Divergent responses to fire in South African and North American grassland communities

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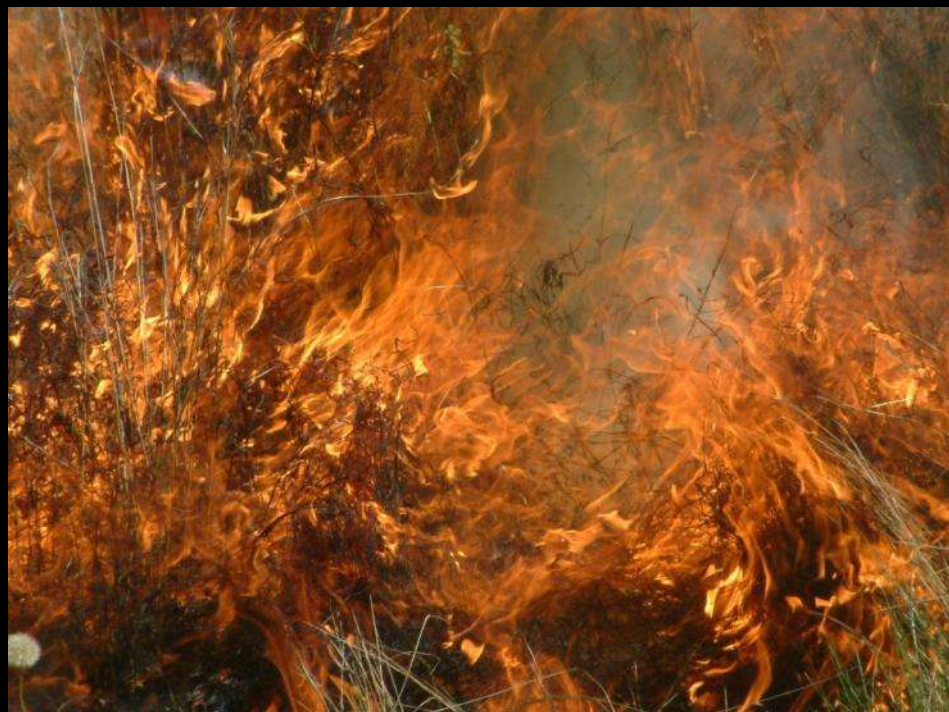
Introduction

- Does fire frequency affect mesic grassland plant community structure and composition similarly in North America and South Africa?
- Why ask the question?



Introduction

- Grasslands:
  - One of the most extensive biomes
  - One of the most threatened biomes
- Conservation of grasslands depends largely on responses to disturbance
- Perception of grassland responses to disturbance vary regionally and between continents

Introduction

- Some indications of convergence in mesic grassland responses to precipitation, fire frequency, nutrient addition and grazing between North American and South African grasslands
- Directly comparative studies are rare
- Management and conservation recommendations and strategies vary widely

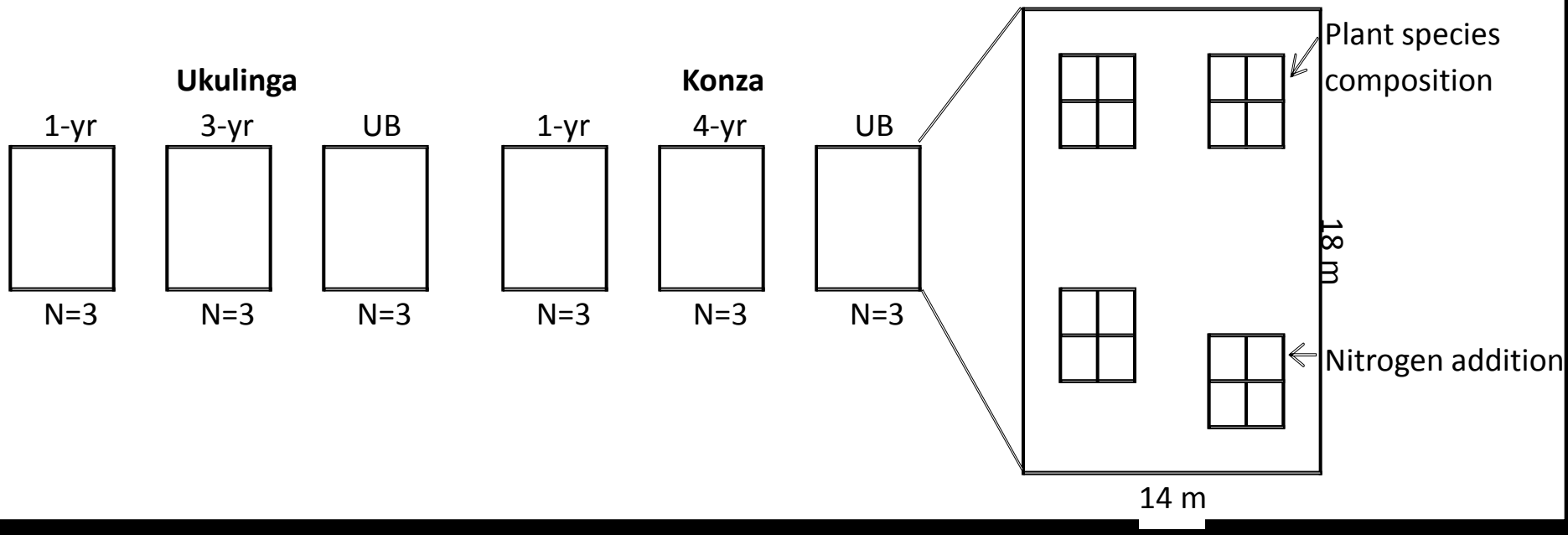
Introduction

- Species changes dependent on:
  - Competition for resources
  - Tolerance of disturbance and stress
- Species traits important in their survival and reproduction

Methods

Konza Prairie		Ukulinga
C_4 grasses & C_3 forbs with scattered trees	Vegetation	C_4 grasses & C_3 forbs with scattered trees
820 mm	Rainfall	790 mm
33.1°C	Mean Max temperature	26.4°C
3.6°C	Mean Min Temperature	13.2°C
1977	Fire experiment initiation	1950
Annual, Intermediate (4), unburned	Fire treatments	Annual, intermediate (3), unburned
10 g nitrogen/m^2 in the form of $NH_4^+NO_3^-$	Nitrogen addition	10 g nitrogen/m^2 in the form of $NH_4^+NO_3^-$

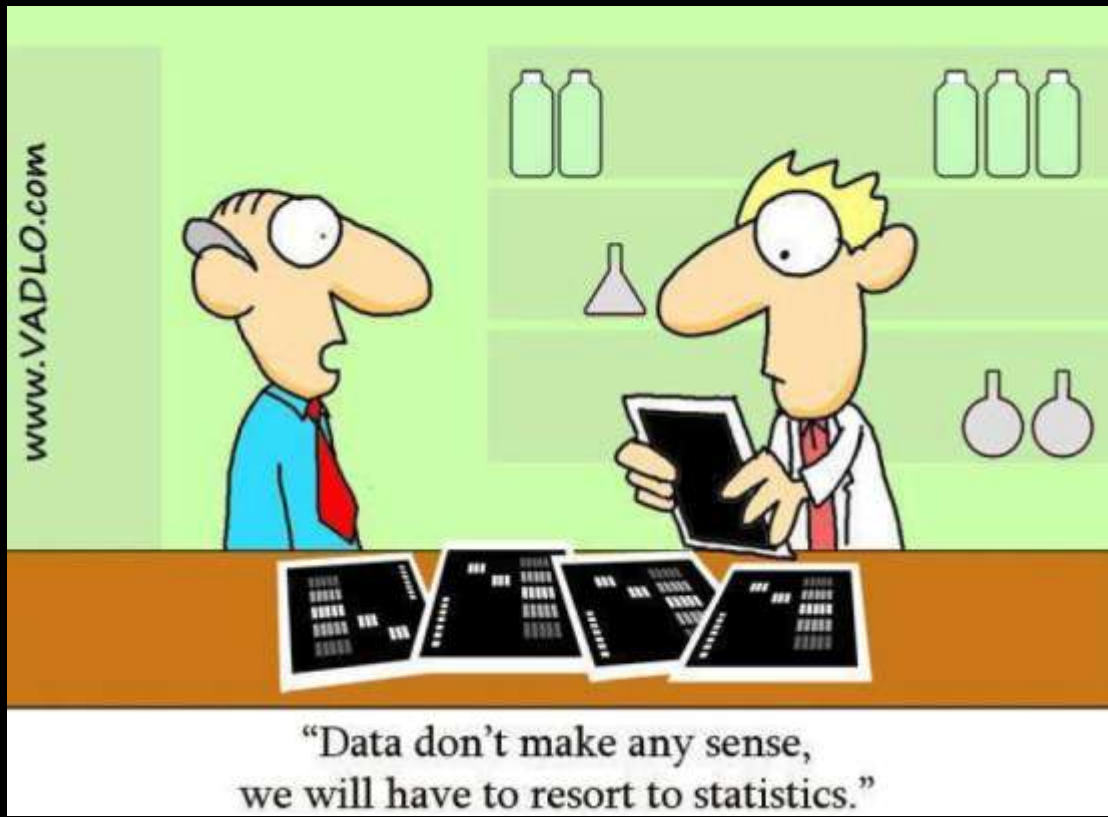
Experimental layout and procedure



- Vegetation surveys twice per season from 2005
- Modified Daubenmire procedure for estimating species cover
- Nitrogen addition from 2006

Statistical analyses

- Canonical correspondence analysis
- Multivariate analysis of variance
- Analysis of similarity
- Linear mixed models



Results - Konza

Richness 4 m^2				
Effect	Num DF	Den DF	F value	Pr>F
Year	4	24	8.78	**0.0002**
Fire	2	5.46	2.91	0.1378
Year*Fire	8	24	2.34	0.0512
N	1	8.76	37.72	**0.0002**
Year*N	4	23.6	2.27	0.0917
Fire*N	2	8.76	0.41	0.6734
Year*Fire*N	8	23.6	2.43	0.0449

Richness 1 m^2				
Effect	Num DF	Den DF	F value	Pr>F
Year	4	24	9.86	**<0.0001**
Fire	2	6.42	1.56	0.2806
Year*Fire	8	24	2.38	**0.0477**
N	1	8.69	56.27	**<0.0001**
Year*N	4	23.6	1.22	0.3306
Fire*N	2	8.69	0.87	0.4530
Year*Fire*N	8	23.6	1.11	0.3890

Relative cover of grasses				
Effect	Num DF	Den DF	F value	Pr>F
Year	4	24	2.61	0.0605
Fire	2	1	17.01	0.1690
Year*Fire	8	24	3.49	**0.0083**
N	1	8.13	1.7	0.2283
Year*N	4	20.6	3.38	**0.0280**
Fire*N	2	8.13	0.13	0.8759
Year*Fire*N	8	20.6	3.06	0.0194

Relative cover of forbs				
Effect	Num DF	Den DF	F value	Pr>F
Year	4	23.7	2.14	0.1072
Fire	2	2.27	16.19	**0.0452**
Year*Fire	8	23.7	3.41	**0.0095**
N	1	7.31	0.46	0.5193
Year*N	4	22.8	4.67	**0.0067**
Fire*N	2	7.31	0.10	0.9036
Year*Fire*N	8	22.8	3.21	**0.0136**

Results Ukulinga

Richness 4 m^2				
Effect	Num DF	Den DF	F value	Pr>F
Year	3	36	9.44	**<0.0001**
Fire	2	12	12.27	**0.0013**
Year*Fire	6	36	1.89	0.1087
N	1	12	34.76	**<0.0001**
Year*N	3	36	0.22	0.8795
Fire*N	2	12	0.67	0.5310
Year*Fire*N	6	36	0.27	0.9452

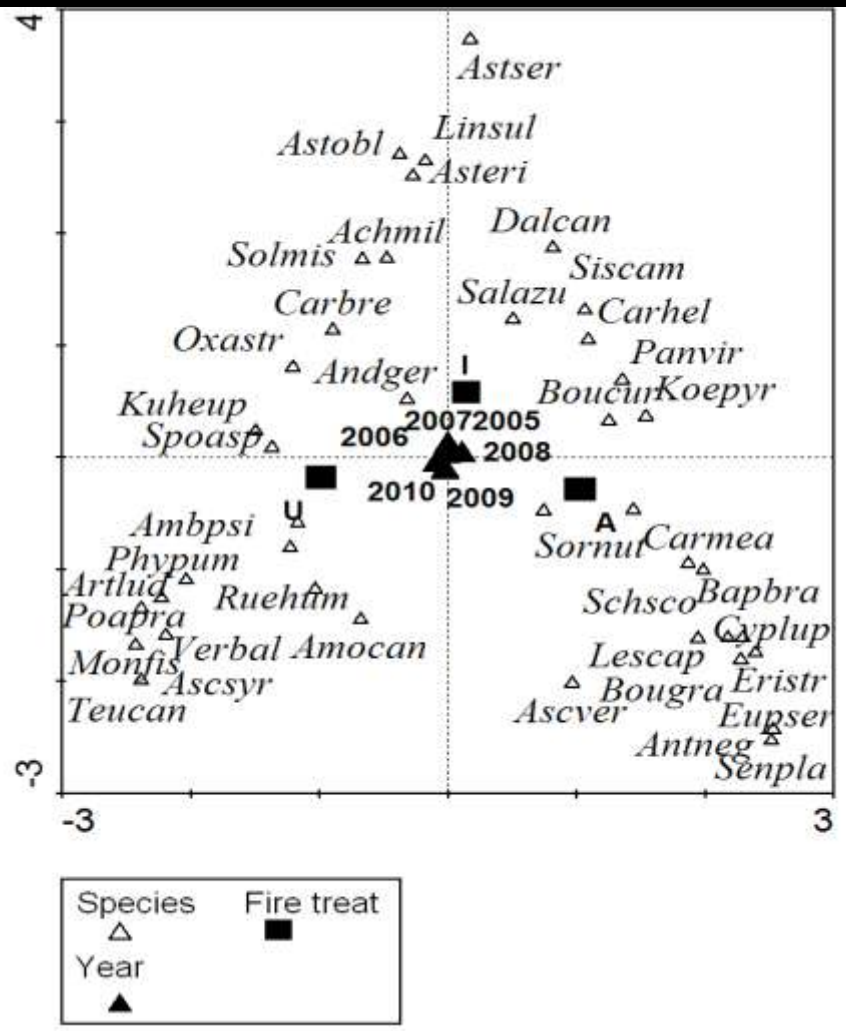
Richness 1 m^2				
Effect	Num DF	Den DF	F value	Pr>F
Year	3	36	9.33	**0.0001**
Fire	2	12	24.09	**<0.0001**
Year*Fire	6	36	4.45	**0.0018**
N	1	12	62.85	**<0.0001**
Year*N	3	36	0.67	0.5759
Fire*N	2	12	0.49	0.6218
Year*Fire*N	6	36	0.49	0.8135

Relative cover of grasses				
Effect	Num DF	Den DF	F value	Pr>F
Year	3	18	3.30	**0.0442**
Fire	2	11.8	7.92	**0.0066**
Year*Fire	6	34.1	6.90	**<0.0001**
N	1	11.5	0.55	0.4739
Year*N	3	18	1.74	0.1949
Fire*N	2	12.2	0.51	0.6109
Year*Fire*N	6	24.2	0.18	0.9792

Relative cover of forbs				
Effect	Num DF	Den DF	F value	Pr>F
Year	3	17.9	3.84	**0.0277**
Fire	2	11.8	10.66	**0.0023**
Year*Fire	6	32.4	5.86	**0.0003**
N	1	11.5	0.67	0.4293
Year*N	3	18.1	0.97	0.4297
Fire*N	2	12.1	0.62	0.5528
Year*Fire*N	6	25.5	0.08	0.9980

Canonical correspondence analysis

Konza



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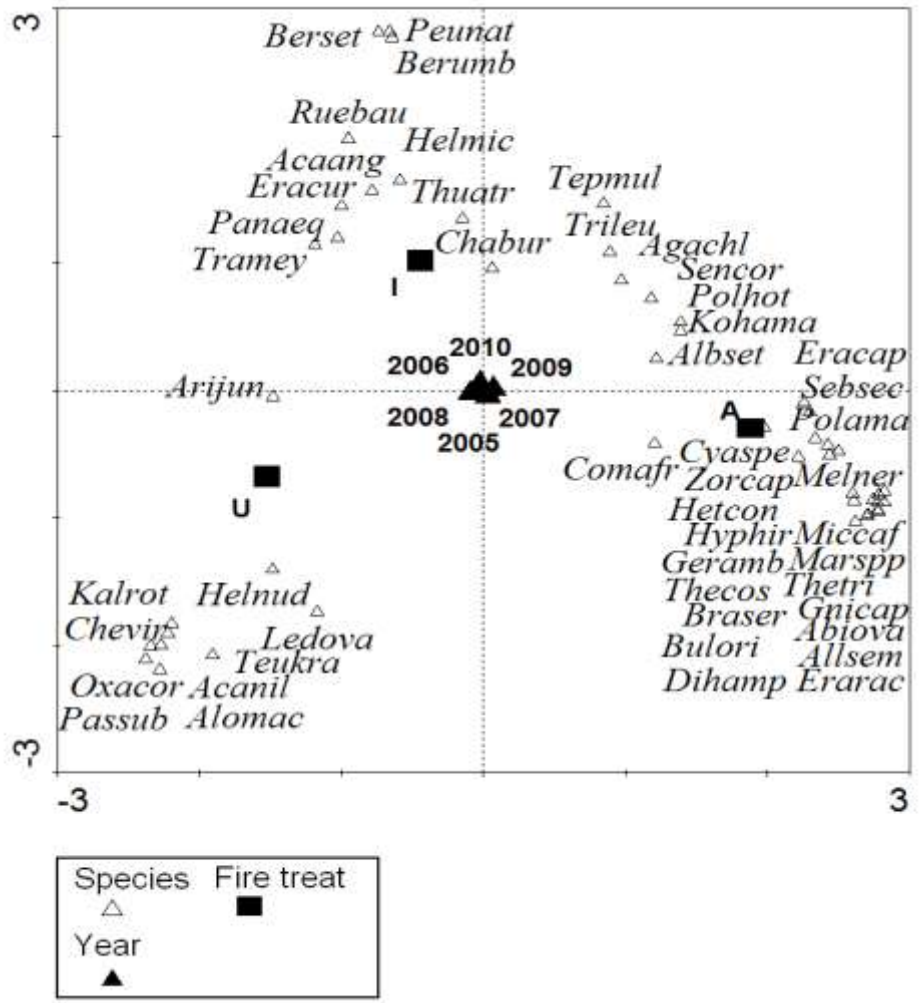
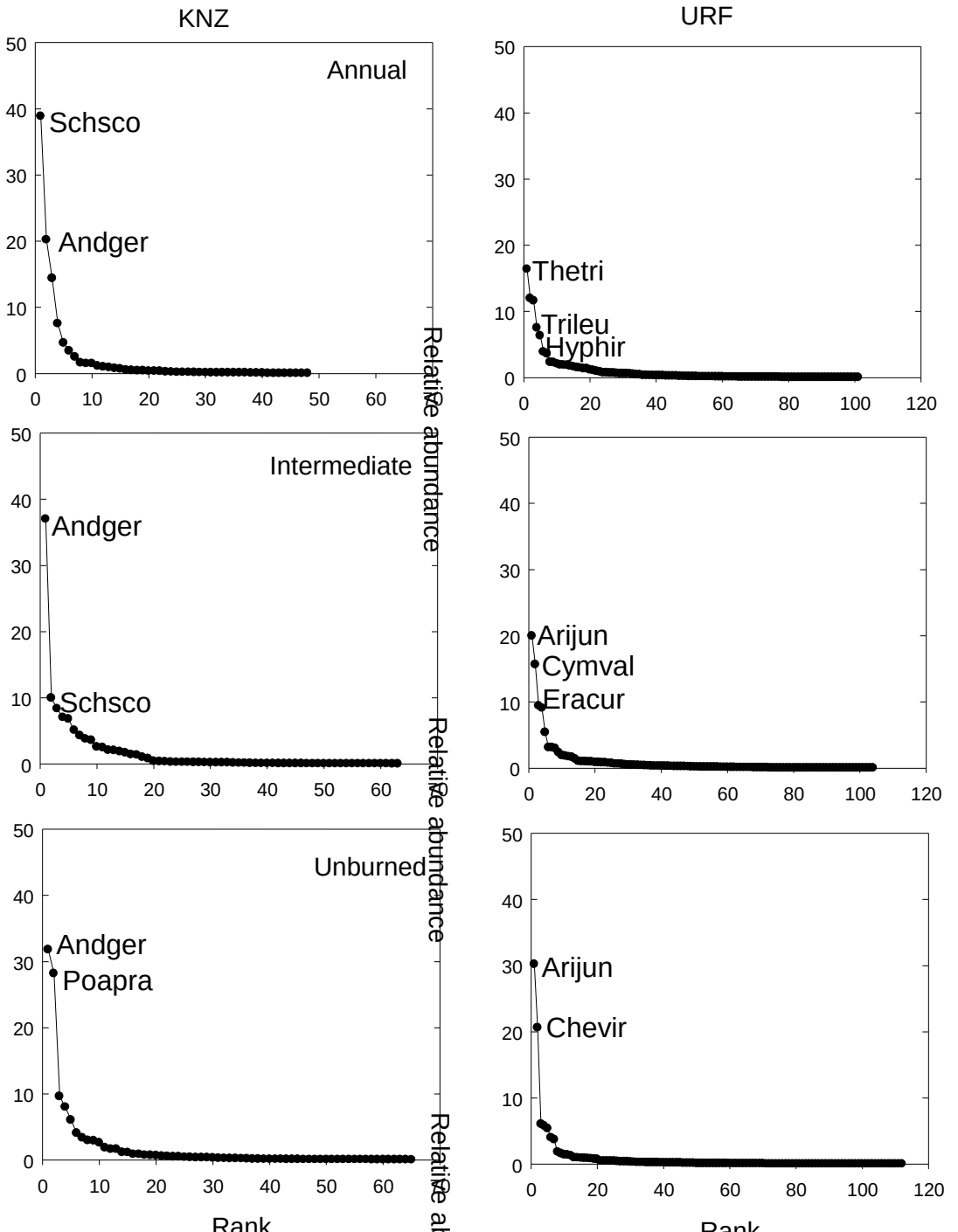
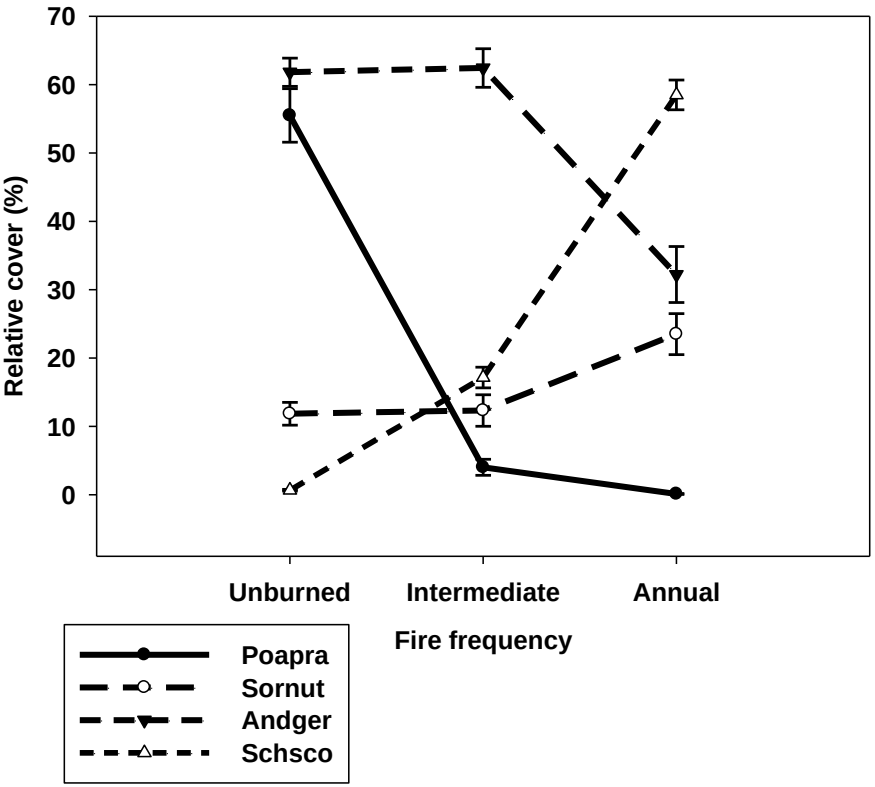
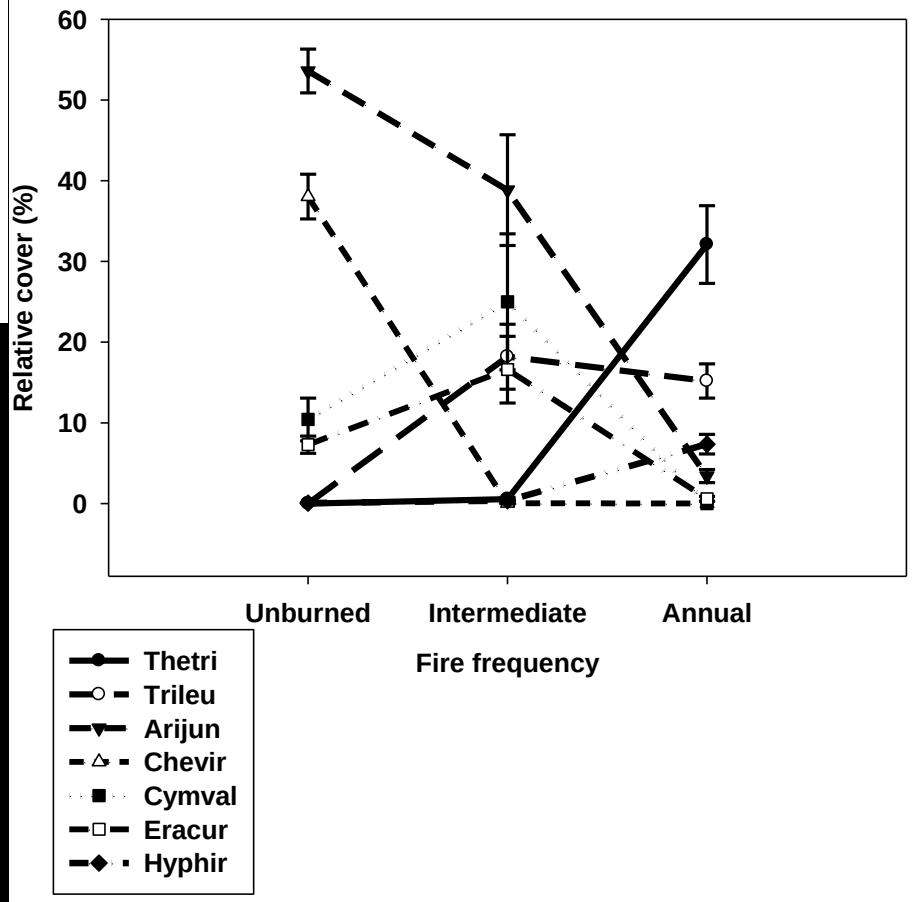


Species rank abundance curves



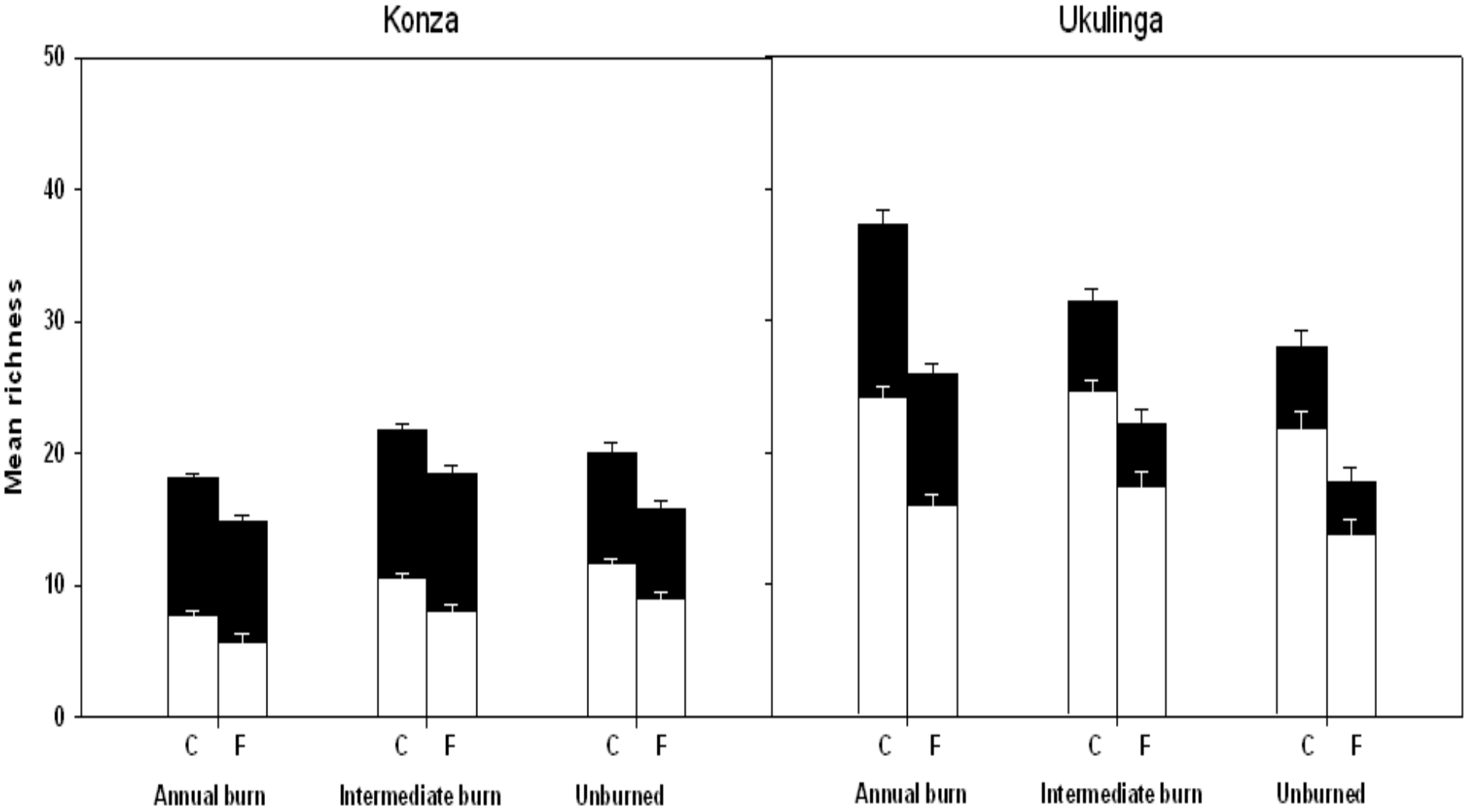
Patterns of mean relative cover





Mean species richness

Control (C); Fertilized (F); White = Forbs; Black = grasses



Discussion

- Fire remains primary driver of community composition and structure
- Diverging responses to fire frequency on the two sites
  - Fire had opposite effects on richness
- Convergent response to nutrient addition
  - Decline in richness

Konza

- Species dominant in annual burn plots remain present and co-dominant throughout
- *Andropogon gerrardii, Schizachyrium scoparium, Sorghastrum nutans*
  - Tall
  - *A. gerrardii* & *S. scoparius* rhizomatous
- *Poa pratensis* increases in unburned plots
  - Shorter, shade tolerant, slow growing

Ukulinga

- Grasses dominating annual burn plots short and tufted and not “dominant”
  - *T. triandra, H. contortus, D. amplectens* and *T. leucothrix*
- Complete turnover of species to unburned treatment – taller, dominant, shade tolerant
  - *Aristida junciformis, Cymbopogon validus*

Plant traits

- Height
- Rhizomatous spread
- Shade tolerance
- Invasion ability
- Invasion resistance

Conclusions

- Grassland community responses to fire frequency vary greatly between the two sites
- This is likely to be the case with regional responses to fire as well
- Fire management should take these varying responses into account