Is more or less fire needed in northern savannas? Fire history (and optimal management) varies with land use and land type.

Robyn A Cowley[A] and Dale Jenner[B]

[A]Department of Primary Industry and Fisheries, PO Box 1346, Katherine NT 0851. E: robyn.cowley@nt.gov.au

[B]Department of Primary Industry and Fisheries, PO Box 8760, Alice Springs, NT, 0871

Keywords: Fire frequency, fire management, savanna burning

Abstract

Fire management recommended for biodiversity conservation and reducing greenhouse gas emissions (reduce late dry season fire) contrasts to that for managing woody plant thickening on pastoral lands (increase late dry season fire). To investigate whether contrasting fire regimes are justified, fire history derived from AVHRR imagery was used to analyse fire frequency between 1997 and 2010 in the Victoria River District (VRD) of the Northern Territory. Fire frequency for all fires (January to December), and late dry season fires (August to December) were derived for different land uses (defence, national park, indigenous, indigenous pastoral and pastoral) and broad land types. Fire frequency was lowest on pastoral land where 32% of pastoral land burnt less than 1/10 years, *cf.* 3-4% of indigenous, park and defence land. Fire frequency was highest on defence and park land with 84 and 67% respectively burning ≥ once every three years, followed by 50 and 44% of Indigenous and Indigenous pastoral land respectively. On grazed land tenures the frequency of fire varied across land types. High grazing value land types burned the least, while low grazing value land types burnt the most. Our analysis shows that areas that are not grazed experience high average fire frequency and will benefit from fire reduction strategies. Conversely, the very low fire frequency on the most productive pastoral land types is likely to have contributed to observed woody thickening in the region. In these important pastoral land types increasing fire frequency may assist to manage woody cover and improve or maintain pastoral productivity. In contrast, where there is a high fire frequency on low productivity pastoral lands (which are often not grazed), there may be opportunities for participation in approved savanna burning methodologies in carbon markets to reduce fire frequency and extent and greenhouse gas emissions.

Introduction

The recommendation for late dry season (LDS) fires to manage woody cover on pastoral land (Cowley *et al.* 2014) conflicts with recommendations to reduce LDS fire by implementing early dry season fire on indigenous and conservation land across northern Australia (Russell-Smith *et al.* 2013), where frequent hot LDS fires have been implicated in declines in biodiversity (Russell-Smith *et al.* 2012; Woinarski and Legge 2013) and higher greenhouse gas emissions (Russell-Smith *et al.* 2013).

We investigated whether these contrasting recommendations are compatible with current fire frequency and timing in the Victoria River District, a region covering 132 440km^2 of the north west Northern Territory. Annual rainfall varies from > 1000mm in the north to <500mm in the south.

Methods

GIS layers of fire frequency and late fire frequency (after July 31) were intersected with cadastral and land systems layers to calculate fire frequency for different land uses and land types in the VRD region. Fire frequency was based on fire history calculated using AVHRR imagery (pixel size 1km) between 1997 and 2010 from the NAFI web site http://www.firenorth.org.au/nafi2/. Land use was separated based on primary land use, into pastoral (59%), defence (9%), national park (12%),

indigenous (8%) and indigenous pastoral (13%, grazed indigenous land). National park that was also indigenous land, was classified as national park. Stock routes were classed as pastoral.

NT land systems map layers (supplied by the Department of Land Resource Management, Northern Territory of Australia) were classified into three grazing value categories based on pasture quality, pasture growth and accessibility (Table 1).

Table 1: Classification of grazing value of different broad land classes in the VRD region.

Grazing value	Land Class
High	Alluvial floodplains
High	Basalt plains and rises
High	Clay plains
High	Coastal floodplains
Moderate	Basalt hills
Moderate	Granite plains and rises
Moderate	Lateritic plains
Moderate	Lateritic plains and rises
Moderate	Limestone hills
Moderate	Limestone plains and rises
Low	Desert dunefields
Low	Desert sandplains
Low	Elevated plateaux surfaces
Low	Lateritic plateaux
Low	Rugged quartz sandstone plateaux and hills
Low	Sandstone hills
Low	Sandstone plains and rises
Low	Tidal flats

Results

Fire frequency varied with land use. One third of pastoral and one fifth of indigenous pastoral land was either unburned or burnt less than 1/10 years (Table 2), compared to only 3 to 4% of non-grazed tenures. 67 and 84% of park and defence land respectively burnt at least every three years, compared to only 32% of pastoral land. Despite the highest fire incidence, defence land had the lowest incidence of LDS fire. Indigenous land had the highest incidence of frequent LDS fires with 31% burning once every three years or more.

When averaged across all land uses, low grazing value land burnt more frequently than high grazing value land (Table 2). 81% of high grazing value land burned less than one in four years, compared to 62% of moderate grazing value land and 45% of low grazing value land. LDS fires were relatively infrequent for all land types, but still more frequent on the lower grazing value land types.

Table 2: The proportion of land area with different fire frequency between 1997 and 2010 for different land uses and land type grazing values in the VRD.

	Fire frequency (all year)				Late fire frequency (Aug to Dec)			
	0 - <1/10 years	1/7 - 1/5 years	1/3 years	>2/5 years	0 - <1/10 years	1/7 - 1/5 years	1/3 years	>2/5 years
Land Use								
Defence	4%	11%	35%	49%	55%	37%	7%	1%
Park	3%	30%	43%	24%	33%	53%	12%	2%
Indigenous	3%	47%	44%	6%	11%	59%	29%	2%
Indigenous Pastoral	20%	35%	23%	21%	33%	47%	18%	3%
Pastoral	32%	36%	23%	9%	45%	38%	14%	3%
Land grazing value								
High	55%	26%	10%	9%	68%	26%	6%	1%
Moderate	25%	36%	22%	16%	42%	42%	13%	2%
Low	9%	36%	38%	18%	28%	49%	19%	3%

However, the variation in fire frequency between land types of different grazing value depended on land use. There was little difference in fire frequency between different grazing value land types on non-grazed land (defence, national park and indigenous) (Fig. 1). However for pastoral and indigenous pastoral land, fire frequency was lower for higher grazing value land types. For low grazing value land, fire frequency was similar across land uses, whereas moderate and high pastoral value land types burnt less frequently on grazed than ungrazed land tenures. The patterns were the same for LDS fires (not shown).

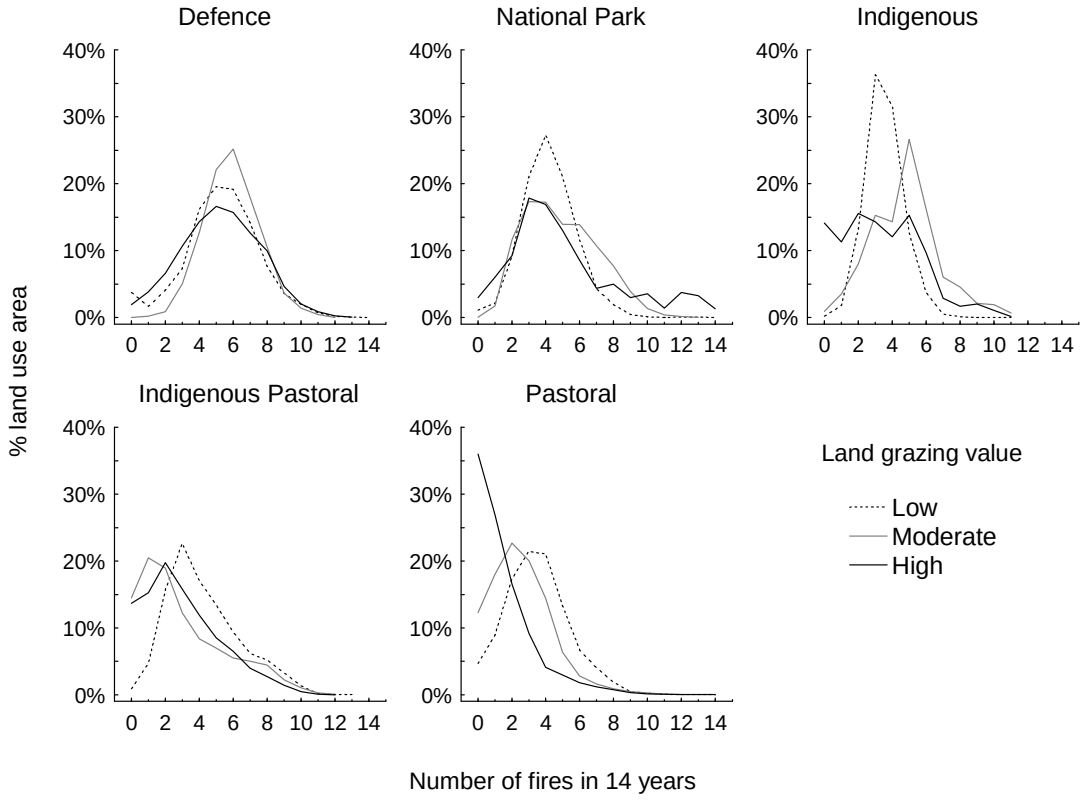

Fig. 1: Effect of land grazing value on fire frequency of different land uses in the VRD between 1997 and 2010.

Discussion

The very low incidence of LDS fires on defence land reflects the deliberate implementation of extensive early dry season burns. The higher proportion of less frequently burning high value grazing land on pastoral (29%) and indigenous pastoral land (14%) (compared with only 1 and 5% high grazing value land on indigenous and conservation land) contributes to the generally lower fire incidence on grazed land.

Moderate and high grazing value land types in the VRD burnt less frequently than the 1 in 4 years recommended to manage woody cover in the region (Cowley *et al.* 2014), and compared with the higher than 1-in-3- year fire interval on defence and conservation land. The current low fire frequency on high grazing value pastoral land may have contributed to the observed woody thickening in the region (Cowley *et al.* 2014). These grazed productive land types may need to be burnt more often to maintain their productivity.

In contrast the high fire frequency of lower grazing value land types across all land uses presents a potential opportunity for participation in savanna burning projects to reduce the incidence and extent of fire and associated greenhouse gas emissions.

Conclusion

While fire frequency needs to be reduced off the pastoral estate (Russell-Smith *et al.* 2013), on pastoral land, fire frequency often actually needs to be increased to manage woody cover, but this varies with land type. Optimal fire management will vary with prevailing fire regimes and land management goals.

References

Cowley, R.A., Hearnden, M.H., Joyce, K.E., Tovar-Valencia, M., Cowley, T.M., Pettit, C.L., and Dyer, R.M. (2014). How hot? How often? Getting the fire frequency and timing right for optimal management of woody cover and pasture composition in northern Australian grazed tropical savannas. Kidman Springs Fire Experiment 1993–2013. *The Rangeland Journal* 36, 323-345.

Russell-Smith, J., Edwards, A.C., and Price, O.F. (2012). Simplifying the savanna: the trajectory of fire-sensitive vegetation mosaics in northern Australia. *Journal of Biogeography* 39, 1303-1317.

Russell-Smith, J., Cook, G.D., Cooke, P.M., Edwards, A.C., Lendrum, M., Meyer, C.P., and Whitehead, P.J. (2013). Managing fire regimes in north Australian savannas: applying Aboriginal approaches to contemporary global problems. *Frontiers in Ecology and the Environment* 11, e55-e63.

Woinarski, J.C.Z., and Legge, S. (2013). The impacts of fire on birds in Australia's tropical savannas. *Emu* 113, 319-352.