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THE DISPERSAL, IMPACT AND MANAGEMENT OF BUFFEL GRASS (*CENCHRUS CILIARIS*) IN DESERT AUSTRALIA

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ABSTRACT

Buffel grass is an introduced perennial tussock grass, which has improved rangeland pastoral production and helped land rehabilitation. More recently, its invasive capacity has been of concern and modelling suggests that it has the capacity to expand across a large area of northern Australia. Our scoping study showed that:

- aerial survey was a valuable tool for mapping presence of buffel on conservation areas;
- hybridisation amongst cultivars is likely to be occurring, leading to local adaptation; and
- buffel grass on rocky hillslopes did not have much effect on species composition of vegetation, birds or ants, under poor seasonal conditions.

INTRODUCTION

Buffel grass (*Cenchrus ciliaris*) first arrived in Australia with the cameleers in the 1870s and gradually naturalised in several northern Australian locations. Pastoralists spread the seed when the opportunity arose but establishment was localised. Starting in the 1940s and 50s, new varieties were imported from countries such as North Africa and India with varying establishment success, depending on locality and climate. Major episodes of expansion followed extended periods of above average rainfall, as well as continuing land clearing and sowing. New varieties continue to be introduced and buffel grass now covers extensive areas of rangelands in Western Australia, Northern Territory, South Australia, Queensland and New South Wales. Estimates of the areas of planted and naturalised buffel grass vary considerably, depending amongst other things on the resolution of the data and how one defines areas of natural spread. A recent modelling study estimated over 60% at a coarse continental scale of mainland Australia as being potentially suitable for buffel grass establishment based on edaphic and climatic requirements (Lawson et al. 2004). Most of the available literature does not distinguish between cultivars and so it should be remembered that 'buffel grass' generally refers to a complex which may have a diversity of attributes.

This central Australian scoping study provides some preliminary information and tools to help meet the challenge of managing buffel grass sustainably for production and conservation in desert Australia. Specifically, the aims of the project were:

- To evaluate the use of aerial survey for mapping buffel grass on conservation areas;
- To identify dispersal patterns and mechanisms in different cultivars; and
- To identify impacts of buffel grass on biodiversity.

OUTCOME 1:

Improved efficiency in detecting and mapping buffel grass incursions into conservation areas.

The effectiveness of aerial survey by helicopter for mapping buffel grass distribution was trialled at Watarrka National Park in central Australia (Puckey et al. submitted). Prior to this study, known buffel grass locations had been recorded in a database from ground observations over a period of approximately 8-10 years and stored within the park's geographic information system (GIS). Records in these databases were limited to presence data only (rather than any record of areas free from buffel grass) and were restricted to areas of the park accessible to ranger staff. Aerial survey provided a means of collecting data rapidly over a much larger geographic area, enabling a strategic approach to prioritising resource allocation. The study greatly increased the known distribution of buffel grass on the park, especially for the more remote or rugged areas. A further benefit of the aerial survey was its repeatability, which permits monitoring change over time.

OUTCOME 2:
Improved understanding of buffel grass dispersal.

The data gained from aerial survey of Watarrka National Park were subsequently used to build a probability surface model for the entire park based on environmental variables using Generalised Linear Modelling and then applied using the park's GIS. Distance to drainage and tracks, followed by ruggedness, hummock grass cover and soil texture were the most important variables in determining the occurrence of buffel grass.

Distance to drainage and tracks tells us something about dispersal mechanisms as well as favourable conditions for persistence, while ruggedness, hummock grass cover and soil texture reflect favourable (or not) conditions. The high probability of occurrence close to drainage and roads presumably reflects not only dispersal pathways for seed, but also habitats with high levels of disturbance, which allow establishment.

In the case of Watarrka, and very likely other protected areas, resources for management of invasive species are limited, and so absolute control is not possible. Instead a hierarchy of decisions will need to be made, based on biodiversity values, park resources, logistics, reservation status of species and communities and information about habitats potentially at risk. Priority areas for control might be, for instance, those with high biodiversity values, near to established seed sources and a high probability of buffel occurrence.

We had anticipated at the outset that it might be possible to identify cultivars with varying abilities to colonise different habitats. Puckey et al. (submitted) observed what appeared to be at least three varieties on Watarrka and thought that they might be behaving in ecologically different ways within the environment. Genetic analysis revealed that there were more than three varieties present in the region and that in fact they included evidence of apparent hybridisation among varieties. Thus morphological differences appear to be an expression of environmental differences rather than varietal type.

We speculate that new 'varieties' better adapted to local conditions are forming through the observed interbreeding between varieties. The strong selection pressure that desert landscapes place on plants also may assist in the formation of new forms of buffel grass better adapted to local conditions. This may explain, at least in part, the apparent variation in the success of varieties when planted in different locations at different times. New forms may be better adapted but may also have poorer characteristics as fodder. On pastoral lands, selective grazing might lead to increasing dominance of unpalatable forms.

OUTCOME 3:
Improved understanding of biodiversity impacts.

The impact of buffel grass cover on vegetation, bird and ant (morpho)species composition was investigated on central Australian rocky hills supporting witchetty-mulga shrublands. While floodplains might have been targeted for study due to their susceptibility to invasion, sites representing zero or low buffel grass cover could not be found. We chose to work instead on the rocky hillslopes because they are currently being colonised. At the time of site selection, seasonal conditions were poor, so that likely cover of buffel grass on rocky hill habitats following rainfall was assessed from moribund tussocks. The first effective rainfall occurred late in the project and was in late winter. Vegetation response was only modest and the maximum assessed cover of buffel grass did not exceed 20%.

A total of 106 ground plant taxa (including ferns, forbs, grasses, sedges, sub-shrubs, vines and seedlings of woody species) were identified from the flora surveys. The mean floristic diversity within a site was high (mean = 32.3, standard error = 1.4), ranging between 24 and 44 taxa, which is consistent for the central Australian ranges based on previous studies. Buffel grass cover by itself did not consistently explain the composition of native ground vegetation but in combination with the extent of bare soil, the cover of litter fall and to a lesser extent low shrubs, tall shrubs and trees, aspect and fire history, there was a significant effect on composition.

A total of 45 morphospecies of ants were captured, of which 20 were seed harvesters, 11 were predators and the remainder unknown. The mean ant diversity was 7.4 overall. Ordinations (not shown) on those taxa which occurred in more than 10% of the sites revealed that neither buffel grass cover by itself nor any of the habitat variables (ground vegetation, low shrubs, tall shrubs and tree cover, fire history, aspect, or bare soil) significantly influenced ant diversity.

A total of 31 diurnal and one nocturnal bird species were observed in the study sites of which seven were known to be breeding. Ordinations of the 20 species which occurred at two or more of the 18 sites showed that buffel grass cover contributed only 5% to the overall variation in composition; neither it nor the other habitat variables consistently influenced bird species composition. Grouping the species into habitat guilds based on food groups and the foraging and nesting substrates, we found a significant relationship between the guild composition of ground-dwelling species and fire history, low shrubs, trees, bare soil and buffel grass cover to a lesser extent although only 54% of the variation was captured by the ordination.

We were unable to demonstrate that buffel grass had a significant effect on biodiversity under the study conditions. Only minor effects, in combination with other habitat factors, were detected in plants and birds. This is not conclusive evidence for no impact, because the study was constrained by an extended period of very little rain, followed by winter rainfall, when forbs rather than grasses are generally favoured. The levels of buffel grass cover encountered may never have reached the thresholds necessary to have an impact, since cover did not exceed 20% and was patchily distributed.

Other central Australian studies under different conditions show that buffel grass does indeed have an impact. Buffel grass caused the decline of all native plant growth forms (nine classes of ground layer species) and species richness at Simpsons Gap National Park in central Australia, over a 27 year study (Clarke et al. 2005). Best (1998) found that the total number of invertebrate species were significantly reduced by buffel grass invasion in two central Australian land types.

The Watarrka aerial survey also provided insights into biodiversity impacts of buffel grass. The Watarrka probability surface model was overlaid with the available vegetation mapping for the park, divided into 2 x 2 km cells, to quantify the level of threat to native plant diversity, in particular rare plant species diversity. The proportion of rare species with part of their range currently invaded by buffel grass was predicted to be 28%, while 30 native species had >20% of their park distribution affected by buffel grass. Indeed, some of the habitats within Watarrka with the highest plant species richness are under threat from the current and predicted occurrence of buffel grass distribution. Sixty-three percent of cells with the highest species richness scores for native plants were currently affected by buffel grass and 96% of these cells were predicted to be suitable for future buffel grass invasion.

Those species affected by the current distribution of buffel grass are mostly associated with water-courses, alluvial plains and/or soils with greater clay content. This information is important for developing a strategy for managing buffel grass at a landscape scale that is based on invasive potential and known biodiversity values, where previous management had focused on small scale site specific control actions.

CONCLUSIONS

While this study did not detect biodiversity impacts in constrained field conditions, the risk to conservation values is still demonstrable. Aerial survey is a useful tool for mapping buffel grass in conservation parks and, when combined with modelling, can help prioritise control activity. Evidence of hybridisation amongst varieties suggests that the use of less aggressive varieties won't limit invasive potential in the longer term. Moreover unpalatable forms may arise which become dominant due to selective avoidance by livestock.

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