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State and transition models for rangelands. 11. A state and transition model of the *Aristida-Bothriochloa* pasture community of central and southern Queensland

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Abstract

The *Aristida-Bothriochloa* community extends from the *Eucalyptus melanophloia* (silver-leaf ironbark) woodlands with *Bothriochloa ewartiana* (desert bluegrass) in central Queensland to the *E. populnea* (box) woodlands with *B. decipiens* (pitted bluegrass), *B. bladhii* (forest bluegrass) and *Dichanthium sericeum* (Queensland bluegrass) in southern Queensland. Soils are predominantly light textured with lesser areas of clays. The summer-dominant rainfall is between 500–700 mm annually. These native pastures are used for beef cattle production.

This paper presents a general state and transition model for the community. Specific species mixes in the overstorey, shrub and herbaceous layers in the woodland, grassland, grassland with scattered trees, and dense shrubland states are recorded. The causes of transitions between these states and the probability of occurrence are identified. The main pasture condition deterioration is from an increase in less desirable grasses such as *Aristida*, *Chloris*, *Eragrostis*, *Enneapogon* and *Sporobolus* spp., regrowth from the dominant *Eucalyptus* spp., and soil erosion from the fragile soils.

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Introduction

Aristida-Bothriochloa pastures as defined by Weston *et al.* (1981) and Tothill and Gillies (1992) are a major community in Queensland. They extend from the Gulf of Carpentaria to the New South Wales border in a band between the coastal speargrass country in the east and the mitchell grass downs in the west. Only the southern portions of this community, between 22–27° S, are considered in this paper. Eucalypt woodlands dominate this community and occupy some 10.7 M ha of the defined area. Soil types are mainly duplexes and earths of low fertility, although there are fertile heavy clays, alluvial loams and infertile sands. Mean annual rainfall is between 500–700 mm, with 75% summer dominance in the north and 65% in southern areas. The land is used for beef cattle breeding on native pastures with some cattle fattening, often in association with adjacent pastures on more fertile soils.

Pasture associations

Pasture communities vary from north to south, with the undesirable *Aristida* species present throughout. In the north, *Bothriochloa ewartiana* is a preferred species, while in the south, bluegrasses *(Dichanthium sericeum, Bothriochloa bladhii* and *B. decipiens)* are desirable species. The dominant trees in the woodland are poplar box *(Eucalyptus populnea)*, silver-leaved ironbark *(E. melanophloia)* and cypress pine *(Callitris glaucophylla)*. Common pasture grasses include *Chrysopogon fallax, Chloris* spp., *Enneapogon* spp., *Eragrostis* spp. and *Sporobolus* spp. In some places, *Heteropogon contortus, Eremochloa bimaculata, Cleistochloa* spp. and *Triodia* spp. can be significant components.

Grazing management

Continuous grazing is the usual system of grazing management. There is often short-term spelling of particular paddocks, although planned rotations are not common. Burning is used sporadically in early summer following good seasons to help control woody plant regrowth (*Eucalyptus* spp., *Acacia* spp., *Eremophila mitchellii* and *Callitris* spp.) and to provide fresh pasture. Extended dry periods are normal in the zone and feeding of supplements to cattle, which are mainly Brahman-cross, is common.

Problem woody and herbaceous weeds

Killing the *Eucalyptus* spp. by ringbarking, chemicals or pulling has been a common practice to increase pasture production. Such disturbance lead to woody regrowth problems from the *Eucalyptus* species (box and silver-leaved ironbark), as well as from understorey sandlewood *(E. mitchellii)* and cypress pine. In small areas, *Carissa* spp. (currant bush) and *Eremocitrus* sp. (limebush) populations also increase. *Parthenium hysterophorus* (parthenium) is an increasing herbaceous weed problem spreading from the north, and *Pimelea* spp. (flaxweed) is a poisonous plant in the south of the zone.

Pasture condition

Pasture condition estimates by Weston *et al.* (1981) were: 20–60% good, 30–60% fair and 10–30% poor. In 1992, Tothill and Gillies estimated there was 20% in class A, 50% in class B and 30% in class C. In recent years, summer rainfall has been below average in the zone and pastures are expected to deteriorate further. There have been no fires for woody weed control and the open pastures will be less competitive with weeds when average seasons return.

State and transition model

A general state and transition model for the community is shown in Figure 1. The particular

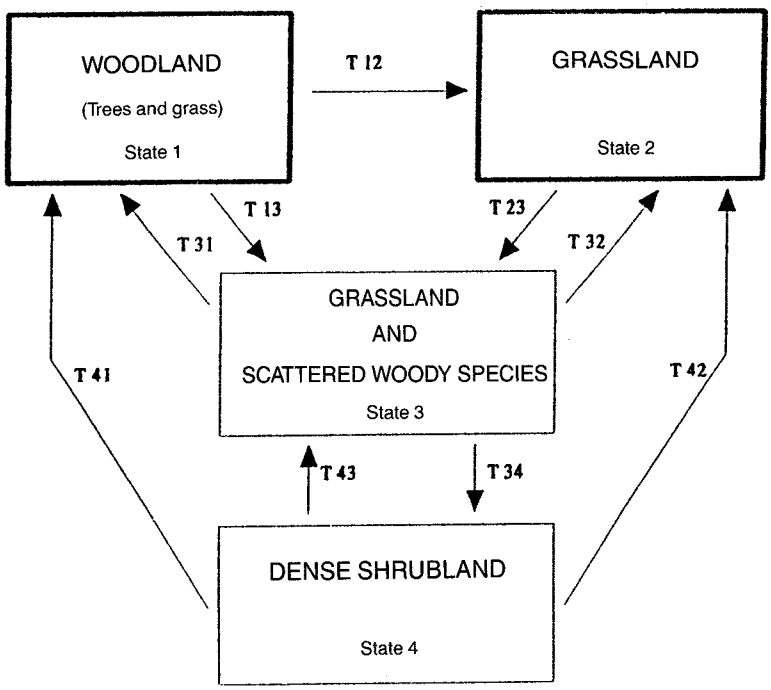

Figure 1. *Aristida-Bothriochloa* community state and transition general model.

combination of tree and herbaceous species will depend on the soil type and climatic conditions for any location; however, distinct states can be defined (Table 1). Within each state, the dominance of herbaceous species may fluctuate in accordance with managerial and seasonal conditions, but at present, our understanding of pasture dynamics for this community is very limited. For example, in the north, *H. contortus* is more abundant following above-average rainfall, whereas less desirable species such as *Aristida* spp., *Sporobolus* spp. and *Chloris* spp. dominate after extended heavy grazing. Within each state, the pasture composition can be ordered along a continuum, which has a value for differentiating the level of animal production and for identifying conditions when transitions might occur. The transitions and time periods

Table 1. Definitions of major vegetation states and common species occurring in the *Aristida-Bothriochloa* community.

State 1. Woodland
Vegetation a mixture of *Eucalyptus* spp. (tree basal area between 4–8 m^2/ha) and native perennial grasses.

Typical woody overstorey species: *E. populnea, E. melanophloia, E. crebra, Callitris spp.*

Typical shrubby understorey species: *Eremophila mitchellii, Callitris spp., Acacia spp.*

Typical herbaceous species: *Bothriochloa ewartiana, B. decipiens, B. bladhii, Chrysopogon fallax, Dichanthium sericeum, Aristida spp., Heteropogon contortus,* and native legumes such as *Glycine spp.* and *Desmodium varians.*

State 2. Grassland
Vegetation dominated by perennial grasses.

Typical herbaceous species: *Cenchrus ciliaris* (sown), *B. ewartiana, B. decipiens, D. sericeum, Cymbopogon spp., B. bladhii, H. contortus, Aristida calycina, Eragrostis molybdea, E. sororia, Brunoniella australis.*

State 3. Grassland and scattered woody species
Vegetation an unstable mixture of perennial grasses, tree seedlings and shrub species.

Typical woody species: *E. populnea, E. melanophloia, Callitris spp., E. mitchellii, Carissa ovata.*

Typical herbaceous layer: *B. ewartiana, B. decipiens, B. bladhii, C. fallax, D. sericeum, Aristida spp., H. contortus, Digitaria spp., Tripogon loliiformis, Chloris spp., Enneapogon spp., Glycine spp.*

State 4. Dense shrubland
Vegetation dominated by dense *Eucalyptus* regrowth and shrub species, in association with lowly productive grasses.

Typical woody species: *E. populnea, E. melanophloia, Callitris spp., Carissa ovata, E. mitchellii, Acacia spp.*

Typical herbaceous species: *Aristida spp., Chloris spp., Enneapogon spp., Sporobolus spp., Tragus australianus, Enteropogon spp.*

Table 2. Transitions between vegetation states defined in Table 1 with an indication of the time frame and 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:** mechanical and chemical clearing of trees and seed sown; favoured by wet growing seasons and requires at least 2 years.
Probability: medium.

T_{13} **Cause:** mechanical or chemical clearing of trees followed by wet summer growing season; occurs rapidly, 1 year.
Probability: very high–medium.

T_{23} **Cause:** heavy grazing, plus dry summers and winter rain; change can occur over 2–15 years.
Probability: high.

T_{31} **Cause:** no fire and no regrowth control; duration 40 years or longer.
Probability: very low.

T_{32} **Cause:** fire (provided by light grazing), and mechanical or chemical treatment of scattered trees; takes at least 2 years.
Probability: medium for fire, high for timber treatment.

T_{34} **Cause:** overgrazing and drought, both associated with an absence of fire; gradual change over 4–20 years.
Probability: high.

T_{41} **Cause:** time, no grazing and some fire; at least 30–100 years required.
Probability: very low.

T_{42} **Cause:** mechanical and chemical treatment, and in some situations a grass seed source; requires 1–2 years with wet growing seasons.
Probability: medium.

T_{43} **Cause:** intense fire (provided by light grazing or high summer rains), or mechanical and chemical treatment of trees; requires 1–2 years with a wet growing season after tree destruction.
Probability: low–medium for fire, high for timber treatment if good seasons and light grazing follow clearing.

for change between the states are described in Table 2.

Role of models

State and transition diagrams are a useful way to communicate to producers the effects of management on vegetation change. The implications of their decisions on pasture composition and the likelihood of any large future costs and animal production levels can be illustrated. For example, timing of timber treatment or changing utilisation (stocking) rates can be planned before pastures pass into a less productive state.

The rates of regeneration from degraded states to more productive states in this community are not known. However, with the fragile soils throughout the zone, pasture cover is required to improve water infiltration and prevent serious erosion.

Use of these models to encapsulate complex biological processes will complement other native pasture management programs such as the State Grazing Lands Monitoring system (Qgraze), the producers paddock monitoring system (Grass Check) and the education activity (Pasture Watch).

Knowledge gaps

The species present in each state and their location in the pasture continuum within each state, and the causes of transitions between these states need to be determined. Surveying of pasture composition and soil associations in the *Aristida-Bothriochloa* community is required as this zone has had little previous research, beyond developing species lists for some areas.

Cattle production from each state can be linked to the competitive effects of woody species; however, the effect of different pasture composition within a state on animal production is not known.

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