PROCEEDINGS OF THE AUSTRALIAN RANGELAND SOCIETY

19th 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 19th Australian Rangeland Society Biennial Conference. Pages. (Australian Rangeland Society: Australia).

For example:

Bastin, G., Sparrow, A., Scarth, P., Gill, T., Barnetson, J. and Staben, G. (2015). Are we there yet? Tracking state and change in Australia's rangelands. In: 'Innovation in the Rangelands. Proceedings of the 18th Australian Rangeland Society Biennial Conference, Alice Springs'. (Ed. M.H. Friedel) 5 pages. (Australian Rangeland Society: Parkside, SA).

The Australian Rangeland Society

Simulated impacts of wet season spelling and intensive rotational grazing on pasture condition in a degraded northern Mitchell grass savanna

Robyn Cowley[1], Dionne Walsh[1] and Jane Douglas[2]
1 NT Department of Primary Industry and Resources, GPO Box 3000, Darwin NT 0801.
robyn.cowley@nt.gov.au; dionne.walsh@nt.gov.au
2 NT Department of Primary Industry and Resources, PO Box 159, Tennant Creek NT 0861.
jane.douglas@nt.gov.au

Keywords – land condition, rangeland management, modelling, grazing systems, spelling

Abstract
The northern Australian pastoral industry is intensifying development and grazing systems to facilitate greater productivity and capital value. A three year field trial in the Barkly region of the Northern Territory (Beetaloo) comparing intensive rotational grazing (IRG) combined with wet season spelling (WSS) to set stocking (SS) at similar average annual stocking rates (SR) and paddock sizes, found no change in pasture condition in either grazing system. Given the short duration of the trial we used GRASP to simulate how the intensified grazing system might influence pasture condition in the longer term (30 years) comparing: 1) continuous SS; 2) SS with an annual 3 month WSS; and 3) annual WSS with IRG; for a range of graze dates, climate windows, starting pasture conditions and SR. SR that facilitated pasture recovery in drier climate windows or from C condition pastures were 2/3 of safe SR in wetter climate windows or B condition pastures. Adding WSS to SS facilitated faster pasture recovery times at higher safe SR. For WSS + IRG, if any of the grazes were during the growing season, the SR that promoted pasture recovery was one to two thirds less than the safe SR when grazing occurred only during the dry season. Dry season IRG + WSS had higher safe SR and shorter recovery times than the Grazing Land Management (GLM) derived carrying capacity with continuous grazing, or SS + WSS. This study suggests that WSS + IRG may be a useful tool to enhance recovery of degraded grasslands. However, recovery timeframes were still in the order of decades and any wet season IRG should be avoided or carefully managed to prevent further pasture condition decline.

Introduction
In northern Australia the pastoral industry is undergoing a period of rapid infrastructure intensification. Previously large poorly watered paddocks are being fenced into smaller fully watered systems, resulting in increased carrying capacity by bringing previously unwatered areas into production. Areas surrounding the original waters were often historically overgrazed and are now in poor pasture condition. Hence the industry is also exploring the use of pasture spelling and intensive rotational systems to increase carrying capacity through improvement in pasture condition. This is more hopeful than evidence based, as none of the four studies in the Northern Territory over the last decade that have compared IRG systems to continuous grazing have found recovery of pasture condition, or consequent higher carrying capacity (Cowley *et al.* 2016), although this may reflect the relatively short duration of the studies.

Vegetation change in rangelands is notoriously slow between periods of wetter seasonal conditions when more rapid change can occur, providing propagules are present. In the Mitchell grasslands of northern Australia, pasture condition decline is characterised by the replacement of palatable perennial grasses with annual grasses and forbs close to water (Fisher 2001). The reversibility of these changes with grazing management is theoretically more likely than when vegetation has transitioned to an alternative stable state, such as from open grassland to closed shrubland. However, there are few documented examples of recovery except in long term monitoring regimes (e.g. Watson and Novelly 2012) when causal factors can only be deduced after the fact. Given the short duration of controlled IRG field studies, we employed simulation modelling to provide insights into how different grazing systems may contribute to pasture condition change over longer timeframes using the Beetaloo trial to inform scenario design and model parameterisation.

Methods
A version of GRASP that simulates perennial grass change in response to utilisation (Scanlan *et al.* 2014) was used to simulate a range of grazing scenario effects on safe SR and pasture condition using 30 year climate windows for Beetaloo station:

1. Continuous set stocking (SS)
2. Set stocking with wet season spelling every year (WSS)
3. Wet season spelling every year combined with intensive rotational grazing (WSS+IRG).

Two start pasture condition states were tested:
- B condition = 60% perennial grasses, the average of the Beetaloo trial site.
- C condition = 20% perennial grasses, representative of pasture condition near old waters.

SR tested were between 0 and 25 AE km^{-2}. Safe SR were defined by:
- pasture condition never declined below the start condition during the climate window;
- pastures recovered to A condition (78% perennial grasses) within the 30 year window;
- pastures were still in A condition at the end of the 30 year window; and
- the highest SR per year of recovery given all the above conditions were met.

Three different 30 year climate 'windows' were compared (Table 1, Fig. 1). The 1945 window had the most dry years, including a failed wet season with only 52mm early in the simulation in 1952. The 1965 window had the least variable rainfall with the fewest dry years. The 1985 window had the highest median but also the most variable rainfall year to year.

Table 1. Climate window rainfall statistics.

Climate window	Median (mm)	Coefficient of variation (%)
1945-1975	456	45
1965-1995	460	42
1985-2015	576	48

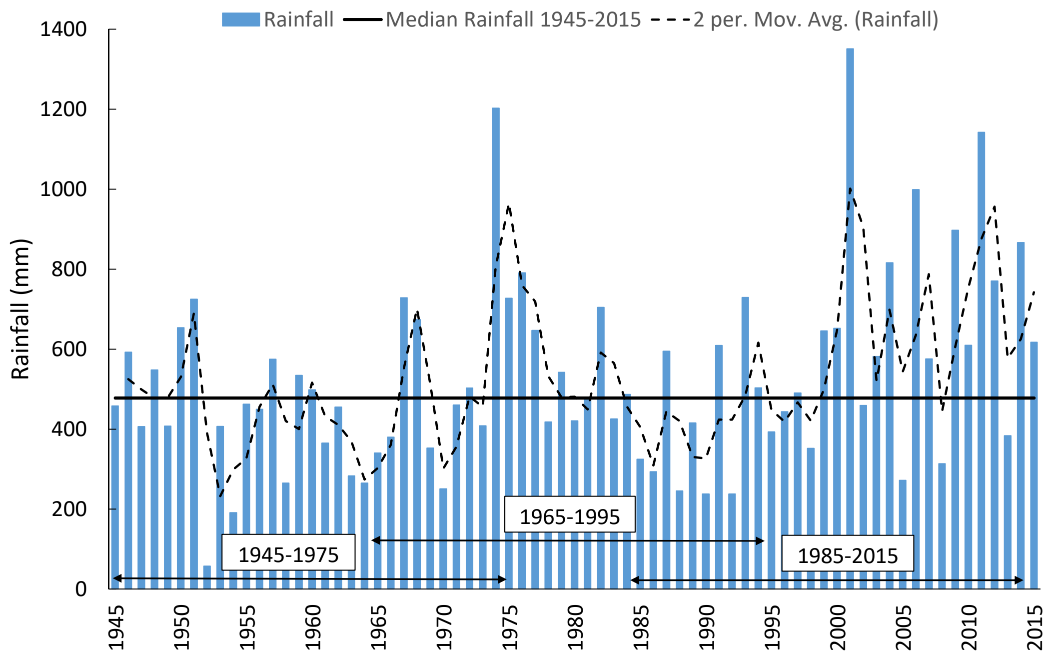

Fig. 1: Rainfall for the different climate windows tested at Beetaloo Station, Barkly region, NT.

Simulated wet season spelling was for 3 months from January 1st through to the end of March every year. IRG was for 2 x 3 day grazes per year on the dates listed in Table 2, at instantaneous SR of 0.5 to 12 AE ha^{-1} (annualised SR 0.8 to 19.7 AE km^{-2}).

Table 2. Graze dates for IRG scenarios tested.

Light shaded dates are late wet season. Dark shaded dates are early wet season. All other dates are dry season.

IRG Scenario	1	2	3	4	5	6	7	8	9	10
Graze 1	1-Apr	16-Apr	1-May	16-May	1-Jun	16-Jun	30-Jun	12-Jul	27-Jul	20-Aug
Graze 2	24-Aug	8-Sep	23-Sep	8-Oct	24-Oct	8-Nov	22-Nov	4-Dec	19-Dec	12-Jan

For comparative purposes the long term safe stocking rate was also calculated following GLM methods (MLA 2010) applying 20% utilisation to median growth, assuming intake was 8kg/AE/day.

Results

The modelled median pasture growth at the B condition site of 1681kg ha^{-1} equated to a GLM-derived safe long term SR of 11.5 AE km^{-2}. A rigorously set stocked system (no adjustments in drier years at all) that leads to pasture condition recovery required lower average SR than the GLM derived value (Table 3). C condition pastures always required lower SR and longer recovery times than B condition pastures. Different climate windows had different safe SR and rates of recovery. Annual wet season spelling increased average safe SR by 20% and shortened the recovery by 1 to 8 years compared with set stocked, although the average safe SR across climate windows (11.1 AE km^{-2}) was comparable to the GLM-derived long term safe SR.

When IRG during the dry season was combined with WSS the average annualised safe SR for B condition doubled compared to WSS + SS, with similar or shorter recovery times, depending on climate window. For C condition pastures, dry season IRG + WSS increased safe SR by 30 to 170%, and shortened recovery time by 2 to 7 years depending on climate window and date of IRG. However if any of the intensive grazes occurred during the growing season, even with WSS, safe SR were lower than if only dry season intensively grazed. Safe SR if IRG was in April or December to January were on average 76% and 32% respectively of safe SR if intensively grazed in the dry season only, with similar or longer recovery times. Early wet season IRG had the lowest safe SR of any grazing system at 66% of SS levels.

Table 3. Average annual stocking rates and recovery times for a range of climate windows, start conditions and grazing management that promoted recovery to A condition in the Barkly region, NT.

Grazing management	Continuous set stocking		Set stocking with WSS		IRG dry season only with WSS		IRG (one in April) with WSS		IRG (one in December / January) with WSS	
Start condition	B	C	B	C	B	C	B	C	B	C
Safe stocking rate (AE km^{-2})										
1945-1975	7	5	7.6	5.3	19.7	13.5	13.2	8.2	4.9	3.3
1965-1995	11	7	13.6	9	24.5	16.1	18.1	11.5	8.2	4.9
1985-2015	9	5	12	5.3	17.5	6.6	13.2	4.9	6.6	3.3
Recovery time (years)										
1945-1975	18	26	11	18	12	19	12.5	17.5	12	18
1965-1995	12	18	11	17	11	15.8	13	17.5	12	15.7
1985-2015	17	20	16	16	11.5	13.2	13.5	14.5	12.7	16

Discussion

Regardless of the grazing system employed, the safe SR varied greatly with seasonal and pasture conditions. Although the simulations predicted recovery from C to A condition within 13 to 26 years provided suitable SR and WSS were in place, in reality there may be limited seed bank or loss of topsoil in degraded areas around old waters that slows or prevents recovery.

The very low safe SR when IRG was applied during the early wet season (December / January) was consistent with the Beetaloo managers' anecdotal experience that IRG during the wet season was deleterious to pasture condition, and with previous findings that total growth and the proportion of perennial grasses is reduced with early wet season grazing (e.g. Ash and McIvor 1998). It is recommended that early wet season IRG should be avoided.

However, this study does support hopes that *dry* season IRG combined with WSS would shorten recovery times and increase safe SR, and although a single graze of IRG in the late wet season required lower SR than dry season IRG, it still had higher safe SR and shorter recovery times than WSS + SS. Given the better simulated outcomes when annual WSS was combined with dry season IRG, if this was to be applied over a larger area it raises the question of where to place stock during the wet season to enable annual WSS. If stock are placed on other areas during the wet season *every year*, how sustainable is this for the wet season grazed area over the longer term and how will it affect animal production over the wet season? Spelling less frequently would increase recovery times. Increasing stocking rates in some years to enable spelling in other paddocks would also either increase recovery times, or lead to further pasture decline.

The combined experience and learnings gained from the on ground demonstration at Beetaloo and the simulation modelling suggests that while improvement in carrying capacity due to recovery of degraded pastures is possible, it is also likely to take decades of careful stocking and spelling to achieve. For this reason it should not be an assumed short-term outcome when assessing the economic feasibility of development scenarios.

References

Ash, A. J., and McIvor, J. G. (1998). How season of grazing and herbivore selectivity influence monsoon tall-grass communities of northern Australia. *Journal of Vegetation Science* **9**, 123-132.

Cowley, R., Douglas, J., Ffoulkes, D., and Walsh, D. (2016). *Cell grazing doesn't pay its way in the Northern Territory.* Northern Beef Research Update Conference, 15-18 August, Rockhampton. (North Australia Beef Research Council: Gympie.)

Fisher, A. (2001). *Biogeography and Conservation of Mitchell Grasslands of Northern Australia.* Unpublished Ph.D. thesis. (Northern Territory University: Darwin.)

Meat and Livestock Australia (2010). 'Grazing Land Management – Barkly Version Workshop Notes.' (Meat and Livestock Australia: North Sydney.)

Scanlan, J. C., McIvor, J. G., Bray, S. G., Cowley, R. A., Hunt, L. P., Pahl, L. I., MacLeod, N.D., and Whish, G. L. (2014). Resting pastures to improve land condition in northern Australia: guidelines based on the literature and simulation modelling. *The Rangeland Journal* **36**, 429-443.

Watson, I. W., and Novelly, P. E. (2012). Transitions across thresholds of vegetation states in the grazed rangelands of Western Australia. *The Rangeland Journal* **34**, 231-238.