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PRINCIPLES FOR SUSTAINABLE GRAZING MANAGEMENT OF SOUTHERN RANGELANDS

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ABSTRACT

We propose a framework for sustainable grazing management of southern rangelands based on the concept of tactical grazing. The underlying principles are (1) establishment of paddock objectives (2) conditioning of pastures and landscapes to realise opportunities and avoid hazards arising from temporal and spatial variability of rainfall (3) development of strategies involving manipulation of stocking rate, rest, prescribed fire, inter-specific competition and total grazing pressure (4) use of monitoring systems to provide triggers for tactical decisions and assess progress towards management objectives and (5) management of areas of high conservation value for specific conservation objectives. We suggest that these principles could be applied within a wide range of management regimes but caution against some aspects of more intensive approaches currently attracting interest in the southern rangelands.

INTRODUCTION

We define the southern rangelands as those arid and semi-arid areas of the continent with non-seasonal or winter-dominant rainfall. Wool growing has traditionally dominated pastoral activity in these lands, although cattle enterprises have been part of many businesses. Economically, the value of pastoralism is small relative to the mining and tourism industries, and alternative land uses (eg biodiversity conservation) are increasingly recognised. Nevertheless, pastoralism remains the dominant land use and maintenance of the ecological integrity of the region is inseparable from the sustainability of pastoral businesses.

Research in the southern rangelands since the 1960's has provided a basis for understanding how the vegetation and function of these landscapes change under the influences of seasonal variation, total grazing pressures (by domestic, feral and native herbivores) and fire regimes. Knowledge gained by experimentation and observation has been synthesised into conceptual and simulation models at a range of spatial and temporal scales (eg Harrington, *et al.*, 1984, Hacker *et al.* 1991, Ludwig, *et al.*, 1997).

Importantly, the knowledge of pastoralists themselves has been increasingly documented (eg Heywood et al., 2000). In western NSW, some have commenced programs of participative R&D, with funding support from State and Commonwealth governments, to test their own ideas of grazing management in cooperation with researchers. These developments are promising for pastoralists, institutions and scientists alike. They should foster development of personal goals and the building of a capability to learn more from each other (Hodgkinson *et al.*, 2002).

In this paper we set out the principles, as we see them, for achieving sustainable pastoralism in the southern rangelands. Our focus is on the resource base, and primarily from a production perspective, but we recognise the importance of the economic and social dimensions of sustainability, and the need to conserve biodiversity at local and regional scales. We use the framework we developed earlier for application of tactical grazing at the whole property level (Hacker and Hodgkinson, 1996) to embed our remarks.

THE ENVIRONMENT

The southern rangelands comprise a wide variety of plant communities, reflecting underlying geological and geomorphological processes. Important broad types for pastoralism include shrub steppe, woodlands and grasslands. Fertility is typically low but tends to be higher on heavier textured soils.

The rainfall environment is semi-arid or arid (50-500mm/year) and as such rainfall occurs in erratic "packets", with intervening periods often reaching 'drought' status. Distribution is either non-seasonal or weakly winter-dominant. In these environments, in which evaporative demand may exceed rainfall by an order of magnitude, local concentration of water and nutrients is an essential feature of landscape function. Current understanding of these landscapes (Ludwig, *et al.*, 1997) recognises that sinks or patches which capture water through local redistribution of rainfall, and water- or wind-borne nutrients, are important for maintaining vital processes, particularly during drought. Feedback through recruitment and survival of plants builds and maintains the patches and contributes to the evolution of landscapes. When long-term rainfall increases, feedback from more frequent and larger growth pulses results in more and larger patches, and capture of water and nutrients becomes more localised. The opposite occurs when climate shifts to drier conditions.

The rainfall environment makes these lands fire-prone but fire frequency is much lower than in northern savannas because of the non-seasonal rainfall pattern. Natural wildfire from lightning strikes combined with the burning practices of Aboriginal people created open grasslands with scattered shrubs and trees over extensive areas, which attracted pastoral settlement. Even within the shrub steppes, infrequent fires may have resulted in a mosaic of shrub and grass dominated states that alternated on lengthy time scales (Mitchell *et al.*, 1979)

Natural "water points" are widely spaced and could support only sparse populations of kangaroos prior to pastoral development. The introduction of domestic stock and feral animals dramatically altered this situation. The addition of permanent stock watering points supported these introduced animals as well as promoting the increase of some kangaroo species which now contribute substantially to the total grazing pressure (Hacker *et al.*, 1999).

APPLICATION OF SUSTAINABLE GRAZING MANAGEMENT

Equilibrium models of ecological function are not likely to be suitable for environments with the characteristics outlined above. The tactical grazing framework was developed for exploiting opportunities to promote vegetation and landscape function changes that are favourable for stock production (or other objectives), and for avoiding hazards that may result in unfavourable changes, in rangelands not at equilibrium (Westoby *et al.*, 1989). It is a process involving the establishment of resource management objectives for individual paddocks, the identification of strategies to achieve them, and tactical decision making informed by active monitoring of the resource.

Paddock objectives and priorities

Paddocks are the basic unit of management and each should have a management objective consistent with the goals of the operator. The objective may be to maintain things as they are, or to change the paddock to some other state, which may raise business profits and/or conservation value. Establishing the objective should involve consideration of influences operating at larger scales (eg property, catchment, region, or larger) so that the basic unit is seen as an integral part of the overall system.

While the process for establishing the objective cannot be formalised, it will involve assessment of the current state of the vegetation, landscape or biodiversity and a judgement regarding the capacity of the system to respond to management. Some simple techniques are available to assist in the assessment of vegetation and landscape function (Campbell and Hacker, 2000). Biodiversity is harder to assess but measuring the abundance and variety of birds is a good start. From the assessments, objectives can be formed such as to reduce the unpalatable shrub level, increase the palatable shrub and/or grass level or increase the diversity of birds. While paddock objectives are the starting point of tactical grazing they are not immutable and may change, for example, if seasonal conditions produce unexpected floristic changes or if an initial objective is achieved.

In addition to an objective, each paddock should be assigned a priority, based on the current productivity and/or potential for change, to guide decision making when the management requirements of all paddocks cannot be satisfied in any planning period.

Principle 1: Paddock objectives for vegetation, landscape function and biodiversity should be established and revisited.

Paddock strategies

Paddock strategies are essentially guidelines that describe, in terms that can be monitored for tactical implementation, the management required to achieve the objective. They need to address both the opportunities and hazards created by the erratic and non-seasonal nature of rainfall in the southern rangelands.

This variability produces, during favourable seasons, periods of rapid vegetation change (eg establishment of new cohorts), followed by periods of relative quiescence. These rapid changes may be either favourable or unfavourable from a pastoral perspective. During severe drought conditions, changes may again be rapid (eg mortality of palatable species) but are generally unfavourable from a pastoral perspective. Although periods of rapid change can produce major and long lasting shifts in vegetation, slower changes during the longer intervening periods can be important in vegetation dynamics over the long term. Further, the management of grazing during these periods can 'condition' the response of the system during those periods when seasons permit or force rapid changes (Watson *et al.*, 1996). The response to the more extreme seasonal events is thus determined largely by the management applied during more usual conditions. Examples would include the differential responses of heavily and moderately grazed pastures to intense rainfall, drought, or rain at times favourable for germination and growth.

Spatial variability in rainfall distribution compounds the temporal variability discussed above, particularly during periods of thunderstorm activity. Plant growth may vary between paddocks, so that the tactical adjustments to stock density, or other management interventions, required to progress towards the paddock objectives have both spatial and temporal components.

Principle 2: Paddock grazing strategies must condition pastures and landscapes to realise opportunities and avoid hazards arising from temporal and spatial variability of rainfall.

Paddock strategies will vary depending on the objective established for each paddock. Ultimately, each strategy needs to be formulated in terms that will allow tactical decisions to be made on the basis of ongoing monitoring of pastures and landscapes. A number of tools are available to seize opportunities or avoid hazards, the application of which can be guided by a paddock strategy amenable to monitoring and tactical decision making.

Tools for tactical grazing

1. Stocking rate

Continuous grazing is generally regarded today as incompatible with maintenance of long-term pastoral productivity. Nevertheless, continuous grazing for extended periods, at conservative rates, may not necessarily prejudice paddock management objectives. This will be particularly so for paddocks which have lost much of their desirable perennial component, have little capacity to respond to grazing management, and where the objective is simply to maintain the capacity to respond to rainfall without further deterioration. A fundamental requirement in these situations is to maintain ground cover at levels that will minimise soil loss. Paddock strategies involving primarily adjustment in stocking rate can thus be formulated based on minimal cover requirements. A level of 40 per cent (including litter, cryptogams etc) is becoming generally accepted for the semi-arid rangelands. Such strategies will avoid the hazards associated with bared soil surfaces and provide an opportunity for improvement should particular seasonal conditions result in unexpected recruitment of desirable species.

2. Resting

Palatable perennial grass loss, and grass loss in general, is a problem in the wooded grasslands and to a lesser extent in the shrub steppe. The loss has the greatest impact on sheep weight gain and wool growth during dry times when green leaf becomes scarce (Freudenberger *et al.*, 1999).

Losses occur episodically, linked to periods of drought. In the long-term grazing study on Lake Mere station near Louth, NSW no established grasses died during times of average or above average rainfall; death only occurred during drought periods and the proportion of plants that died increased with increasing grazing pressure prior to the droughts (Hodgkinson, 1995).

Grazed height, or level of utilisation, can therefore indicate when continued grazing would expose grasses to rapidly increasing risk if seasonal conditions deteriorate, and when rest should be applied to allow recovery. Although much remains unknown about the appropriate threshold for individual species, and the best criteria for specifying of the degree of recovery required, 'best bet' strategies for resting can be formulated based on observable vegetation features. Such strategies will particularly address the hazard of perennial plant loss during drought and, if recovery criteria include seeding, could also ensure that vegetation is conditioned to respond as well as possible to the opportunities of above-average seasons.

3. Prescribed fire

The opportunity to use prescribed burning for unpalatable shrub management is made by periods of sustained high rainfall, sometimes with the assistance of resting from grazing. These opportunities are rare but fire can have a huge impact on the vegetation for years or decades ahead. If missed, then the opportunity may not be repeated in a manager's lifetime. Prolonged rainfall is required to grow sufficient fine fuel to carry fire; summer/autumn rain for perennial/or annual grasses, such as *Stipa* species, followed by winter rain for forbs between grass tussocks. Burning opportunities will occur in the following warmer months

Seedlings of all problem shrub species are highly susceptible to fire but species differ when shrubs mature and become reproductive. If all leaves of a shrub are burnt or scorched, mortality is species and height dependant (Hodgkinson, 1998). Knowing the shrub species and their height distribution allows prediction of shrub reduction by fire (Daly and Hodgkinson, 1996). The season in which the fire occurs and the intensity of the fire have little impact on mortality apart from determining the proportion of the paddock burned and the scorch height. Grasses, apart from *Eragrostis eriopoda,* regrow after fire because of buried tiller bases.

A second fire, a year after the first, can substantially enhance the mortality of shrubs, especially those of the genus *Eremophila*, when burning occurs in the autumn but not the spring (Hodgkinson and Noble unpublished data). Two fires a year apart are naturally unlikely but the second defoliation by fire can be simulated by chemicals or herbivory. Chemicals have proved uneconomical and of variable efficacy. Herbivory has not been studied but blitz grazing by goats after a fire is effective in killing normally unpalatable *Eremophila* species (Keith Francisco, Cobar personal comm.).

Paddock strategies that incorporate management burning can be formulated in terms of required fuel loads (generally in excess of 1000 kg per ha is desirable) and the requirements for pre- and/or post-fire grazing. They are aimed particularly at taking advantage of seasonal opportunities.

Prescribed fire for shrub control, coupled with pre- and post-fire resting, has been shown to be a profitable management strategy (Burgess, 1988). The poor adoption, despite concerted extension programs in both NSW and Queensland may reflect graziers' unwillingness to forego short-term forage supplies for longer term gains in forage production. Alternatively, adoption may be limited by inadequate financial resources, litigation fears and difficulties in organising human resources to seize the short-term opportunity to burn.

4. Inter-specific competition

Grazing management may alter competitive interactions between species. Survival of shrub seedlings, for example, is enhanced by grazing of neighbouring grass plants, resulting in reduced transpiration and improved seedling water relations (Harrington, 1991). Manipulating grazing to suppress undesirable shrub seedlings, or enhance establishment of desirable species, may thus form part of strategies that address both hazards and opportunities.

5. Control of total grazing pressure

As noted earlier, non-domestic animals comprise a significant proportion of the total grazing pressure in the southern rangelands. All of these species must be managed as part of the tactical grazing process. Control of access to watering points is fundamental to the management of total grazing pressure. Establishment of self-mustering facilities not only contributes to the efficiency of stock management but also facilitates trapping of feral goats and the closure of water points to deter kangaroos when paddocks are rested.

Principle 3: Strategies to achieve paddock management objectives will involve manipulation of stocking rate, rest, prescribed fire, inter-specific competition and total grazing pressure.

Paddock monitoring

Tactical grazing requires the establishment of monitoring systems within individual paddocks that allow strategies to be implemented tactically, and progress towards objectives assessed. It is important that strategies are framed in terms that allow monitoring to become an integral part of day to day management so that on-going observation of vegetation and landscape features (eg grazed height/utilisation of key species; soil cover) can provide the basis for the short term, tactical management decisions. Monitoring that assesses progress towards objectives will generally involve the measurement of different parameters to those associated with tactical decision- making (eg changes to landscape function, pasture composition, or shrub cover) but the same network of sites can serve both functions. Simple systems for both types of monitoring, developed with pastoralists, are being promoted for NSW rangelands (Campbell and Hacker, 2000).

Principle 4. Management should be informed by monitoring systems at paddock level that provide triggers for tactical decisions and assess progress towards management objectives.

Biodiversity

While pastoral management that conforms to the program outlined above should conserve biodiversity to the maximum extent possible within a production system (Curry and Hacker 1990) some aspects of conservation may not be accommodated by this approach. Some areas with high conservation value may require the complete removal of grazing. Others may require grazing to be managed in a way that removes its influence as a threatening process within a management regime aimed at specific conservation outcomes. Increasingly, the establishment of such areas is accepted as requiring public support, opening the opportunity for conservation to become an alternative enterprise within pastoral businesses.

Principle 5. Areas of high conservation value should be managed for specific conservation objectives.

IMPLEMENTATION

At the whole property level, implementation of tactical grazing will involve an ongoing process in which stock are distributed among paddocks according to the management requirements of each, as defined by the paddock strategy, and the monitored effect of recent grazing. Allocation of stock to paddocks may also need to account for constraints that arise from local conditions or stock husbandry requirements. If all stock on hand cannot be accommodated while satisfying the management requirements of each paddock, then stock must be sold or agisted elsewhere, management objectives temporarily ignored (depending on their priority), or a higher level of seasonal risk accepted. Hodgkinson *et al.* (1999) have demonstrated that in the Cobar area of NSW, implementation of resting by agistment should be a profitable alternative to set stocking at rates higher than 0.3 sheep/ha.

Tactical grazing will generally require that part of the property should be destocked to ensure that grazed paddocks can be rested when necessary. In principle there seems no reason why the approach discussed above could not be applied within management systems in which the proportion of the property destocked at any time, and the number of flocks or herds, varies widely.

In the extreme, such application would have obvious similarities with the more intensive regimes associated with the concept of holistic resource management (Savory, 1988). A major difference, however, lies in the emphasis placed by the latter on 'animal impact' and 'herd effect' in promoting water and nutrient cycles. Our understanding of landscape function in the southern rangelands suggests that any effect of hoof action in promoting infiltration in runoff zones may detract from overall landscape function, and that disruption of the soil surface could result in increased risk of erosion (Eldridge, 1998). While some advantages may accrue through seed trapping, the benefits of surface disruption in semi-arid and arid rangelands remain open to question.

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