The occurrence and causes of episodic recruitment of *Astrebla* spp.

Orr, D.M. and Silcock. R.

Department of Employment, Economic Development and Innovation, PO Box 6014, Red Hill, Rockhampton Queensland 4701 david.orr@deedi.qld.gov.au

Keywords: episodic recruitment; *Astrebla* spp.; El Nino Southern Oscillation.

Abstract

This paper examines the seasonal climate patterns resulting in three large and apparently rare episodic recruitments of *Astrebla* spp. in Queensland. Each of these recruitments occurred following a 3-year rainfall sequence of: above average rainfall in the first summer, below average rainfall throughout the second year followed by above average rainfall in the third summer. Each of these recruitment events was associated with the occurrence of the El Nino Southern Oscillation weather phenomenon. It is concluded that modelling the frequency of recruitment could identify those regions needing more precise grazing management.

Introduction

Astrebla spp. (Mitchell grass) are long-lived, palatable tropical native perennial grasses of considerable importance to the northern Australian grazing industry. Roe and Davies (1985) and Roe (1987) reported that, in the longer term, one major issue facing the sustainability of *Astrebla* grasslands is the large variation in *Astrebla* spp. density due to irregular recruitment. Earlier, Williams and Roe (1975) were unable to define unequivocally the conditions which produce and maintain substantial *Astrebla* spp. populations: however, from an examination of recruitment occurrences in relation to daily rainfall they suggested that rains of c. 120 mm or more over several days in November or December can produce seedlings. These seedlings establish with follow-up summer and autumn rains and average summer rains during the following year. Nevertheless, Groves and Williams (1981) examined three examples of population process in arid Australia and concluded that recruitment of many Australian grasses is generally by population explosion and is markedly episodic with the time interval between substantial cohorts often exceeding the lifespan of all but a few older plants.

This paper examines the factors leading to the occurrence of three large and apparently rare recruitment events reported for *Astrebla* spp. in Queensland.

Methods

Three large *Astrebla* spp. recruitment events have been scientifically documented: two at the former CSIRO Research Station, Gilruth Plains, Cunnamulla (28^0 S, 146^0E) in 1941 (Roe 1941) and in 1983 (Orr 1991). The third event occurred within an extensive grazing study at Toorak Research Station, Julia Creek (21^0 S, 141^0E) in 1989 (Orr 1998). This paper examines the rainfall pattern surrounding these three events and, for the 1983 and 1989 events, the soil seed banks present prior to this recruitment.

Results

Recruitments of 40, 15 and 30 seedlings/m^2 of *Astrebla* spp. were recorded in the autumn 1941, July 1983 and autumn 1989. Germinable soil seed bank of *Astrebla* spp in spring 1982 at Cunnamulla was 200 seeds/m^2 and in spring 1988 at Toorak was also 200 seeds/m^2 while the soil seed bank of *Iseilema* spp. in spring 1988 at Toorak was 50 seeds/m^2.

For the 1941 event, seed produced over the 1938-39 above average rainfall summer failed to germinate in August 1939 probably because of low temperature and dormant seed. It was still prevented from germinating by the 1939-40 summer drought and finally germinated during the above average rainfall of the 1940-41 summer. For the 1983 event, above average rainfall during the 1980-81 summer produced seed, this seed failed to germinate during the severe 1981-82 summer drought while above average rainfall during March- April 1983 caused this seed to germinate. Similarly, for the 1989 event, summer rainfall was above average during the 1986-87 summer and produced seed, severe drought over the 1987-88 summer prevented this seed from germinating with above average rainfall during February-March 1989 resulting in germination and successful recruitment (Fig. 1).

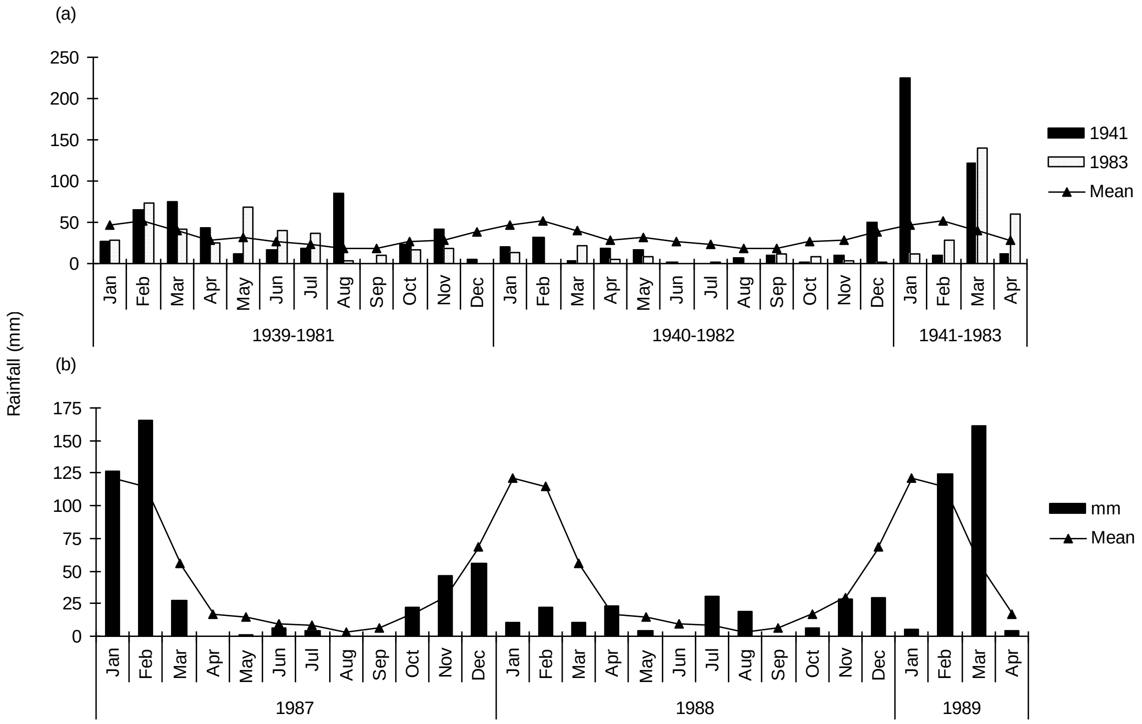

Fig. 1. Monthly rainfalls for (a) Gilruth Plains for 1939-1941 and 1981-1983 and (b) Julia Creek for 1987-1989 in relation to the mean monthly rainfall for each site.

The importance of the 1989 recruitment event can be judged by the fact that in 2009, 20 years later, plants resulting from this 1989 recruitment contributed of 25% of the plant density and 45% of the basal area.

Discussion

A consistent feature of these three apparently rare *Astrebla* spp recruitment events is the 3 year sequence of rainfall: above average rainfall in the first summer to produce seed, drought during the second year to prevent this seed germinating and above average rainfall to bring about seed germination and seedling establishment.

A feature common to all three *Astrebla* spp. recruitment events is that all were associated with extremes of seasonal rainfall and were associated with the occurrence of a particular phase of the El Nino Southern Oscillation (ENSO) weather phenomenon. The years 1939-41 and 1982 at Cunnamulla and 1987 at Julia Creek were severe drought as indicated by the occurrence of El Nino conditions (McKeon *et al*. 2004). The breakdown of the 1939-41 El Nino event in 1941, the 1982 El Nino event in autumn 1983 and the 1987 El Nino event in 1988-89 provided the conditions for the large scale recruitments of *Astrebla* spp.

The role of the second year drought in facilitating the large recruitment in the third year is not clear. Silcock *et al*. (1990) reported that *Astrebla* spp. seed has capacity to survive 8 years under laboratory storage although, under field conditions, Orr (1999) demonstrated that most *Astrebla* spp. seed germinates in the summer after it is produced. In a field study of *Astrebla* spp. recruitment in relation to the size of the soil seed, Orr and Evenson (1991) recorded a mean seed bank of 210 seeds/m^2 bank between 1980 and 1984 but recorded recruitment of < 6 seedling/m^2. Therefore, the role of drought in the second year of these large recruitment events may be to "prime" the seed so that much of the available seed is able to germinate.

Williams and Roe (1975) suggested that *Astrebla* spp. recruitment in the northern *Astrebla* grasslands of Queensland, where the Toorak site is located, is often restricted by high densities of the annual grass *Iseilema* spp. However, the density of *Iseilema* spp. at the time of the 1989 *Astrebla* spp. recruitment was 50 plants/m^2 and Orr and Evenson (1993) have demonstrated that *Astrebla* spp. seedlings are competitive with *Iseilema* spp. at densities up to 280 plants/m^2. However plant densities as high as 5000 plants/m^2 have been recorded at Toorak (Orr 1991) and such high densities are likely to restrict *Astrebla* spp. recruitment.

Given that the sequence of rainfall appears instrumental in the occurrence of large, episodic *Astrebla* spp. recruitment events, modelling the frequency of such events may provide further greater understanding of the dynamics of this important perennial grass in an important vegetation community. Furthermore, given the geographic range of *Astrebla* grasslands in northern Australia, such modelling could highlight those regions that are at greatest risk of reduced *Astrebla* spp. density and so require more precise grazing management.

Acknowledgements

We acknowledge many staff of DEEDI (formerly DPI&F) for contributing to the Toorak grazing study since 1984, particularly, the ongoing support of Toorak staff for maintaining the study. We acknowledge ongoing discussions with Dr Greg McKeon on the impacts of climate variability on plant dynamics. Financial support for the Toorak study was received from Australian Wool Corporation and BHP Billiton Cannington mine.

References

Groves, R. H. and Williams, O. B. (1981) Natural grasslands. In *Australian Vegetation*, Ed. R. H. Groves, Cambridge University Press, pp. 293-316.

McKeon, G. M., Hall, W. B., Henry, B. K., Stone, G. S. and Watson, I. W. (2004) Pasture degradation and recovery in Australia's rangelands: Learning from history. Queensland Department of Natural Resources, Mines and Energy, p. 28.

Orr, D. M. (1991) Trends in the recruitment of Astrebla spp. in relation to seasonal rainfall. *Rangeland Journal* **30**, 107-17.

Orr, D. M. (1998) A life cycle approach to the population ecology of two tropical grasses in Queensland. In *Population Biology of Grasses*, Ed. G. Cheplick, Cambridge University Press, pp. 366-389.

Orr, D. M. (1999) Effects of residual dormancy on the germinable soil seed banks of tropical pastures. *Tropical Grasslands* **33**, 18-21.

Orr, D. M. and Evenson, C. J. (1991) Effects of sheep grazing *Astrebla* grassland in central western Queensland III. Dynamics of *Astrebla* spp. under grazing and exclosure between 1975 and 1986. *Rangeland Journal* **13**, 36-46.

Orr, D. M. and Evenson, C. J. (1993) A glasshouse study of competition between *Astrebla lappacea* (Curly Mitchell grass) and two associated species. *Rangeland Journal* **15**, 298-301.

Roe, R. (1941) Studies on the Mitchell grass association in south-western Queensland. 1. Some observations on the response of Mitchell grass pastures to good summer rains following the 1940 drought. *Journal of the Council for Scientific and Industrial research* **14**, 253-259.

Roe, R. and Davies H. I. (1985) Long-term variation in the density of *Astrebla* spp. in the Warrego region of Queensland. *Tropical Grasslands* **19**, 87-95.

Roe, R. (1987) recruitment of *Astrebla* spp. in the Warrego region of south-western Queensland. *Tropical Grasslands* **21**, 91-92.

Silcock, R. G., Williams, L. M. and Smith, F. T. (1990) Quality and storage characteristics of the seeds of important native species in south-west Queensland. *Australian Rangeland Journal* **12**, 14-20.

Williams, O. B. and Roe, R. (1975) Management of arid grasslands for sheep: plant demography of six grasses in relation to climate and grazing. *Proceedings Ecological Society of Australia* **9**, 142-156.

Orr, D.M and Silcock, R. The occurrence and causes of episodic recruitment of *Astrebla spp*. (2010). In: *Proceedings of the 16th Biennial Conference of the Australian Rangeland Society*, Bourke (Eds D.J. Eldridge and C. Waters) (Australian Rangeland Society: Perth).