Managing complexity: the example of invasive wetland forage grasses

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Summary Research has pointed to burning and grazing as useful tools for reducing the abundance of para grass in seasonally inundated wetlands to restore conservation assets. However, the use of these tools is complicated by a range of ecological, economic and social factors, including spatial heterogeneity, delayed restoration responses, inter-specific interactions, on-going management requirements and conflicting interests of different stakeholders. This complexity points to the fact that provision of a management tool is only one of the elements required to effectively address an invasive species problem.

Keywords Complexity, weed management, wetlands.

INTRODUCTION

Invasive plant species are often dealt with in isolation, whether from a research or management point of view. In most cases where the intention of research is to quantify the impacts of weeds, a single species approach is taken (Grice *et al.* 2004a, Scott and Grice 2008). Similarly, management frequently focuses on single species even though, in many situations, several or many invasive species coexist and interact (Grice *et al.* 2004b). Moreover, problems caused by invasive species do not occur in isolation from other land or resource management issues. Invasive plants exist as components of complex and dynamic ecosystems and must be managed accordingly. In this paper we discuss the challenge of managing this complexity using the example of invasive wetland forage grasses from northern Australia. The ideas are based on results of research conducted to devise ways of restoring the biodiversity of wetlands invaded by para grass (*Urochloa mutica* (Forssk.) T.Q.Nguyen).

Wetlands are diverse and important ecosystems in northern Australia. They are valued, among other things, for their roles in influencing hydrology and water quality, the fisheries that rely on them, their aesthetic and recreational attributes and the biodiversity that they support. Certain seasonally inundated wetlands are also used for pastoralism. In order to increase the pastoral productivity of seasonally inundated wetlands, several exotic forage grasses have been introduced. These include para grass, hymenachne (*Hymenachne amplexicaulis* (Rudge) Nees) and aleman grass (*Echinochloa polystachya* (H.B. & K.) Roberty).

MATERIALS AND METHODS

The Townsville Town Common Conservation Park (TTCCP) is located in north-east Queensland (19°11'30"S, 146°45'30"E) and supports a range of plant communities, including seasonally inundated, freshwater wetlands. These are especially valued because of the populations of water birds that they support. Particularly significant are the large numbers of the iconic magpie geese (*Anseranas semipalmata* Latham) and brolgas (*Grus rubicunda* Perry) that, at least in the past, have used the area for feeding and breeding.

The TTCCP was used for communal grazing between the 1880s and 1970s. It was gazetted as an Environmental Park in 1980 and became a Conservation Park under the *Queensland Nature Conservation Act (1992)* in 1994. While the date of its introduction is unknown, para grass was present at low density in the 1970s but, with the removal of livestock, it increased to become a dominant plant in the freshwater wetlands. This had major consequences for the flora, fauna and ecosystem structure and function (Williams *et al.* 2005).

Research conducted between 2004 and 2008 tested the potential for using burning and livestock grazing to restore freshwater wetlands of the TTCCP in which up to 90% of the above-ground biomass consisted of para grass (Grice *et al.* 2006). While the research focused mainly on documenting responses to treatments by vegetation (above-ground biomass and composition) and vertebrate fauna, it also allowed us to identify factors that complicate management of this situation.

THE COMPLEXITIES

Control methods The experiment on the TTCCP pointed to the possibility of reducing the prevalence of para grass by using mid-late dry season burning. Grazing may also have a role to play. Fire killed a small proportion of individual plants and greatly reduced the above-ground biomass of para grass over the first part of the ensuing wet season and, to some degree, into the following dry season. Importantly, fire removed the heavy layer of thatch that accumulates at the base of the

para grass sward. The challenges of practical application of these results lie in identifying and exploiting the window of opportunity for burning (defined by fuel moisture levels and weather conditions), managing fire risks, and indefinitely implementing a regime of repeated burnings. Providing the people and financial resources to apply control methods at times and scales that are optimum can be a problem

Other invasive plants Several other invasive plant species are present on the TTCCP. Two species in particular complicate the management of para grass. Hymenachne, like para grass, is a stoloniferous forage grass also found in the freshwater wetland, though infestations are currently small and spatially restricted. It is capable of growing in deeper water than para grass. The complication attributable to the presence of this species is that it may benefit from any reductions in the abundance of para grass. It is a Weed of National Significance (WONS) for which there are no established methods suitable for broad-scale control. The other complicating invasive species is Guinea grass (*Megathyrsus maximus* (Jacq.) B.K.Simon & S.W.L.Jacobs). This does not grow in the freshwater wetland but has invaded the adjacent *Melaleuca-Eucalyptus* woodland. It is of concern because it produces much higher above-ground biomass than local native grasses and fuels destructive high intensity fires. The complication here is that prescribed fires conducted to reduce para grass dominance could escape into high fuel loads in the adjacent woodland. Co-ordinated management of para grass and other invasive species with which it interacts may be critical to the overall restoration of the TTCCP.

Listed native species During the course of the research a small population of *Paspalidium udum* S.T.Blake was discovered in the TTCCP wetlands (Collett and Williams 2007). This species is listed as vulnerable under the *Queensland Nature Conservation Act (1992)*. It is vulnerable to competition from para grass, but its ecology is poorly known, as is its response to burning designed to manage para grass. Management strategies for para grass must account for the presence of *P. udum* even in the face of this ignorance.

Capacity of native plants to recover The TTCCP wetlands are not species-rich but they do support a variety of plant growth forms. Two species are particularly important for their roles in supporting high-profile wetland bird species. The tubers of bulkuru (*Eleocharis dulcis* Hensch.) and the seeds of wild rice (*Oryza meridionalis* N.Q.Ng) provide important food resources for brolgas and breeding magpie geese respectively. Reducing the abundance of para grass does not necessarily lead to the recovery of these or other native plant species because long-term overwhelming dominance by para grass may have led to depletion of reserves of their seeds or other propagules.

Spatial heterogeneity Fine scale heterogeneity in the responses of para grass to burning is apparent. This may be driven by a combination of spatial variation in para grass biomass, fuel moisture levels and water depth, and temporal variation in fire weather conditions during the course of individual fires. Ironically, the greatest reductions in para grass abundance are apparently associated with channels in which water is deeper and the period of inundation longer. Further knowledge of the ecology of the wetland is required to understand this phenomenon and incorporate it into management plans.

Interaction with feral pigs Formerly, the sedge bulkuru dominated significant parts of the freshwater wetland. Nowadays, this species is reduced to small patches. These patches are vulnerable to feral pigs that are abundant on the TTCCP. Feral pigs selectively root up remnant patches of bulkuru to feed on its tubers. Pigs may compete with brolgas for this resource and replace them as a factor in the life cycle of bulkuru. Disturbance by pigs may also inhibit recovery of remnant bulkuru stands and so require that control programmes for para grass and feral pigs be developed in conjunction with one another.

Control of a 'commercial weed' Management of some invasive species is complicated by the fact that they are simultaneously commercially valuable and commercially and/or environmentally deleterious. Action to counter the deleterious effects of such 'commercial weeds' (Grice 2006) can attract negative reactions from some sectors of the community, even in cases such as hymenachne, which is a WONS and declared a weed under state legislation. Para grass is not a declared species though it may be problematic to both agriculture and the environment.

Other social issues Prescribed burning and the use of livestock on a conservation reserve are also controversial. Some elements of society take a negative view of prescribed burning on national parks, and legislation precludes livestock grazing of national parks. The temporary use of cattle on TTCCP was facilitated because of that reserve's status as a Conservation Park (rather than a National Park). More specifically, burning on the TTCCP can attract negative reactions from

sections of the community of Townsville-Thuringowa, a large urban area adjacent to it. These reactions relate largely to the effects of smoke created by burning. In contrast, the bird-watching community is generally accepting of the value of burning as a means of restoring bird habitat. A further complication is that burning on TTCCP must be managed so as to minimise the effects of smoke on the operation of the large commercial and military airport that abuts the TTCCP.

DISCUSSION

Research has pointed to burning and grazing as useful tools for reducing the abundance of para grass in a seasonally inundated wetland to restore conservation assets. However, the application of these tools is complicated by a range of ecological, economic and social factors. To be effective, fire (and/or grazing) must be used repeatedly and indefinitely, while dealing with the fine-scale spatial heterogeneity of the system. The responses of both native plants, including one with 'Vulnerable' conservation status, and other invasive species must be taken into account, though there are significant knowledge gaps in relation to them. A suggested interaction between the invasive plant (para grass) and a feral animal (pigs) may require simultaneous control programmes to hasten restoration. Finally, there is a need to consider the multiple agendas and interests of numerous stakeholder groups.

These interacting issues can be addressed in developing and implementing weed management plans. Such a situation requires good knowledge of the ecology of the ecosystem but also a willingness and ability to acquire and incorporate new information. It also needs understanding of the social issues surrounding the effects of invasive species and how they might be managed. Particularly in the case of controversial weeds, it is important to work toward mutual understanding of divergent viewpoints. Inevitably, there will be trade-offs to balance competing ecological, economic and social imperatives.

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