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DEVELOPING A RESEARCH AGENDA FOR THE DISTRIBUTION AND RATE OF SPREAD OF BUFFEL GRASS AND IDENTIFICATION OF LANDSCAPES AND BIODIVERSITY ASSETS AT MOST RISK FROM INVASION

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ABSTRACT
In 2007, the Biodiversity Working Group of the Australian Collaborative Rangelands Information System nominated buffel grass (*Cenchrus ciliaris*) as a transformer weed of Australian rangelands with potentially serious implications for biodiversity. As a step towards tackling the lack of biodiversity-related information about the grass, the Australian Government Department of the Environment, Water, Heritage and the Arts funded a workshop to develop a research agenda addressing distribution and rate of spread of buffel grass, and identification of landscapes and biodiversity assets at most risk from invasion.

The workshop report provided a summary of existing knowledge, a prioritisation according to the importance for conservation management and the feasibility of research, a proposed research agenda and potential collaborating organisations. This paper describes the background to the workshop and provides some detail on the proposed research agenda.

KEY WORDS
Buffel grass, spread, distribution, risk, biodiversity value

INTRODUCTION
Buffel grass has been widely introduced into Australian rangelands to support the pastoral industry and it has become an intrinsic part of many rangeland pastures, particularly in the semi-arid tropics. Its attributes of grazing and drought tolerance and positive response to fire, and its ability to colonise bare or heavily grazed areas, have enabled it to spread into many areas beyond the boundaries of its introduction. Buffel grass is almost certainly present in all rangeland bioregions and is continuing to establish in new areas and to increase where it already exists. The modelled distribution of buffel grass at a coarse continental scale (Lawson *et al.* 1994) indicates its potential to spread into over 60% of the Australian mainland.

Because of its spread into non-target areas, it also threatens biodiversity values in diverse inland regions (Friedel *et al*. 2006). In 2007, the Biodiversity Working Group of the Australian Collaborative Rangelands Information System recognised the importance of tracking changes in transformer weeds such as buffel grass (Bastin *et al.* 2008), where transformer weeds are invasive plants that can transform the basic attributes of habitats (Richardson *et al.* 2000). The Biodiversity Working Group noted the lack of information about the distribution of buffel grass and the threats it posed to biodiversity.

In 2007 the Australian Government Department of the Environment, Water, Heritage and the Arts commissioned a workshop to provide:

- a summary of the state of knowledge for specific issues relating to the spread and potential distribution of buffel grass, and to the identification of landscapes/environments where biodiversity assets are at most risk, outlining where we are now, what we can currently do and what needs to happen
- a prioritisation according to importance for management and the feasibility of research, relevant to the diversity of landscape types in arid and semi-arid regions
- a proposed research agenda; including the development and implementation of a robust methodology for monitoring spread and impacts of buffel grass on biodiversity assets

- potential collaborating organisations including CSIRO, government agencies and academic institutions with skills relating to the specific issues.

Twelve participants brought expertise in buffel grass and weed ecology, management and modelling, and in biodiversity conservation to the workshop, and represented eight different agencies and four states, to ensure a geographic breadth of experience.

CURRENT UNDERSTANDING

The establishment and spread of buffel grass is determined by its life history attributes and by environmental preferences. The workshop summarised the state of knowledge of the spread of buffel grass according to: seedbank longevity, germination requirements, drivers of establishment and spread, longevity of tussocks, buffel rundown (due to nutrient decline), seed production, vectors of spread, cultivation effects and varietal differences. The state of knowledge about the distribution of buffel grass was summarised according to habitat preferences (climate, soil type, soil moisture regime (run-on/run-off), mineralogy/lithology, soil fertility under agronomic conditions and under naturalised conditions, habitat condition/patch size, cover of woody vegetation), disturbance regime, competition, interaction amongst attributes, varietal differences and geographic distribution. Adequacy of knowledge was low in most cases and often limited to planted pastures in Queensland.

To identify areas where biodiversity values are at greatest risk from buffel grass invasion, information about areas of high biodiversity value needs to be intersected with information about the environmental preferences of buffel grass. Of these, riparian areas and landscape components with relatively high soil fertility and assured moisture are at greatest risk, although many other arid and semi arid habitats may also be susceptible. Adequacy of knowledge was greater at a local scale than at a regional scale.

REQUIRED ACTIONS

The workshop determined that, in order to understand distribution, spread and risk, two related activities were necessary: (i) model the future distribution and spread of buffel grass on the basis of where it is now, and (ii) develop a system for monitoring the spread of buffel grass, targeting those areas of high conservation value which are at greatest risk.

Modelling distribution and spread

Conservation managers need modelling of distribution at landscape-scale but, because it depends on detailed and location-specific information, landscape-scale modelling is unrealistic for regional decision-making or national policy development. For higher level decision-making, modelling at sub-IBRA level is likely to be appropriate, because areas of high biodiversity value are determined in a regional context and because directly extrapolating landscape model outcomes from one region to another will be flawed due to regional differences. The challenge for regional scale modelling is the lack of quantitative data for all components. Solutions proposed included the use of Bayesian belief networks to capture expert knowledge, and combing through agency data sets gathered for other purposes for relevant information.

Temporal modelling of spread appears to be harder to achieve. Local and frequent events which drive spread will be easier to model than large, infrequent events, for which there will be limited data. Multiple dispersal mechanisms make the task more complex, and may ultimately limit spread modelling to a local scale.

Modelling risk to areas of high biodiversity value

In order to be robust, modelling risk to areas of high biodiversity value should be based on a diversity of regional case studies, selected on the basis of: wide geographic coverage, data availability, a range of biodiversity values, various stages of invasion, a range of disturbance types/land uses, intact versus fragmented landscapes, where clearing occurs and attempted control. Bayesian belief modelling incorporating expert opinion may help refine predictions; validation of outputs will be important.

Monitoring distribution and spread

Monitoring of buffel grass will generally have to be embedded in existing monitoring systems, such as bioregional surveys and pastoral monitoring systems, and negotiations to achieve this are imperative. Broad scale assessment with satellite remote sensing is unlikely to be effective because buffel grass is spectrally indistinguishable from other ground layer species for most of the time. Aerial survey is feasible for high value areas like parks but would not be cost-effective regionally. Neither satellite nor aerial data can identify low densities of buffel grass and hence early stages of invasion. Ground survey is expensive and will need to be targeted at high risk areas. More extensive community-based monitoring could be used to complement on-ground surveys.

PRIORITIES FOR RESEARCH

The workshop participants prioritised prospective research activities according to their importance for management and the feasibility of research, and taking into account the availability of data. The highest priority is to determine where buffel grass is now, where it might establish in future and how these current and forecast distributions impinge on areas of high biodiversity value. Research into refining monitoring systems and developing the capacity to model spread rate is somewhat less important for obtaining immediate management outcomes and, moreover, some aspects such as modelling event-driven spread may be harder to achieve. Lower priority activities are not unimportant in an absolute sense but they may require extensive resources to progress; they will add refinements to the highest priority activities.

The workshop demonstrated that the ecology of buffel grass in natural systems and the functional implications of hybridisation are not understood in any detail, but there is sufficient knowledge to make progress with modelling distribution and identifying risk. Further research into ecology and hybridisation of buffel grass is desirable in the longer term because it will allow models to be refined and it is also likely to inform management intervention.

PROPOSED RESEARCH AGENDA

1. Develop a national GIS of buffel grass distributions consistent with that sponsored by the National Land and Water Resources Audit (NLWRA) (2007) for invasive weeds. At present the level of available NLWRA mapping at the 1:100,000 scale is too coarse for detecting change. Better resolution data are needed for modelling. Where available, compile data from subregional data bases, including estimates of abundance if possible, stratified at least to the level of none, rare, restricted, widespread. Depending on record dates and adequacy of data, stratify in 10 year or less time slices.

2. Conduct an expert workshop to determine (a) the most appropriate approach(es) to modelling buffel grass distribution at a range of spatial scales (local, regional and national) and (b) the most appropriate approach(es) to modelling buffel grass spread at local and regional scales. Develop a project proposal relating to each, with priority being given to developing distribution models. Participants should represent a diversity of modelling approaches and should include experts in buffel grass and weed ecology, to ensure the purpose of models is clear.

3. Develop and validate regional (sub-IBRA) buffel grass distribution modelling capability in one case study region where regional GIS and data availability are good. Develop and validate an appropriate regional (sub-IBRA) model of high biodiversity value areas in the same sub-IBRA. Combine models to predict high risk areas. Validate, then test and adapt procedures in other sub-IBRAs.

   Gather data in support of spread modelling (e.g. life-history, dispersal and habitat preference) as part of other activities e.g. 4.

4. Research functional understanding to improve management e.g. Are there thresholds for cover levels of native vegetation which limit spread of buffel grass? Can we predict the distribution of buffel grass under climate change scenarios in case study areas?

5. Monitoring may not require specific research activities if it is 'piggy-backed' on existing or planned biodiversity monitoring systems. Researching data integration from different monitoring systems for national reporting could occur under 1. The capacity to conduct reliable aerial surveys of at-risk high biodiversity value areas may need testing, although detecting new incursions may not be achievable.

6. Develop an on-line bibliography for buffel grass (and potentially other transformer weeds) as part of research activities, and host it on the ACRIS website.

Organisations identified as having expertise relevant to the research agenda and which could contribute to collaborative research included CSIRO Sustainable Ecosystems and CSIRO Entomology, primary industries and conservation agencies in the Northern Territory, Queensland, South Australia and Western Australia, Natural Resource Management Boards in South Australia, and universities in Adelaide, Brisbane, Melbourne, Perth and Townsville.

The report is currently under consideration by the ACRIS Management Committee.

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