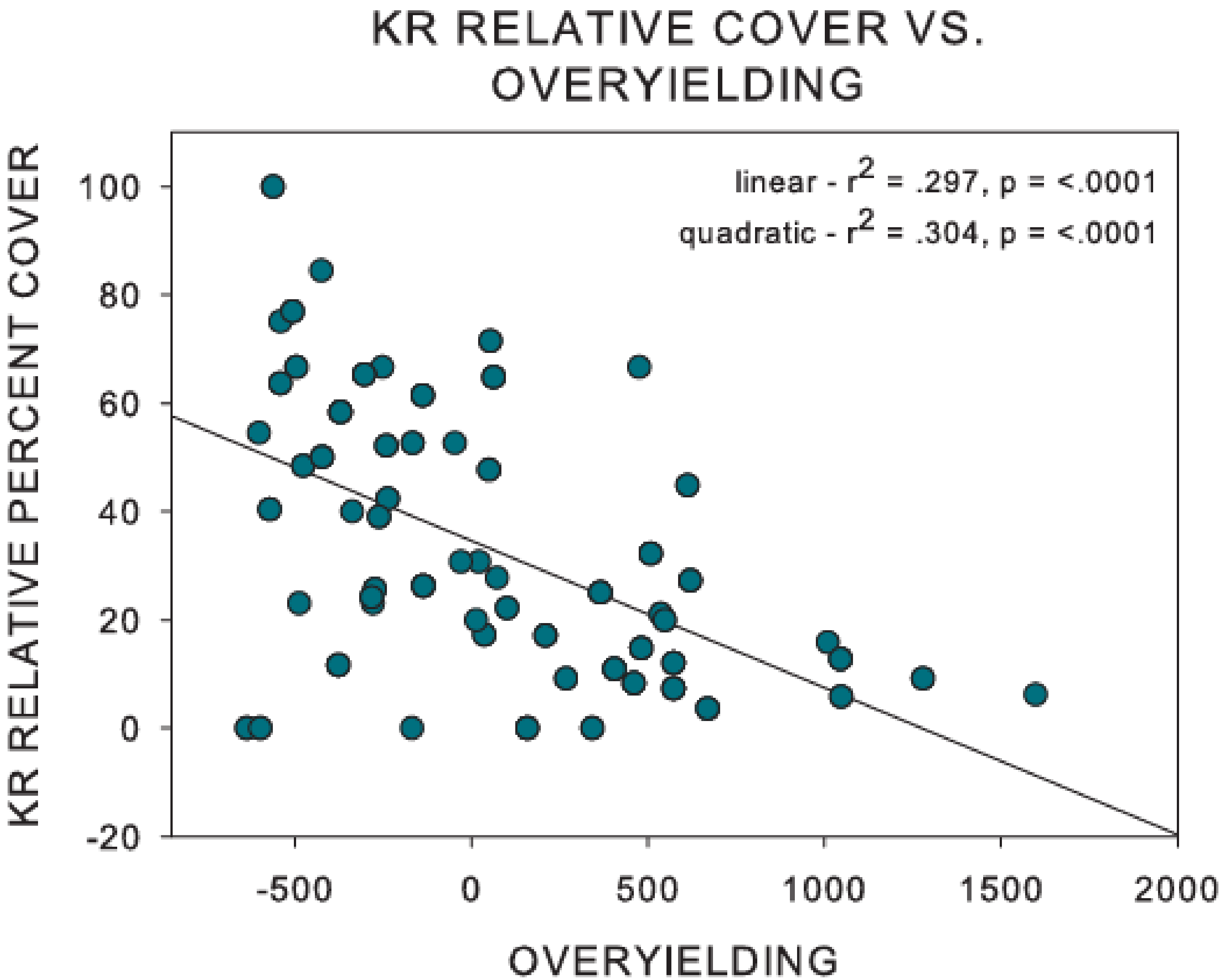
Richness and Invasion (2010)



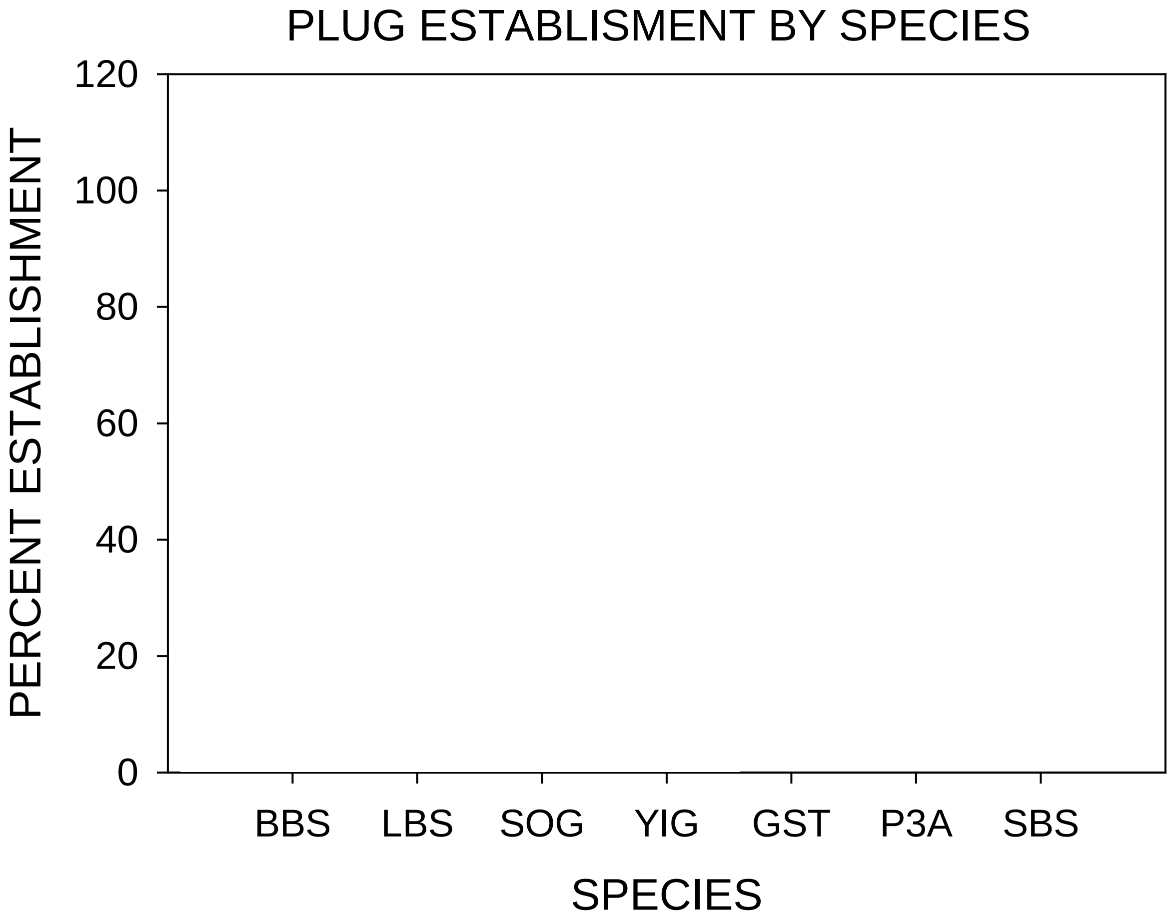
Establishment and Invasion (2010)



Complementarity and Invasion



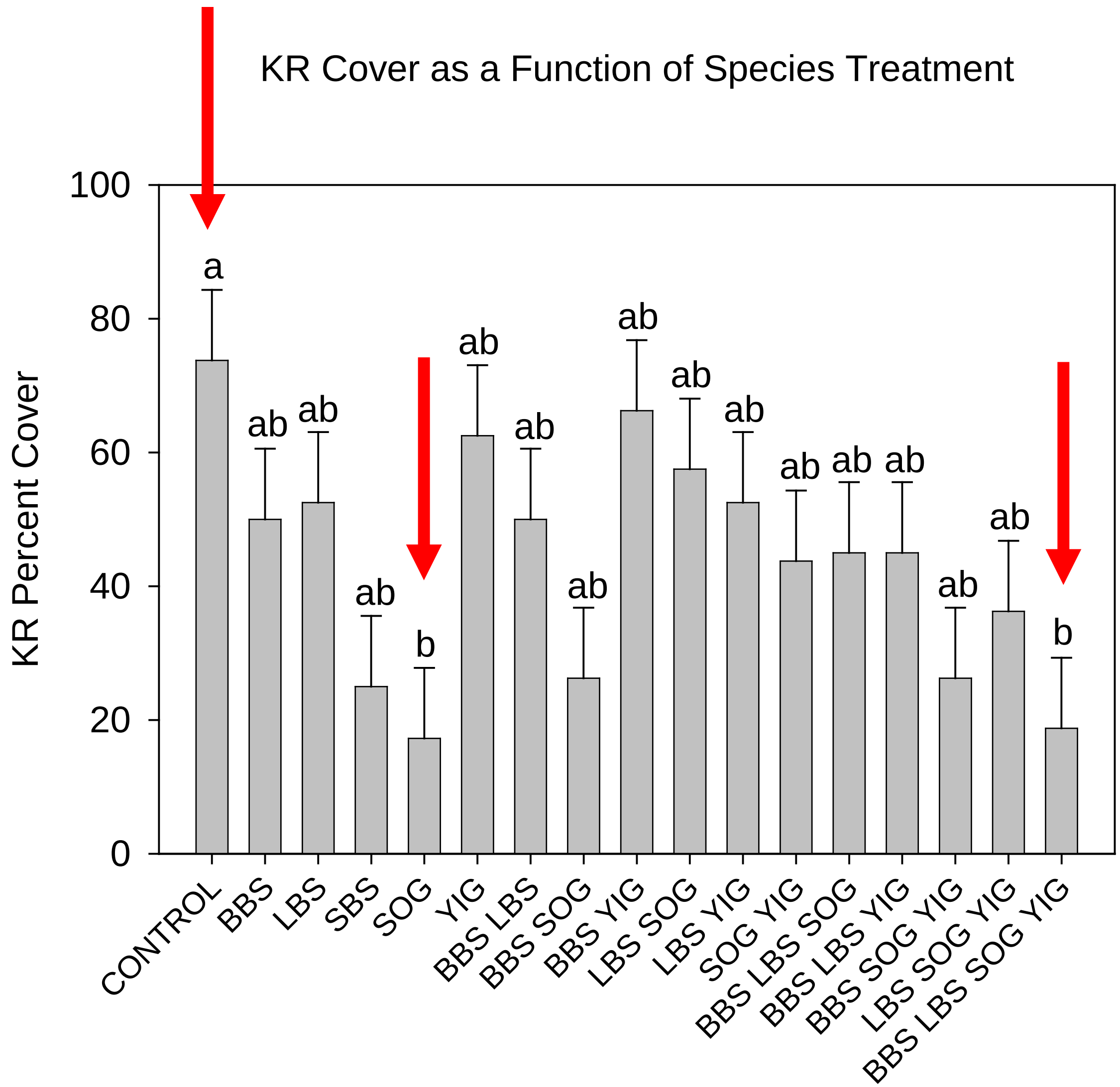
Restored Species Establishment
Fall 2012 (post-drought)



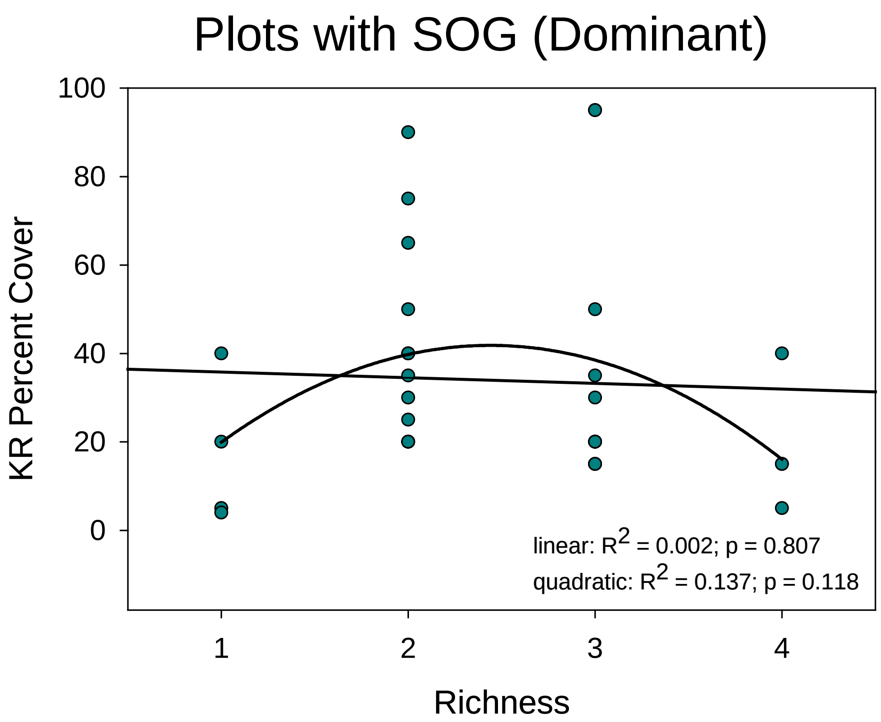
KR Cover as a Function of Species and Richness Treatment (2012)

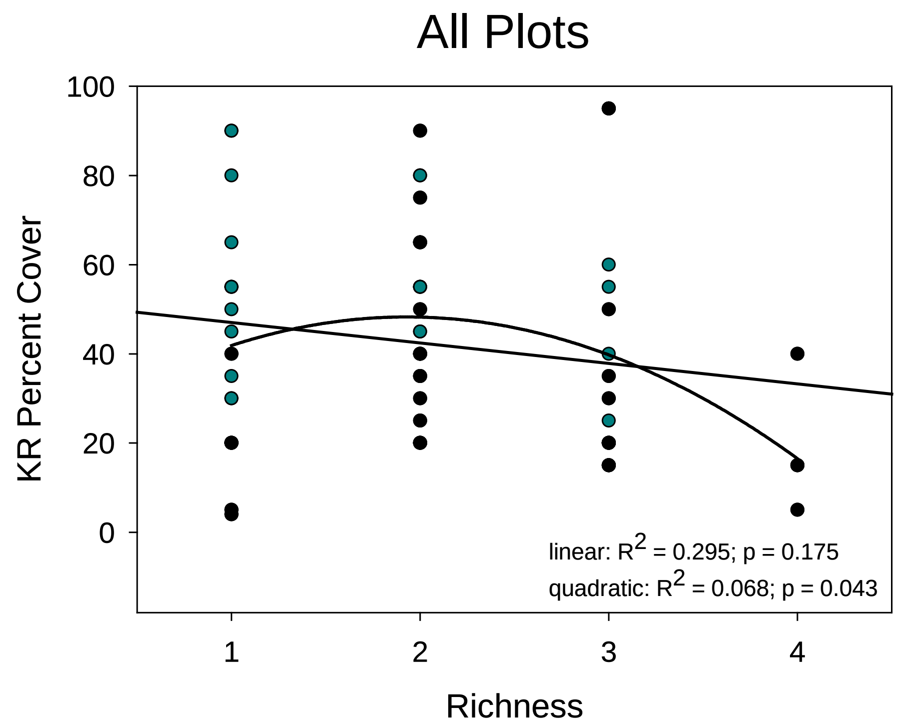
Factor	F	p	R^2	direction
Restored grass cover	22.24	<0.0001	0.222	-
Resident grass cover	0.58	0.449	0.007	-
All grass cover	30.81	<0.0001	0.279	-
BBS	0.733	0.424	0.109	-
LBS	0.241	0.637	0.029	-
SOG	13.43	0.0009	0.302	-
YIG	0.104	0.752	0.007	0
P3A	4.68	0.275	0.824	+
SBS	3.02	0.224	0.602	-
TWG	1.03	0.348	0.147	+

Species and Richness Treatment and Invasion (2012)



Richness and Invasion (post-drought)





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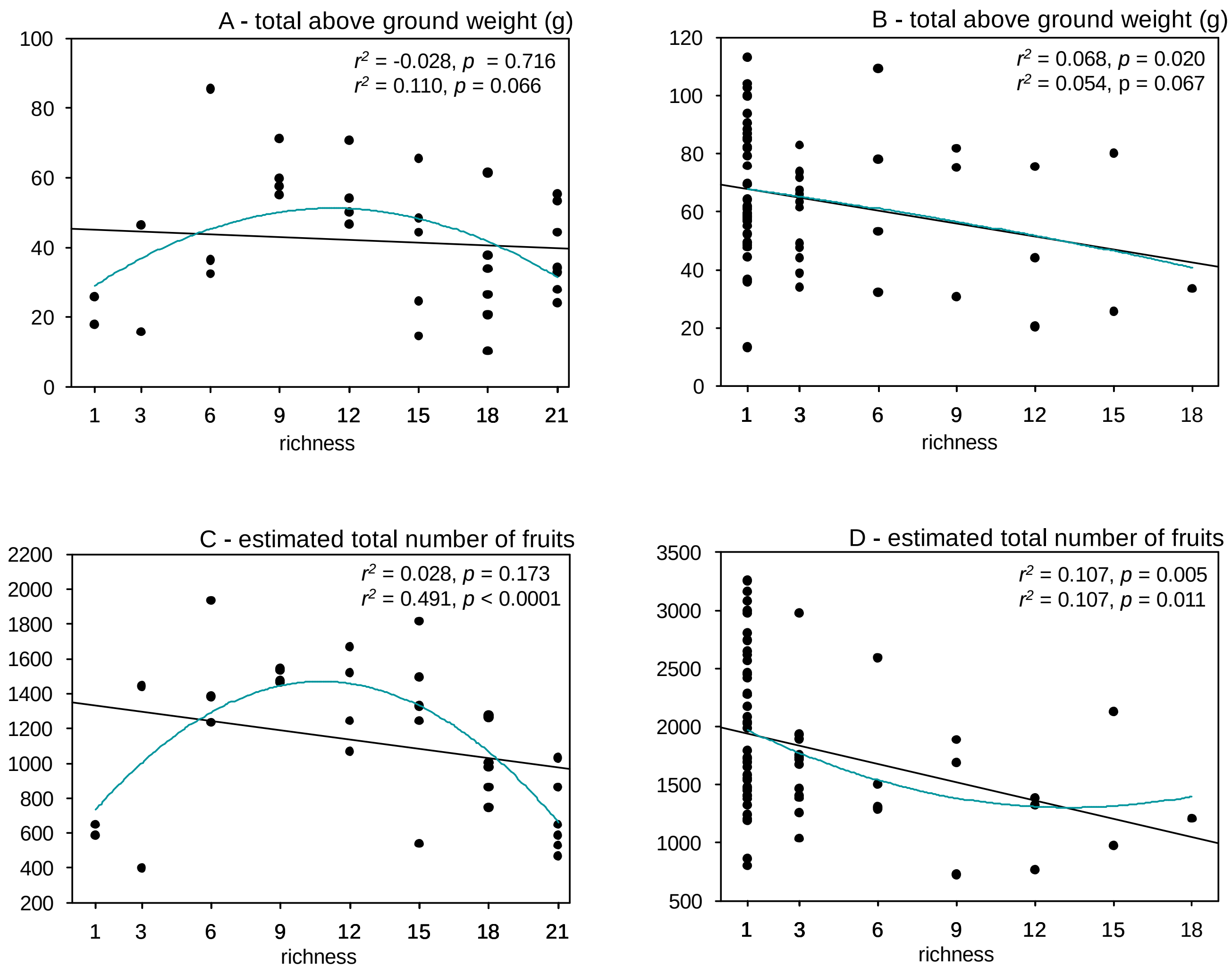
Mass Ratio and BD-EF Living in Harmony?

Lolium

treatments with competitive dominant

treatments without competitive dominant



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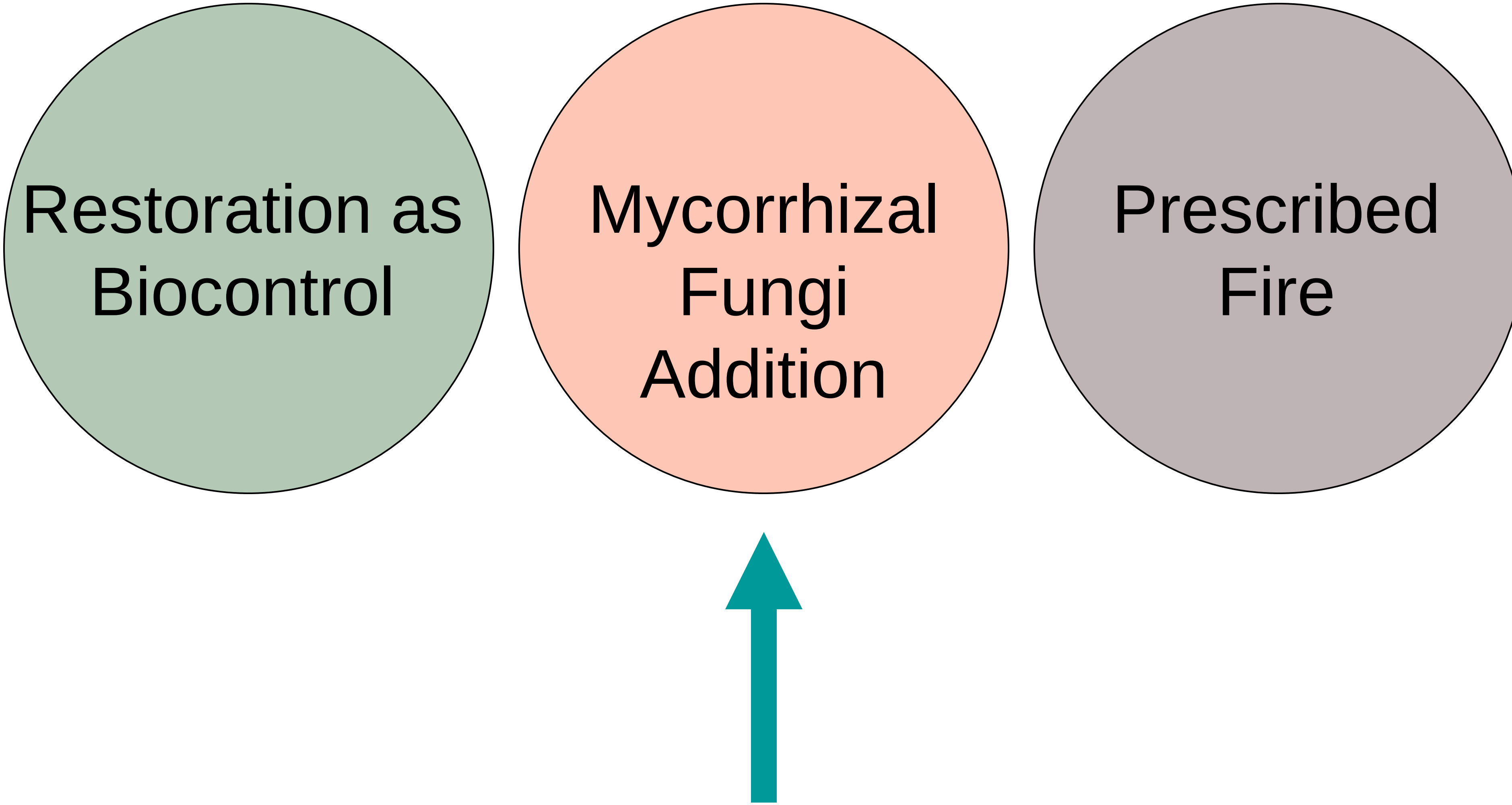
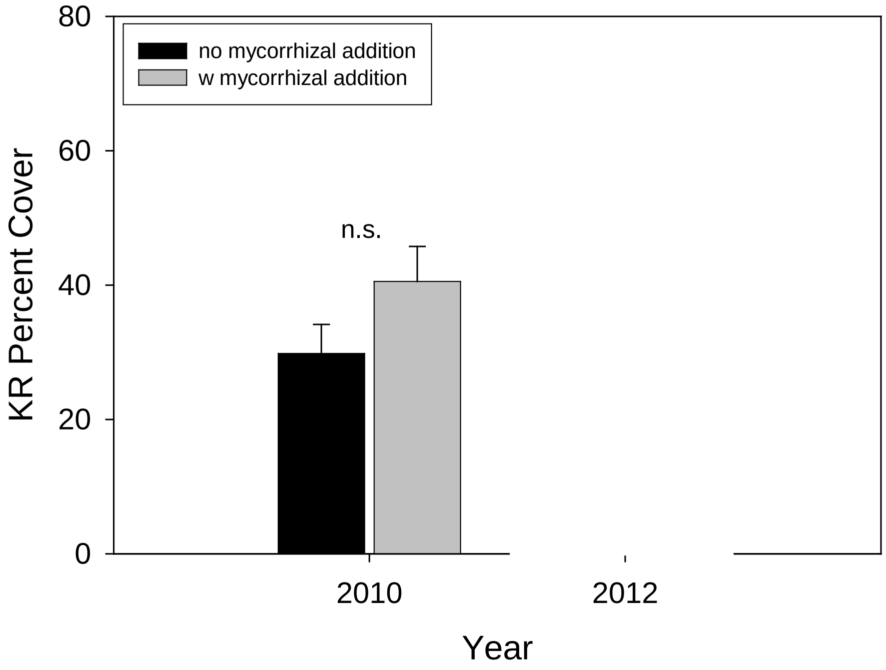
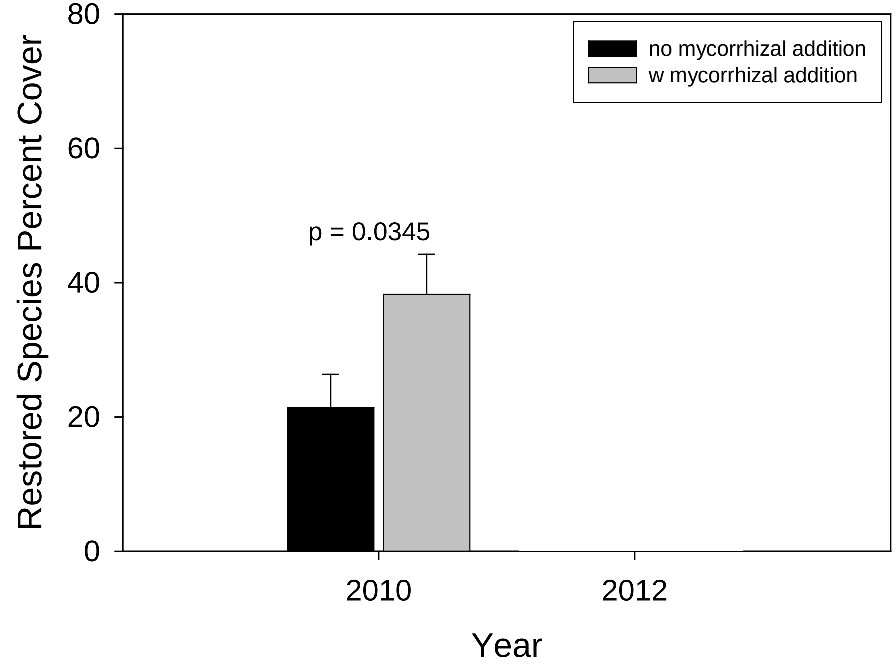
Mediating Competition Through Management



KR and Restored Species Re-establishment Following Burn as a Function of Mycorrhizal Fungi Addition





Commercial inoculant of mycorrhizal fungi:

Glomus mosseae

Glomus aggregatum

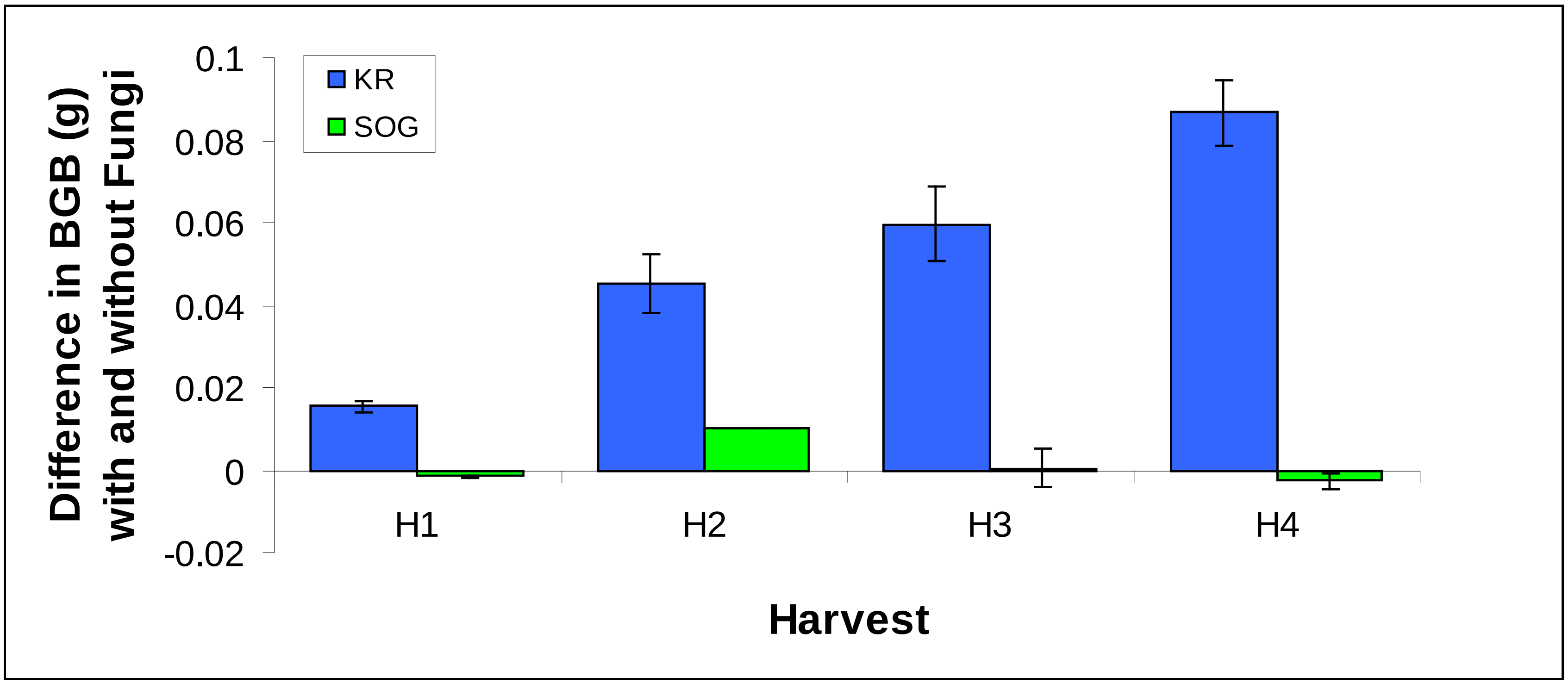
Glomus intraradices

Pisolithus spp.

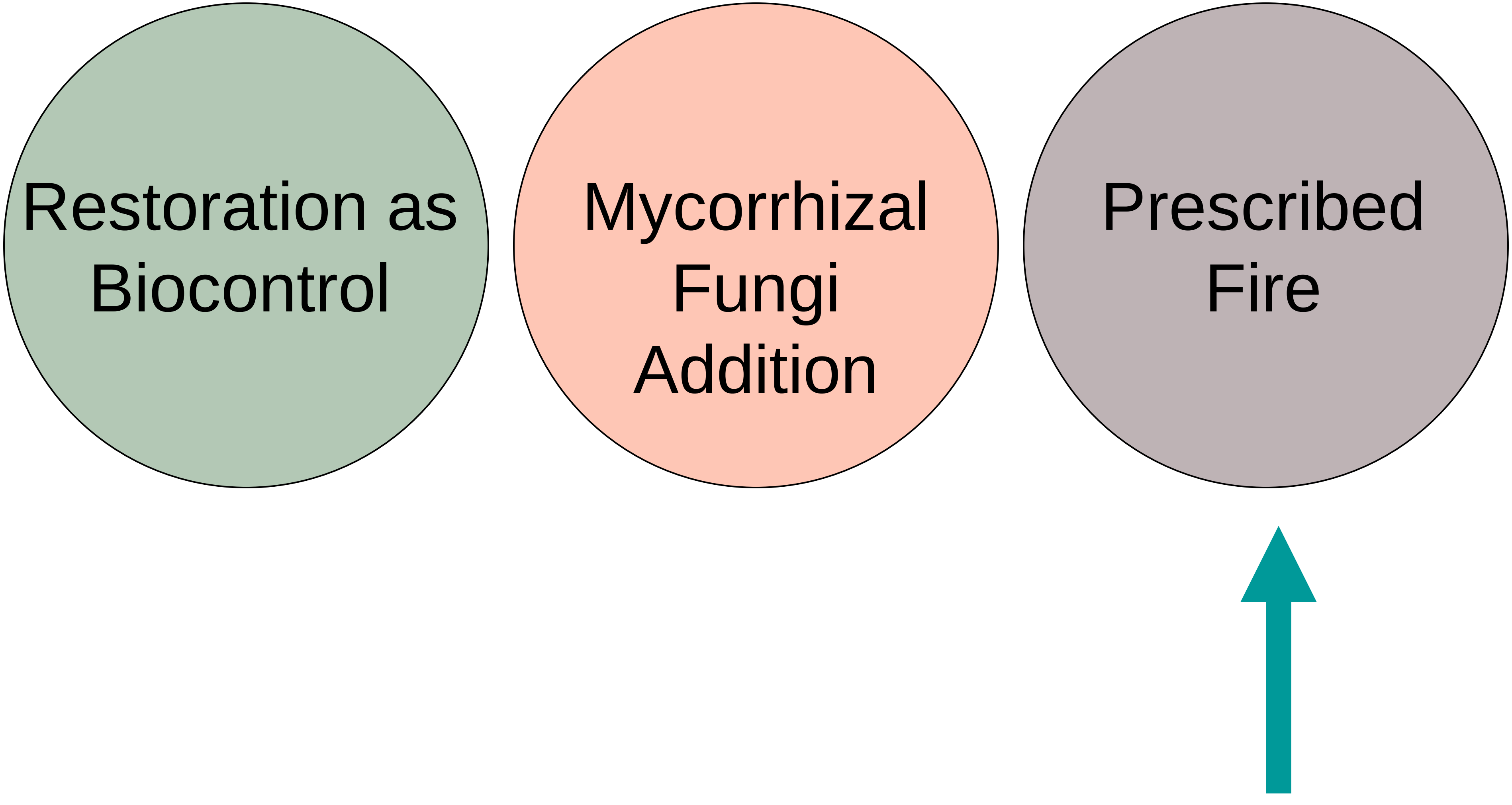
Rhizopogon spp.

KR and Native Species Competition as a Function of Mycorrhizal Fungi Addition

Positive values indicate increased biomass with added fungi



Mediating Competition Through Management

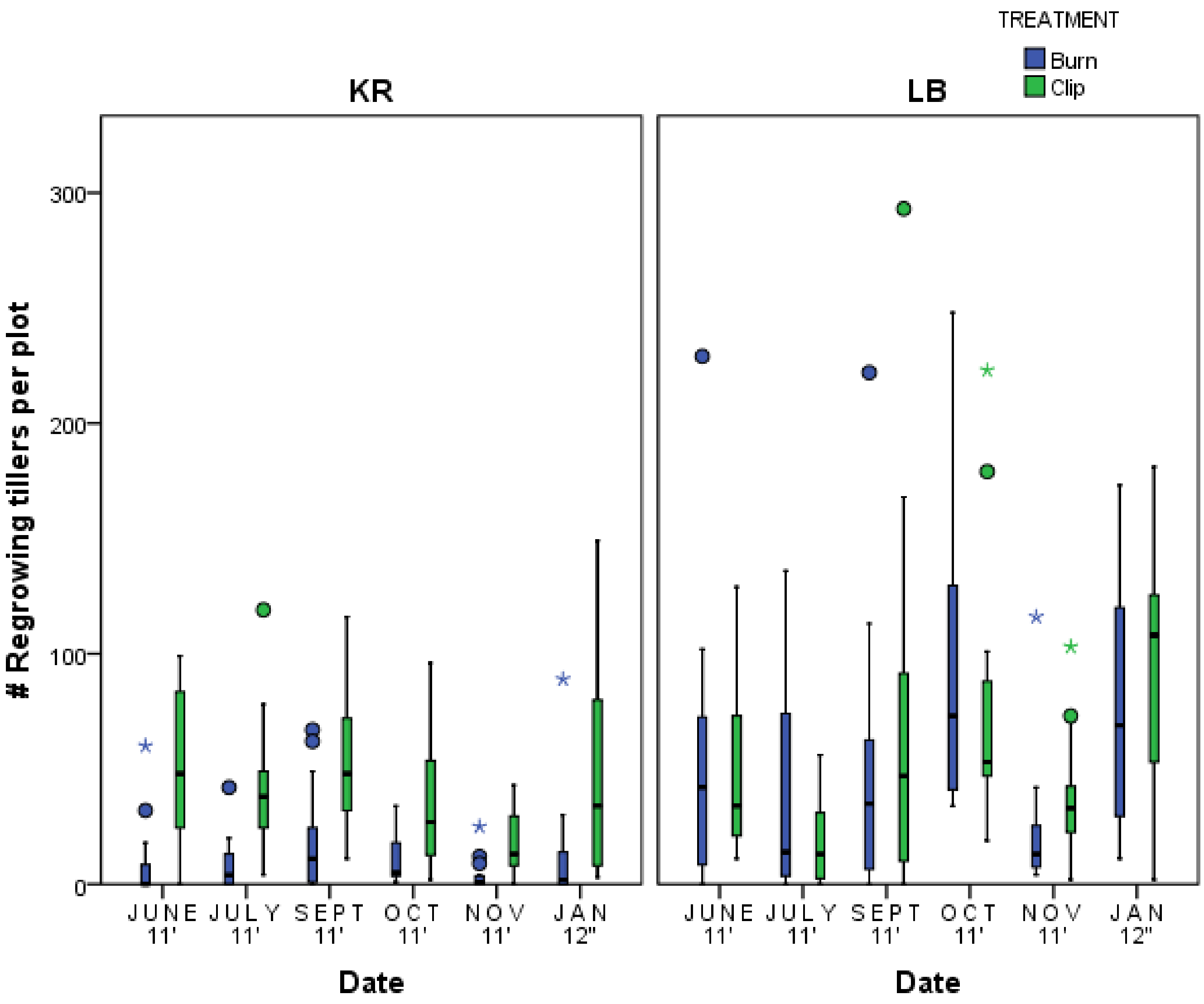


Season, Phenology, and Prescribed Fire

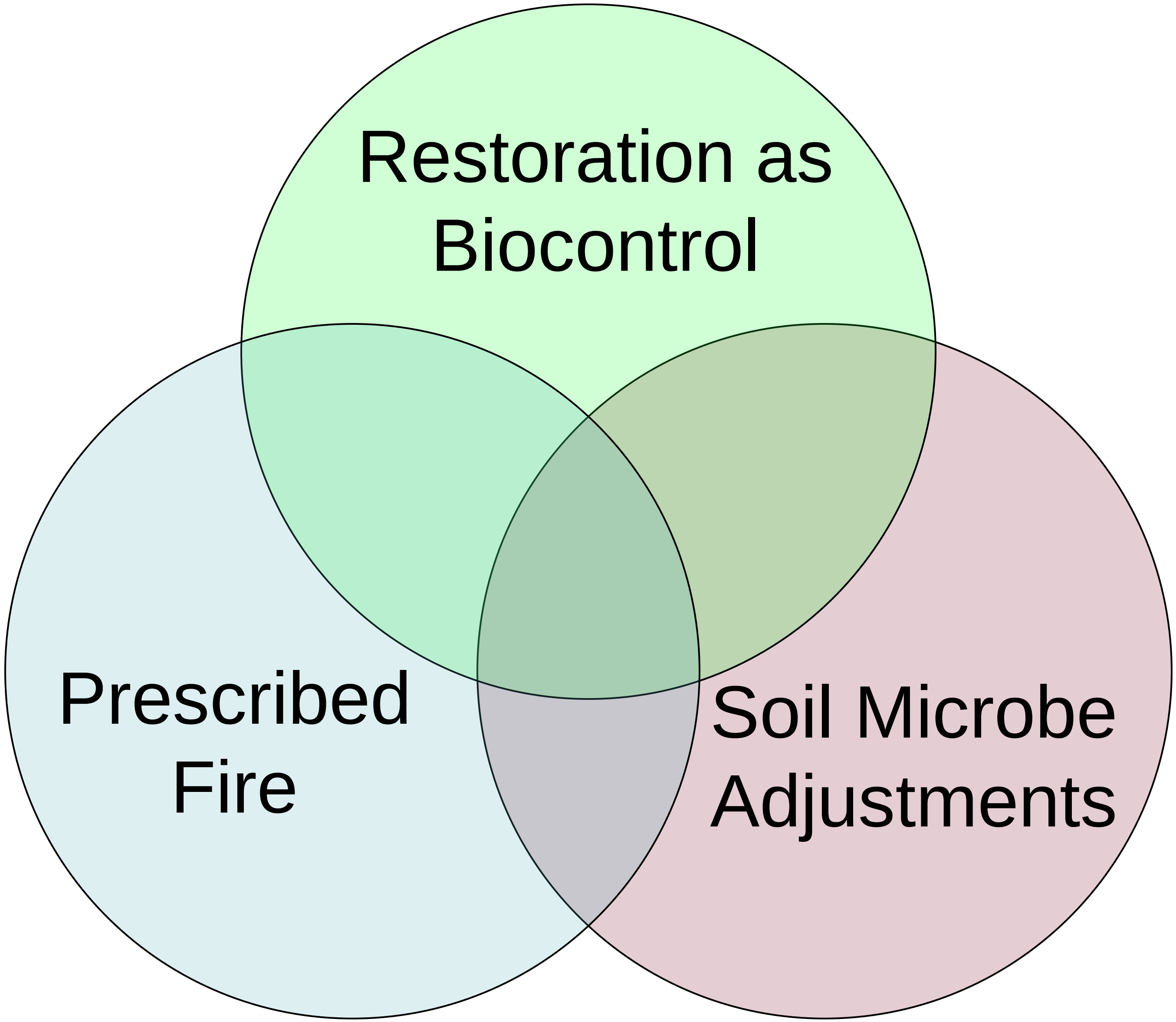
Season, Phenology, and Prescribed Fire

Season, Phenology, and Prescribed Fire

in collaboration with Scott Havill and Susan Schwinning, TX State Univ.



Mediating Competition Through Management



Conclusions

- **Restoration as Biocontrol** – something is better than nothing; competitive, rapidly establishing species (e.g., sideoats grama) provide resistance to re-invasion under drought
- **Mycorrhizal Fungi Addition** – favor KR in field and greenhouse studies
- **Fire** – KR is overall more sensitive to fire than little bluestem; season, environmental conditions, and phenology matter

Acknowledgements



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USDA NIFA

United States Department of Agriculture
National Institute of Food and Agriculture

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Cost Calculations - Seed vs. Plug

On a 1 hectare plot (100 m x 100 m)

Seed (seed only)	Establishment Success
Year 1 = $415	20%
Year 2 = $415	25%
Total = $830	

Plug (seeds, plugs, labor)	
Year 1 = $1760	60%
Year 2 = $920	80%
Total = $2680	

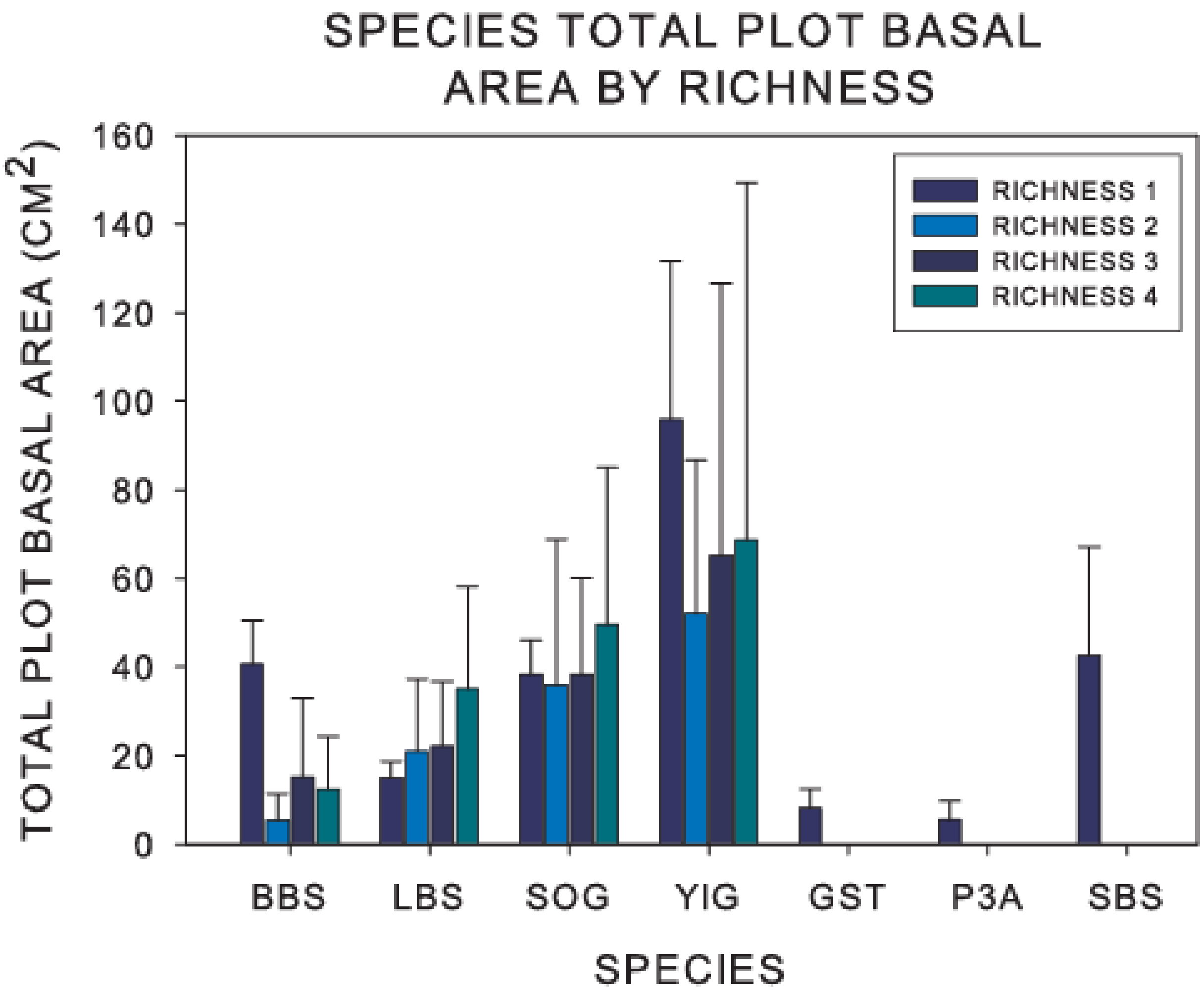
Results – Soil Available Nutrients

No differences among species in soil nutrient use.

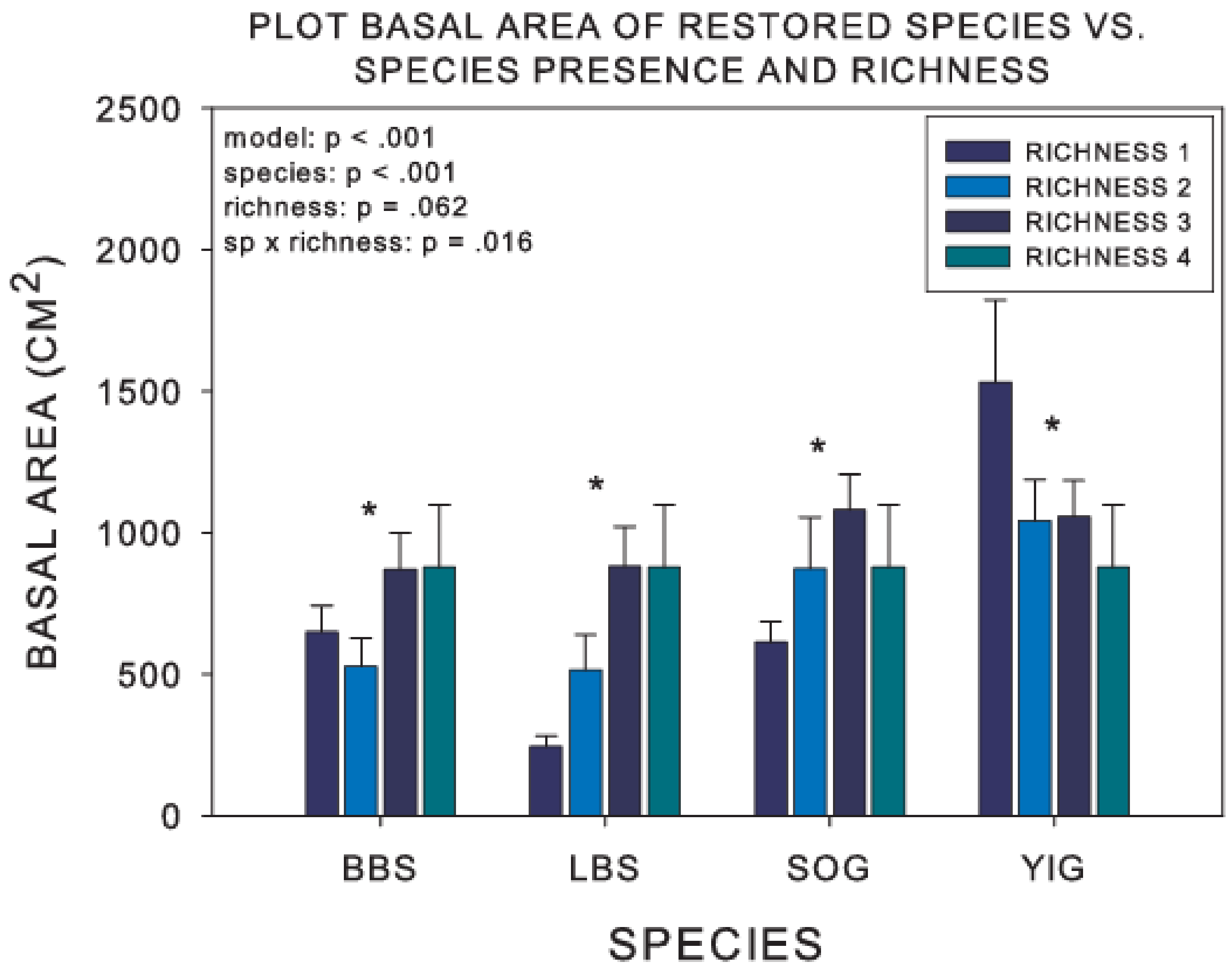
Factor*	KR Percent Cover		Native Herbaceous Species Cover		KR Cover as a Proportion of Native Herb Cover	
	R^2	P	R^2	P	R^2	P
Nitrate	0.100	0.316+	0.006	0.802	0.049	0.486+
Ammonium	0.150	0.213+	0.824	<.0001+	0.033	0.573+
Phosphate	0.190	0.154+	0.000	0.934	0.305	0.063+

Factor*	Nitrate		Ammonium		Phosphate	
	F	P	F	P	F	P
Mycorrhizal Fungi Addition	7.280	0.014(-)	0.730	0.398	0.135	0.715

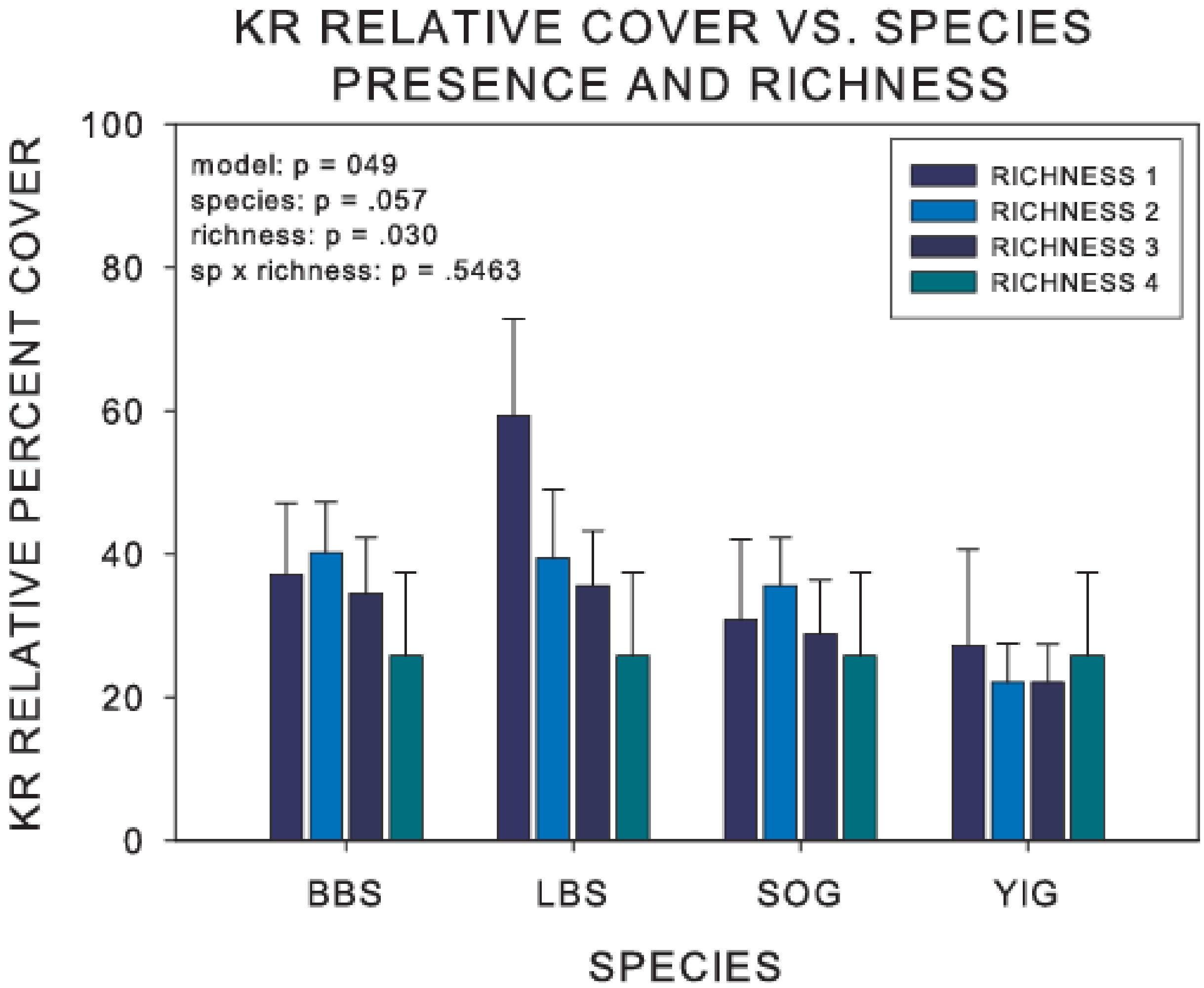
Results – Establishment, Species x Richness



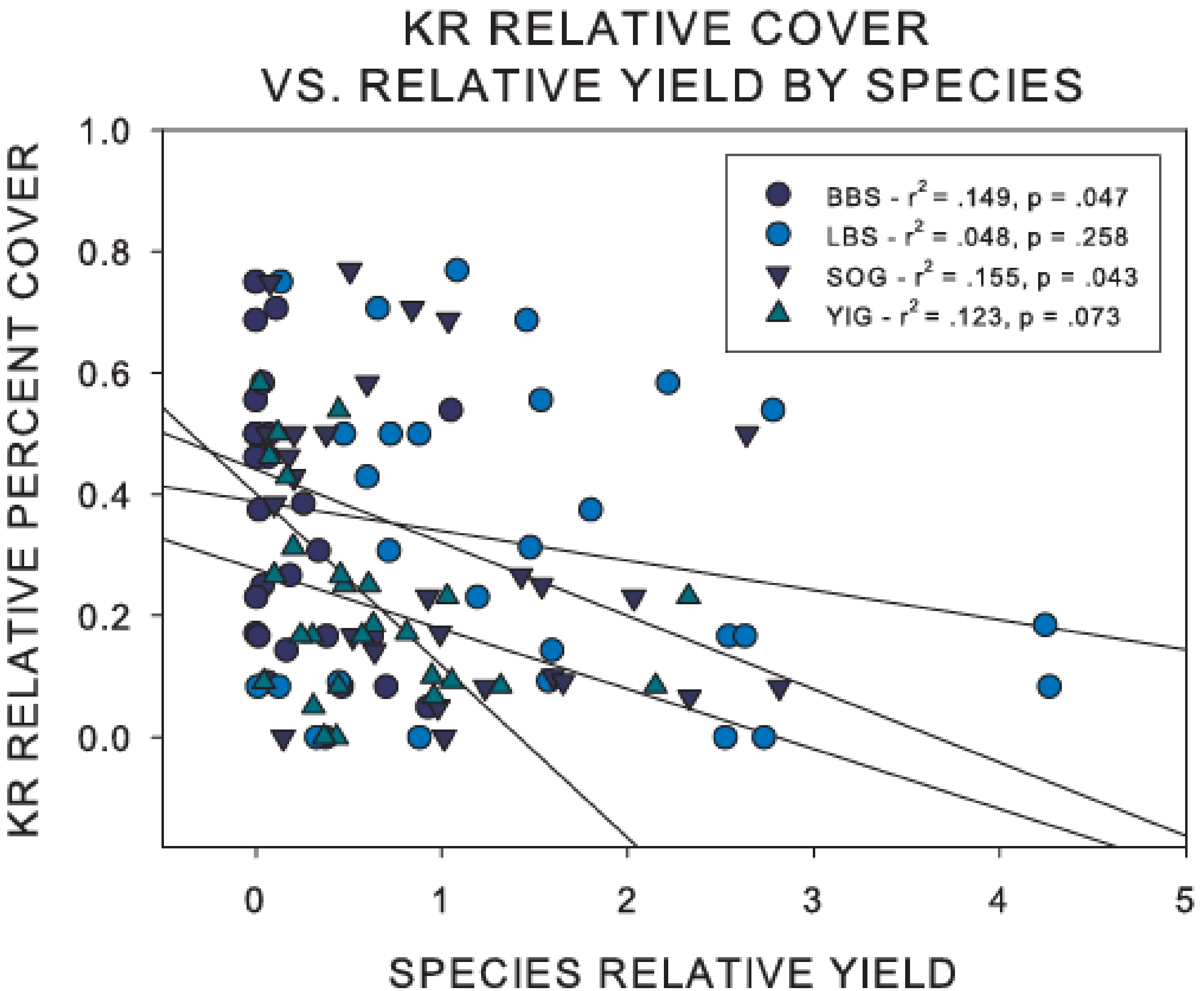
Results – Restored Species Effects on Plot Productivity



Results – Species Effects on Invasion



Results – Species in Mixtures and Invasion



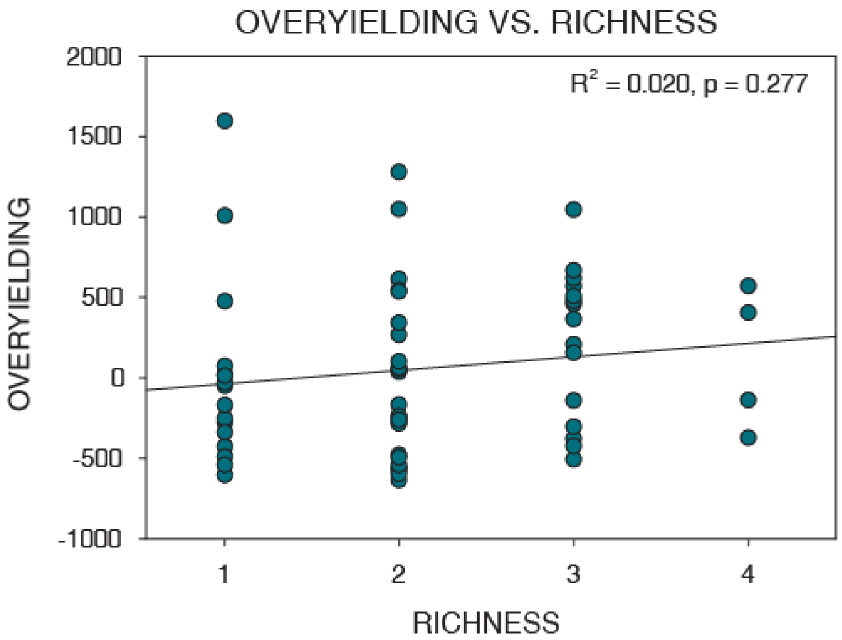
The better a species performs in a mixture, the greater its potential for suppression of KR.

Results – Monospecific Vs. Mixture Performance COMPLEMENTARITY

Overyielding (OY)

= ave. yield of monocultures – plot yield

OY > 0 = mixture performs better than average of monocultures.

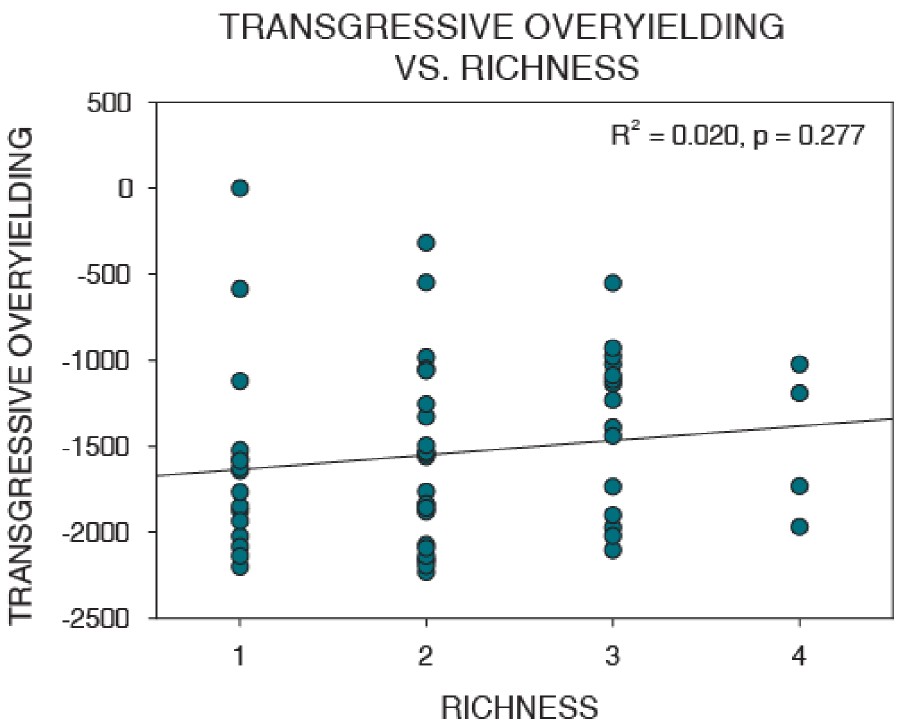


Hector et al. 2009

Results – Monospecific Vs. Mixture Performance COMPLEMENTARITY

Transgressive Overyielding (TOY)
= yield highest performing monoculture – plot yield.

TOY > 0 = mixture performs better than highest performing monoculture.



Hector et al. 2009

Results – Intra- vs. Interspecific Competition

Relative Yield (RY):

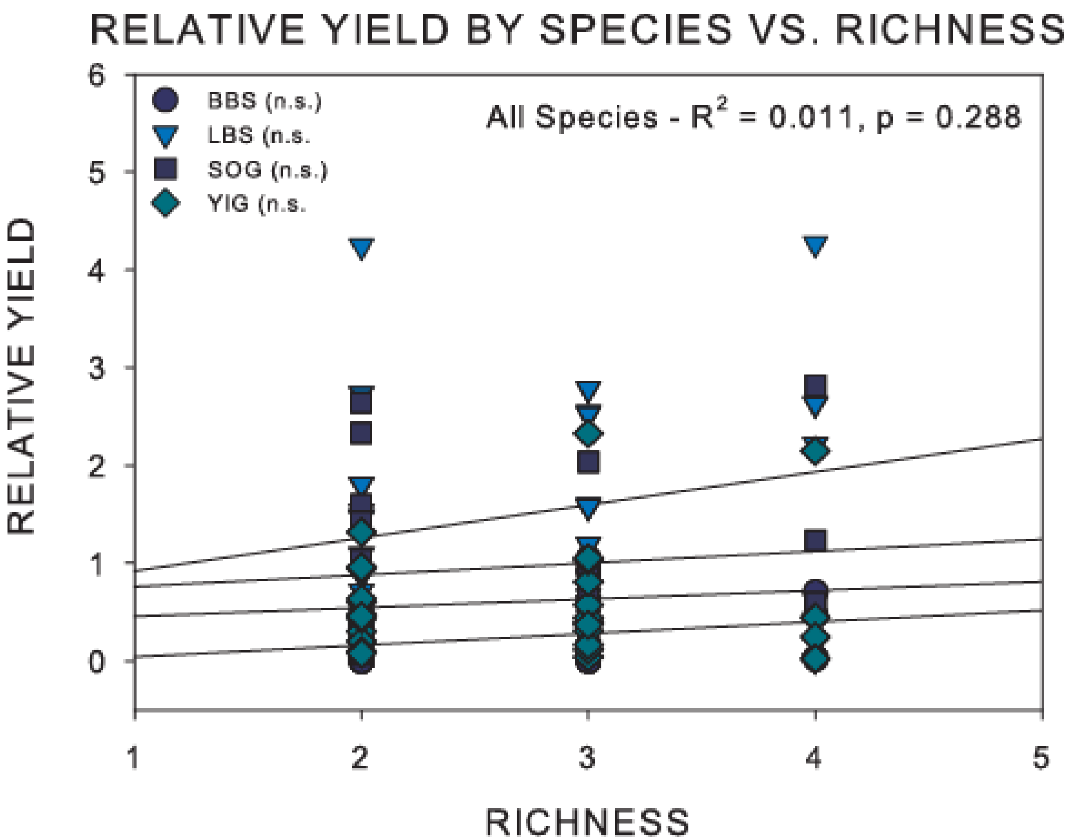
Measure of individual species performance in mixtures relative to their average performance in the monocultures.

$RY_{ij} = Y_{ij}/(Y_i/n_j)$, where Y_{ij} is the yield of species i in mixture j, Y_i is the yield of species i in monoculture (here the average), and n_j is the number of species in mixture j.

e.g., Dukes 2001

Results – Intra- Vs. Interspecific Competition

RYij > 1 = species performs better in mixture than monoculture.



Conclusions

•Native species establish at high rates from plugs.

•Richness trends positively with higher productivity and complementarity (basal area, OY and TOY).

•Some species are more limited by intraspecific (LBS) than interspecific (BBS, SOG, YIG) competition.

•Something is better than nothing (0 vs. 1 richness).

•KR cover is significantly negatively correlated with richness and restored species basal area.

•KR cover is significantly negatively correlated with OY and TOY = plots containing competitive species with high complementarity are more effective for invasive species control in this system.

•No differences among species in soil nutrient use.