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LIKELY IMPACTS OF CLIMATE CHANGE ON CHANGES IN SPECIES COMPOSITION IN *ASTREBLA* (MITCHELL GRASS) PASTURES

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ABSTRACT

Summer rainfall is the dominant influence on pasture composition in *Astrebla* grasslands, although grazing can modify this rainfall influence. Predictions for climate change for northern Australia suggest reduced rainfall totals with increased rainfall variability.

This paper compares the frequency of four grass and four forb species on two sampling occasions in *Astrebla* grassland. The first sampling occurred following three years of increasing summer rainfall while the second sampling occurred following three years of declining summer rainfall. The frequency of three of the four grasses was higher following good rainfall while that of the four forb species was higher following below above rainfall.

Results indicate that, with a likely climate change scenario of reduced rainfall coupled with increased variability, that *Astrebla* grasslands are likely to have increased *Astrebla* spp. plant turnover, higher forb and lower grass species frequencies. Grazing management will need to monitor these changes in species composition to adjust carrying capacities for sustainable production.

INTRODUCTION

Large changes in species composition in *Astrebla* (Mitchell grass) grassland occur in response to trends in seasonal rainfall. For example, Orr (1986) measured substantial changes in pasture composition between 1972 and 1984 and related these changes to short term trends in seasonal rainfall. These changes reflected the two distinct components of *Astrebla* grassland vegetation: firstly, *Astrebla* spp. tussocks are long lived with few major recruitment events and; secondly, the suite of mainly ephemeral species whose populations fluctuate rapidly over a relatively short period of time (Orr 1986).

Climate change is an important global issue that is yet to be recognised by many rangelands users (McKeon *et al.* 1998). These authors suggested that, while the possible future changes in summer rainfall appear to be of the same magnitude as that experienced in 30 year rainfall periods experienced over the past 100 years, the key issue for grazing management is the change in climate variability, especially in the sequence of wet and dry years. Gabriel and Wilcocks (2004) have projected that total annual rainfall across Queensland will decline by up to 15 percent coupled with increased variability. The greatest reduction in soil moisture will occur in inland areas because of the combined effects of reduced rainfall and increased temperatures. Given this climate change scenario, and the fact that seasonal rainfall drives species composition, climate change induced changes in species composition are likely in *Astrebla* grasslands and may have implications for long term carrying capacities.

This paper presents the results from an ongoing study of plant species diversity. Specifically, here we compare and contrast the frequency of four grass and four forb species at two different phases of the longer term rainfall cycle – firstly following three consecutive years of above average rainfall and again following three consecutive years of below average rainfall.

METHODS

A grazing study incorporating 6 grazing treatments was established in *Astrebla* grassland at "Toorak" Research Station, Julia Creek in 1984 and remains current in 2006. Treatments are unreplicated paddocks where sheep numbers are adjusted annually to consume 0 (exclosure), 10, 20, 30, 50 and 80% of the total forage available at the end of each summer growing season over the ensuing 12 months. Paddock sizes are 1, 54, 27, 18, 12 and 7 ha respectively. Mean annual rainfall at Julia Creek is 401 mm with 85% falling between October and March.

Ephemeral species are often present briefly following rainfall and are selectively grazed by sheep, especially the forbs, making field studies of overall plant species diversity potentially unreliable. In contrast, greenhouse studies of the soil seed bank can more reliably determine species occurrences.

Plant species diversity was determined by germinating seed within soil samples collected during September 2001 and October 2004. Soil samples were collected within 60 x 60 metre grid cells across the experimental site using a Geographic Positioning System (GPS). Each sample comprised 4 individual soil cores (5 cm diameter and 5 cm deep) and a total of 16, 162, 69, 49, 36 and 20 soil samples were collected from the 0, 10, 20, 30, 50 and 80% treatments respectively. Further details are provided in Orr and Phelps (2003).

RESULTS

Rainfall trends

The spring 2001 sampling occurred following 3 consecutive summers of above average rainfall (1998-99, 1999-00, 2000- and 2001) while the 2004 sampling occurred following 2 consecutive summers of below average rainfall (2001-02, 2002-03) and 1 summer (2003-04) of near average rainfall (Figure 1).

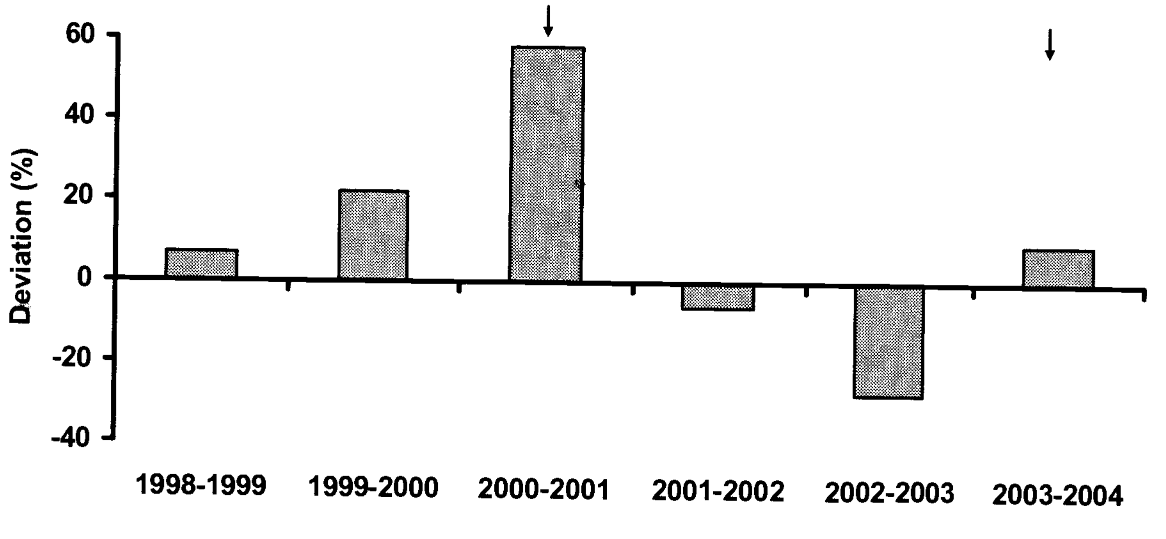

Figure 1: Deviation (%) from mean summer rainfall between 1998-99 and 2003-04 at "Toorak" Research Station, Julia Creek
(Arrows indicate sampling dates)

Changes in species occurrences

Three of the four grasses, *Astrebla* spp., *Iseilema* spp. and *Brachyachne convergens,* had higher frequencies in 2001 than in 2004 (Figure 2). In contrast, all four forb species had higher frequencies in 2004 than in 2001.

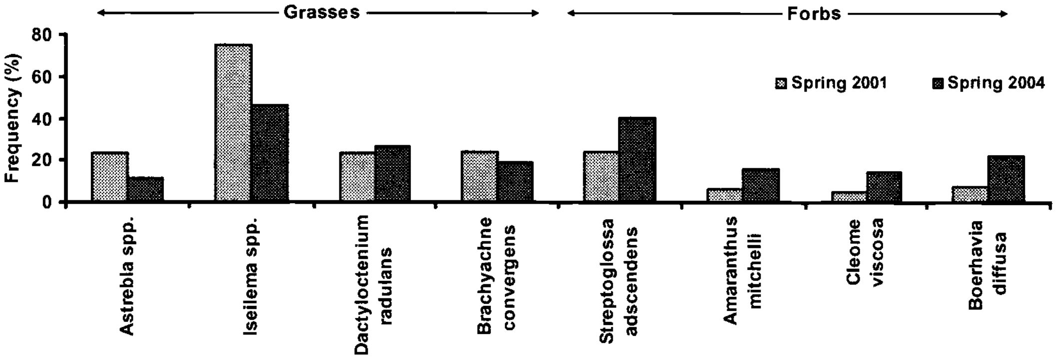

Figure 2: Changes in the frequency (%) of 4 grass and 4 forb species in *Astrebla* grassland at "Toorak" Research Station, Julia Creek between 2001 and 2004

DISCUSSION

This study demonstrates that large shifts in species frequencies occur over relatively short periods of time in *Astrebla* grasslands consistent with earlier studies in these grasslands (Everist and Webb 1975, Orr 1986). Such changes in composition need to be interpreted in relation to the two components: *Astrebla* spp. and the suite of ephemeral grasses and forb.

Extremes of seasonal rainfall variability have been associated with phases of the El Niño-Southern Oscillation (ENSO) and year-to-year rainfall variability is a key feature driving *Astrebla* spp plant dynamics. Life span of *Astrebla* spp. tussocks exceed 20 years with substantial death resulting from extended or severe drought periods e.g. Cunnamulla in 1982 and Julia Creek in the late 1980's (Orr 1998). In contrast, recruitment events require long periods of moisture availability such as can occur during La Niña conditions. For example, 1982 and 1987 were El Niño years and were associated with severe droughts at Cunnamulla and Julia Creek. The breakdown of the 1982 El Niño in autumn 1983 and the 1987 El Niño during 1988-89 provided the warm and wet conditions necessary for seedling survival and so contributed to major recruitment events (Orr 1991, Orr 1998). Therefore, the climate change scenario of reduced total rainfall with increased variability may increase *Astrebla* spp. plant turnover through reduced survival which may be offset by more frequent recruitment.

Reasons for lower rainfall reducing the frequency of grass species and increasing that of forbs are not clear. However, forbs generally flower and seed earlier than grasses in *Astrebla* grasslands. Therefore, reduced total rainfall may favour forbs at the expense of grasses. In particular, the reduced frequency of the annual grass *Iseilema* spp should enhance *Astrebla* spp. recruitment which occurs when the density of *Iseilema* spp. is low (Orr and Evenson 1993, Orr 1998).

The current and future impact of climate change is an important component in assessing the likely changes in *Astrebla* grasslands. However, the impact of climate change on major sources of variability such as ENSO and year-to-year variability (e.g. length of droughts, intensity of drought, frequency of La Niña events) is as yet uncertain. Similarly the response of species to unprecedented events is unknown (e.g. the combination of rainfall deficit and temperatures higher than previous experience). Hence, continued monitoring of species response to emerging conditions will be an important component for predicting species responses and in adapting management to climate change.

In terms of the future grazing management, *Astrebla* spp. is the major forage source for grazing animals while the ephemeral species are selectively grazed while they are present in the pasture. Given the key role of *Astrebla* spp. in the grazing of these pastures, then climate change is likely to make this pasture type more vulnerable to over use. Therefore, grazing management will need to carefully monitor species change to remain sustainable.

CONCLUSIONS

Likely reductions in total rainfall coupled with increased rainfall variability due to climate change are likely to result in changes in species composition in *Astrebla* grasslands. These changes may increase *Astrebla* spp. turnover, increase the frequency of forbs species and reduce the frequency of annual grasses, especially *Iseilema* spp. Grazing management needs to incorporate these likely changes to remain sustainable.

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