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The effectiveness of virtual fencing to re-distribute grazing pressure across topography classes in a north Australian rangeland for land condition and drought resilience outcomes

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Abstract

The selective grazing behaviours of cattle often lead to degradation of preferred areas, reducing land condition and productivity. Virtual fencing (VF) is being tested to control cattle grazing distributions in extensively managed herds in northern Australia. By redistributing grazing pressure, VF could enable increased rest in overgrazed areas and increased utilisation of less preferred areas that would otherwise have limited productive value and be a fire risk.

Baseline location results indicate that cattle preferred flat plains over all other topographies. Baseline pasture results indicate that the lowest proportion of 3P (perennial, palatable, and productive) pastures occur in the flat plains, which is likely associated with historical overgrazing. Preliminary findings suggest that VF can successfully alter grazing patterns, reducing pressure on flat plains and thus potentially promote recovery in these areas. This outcome is promising for land condition management, as it addresses the tendency of cattle to overgraze preferred areas.

The study highlights the potential of VF to improve land condition and drought resilience outcomes in northern rangelands. However, challenges remain in managing the complex mosaic nature of topography. Continued implementation of VF in the experiment is expected to improve land condition, carrying capacity, and drought resilience. VF could become a valuable tool for managing grazing impacts, improving year-to-year production, and achieving environmental and economic goals in the extensive grazing systems of northern Australia.

Introduction

Cattle are highly selective grazers at the patch and landscape scales (e.g., Mott 1987; Senft *et al.* 1987), preferring specific areas, especially those close to water and on flatlands, while under-utilising other, less preferred areas within a paddock (Andrew 1988). Uneven grazing distribution can degrade land condition, reduce productivity, and limit the sustainability of rangeland systems (Hunt *et al.* 2014). Addressing this challenge requires innovative management strategies to redistribute grazing pressure and promote recovery in overgrazed areas and to protect riparian areas.

Virtual fencing (VF) technology offers a promising solution by enabling remote control of cattle movement without the need for physical barriers. VF has the potential to improve grazing management by redistributing grazing pressure over time within physical paddocks. This approach aims for increased rest in degraded areas by excluding cattle from specific areas over time, and better utilisation of typically undergrazed areas by containing cattle in these areas for periods of time. While VF has been tested in various contexts, its effectiveness in north Australian rangelands, characterised by diverse topography and extensive management systems, is poorly understood.

This study evaluates the effectiveness of VF in altering cattle grazing patterns across different topography classes in a north Australian rangeland. Specifically, it examines whether VF can reduce grazing pressure on flat plains and improve land condition outcomes, while increasing utilisation and thus productive value on the rugged and typically under-grazed topography classes. This study aims to inform sustainable grazing practices by elucidating how VF intervention affects pasture and cattle outcomes in extensive production systems.

Methods

The study was conducted at the Department of Primary Industries Spyglass Beef Research Facility, located 110 km north of Charters Towers, Queensland (19°29'24.6"S, 145°41'30.3"E). The site has an average annual rainfall of approximately 610 mm and features diverse topography, including flat plains, open slopes, and highlands.

GPS data were collected at 10-minute intervals using eShepherd® VF collars (Gallagher Ltd) fitted on all study cattle. This study consists of two experiments: The baseline experiment (August 2024) and the VF experiment, which is ongoing, with data presented herein for June 2025 to January 2026. In the baseline experiment, Droughtmaster heifers (n=227) grazed a 1,300-hectare paddock to assess their topography preferences. The VF experiment compared two treatments within each of two replicates: 1) VF treatment: cattle were moved around the landscape using VF collars to incorporate rest for preferred areas and increase utilisation of less preferred areas, and 2) Control treatment: cattle with deactivated collars were allowed unrestricted access across their physical paddock. The paddocks for VF and Control herds were matched for total area, watering points, soil types, and topography and ranged in total area from 389 to 799 hectares. Stocking rates were adjusted annually based on forage availability, and cattle movement planning was conducted in consultation with a producer advisory group.

Cattle preference levels for topography types were quantified using Ivlev's electivity index (Ivlev, 1961), which expresses the time that cattle spent grazing in each topography type relative to its availability. Index values range from -1 (land class never used) to 1 (land class exclusively used), with 0 indicating neutral use relative to availability. Topography was classified using Weiss's Topographical Position Class (TPC, Weiss, 2001), which considers elevation differences and local slopes. Land condition was assessed using the ABCD framework (Hunt et al., 2014), which evaluates pasture and soil condition. The proportion of 3P species was also assessed along with Indian couch grass (*Bothriochloa pertusa*) occurrence as a proxy for disturbance (Spiegel 2023). Measurements were taken at evenly spaced grid points at 325-metre intervals across the four VF experiment paddocks.

Results

Preliminary findings for the baseline experiment demonstrated that flat plains was the only TPC with a positive Ivlev's index value, and more rugged TPCs had negative Ivlev's values (Table 1). The flat plains also exhibited the lowest proportion of 3P species, while highlands had the greatest. Land condition ratings ranged from B (fair) for open slopes and highlands to C (poor) for flat plains and lowlands. *Indian couch grass* was found across all TPCs, with the greatest overall occurrences observed on the flat plains (medium frequency), and to a lesser extent on open slopes and highlands (both low to medium frequency) and lowlands (low frequency).

Table 1. Preliminary baseline results for cattle preference, mean land condition (ABCD), and the estimated contribution of 3P (perennial, palatable, productive) pasture species to yield according to topographical position class for experimental paddocks at Spyglass Beef Research Facility.

Topographical position class	Ivlev's index value	Mean land condition (ABCD)	Mean 3P% (Mean 3P yield, kg DM/ha)
Flat plains	0.13	C	46% (933)
Lowlands	-0.29	C	56% (817)
Open Slopes	-0.33	B	54% (982)
Highlands	-0.44	B	63% (1,060)

Preliminary analysis of the VF experiment shows Ivlev's values for relative use of flat plains was lower for the VF treatment compared to the Control (Figure 1). Conversely, the Ivlev's values for relative use of open slopes was higher for the VF treatment compared to the Control (Figure 1). For context on the cattle preference results, the total areas of virtual paddocks and the percentage of the component TPCs within the virtual paddocks are shown in Figures 2a and 2b, with pasture biomass decline for each treatment paddock shown in figures 2c and 2d. The VF areas that cattle were confined to were primarily comprised of flat plains and open slopes, regardless of month or the size of the virtually fenced area

(Figures 2a and 2b). The large and abrupt increase and then decrease in the virtual fence sizes is associated with opening up to an extended ‘front fence’, and subsequent ‘back fence’ to allow cattle to naturally move to the new area. Change in pasture biomass at the paddock level was similar between the VF and Control treatments (Figures 2c and 2d).

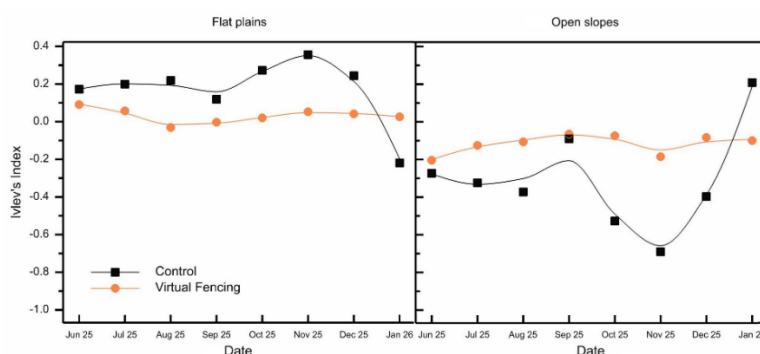


Figure 1. Preliminary VF experiment results for cattle preference for Topographical Position Class in experimental paddocks at Spyglass Research Facility, quantified using the Ivlev's index.

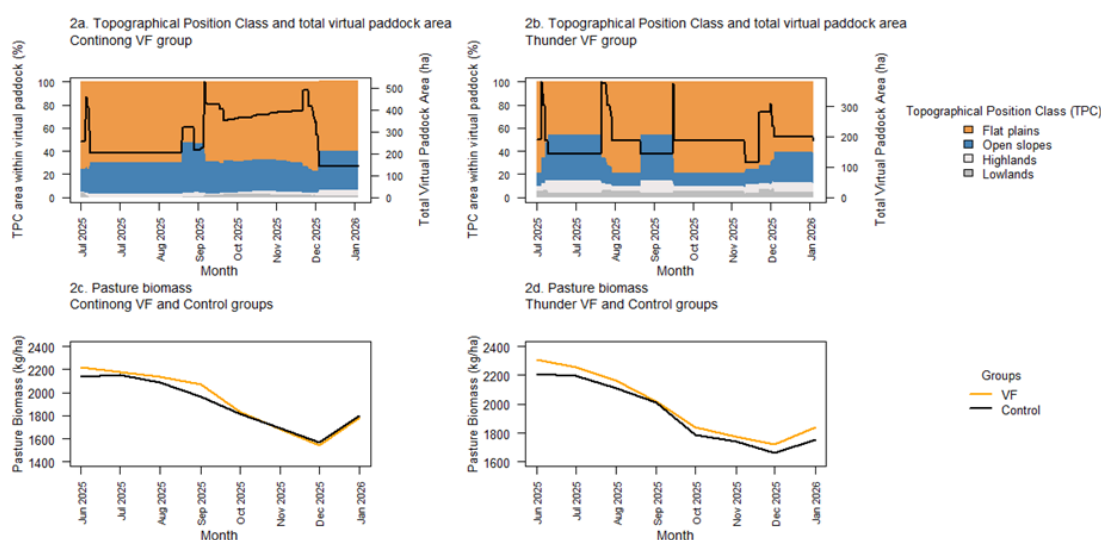


Figure 2. The virtual paddock size (blackline) and percentage of each Topographical Position Class within virtual fencing treatment paddocks (2a and 2b) and pasture biomass of treatment paddocks as determined by CIBO labs in the virtual fencing treatment and control paddocks from June 2025 to January 2026.

Discussion

This study demonstrates the potential of VF to redistribute grazing pressure across the variable topographical classes present within paddocks of the north Australian rangelands. Results confirmed that cattle naturally exhibit a preference for flat plains, which are often overgrazed, while open slopes and highlands remain underutilised. This uneven grazing pattern over time contributes to land degradation, particularly in areas with low proportions of 3P species and poor land condition ratings. Preliminary findings suggest that VF can enable redistribution of grazing pressure from overgrazed areas to undergrazed areas, in this case from the flat plains to the open slopes. This redistribution of cattle grazing pressure could allow overgrazed areas to recover and enable increased utilisation of undergrazed areas. Seasonal (month) interaction effects on grazing preferences require further investigation in this study.

The combination of stocking rates aligned with feed availability, and the strategic resting periods for specific areas enabled by VF, will ensure that pasture utilisation is managed at both spatial and temporal scales to support improved land condition and pasture productivity outcomes. Importantly, VF should be regarded as a management tool, with its success in achieving land condition and production goals

dependent on best practice management, particularly in preventing unintentional localised overgrazing or increased patch level grazing. While these results are promising, the often complex mosaic nature of the landscape presents challenges for consistently confining cattle to specific TPCs at a time and overcoming selective grazing at the finer spatial scales. Additionally, the presence of other herbivores on the landscape, including chital deer, rabbits and marsupials, will also impact the recovery of rested areas.

Notwithstanding some of the potential challenges highlighted, the implications of these findings are significant for sustainable rangeland management. VF offers a practical tool for improving cattle grazing distributions while reducing costs associated with the installation of physical fencing and mustering cattle. This research is ongoing to assess the biological and economic implications of VF, including its impact on land condition, pasture recovery, and cattle annual live weight production, on which the drought resilience of a production system depends. Building on the preliminary results presented, planned statistical analyses will investigate the seasonal and temporal variations in cattle grazing patterns and pasture outcomes.

Conclusion

Preliminary findings demonstrate success in redistributing cattle grazing pressure from a preferred topographical class (flat plains) to a less preferred class (open slopes), promoting rest in the flat plains and utilisation in the open slopes. This was achieved despite the challenges associated with the complex ‘mosaic’ nature of a landscape attribute such as topography. Whether the VF treatment ultimately results in positive outcomes for land condition, drought resilience, production and business success in a northern commercial production systems context is yet to be determined by this ongoing study.

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