ECOLOGICAL AND ECONOMIC CONSIDERATIONS FOR THE MANAGEMENT OF SHRUB ENCROACHMENT IN AUSTRALIAN RANGELANDS

N.D. MacLeod[1], J.R. Brown[2] and J.C. Noble[3]
[1] CSIRO Division of Tropical Crops and Pastures, St Lucia Q 4067, Australia
[2] CSIRO Division of Tropical Crops and Pastures, Aitkenvale Q 4814, Australia
[3] CSIRO Division of Wildlife and Ecology, Lyneham ACT 2602, Australia

Summary. Shrub encroachment problems in rangelands are discussed. An approach to economic control is suggested that is based on seizing windows of opportunity based on ecological understanding of the shrub species. A change in management philosophy is advocated from production orientation towards a balance with resource conservation goals centred on recognition of state and transition paths associated with the underlying pasture resource systems.

INTRODUCTION

The encroachment of native and exotic shrub species into rangeland pastures is imposing significant economic and environmental costs (5). For example, it is estimated that the aggregate income loss for the semi-arid rangelands of NSW and Queensland alone is in the range of $40-$80 million (8). The effective address of these problems is being hampered by two problems. Firstly, many conventional control options (e.g. mechanical clearing, chemicals, range reseeding) appear to be either impractical or uneconomic for broad-area application (6). Secondly, there is a view held by many land managers that alternatives, such as prescribed fire, which do offer scope for economic control (3), also require unacceptable trade-offs between short term production losses and long term benefits (4). This view is reinforced by the strongly held belief in the right of individual landholders to make exclusive decisions concerning rangeland use (7), despite the existence of significant spillovers (e.g. weed spread) that may be imposed on other parties (2).

We argue that in attacking these two problems, opportunities may exist for finding economic control strategies, by exploiting windows of opportunity based on a realistic understanding of the potential states and transition paths associated with the underlying pasture resource base. A change of prevailing management objectives from an exclusive production orientation to accommodate a greater emphasis on resource conservation goals is also advocated.

ECONOMIC CONSIDERATIONS

The few economic analyses of shrub control have related to heavy infestations and shown relatively poor results (5), due largely to high treatment costs relative to productivity gains and the low capital value of rangeland pastures (6). However, many rangeland pastures may carry low levels of infestation with limited immediate economic impact but carry large potential for future damage (2). Management thresholds or switching points may be defined for decision-making purposes where the longer-term economic value of the herbaceous component as fuel to carry prescribed fire for shrub control may be much higher than its short-term (opportunity) value as forage. Similarly, the benefits from future loss-minimisation on a large scale may justify the high cost of treatment on areas from which encroachment may spread (2). In some cases where treatment efficiency is density dependant and cost is inversely related to density, treatment may never be an economic proposition (2,6). It is imperative that land managers appreciate their position when facing thresholds, have a clear recognition of the real economic

implications, and act accordingly. Otherwise, they may find that they have passed the threshold before the negative economic effects are actually apparent.

ECOLOGICAL CONSIDERATIONS

Newly emerging non-equilibrium ecological models such as the 'state and transition' model (12) provide valuable insights into rangeland pasture management decisions, including those relating to shrub control. These models, by categorising pastures into different status groups (states) and describing the processes of change (transition paths) between those states, place different options and management thresholds into a clear perspective. A significant departure from traditional models based on concepts of succession and competition, state and transition model logic calls for management based on exploiting windows of opportunity and recognition that transition paths may be asymmetric or unidirectional (12). For example, severe shrub encroachment caused by overgrazing may not be corrected by easing stocking rates. Restoration may require other interventions such as complete spelling and prescribed fire or mechanical/chemical treatment (9). There may also be scope for integrating control methods that in isolation are uneconomic but in combination can yield positive results. For example, sub-lethal chemical applications to mimic shrub mortality in response to fire under low fuel loads may make shrub control requiring episodic burning feasible (10). In many cases, however, once a transition has been made to an undesirable (shrubby) state it may become increasingly difficult to reclaim it in both an ecological and economic sense (5,9).

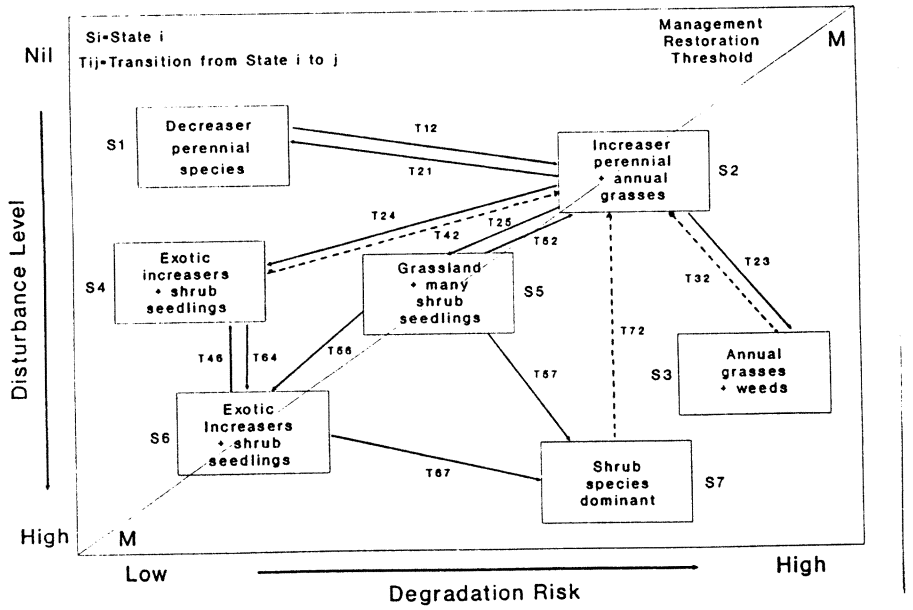

Figure 1. State and transition model for northern woodlands. Boxes represent stable configurations of vegetation. Arrows are transition pathways. Solid lines represent transitions of medium or high probability of occurrence. Dashed lines represent low probability transitions. See Ash *et al.* 1993 for a detailed description of transition pathways.

An example of the state and transition model applied to northern woodlands (2) is shown in Fig. 1. This shows how transitions can be divided into those amenable to management from those requiring restoration by crossing a 'management-restoration' threshold shown by the narrow line MM. The threshold concept raises a key issue of whether a pasture has been 'encroached' upon by shrubs in an economic or an ecological sense. The difference is seen is asking two separate questions; viz. (i) when and how much does forage production decline as weed densities increase; and (ii) when is it no longer economic to restore forage production? From a management perspective the distance between these two threshold points represents a trade-off zone between short and long term benefits and will affect management decisions concerning present and future pasture use and shrub control. This highlights two basic options; viz. (i) to keep open areas open, versus (ii) invoking control measures for restoration; for which the economic decision making processes and evaluations are different. Below the threshold most of the reverse transitions (i.e. to more desirable states) require restoration (e.g. mechanical clearing, chemicals, fire, reseeding) which may be relatively expensive, possibly uneconomic (see above) and ecologically risky (i.e. low chance of success). Above the threshold most transition paths can be effected through simple management strategies (e.g. stocking rate manipulation, fire).

The threshold gap also establishes the need for R&D to define the relationships between weed density and forage production, both short and long term. While these relationships are well documented for agricultural production, they are poorly understood within a rangeland context, with most emphasis having been placed on the biology of the key shrub species (6). As long as principal benefits of shrub control remain tied to animal productivity considerations, and economic factors weigh heavily in the decision processes of individual landholders, these relationships will be of extreme importance. The need for R&D to examine the economics of excluding shrub populations from rangeland pastures, rather than attempting to remove them, becomes a real issue.

CHANGING MANAGEMENT ORIENTATION

Management objectives dominated by a focus on assumptions of economic rationalism (e.g. profit or wealth maximisation) imply production supremacy in decision-making. This orientation is appropriate for states above the management-restoration threshold which are primarily production states. The primary goal orientation and legitimate use for planning is production/exploitation. However, effective management of pasture units in states lying below the management-restoration threshold (MM) will require a conservation/restoration supremacy or at best a higher weighting on resource conservation objectives than is evident in many cases at present. These are primarily conservation states where orientation and legitimate use is conservation/reclamation/restoration. Herbage should be managed in a conservative manner and managers should be fully cognisant of that fact. This is consistent with an emerging view that a stronger land care ethic should be ingrained into rangeland management values (11).

Rangeland management units (e.g. paddocks or whole property) typically comprise a mix of pasture resources in different states. For example, in the northern woodlands context, a manager may have access to country that is representative of many of the states in Fig. 1. In these circumstances management focus should be shifted from production to resource conservation goal orientation spatially with different parts of the management unit identified by their current productive state, shrub risk potential and/or restoration opportunity and managed accordingly. Appreciative and pro-active management can shift pasture resources between states and/or retain

pastures in desirable states, particularly those that are free of shrub problems. To achieve this it is essential that managers recognise that windows of opportunity and monitoring needs are different for the different states. Moreover, it is not essential to rigidly adhere to a given objective. Units that are targeted for shrub control may, under runs of good seasons, produce herbage in excess of that needed for effective control. A rational decision could be taken to opportunistically graze the excess. Open pastures with minimal shrub populations may be burnt under similar circumstances to preserve their status. We are simply advocating that managers recognise the states and transitions associated with their pasture resources and appreciate the implications for resource allocation decisions. Under this scenario the prevailing mindset changes from exploitation to conservative management of the system.

CONCLUSION

Shrub encroachment problems in extensive rangelands impose significant losses on individual landholders and the wider community. Once these problems have arisen, control options are generally restricted by ecological opportunity and economic considerations. Moreover, a strong production orientation in land use decision making may reinforce the encroachment problems and promote a lack of concerted action to overcome them.

We are suggesting that management of rangeland pastures requires an intelligent balance between production and resource conservation objectives. Land managers should have a clear understanding of both the economic and ecological implications of their actions in both the short and longer terms. With such a balance there is more likely to be a desirable shift in management orientation to one that is consistent with sustainable production over time.

REFERENCES

1. Ash, A.J., McIvor, J.G. and Brown, J.R. 1993. Proc. XVII Int. Grassl. Congr., Palmerston North. In press.
2. Auld, B.A., Menz, K.M. and Tisdell, C.A. 1987. Weed Control Economics. Academic Press, London. pp 123-51.
3. Burgess, D.M.D. 1988. Aust. Rangel. J. 10(1), 48-59.
4. Eliason, P. 1991. National Focus Vol. 3, N.F.F., Canberra. pp 29-30.
5. Johnston, B.G., MacLeod, N.D. and Young, M.D. 1990. Aust. Rangel. J. 12(2), 91-115.
6. MacLeod, N.D. and Johnston, B.G. 1990. Aust. Rangel. J. 12(1), 40-53.
7. Morrissey, J.G. and O'Connor, R.E.Y. 1988. Contrib. paper to 5th Bienn. Conf. Aust. Rangel. Soc., Longreach, June 14-17.
8. Noble, J.C. and Hodgkinson, K.C. 1993. In: Proc. Workshop on Woody Weeds, Cobar, June 1992. NSW Agric. In press.
9. Noble, J.C., Cunningham, G.M. and Mulham, W.E. 1984. In: Management of Australia's Rangelands. CSIRO, Melbourne. pp 171-86.
10. Noble, J.C., Grice, A.C., MacLeod, N.D. and Muller, W.J. 1993. In: Proc. 1st Int. Weed Control Congr., Monash Univ., February. pp 362-4.
11. Roberts, B.R. 1989. Proc. Conf. on Land Degradation. Aust. Nat. Univ., Canberra.
12. Westoby, M., Walker, B.H. and Noy-Meir, I. 1989. J. Range Manag. 42(4), 266-89.