PROCEEDINGS OF THE AUSTRALIAN RANGELAND SOCIETY BIENNIAL CONFERENCE

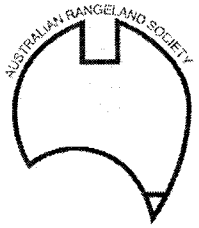
Official publication of The Australian Rangeland Society

Form of Reference

The reference for this article should be in this general form;
Author family name, initials (year). Title. *In*: Proceedings of the nth Australian Rangeland Society Biennial Conference. Pages. (Australian Rangeland Society: Australia).
For example:
Anderson, L., van Klinken, R. D., and Shepherd, D. (2008). Aerially surveying Mesquite *(Prosopis* spp.) in the Pilbara. *In*: 'A Climate of Change in the Rangelands. Proceedings of the 15th Australian Rangeland Society Biennial Conference'. (Ed. D. Orr) 4 pages. (Australian Rangeland Society: Australia).

Disclaimer

The Australian Rangeland Society and Editors cannot be held responsible for errors or any consequences arising from the use of information obtained in this article or in the Proceedings of the Australian Rangeland Society Biennial Conferences. The views and opinions expressed do not necessarily reflect those of the Australian Rangeland Society and Editors, neither does the publication of advertisements constitute any endorsement by the Australian Rangeland Society and Editors of the products advertised.



The Australian Rangeland Society

POLICY IMPLICATIONS OF ALTERNATIVE MODELS OF PASTORAL DECISION MAKING

Ron Hacker[1], Nick Milham[2] and Dean Patton[1]

[1] NSW Agriculture, Agricultural Research Centre, Trangie, NSW 2823
[2] NSW Agriculture, Locked Bag 21, Orange, NSW 2800

ABSTRACT

The mainstream view of pastoral management is founded on the principle of 'conservative stocking' as the basis for economic viability and ecological sustainability. Under this paradigm public and private interests in rangeland management should coincide. The only policy response required from government (except in extreme cases) should be the provision of effective research and extension services and appropriate opportunities for structural adjustment.

However, studies of pastoral decision-making based on optimal control theory predict that when future returns are discounted management strategies that are optimal for private benefit tend to be exploitative rather than conservative. This is particularly so if the resource is already degraded, reflecting the long lag time between management action and increased economic returns. Only when no discount is applied to future returns do privately optimal management strategies tend to coincide with the conservative stocking policy advocated by the mainstream view. Under this model, the mainstream policy settings may not be sufficient to secure the public interest. Instead, it could be argued that the market is failing and that a *prima facie* case exists for some form of government intervention, including the option of economic incentives, to ensure that land management outcomes conform to community expectations.

INTRODUCTION

How can government best ensure the sustainable use of rangeland resources? This is an important question given that public resources devoted to industry support activities such as research and extension are being increasingly scrutinised to ensure that public benefits are delivered. It is also a question of vital concern to those stakeholders who value rangelands more for their non-consumptive values than as sources of traditional livestock products.

We can not consider here the various policy instruments that might be employed to support sustainable use of rangelands. We argue though that since pastoralism is likely to remain the dominant use of these lands any such instruments must take account of the decision-making processes that determine pastoral management. We suggest that what might be called the 'mainstream view' of pastoral management does not provide an adequate explanation of these processes, or a comprehensive basis for policy formulation.

THE MAINSTREAM VIEW

What we call the 'mainstream view' of pastoral management rests firmly on the tenet of 'conservative stocking', by which we mean the package of management actions aimed at limiting total grazing pressure to something approaching the short- or long-term carrying capacity of the land. These actions include the maintenance of 'moderate' or 'conservative' stocking rates for livestock, control of feral and native animals, and prompt action to reduce stocking rate in the face of developing drought conditions. The economic objective is to maximise gross margin per hectare by manipulating stocking rate (principally) so that productivity is neither diminished by under-utilisation nor compromised by reduced productivity per head.

Lange *et al.* (1984), Morrissey and O'Connnor (1988), Purvis (1986) and Wynne (1994) provide examples of successful pastoral businesses based on this broad philosophy. Hacker *et al.* (undated) provide supporting evidence from a comparative study of gross margins for properties in the Western Division of NSW. Much overseas research in arid and semi-arid rangelands also supports the economic advantages of moderate stocking (eg Holechek *et al.* 1999). Holechek (1996) emphasised the ecological benefits of conservative stocking as the '*surest way to improve and maintain range condition*' which in turn was closely related to financial performance in his study of ranches in southern New Mexico.

Despite the scientific and practical evidence, however, many pastoralists adopt stocking rates that exceed, on a long-term basis, those which would be regarded as 'conservative' or 'moderate' by land management agencies. Holechek *et al.* (1999) drew particular attention to this point and concluded that given the overwhelming evidence in favour of conservatism in grazing practice the continuation of overgrazing as 'an important problem on rangelands in the US and other parts of the world' could only be explained by ignorance rather than monetary incentive. Graziers, on this view, are not sufficiently aware of the benefits of conservative stocking to adopt what may appear at first glance to be a counter-intuitive policy. Some, at least, persist in exploitative overgrazing to the detriment of both themselves and the environment.

If accepted in the Australian context this view would have important policy implications. Since both public (ecological) and private (financial) interests should be satisfied by conservative stocking the market should work efficiently to ensure that rangeland use is sustainable. There would seem to be no case for government intervention to secure the public interest other than to ensure that appropriate knowledge is generated and effectively transferred to a private sector that is capable of acting on it. Adequate funding for rangeland research and extension services, together with structural adjustment programs if necessary, would therefore be the major instruments underpinning sustainable rangeland use.

AN ALTERNATIVE VIEW

An increasing body of literature, however, suggests that "conservative stocking" cannot be regarded universally as the means by which private benefit can be maximised. Those studies from which the mainstream view is generated have been essentially biological or have utilised economic methodologies (eg gross margins) which are incapable of incorporating important characteristics of the decision 'problem' confronting all pastoral managers.

Essentially this 'problem' is to choose from a range of possible management strategies (eg stocking rates or grazing sequences) the one which will maximise a particular objective given the current state of the resource (eg the amount of forage available or the range condition), the way in which it can be expected to change in response to the management imposed and hence its future productivity, and the uncertainty associated with future seasonal conditions. This choice must be made at regular intervals. Analytical methods broadly described as optimal control techniques incorporate these dynamic processes. The objective to be maximised is usually the net present value of the long run stream of profit or utility, or the long run average value of these variables. The latter may be regarded as a special case equivalent to the application of a zero discount rate (Wang and Hacker, 1997). An essential part of such analyses is the derivation of transition probabilities, by use of a biological model, which specify the behaviour of the system in response to imposed management strategies under a variable climate. These probabilities also allow the long run evolution of the system under economically optimal management to be predicted.

Application of optimal control approaches to rangeland systems (eg Williams, 1985; Wang and Hacker, 1997) produces results which differ considerably from the expectations of the mainstream view. They highlight the importance of the discount rate and the initial state of the land in determining the choice of optimum management policies. Generally, as the discount rate increases and future returns are progressively devalued, more exploitative polices (eg heavier stocking rates) become

optimal even though they may lead to the long-run degradation of the resource. Further, if the resource is already severely degraded an exploitative policy that aims to utilise forage whenever it is available may be optimal rather than a restorative one.

If future returns are not discounted, however, then more moderate policies are selected, consistent with the mainstream view. Management strategies which are likely to improve range condition (eg destocking) are selected in most circumstances where range is already in poor condition and otherwise moderate stocking rates are selected dependent on forage availability. The contrast between the long run trajectories of the system studied by Wang and Hacker when subjected to optimal policies determined on the basis of these contrasting criteria is shown in Table 1.

The table clearly shows that under optimal decision-making private and public interests are only likely to be compatible in the special case of zero (or very low) discount rate. The reason lies in the long response times under arid conditions. Regeneration of even moderately degraded range may require decades while the time frame for severely degraded systems may be considerably longer (Holochek, 1996; Wang and Hacker, 1997). If future increases in productivity are discounted at even moderate rates the conservative management of these systems rapidly becomes untenable from a private perspective.

We acknowledge that the ecological models underlying these analyses are somewhat simplistic. The IMAGES model (Hacker *et al.* 1991) used by Wang and Hacker, for example, does not explicitly include ecological thresholds or alternative stable states although the vegetation dynamics it encapsulates are capable of producing discontinuous equilibria under optimal management. Milham (1994) has previously recognised this problem as well as the difficulty of satisfactorily addressing it. We would argue though that the essential insights of the optimal control approach - the importance of discount rate and initial system state in determining optimal management policies - are unlikely to be altered by more sophisticated ecological models. Nor are these general findings unique to rangelands. Clark (1973) noted that fish stocks that are valuable but have slow reproduction could be exploited to extinction by private firms that adopt a high discount rate.

Formulation of pastoral decision making as an optimal control problem leads to the expectation that a wide range of management styles might be observed in practice. They will be determined by the variable condition of land and its capacity to respond to restorative management, the aridity of the environment as this affects response times, and the personal time preferences (or discount rates) of individuals. Godden (1997) has proposed the further possibility of a downward sloping supply curve for farms facing additional constraints eg. minimum income requirements. Where these requirements are not satisfied individuals may increase stocking rates, neglecting some components of production (eg good husbandry) and increasing the potential for land degradation. Such additional constraints may well apply at particular stages of the business or family cycle, or under the general economic conditions currently facing graziers in the sheep rangelands (ABARE, 1999).

Given these considerations it is hardly surprising that management styles observable in practice range from the conservative to the exploitative and that these styles appear to have coexisted in the rangelands over the long term despite the efforts of rangeland scientists and extension agents. Far from being the result of ignorance we would argue that the observable pattern of pastoral management closely reflects what would be expected if managers seek to maximise their long run profits subject to their personal time preferences and other constraints. Indeed, the management styles observable in practice probably reflect a much more fundamental understanding of both commercial and ecological realities than scientists and policy makers have generally appreciated.

Under these circumstances increased research and extension effort, and provision for structural adjustment, may not be sufficient to secure the public interest. The market will likely fail to ensure that land use outcomes generally conform to community expectations and a *prima facie* case exists for considering other forms of government intervention to address the problem.

DISCUSSION

Pastoral leases throughout the rangelands are held under acts that provide for sanctions if land in not managed according to certain criteria. These criteria are generally broad, there is usually no graduated system of penalties, and the ultimate sanction of lease forfeiture is rarely used. We are not arguing that such sanctions should be abandoned. They will probably always be required as a measure of last resort. This indeed is the role they have played to date.

However, the optimal control model outlined above indicates that in many circumstances resource outcomes which are in the public interest will only be achieved at private cost except for those individuals who genuinely have no time preference for money. We therefore argue that incentives intended to redress this imbalance, including financial incentives, may be justified on the grounds of public benefit. Such incentives would essentially reward the public good resulting from private management. They would have the advantage over sanctions of proactively influencing decision-making rather than representing a reactive deterrent of often dubious credibility.

We are not able to discuss in detail here what form such incentives might take although we suggest that they would be based on voluntary agreements, tied to measurable resource outcomes and include a range of options from relaxed lease conditions to direct monetary payments. Our main point is to emphasise that the alternative model of decision making outlined above seems to provide a better explanation of pastoral management than the mainstream view. A logical consequence is an imperative to broaden the range of policy instruments to include measures that better target the real 'market failure' problem and that balance the conventional emphasis on research and extension and sanctions to achieve sustainable land use.

REFERENCES

ABARE (1999). Physical and financial performance estimates, New South Wales, AAGIS Region 111, 1997-98,*Farm surveys report 1999*, Canberra.

Clark, C.W. (1973). The economics of overexploitation. *Science* 181: 630-34.

Godden, D. (1997), Agricultural and Resource Policy: Principles and Practice, Oxford University Press, Melbourne.

Hacker, R.B., Wang, K.M., Richmond, G.S. and Linder, R.K. (1991). IMAGES: An integrated model of an arid grazing ecological system. *Agric. Syst.* 37:119-63.

Hacker, R.B., Barclay, R.M., Brill, B.J., Curran, G.C., Norris, D.A. and Woods, G.R.(Undated). The Western Uplands Landsafe Management Project. Final Report. Project N061, Murray-Darling Basin Natural Resources Management Strategy. 115pp.

Holechek, J.L. (1996). Financial returns and range condition on southern New Mexico ranches. *Rangelands* 18:52-6.

Holechek, J.L., Gomez, H., Molinar, F. and Galt, D. (1999). Grazing studies: what we've learned. *Rangelands* 21:12-6.

Lange, R.T., Nicholson, A.D. and Nicholson, D.A. (1984). Vegetation management of chenopod rangelands in South Australia. Aust. Rangel. J. 6:46-54.

Milham, N. (1994). On incorporating ecological thresholds in farm-level economic models of resource management. *J of Environ. Manage.* 41:157-65.

Morrissey, J.G. and O'Connnor, R.E.Y. (1988). 28 years of station management: 'fair use and a fair go'. Paper presented to 5th Biennial Conference of the Australian Rangeland Society, Longreach, June 13-15.

Purvis, J. R. (1986). Nurture the land: my philosophies of pastoral management in central Australia. Aust. Rangel. J. 8:110-7.

Wang, K.M. and Hacker, R.B. (1997). Sustainability of rangeland pastoralism – a case study from the West Australian arid zone using stochastic optimal control theory. *J. Environ. Manage.* 50:147-70.

Williams, B.K. (1985). Optimal management strategies in variable environments: stochastic optimal control methods. *J. Environ. Manage.* 21:95-115.

Wynne, B. (1994). Likely survivors in the wool industry in the Australian rangelands. Working Papers, 8th Biennial Conference, Australian Rangeland Society, Katherine. pp 22-27.

Table 1. Long run behavior of an arid chenopod shrubland under optimal management. Each cell in the table represents a possible state of the rangeland, defined by ranges of the four variables in the margins. Shaded cells are equilibrium states in which the rangeland will occur with probability > 0.01 under long run application of optimal management policies; light – with 6% discount rate; dark – with zero discount rate; hatched – with either discount rate. Boxed cells are those states in which the rangeland will occur with greatest probability as indicated by the cell entry – normal type - 6% discount rate, italics – zero discount rate. * and + indicates states in which the system will occur with probability < 0.005 under 6% and zero discount rates respectively. Blank cells are transient states from which the system will be absorbed into the equilibrium state. Derived from Wang and Hacker (1997) – Tables 3 and 6.