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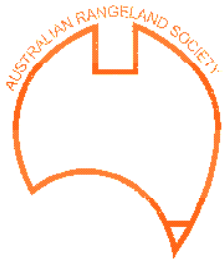

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Drought induced death of bladder saltbush (*Atriplex vesicaria*) in the north east pastoral district of South Australia

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Abstract. Bladdder saltbush (*Atriplex vesicaria)* is used extensively as an indicator of land condition in chenopod shrublands in South Australia. It is palatable, long lived, drought tolerant and its occurrence is widespread over a wide range of soil types. In recent years the SA Pastoral Lease Assessment Program has commonly found widespread mortality at rates in excess of 90% for this species and while this is just one facet used to assess land condition, it is important to understand if this is primarily due to management or climatic conditions. An area in the Barrier Ranges Outwash IBRA subregion, consisting of five paddocks covering 161 km^2 was monitored in 2011. This area had been voluntarily destocked by a land manager since prior to the summer of 2001. Density transects in both the ungrazed and grazed areas were examined and found to have mortality ranging from 98% to 99% in both stocked and unstocked areas.

Adjusted rainfall data and models of 'Growth' developed by Australian Grassland and Rangeland Assessment by Spatial Simulation (AussieGRASS) (http://www.longpaddock.qld.gov.au/) are examined in data modelled back to 1890. The number of consecutive years of low 'growth' from 2001 to 2009 is of the order of that in the severe droughts of the 1960's, 1930's and 1890's. This suggests that despite resilience of bladder saltbush to drought, a threshold has been passed where most shrubs have not survived and this has occurred even in the absence of grazing pressure.

Introduction

The South Australian Pastoral Land Management and Conservation Act 1989 applies to 48 million hectares of land held under Pastoral Leases and covers around half of the state in area. Amongst its objects is to "provide for the effective monitoring of the condition of pastoral land". A range of methods are used to determine this land condition but in the vast areas dominated by chenopod shrubs, bladder saltbush (*Atriplex vesicaria*) is used as an important indicator of land condition (Gould et al 2001).

Research has shown that this species is palatable and preferentially grazed over most other perennial species, is long lived, drought tolerant and its occurrence is widespread over a wide range of soil types (Hunt 2010).

The second round of the 14 year cycle of lease assessments, which form part of the lease renewal process, commenced in the North East Pastoral district in 2009. This was at the end of an extended drought period. Although not found exclusively, a large proportion of long term monitoring sites demonstrated dramatic reduction in density of bladder saltbush. Dead shrubs are commonly found to have fine twigs still in place suggesting low levels of grazing. Verbal accounts from land managers were consistent in describing isolated rainfall events in

certain localities that saw enough rainfall for some saltbush to survive, while death occurred in other areas, often within the same paddock and more remote from water.

On the ungrazed property being examined, the lessee had observed that despite having conservative stock numbers the feed response had been low towards the end of 2001 and stock had started to utilise the perennial bush species. Their policy was to sell stock and reduce numbers going into summer, but in this year they removed all stock and agisted their breeding stock. Extremely dry conditions extended into 2002, seeing widespread death of bladder saltbush. At the time of assessment in 2011 no stock had been returned to five of these paddocks.

The area examined has a documented history of severe degradation from loss of perennial cover and soil disturbance prior to the 1970's. Monitoring sites had been set up from 1978 and demonstrate widespread recovery to predominantly excellent conditions in 1993, although belt transects sampling density have only been measured in 1993 and 2011.

Methods

The Pastoral Lease Assessment Program has a network of around 8000 Photopoint monitoring sites across Pastoral Leases in SA with the aim of providing at least one site per paddock (Gould et al 2001). Various factors are assessed at these sites with many including a 100 x 4 m belt transect to estimate density of long lived perennial species.

Four sites have been selected to demonstrate and compare density estimates. These are representative of data found at other sites in a wider area, but with spatial variability in vegetation community composition and isolated rainfall events, the chosen sites all occur within 30km of each other. All paddocks containing these sites are considered to have been run conservatively, with periods of destocking though the drought years.

Results

Data in figure 1 depicted as individuals per 400m^2 transect, represents a drop ranging from 10000 to 75 shrubs/ha to 2500 to 50 shrubs/ha.

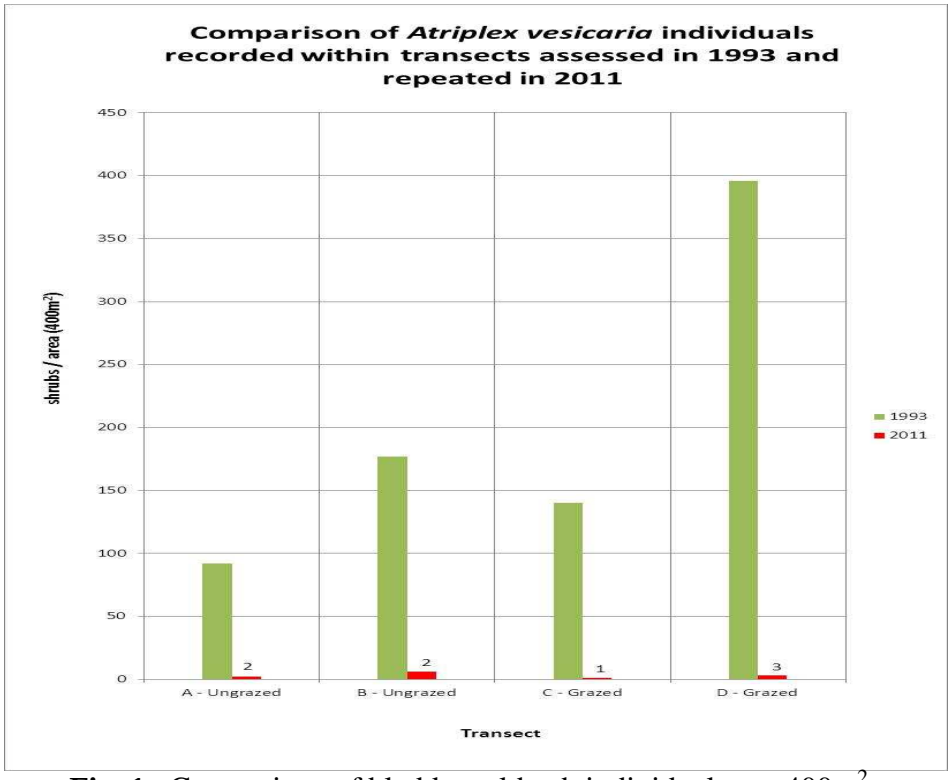

Fig. 1. Comparison of bladder saltbush individuals per 400m^2 transect – 1993/2011

Discussion

Bladder saltbush has a lifespan of 15 to 30 years. It is dioecious (male and female flowers are borne on different plants). Seeds do not spread far from the adult plant. Its seeds germinate best after 50mm of rain over two or three days at temperatures of 15 to 18^{o}C (tending to winter conditions) however seedlings only establish about once every five years because in many years, rainfall is insufficient to ensure seedling survival. Seed remains viable for approximately 2 years (Hunt 2010).

Some have speculated that large recruitment events occurred in response to rainfall conditions in the mid 1970's and that is consistent with 30 years to the mass death events. However numerous monitoring sites have demonstrated successive recruitment events over this time and death has not been restricted to any of the mixed ages of plants observed.

Studies have also shown that utilisation from stock grazing can increase shrub mortality (Leigh & Mulham 1971, Read 2004). There was no evidence of excessive grazing and in a lesser drought perhaps a measurable difference would have been detected at these sites. However the observations suggest that the extent of this drought had passed a threshold of survival for even ungrazed individuals.

Research from Leigh and Mulham (1971) hypothesized that the inability of bladder saltbush to persist after complete or severe grazing is due to the removal, by grazing, of potential growth sites which apparently occur only along the young stems. With even fine tips of twigs dried on dead plants observed, it would appear these stems have dried rather than been grazed, but with equal effect of causing shrub mortality.

Although not examined in this poster presentation, similar to Read (2004) less death was found in low bluebush populations than bladder saltbush at other sites, although still at rates far in excess of the 73% browsed and 88% unbrowsed found in the 1997 – 1998 survey period of that study.

Land managers are interviewed as part of the lease assessment process. Comments that are a result of daily observations out on the land, commonly described an increasing level of leaf drop and dieback as periods without effective rainfall increased, culminating in rapid rates of widespread death. Land managers are also very observant how a seemingly good rainfall event can be of little use under certain condition of temperature and high wind speed.

The AussieGRASS Environmental Calculator is a national simulation framework for Australian grasslands developed by the Department of Environment and Resource Management in Queensland, initially developed as a tool to assess drought conditions.

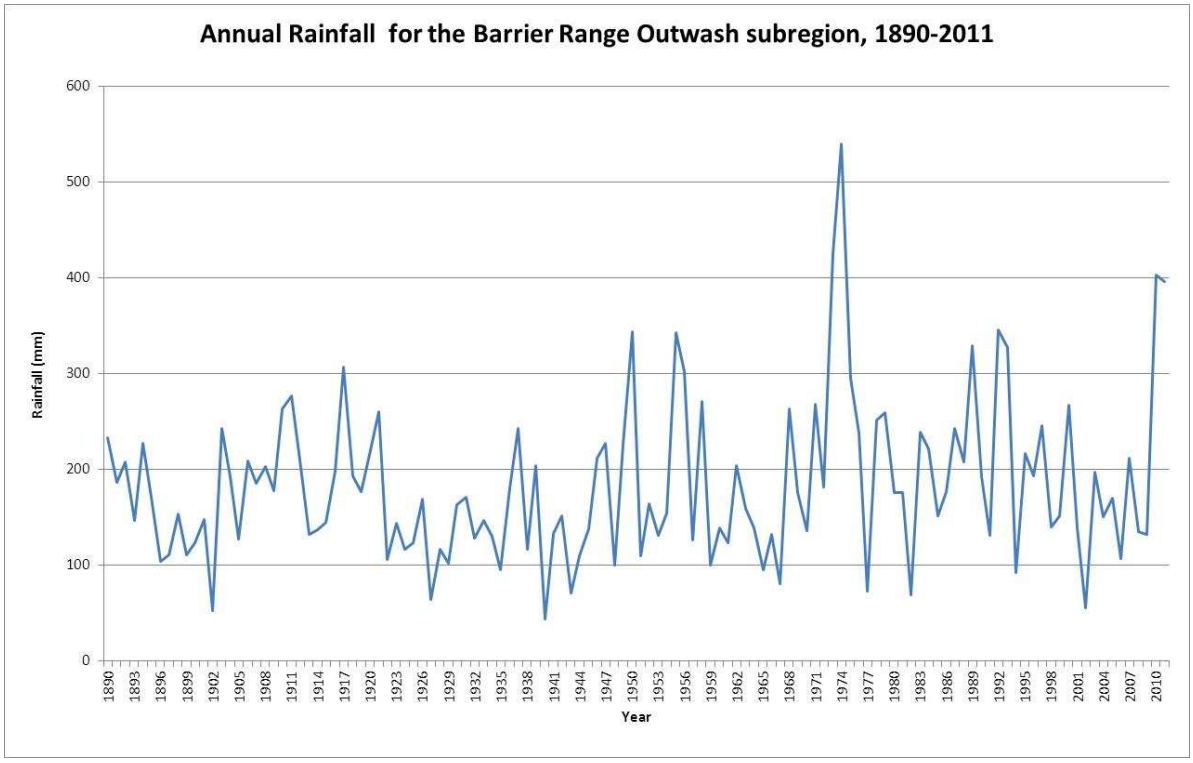

Fig. 2. Annual rainfall for the Barrier Range Outwash IBRA subregion 1890-2011

Figure 2 shows adjusted annual rainfall data supplied by AussieGRASS (http://www.longpaddock.qld.gov.au/) where Bureau of Meteorology data is adjusted to account for any missing records. While it can be seen that a series of low rainfall years preceded the latest observations, including a particularly dry year in 2002, there is not a strong pattern where similar years have seen similar levels of death.

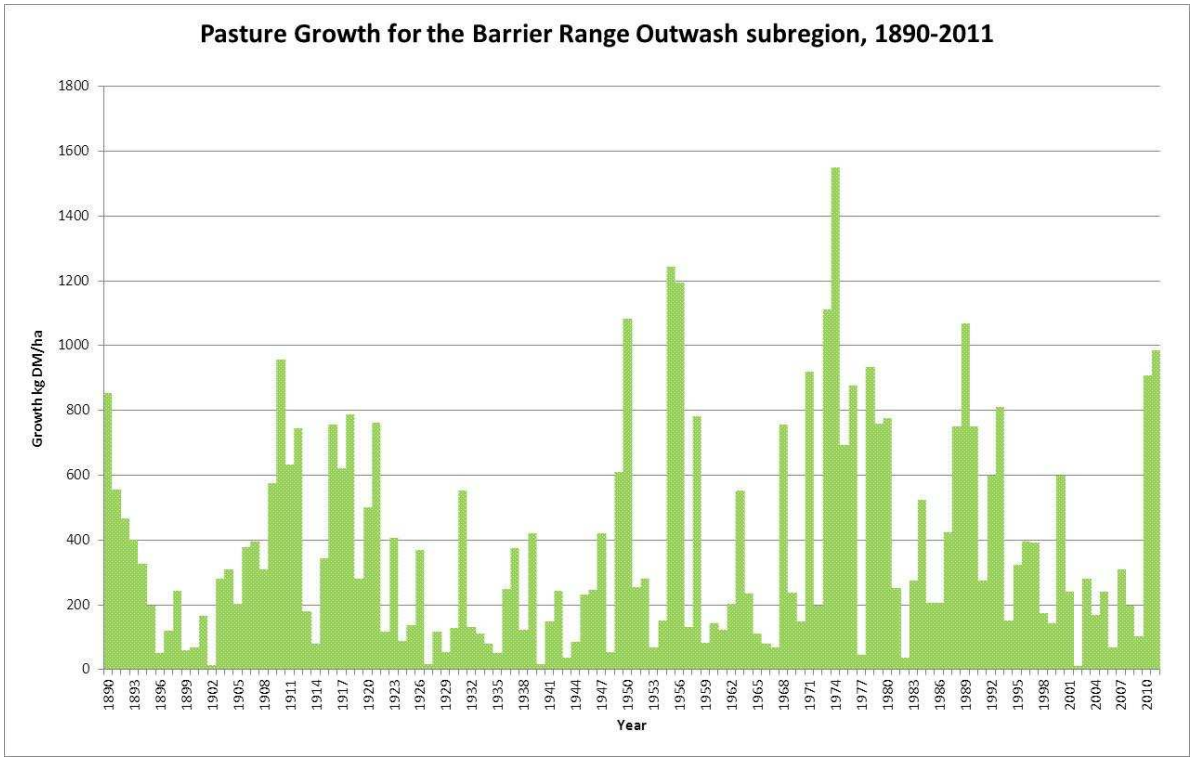

Fig. 3. AussieGRASS projected 'Growth' for Barrier Range Outwash IBRA subregion 1890-2011

Figure 3 shows 'Growth' from the AussieGRASS modelling framework that comprises a grazing systems model known as GRASP, which operates on a 5km, by 5km grid across Australia (Carter et al. 2000, 2003). The model calculates the soil water balance and pasture growth on a daily time-step and requires daily climate inputs (rainfall, temperature, radiation, humidity, evaporation and vapour pressure deficit) for each grid cell (Jeffrey et al. 2001) as well as parameter layers for soil and pasture types. While the figures for kg DM/ha are potentially high for the chenopod shrubland, the trend in terms of soil moisture available for growth will be similar.

Both figures support the characteristic of unreliable rainfall in Australian rangelands and the difficulty in identifying cycles and repeating patterns. In figure 3, a lack of high growth years can be seen from 2001 to 2009. Using 300 kg DM/ha as an arbitrary reference line, similar low growth periods can be seen from 1894 to 1905, 1927 to 1936 and 1959 to 1967.

Another characteristic of note from figure 3 is the extremely low growth in years such as 2002, 1940, 1927 and 1902. Unfortunately our observations from these sites does not go back prior to 1993 and we cant test if a high mortality threshold could be linked to an excessively low 'growth' year or to a series of low growth years without relief.

While extremely high rainfall and growth years preceded the 2011 assessment, no recruitment of bladder saltbush was observed and this is consistent with wider observations. It appears where high levels of death occur, that there was a dominance of dense grass cover. Even where sparse shrubs are producing lots of seed, it is possible that seedlings are either not managing to establish in the dense cover or can't compete with the grasses.

Areas of the North East Pastoral district that have been severely degraded through history are well documented, such as by Ratcliffe (1936) and yet with good management have recovered

to conditions such as those found in the 1993 monitoring. Land condition monitored in 2011 was in a much better state than those earlier reports and it should be expected that these perennial shrub communities will make a full recovery under current management given sequences of appropriate seasons.

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