State and transition models for rangelands. 8. A state and transition model for the northern speargrass zone

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Abstract

A general state and transition model is described for the herbaceous component of the vegetation in the northern speargrass zone (Gladstone to the base of Cape York Peninsula). The states have been identified and named by the dominant vegetation component e.g. perennial tussock grasses, Indian couch grass, and the factors likely to contribute to the transitions between states are listed e.g. utilisation rate, fire, seed source.

Introduction

The northern speargrass *(Heteropogon contortus)* zone extends from Gladstone to the base of Cape York Peninsula and occupies approximately 17 M ha, mostly within 300 km of Queensland's east coast. Soil types vary widely but many are infertile duplexes and earths. Average annual rainfall varies between 600–1200 mm and the vegetation is characteristically a eucalypt woodland. The main land use is cattle breeding and fattening. For this paper, we have combined the northern and central speargrass units of Tothill and Gillies (1992).

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Vegetation changes

Throughout the zone, speargrass is a common but variable component of the pastures. Prior to European settlement, kangaroo grass *(Themeda triandra)* was a more prominent pasture component but, under the altered burning and grazing practices, it declined. These practices favoured speargrass which often became the dominant grass (Shaw 1957).

Pasture management practices vary throughout the region and from property to property, e.g. stocking rates, use of supplements, fire regimes, pasture spelling. These variations coupled with widely variable climatic conditions and soil types lead to vastly different grazing pressures on the pastures, resulting in a range of pasture compositions. This range has been added to in the Townsville–Bowen–Collinsville–Charters Towers area by the naturalisation of Indian couch grass *(Bothriochloa pertusa)*, a stoloniferous, grazing-tolerant grass from India, which now dominates nearly 1 M ha (Walker and Weston 1990).

A number of woody species (both native and introduced) have reached weed status. The major problem native weeds are regrowth of *Eucalyptus*, *Acacia* spp. and *Carissa ovata*, and the major introduced species are *Cryptostegia grandiflora*, *Ziziphus mauritiana*, *Parkinsonia aculeata* and *Acacia nilotica*. All of these species may be dominant components of the vegetation.

When the changes in composition of the pastures and the increases in woody weeds are considered together, there have been marked changes in the condition of the northern speargrass lands. In a 1991 survey, Tothill and Gillies (1992) estimated 30%, 55% and 15% were in A (best), B and C condition, respectively. The changes from A to B and C condition resulted from invasion by exotic weeds, timber regrowth and decline of valuable pasture species.

A state and transition model

The state and transition models discussed in earlier papers provide a convenient means of displaying the differences in pasture compositions (states) and also the causes of the changes in composition (transitions). Figure 1 shows such a model for the northern speargrass and the states and transitions are described in Tables 1 and 2.

The states have been identified and named by the dominant vegetation component i.e. the species or group that comprises most of the vegetation. The transitions have been described by the factors believed to be causing the changes in composition. The probability value is the likelihood of the factors causing the change occurring, assuming other production and management factors do not change. The model is concerned only with the herbaceous component of the vegetation and we have assumed the tree layer remains intact.

This is a general model for the zone, and while no attempt has been made to provide the detail of the actual species in a state, or the level of the factors likely to cause a transition, it shows how the vegetation responds overall. Utilisation rates are an important factor in many transitions and their effects may be influenced by the growing conditions, as pastures can withstand higher utilisation rates under good growing conditions than they can under dry conditions. Similarly, soil fertility may affect the resilience of pastures and the probability of T_{25} may be higher (and that of T_{21} lower) on infertile soils in the northern part of the zone.

Future research

The major information required to use this model for management is to define the levels of the causal factors, and the probabilities of the transitions, for different soil types and rainfall zones.

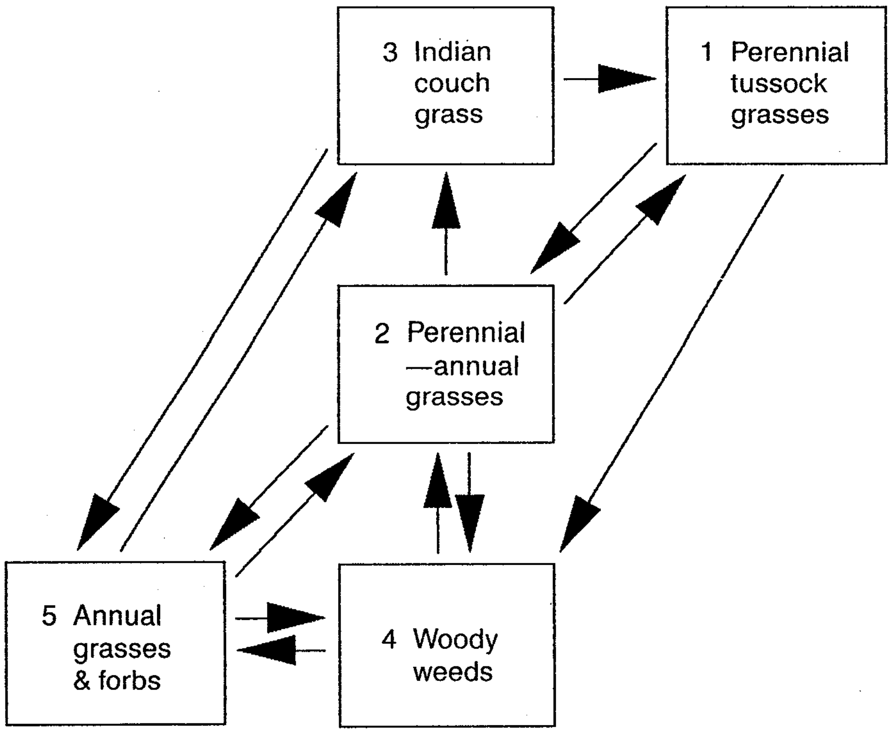

Figure 1. A general state and transition model for pastures in the northern speargrass zone of Queensland.

Table 1. Definitions of important vegetation states occurring in the northern speargrass zone.

State 1. Perennial tussock grasses
Vegetation dominated by palatable, native, perennial tussock grasses.

Typical species: *Heteropogon contortus, Themeda triandra, Bothriochloa bladhii, B. ewartiana, Dichanthium* spp.

State 2. Perennial-annual grasses
Vegetation dominated by a mixture of perennial (as in State 1) and annual grasses and forbs (as in State 5).

Typical species: *Chrysopogon fallax, Bothriochloa decipiens, Eragrostis* spp. (plus those named for States 1 and 5).

State 3. Indian couch grass
Vegetation dominated by Indian couch grass *(Bothriochloa pertusa)*.

State 4. Woody weeds
Vegetation dominated by native or introduced woody weeds.

Typical species: *Cryptostegia grandiflora, Ziziphus mauritiana, Acacia nilotica, Eucalyptus* regrowth, other *Acacia* spp., *Carissa ovata, Parkinsonia aculeata.*

State 5. Annual grasses and forbs
Vegetation dominated by annual grasses, forbs and unpalatable perennial grasses.

Typical species: *Aristida* spp., *Tragus australiana, Sporobolus australasicus, Boerhavia* spp., *Portulaca* spp.

Table 2. Transitions between vegetation states defined in Table 1 with an indication of the probability of the transition occurring. T_{12} is the transition from State 1 to State 2, T_{21} is the transition from State 2 to State 1; etc.

T_{12}	**Cause:** high utilisation during the growing season, especially in below-average rainfall years. **Probability:** medium-high.
T_{25}	**Cause:** very high utilisation for extended period. **Probability:** low.
T_{14} T_{24} T_{54} T_{34}	**Cause:** seed source, sufficient rainfall for germination and establishment of woody plants, lack of fire; favoured by medium-high utilisation. **Probability:** low-medium.
T_{23}	**Cause:** seed source, high utilisation. **Probability:** medium.
T_{35}	**Cause:** very high utilisation for extended period. **Probability:** low.
T_{21}	**Cause:** low utilisation, above-average rainfall, fire. **Probability:** medium.
T_{52}	**Cause:** seed source, low utilisation; may require above-average rainfall. **Probability:** low.
T_{31}	**Cause:** seed source, low utilisation, fire? **Probability:** low.
T_{45} T_{42}	**Cause:** chemical and/or mechanical intervention, fire; (which transition occurs depends on seed availability). **Probability:** low.
T_{53}	**Cause:** seed source, medium-high utilisation. **Probability:** low-medium.

Much of this information is available from both producers and scientists, and needs to be collated in a consistent format.

Conclusions

The model provides a means for organising information related to the states and can aid in communicating this information. For example, the change from State 1 to State 5 is accompanied by a decline in pasture production (McIvor and Ash 1994) and a decline in soil stability. Ground cover, infiltration and water quality are lower and runoff and soil loss are higher for areas in State 5. Ash *et al.* (1993) have used a similar model to relate animal production to vegetation state in tropical tallgrass pastures. Scanlan (1994) has shown how such models can be analysed to predict the composition of states given a range of transition rates.

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