State and transition models for rangelands. 10. A state and transition model for the southern black speargrass zone of Queensland

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Abstract

A brief history and a state and transition model are described for the southern black speargrass zone.

The model proposes 4 states based on the herbaceous layer and timber composition. Transitions between these states are presented together with those factors driving the changes. The probabilities of achieving these transitions are presented along with a number of research needs required to further understand the proposed model.

Introduction

The southern black speargrass *(Heteropogon contortus)* zone comprises the areas of black speargrass extending from Miriam Vale in the north to the Queensland-New South Wales border in the south (Tothill and Gillies 1992). This zone occupes 6 M ha and the predominant land use is cattle breeding and fattening. Soil types vary widely from relatively fertile clays and alluvials through to infertile duplex soils. Average annual rainfall varies from 600 mm in the west to 1200 mm near the coast and 25% of this rainfall occurs during the winter months, particularly in the south.

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Vegetation changes

The vegetation is predominantly eucalypt woodland with narrow leaved *(Eucalyptus crebra)* or silver-leaved *(E. melanophloia)* ironbark dominant, but blue gum *(E. tereticornis)*, spotted gum *(E. maculata)* and Moreton bay ash *(E. tessellaris)* are common. Extensive clearing of timber has occurred in order to promote pasture growth (Scanlan and Burrows 1990), and the control of timber regrowth remains a major problem for property management. This is particularly the case in some areas where high densities of wattles (*Acacia* spp.) can develop following clearing.

Prior to European settlement, kangaroo grass *(Themeda triandra)* was the major grass species. The first white settlement occurred between the 1840s and 1860s and these pastures were grazed by sheep. However, by the 1880s, cattle had replaced sheep partly because of a transition from kangaroo grass to black speargrass. This transition occurred because of altered grazing and fire regimes and drought (Shaw 1957).

Favourable beef cattle prices in the late 1960s and early 1970s resulted in cattle numbers increasing during a time of above average rainfall. The beef market slump in 1974 caused many producers to retain cattle. This increased stocking rate together with prolonged drought resulted in less fuel and consequent reduction in burning in the late 1970s and 1980s. These factors have led to a reduction in the proportion of black speargrass in these pastures (G.M. McKeon and D.M. Orr, unpublished data). Overgrazing remains a major problem for property management.

Relatively large changes in pasture composition have occurred over a relatively short period of time. A survey of vegetation condition conducted between 1978–1980 estimated that 40%, 30% and 30% could be classified as being in good, fair and poor condition (Weston *et al.* 1981). However, in 1991, it was estimated that 20%, 60% and 20% could be classified as being in A, B and C condition, respectively (Tothill and Gillies 1992). Although Tothill and Gillies stress that these two classifications are not directly comparable, these estimates suggest that large changes have occurred.

Regional differences in rainfall throughout the southern black speargrass zone have led to regional differences in the current composition of these pastures. For example, wiregrasses (*Aristida* spp.) are common in the western areas (Paton and Rickert 1989; Orr *et al.* 1991; Orr and Paton 1993), whereas Queensland blue couch (*Digitaria didactyla*) is common in the eastern areas (Jones 1992).

This paper presents our initial attempt to catalogue the alternative vegetation states and the transitions between these states. It is based on current published and unpublished information and represents a working hypothesis of vegetation change for the entire southern black speargrass zone.

The state and transition model

A state and transition model to describe these changes is presented in Figure 1. States have been described in terms of the vegetation components and Table 1 describes the major species belonging to those states.

The transitions between the vegetation states and the probability of these transitions occurring are presented in Table 2.

The proposed state and transition model presented represents a general model for the

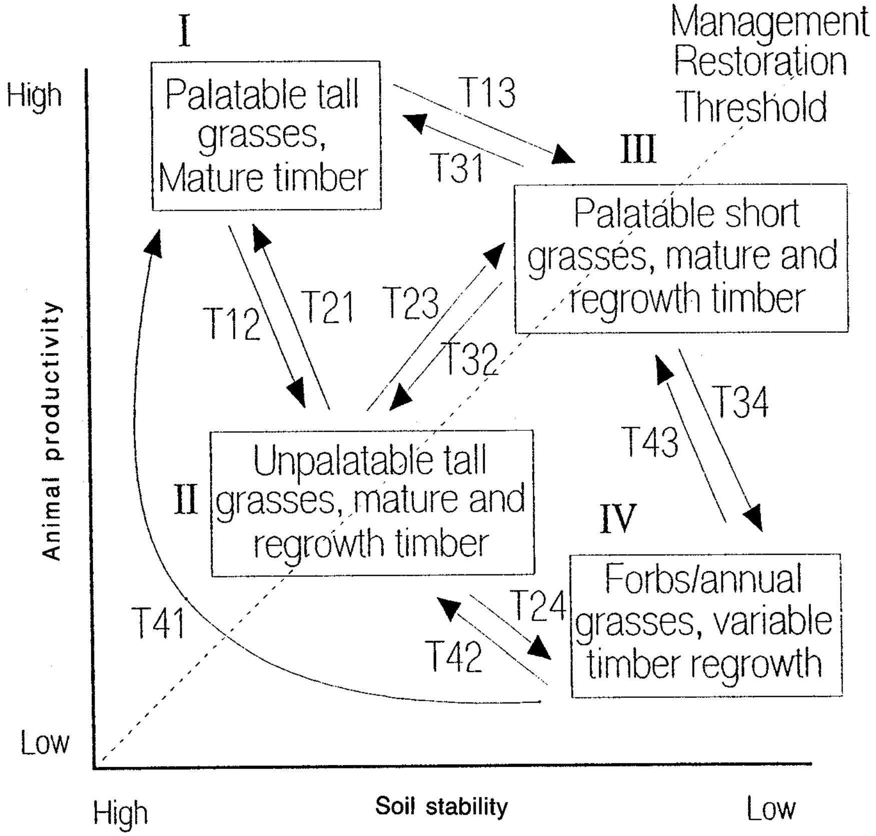

Figure 1. A hypothetical state and transition model for the southern black speargrass zone. Above the management restoration threshold line, simple alterations to management can effect change; below this line, major alterations to management will be necessary to effect change.

southern black speargrass zone. We have not attempted to incorporate differences due to rainfall and soil type. Consequently, no attempt is made to quantify what constitutes "heavy" grazing pressure which will be site specific. Similarly, no attempt is made to provide a detailed list of species.

Research questions

In drawing up the transitions, a number of research questions were raised. These were:

1. What are the management dynamics for changing back to kangaroo grass dominance?
2. What are the minimum populations ("thresholds") to achieve transitions e.g. movement from State II or III back to State I?
3. What are the minimum data sets to define the states, and what do we need for a "ready reckoner" for producers?
4. What is the relative productivity in terms of animal production of the different states?
5. Can exotic tall grass (e.g. *Sporobolus pyrimidalis*) move from State II to State I?

Table 1. Definition of states in the southern black speargrass zone.

State I. Palatable tall grasses
Vegetation predominantly *Heteropogon contortus* with *Bothriochloa bladhii* (particularly on clay soils) and possibly some *Themeda triandra*. Mature trees and some regrowth present.

State II. Unpalatable tall grasses
Vegetation dominated by species such as *Aristida* spp. and *Bothriochloa decipiens*, and annual grasses and forbs are common. Mature and regrowth timber present.

State III. Palatable short grasses
Vegetation dominated by species such as *Digitaria didactyla* (eastern), *Chloris divaricata* and *Eragrostis sorroria* (northern) and *Chrysopogon fallax*, with annual grasses and forbs. Mature and regrowth timber present.

State IV. Annual grasses and forbs
Vegetation dominated by annual grasses and forbs. No mature trees and variable regrowth present.

Table 2. Transitions between the vegetation states as defined in Table 1 and the probability of that transition occurring. T_{12} represents the transition from State I to State II etc.

T_{12} **Cause:** heavy grazing pressure, drought.
Probability: high.

T_{13} **Cause:** very heavy grazing pressure, drought.
Probability: high.

T_{21} **Cause:** fire, reduced grazing pressure, +/− seed/plant source.
Probability: medium +/−[1].

T_{31} **Cause:** fire, reduced grazing pressure, +/− seed/plant source.
Probability: medium +/−..

T_{24} **Cause:** continued heavy grazing pressure, drought.
Probability: high.

T_{42} **Cause:** reduced/no grazing pressure, fire, +/− seed source.
Probability: medium.

T_{23} **Cause:** heavy grazing pressure, run of good seasons.
Probability: low.

T_{32} **Cause:** heavy grazing pressure, + exotic species invasion.
Probability: unknown.

T_{34} **Cause:** continued heavy grazing pressure, drought.
Probability: high.

T_{43} **Cause:** reduced/no grazing pressure, +/− seed source.
Probability: medium +; no −.

T_{41} **Cause:** reduced/no grazing pressure, fire, + seed/plant source.
Probability: unknown.

[1]Probability when seed or plant source present or absent.

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