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Resilience and degradation in a tropical wetland overgrazed by cattle

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Introduction

The Pantanal, one of the largest wetlands in the world, has a great diversity of flora and fauna. The dynamic hydrological regime, combined with heterogeneous topography, has resulted in a mosaic of diverse habitat types in terms of species and physical structure. Due to the abundance of forage resources, the Pantanal floodplains are important for beef cattle production. Cattle prefer grazing near water bodies because these areas have high quality forage as a result of flooding regimes (Santos et al. 2002). Many wetlands go through a wet/dry cycle that is essential to maintain their productivity and function. In drier years, wetland drawdown provides optimal conditions for a diverse range of forage species, and cattle can graze continuously, leading to pasture degradation. It is therefore essential to understand the spatial and temporal dynamics of forage production and consumption.

In this study we assessed and monitored vegetation at the edge of one of the pond habitats intensively grazed by cattle, in order to evaluate degradation and quantify indicators of resilience (Briske et al. 2006).

Methods

To measure changes in vegetation during these periods, 25 plots of 0.25 m^2 were randomly selected at 10-m intervals along a permanent transect of 250 m situated on the edge of a wetland pond at a constant elevation. Measurements were taken at the end of the wet season (March) and dry season (September) in each plot during 3 hydrological years (2007−2010). Variables measured within each plot were: number of plant species (richness); visual estimate of percent live plant species cover; visual estimate of percent soil covered with plants, litter and gravel; mean plant height; and total dry matter yield. We also developed a state and transition model using plant functional groups (Figure 1). Plant cover was classified as: C3 and C4 grasses; invasive forbs; macrophyte forbs; exotic forages; and shrub cover. To determine the loss of grassland resilience, we estimated a threshold between forage cover (functional indicator) and invasive forbs cover (degradation and structural indicator) (López et al. 2011), using piecewise regression (Muggeo 2008). Temporary exclosure cages (1 m^2) were allocated along a transect in order to examine recovery of forage cover for at least one complete growth cycle, and permanent exclosure cages to monitor long-term effects.

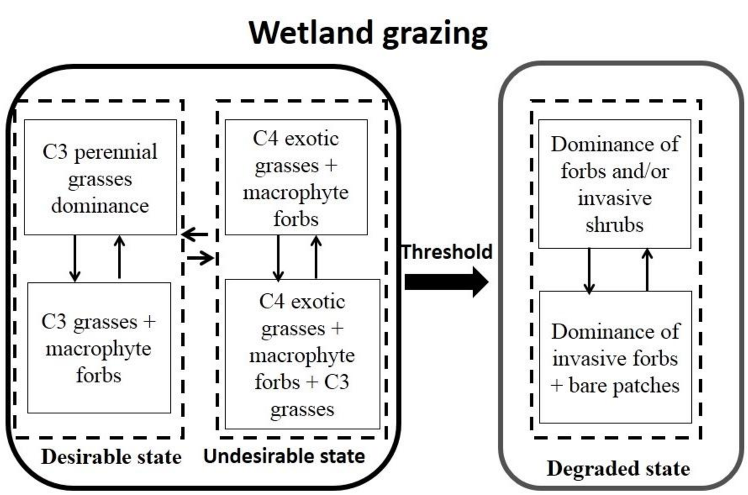

Figure 1. State and transition model for wetland grazing areas using plant functional groups.

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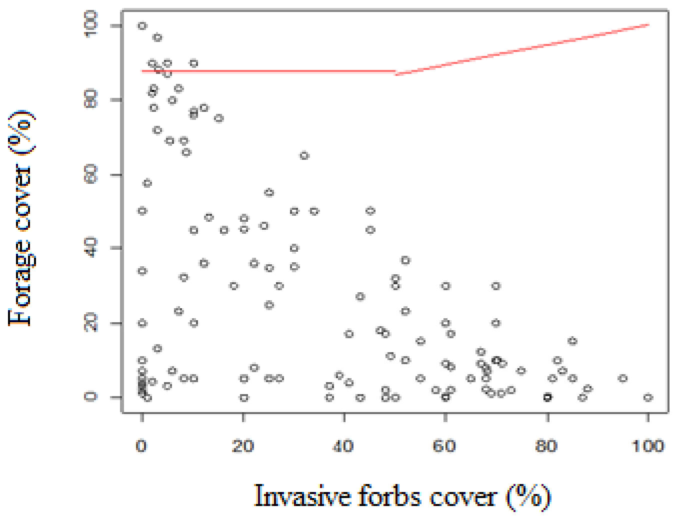

Figure 2. Relationship between forage cover (%) and invasive forbs cover (%) in a wetland grassland, showing the position of the functional threshold identified by piecewise regression.

Results

During the study period we identified and monitored 40 plant species that decreased, while invasive forbs increased. Piecewise regression of forage cover and invasive forbs cover identified a breakpoint at ~50% invasive forbs cover, indicating a loss of function in relation to forage production (Figure 2).

This loss of resilience for forage production was demonstrated in an exclosure cage set up at a site with invasive forbs cover over 70% and around 10% forage cover. The values for forage cover after 6 months, 1 year and 2 years of rest were 5, 3 and 2%, respectively. Permanent exclosure also presented predominance of invasive forbs after 3 years indicating that long rest periods did not ensure the return of desirable species.

Conclusion

During the observations, invasive forbs replaced perennial grasses. This is probably a result of a combination of below average rainfall and the associated overgrazing. Therefore, the main challenge in relation to sustainable management of these wetland areas is to identify grazing thresholds to avoid severe disturbances and subsequent loss of resilience, as well as to define optimal timing, intensity and frequency of grazing. As such, invasive forbs cover can be used as an early warning indicator of habitat degradation.

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