Different weeds, different habitats, same effects: exotic grass invasion in tropical woodlands and wetlands

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Summary There are more than 160 species of naturalised exotic grasses in northern Australia and these have invaded a range of freshwater and terrestrial environments. We have been studying the impacts of two exotic grasses, gamba grass (*Andropogon gayanus* Kunth.) and para grass (*Brachiaria mutica* Forssk.), which occur in tropical savanna and floodplains, respectively. Despite the very different habitats they occupy, there are striking similarities in their impacts on native vegetation and invertebrates. In both habitats, exotic grass invasion results in a shift in plant composition and a reduction of native plant species richness. These changes in plant communities have the potential to undermine biodiversity conservation goals; however, our findings suggest that not all biota are affected in the same way. Although there was a clear change in the composition of wetland and terrestrial flora (diversity and biomass) following weed invasion, freshwater macroinvertebrate communities and terrestrial ant communities showed little or no response. This is particularly interesting given that both these invertebrate groups are considered to be sensitive indicators of environmental change. Although these exotic plants almost completely displace the native vegetation in both environments, in some respects it is simply one grass being replaced by another and the change in habitat structure appears to be insufficient to affect the invertebrate communities. We suggest that, although weeds may pose a clear threat to plant biodiversity, the response of some faunal groups will be determined largely by the degree of structural change.

Keywords Weed risk management, Northern Territory, stakeholder engagement.

INTRODUCTION

Although weed invasion is widely recognised as a major threat to global biodiversity (Vitousek et al. 1996) there are still relatively few studies that have actually documented the impacts of weeds on biodiversity, particularly the effects on fauna (Groves 2002). Many of the studies describing weed impacts have been in situations where the invader is functionally distinct and causes an obvious and dramatic change in plant structure, such as the invasion of native grassland by woody shrubs and trees. The spread of *Melaleuca quinquenervia* Cav. in Florida’s Everglades (Gordon 1998) and mimosa (*Mimosa pigra* L.) on the floodplain grasslands of the Northern Territory (Braithwaite et al. 1998) are good examples of plant invasions causing structural change of a native grassland. Far less attention has been given to the effects of weed invasions where the invader is a functionally similar species, such as the invasion of native grasslands by exotic grasses (Reed et al. 2005).

Displacement of native grasses by exotic grasses is particularly relevant across northern Australia where native grasses traditionally dominate the understorey but the search for improved pasture species for cattle production has left more than 150 species of naturalised exotic grasses (van Klinken 2004). Some of these exotic grasses have become well established in areas outside pastoral lands, including national parks and rural residential areas. The degree to which these exotic grasses threaten the natural ecosystems of northern Australia is very contentious but until very recently has probably been underestimated for two reasons. Firstly, exotic grass invasion in the woodland and floodplain ecosystems in the region does not lead to an obvious and immediate structural change; superficially it is simply a case of one sort of grass being displaced by another. Secondly, until very recently there was little scientific data documenting the effects of exotic grass invasion in these ecosystems.

To address this gap in knowledge, we have been studying the impacts of two exotic grass species which are native to Africa, but which occupy very different habitats. Gamba grass forms very tall clumps and it invades terrestrial habitats mostly in savanna woodlands and para grass is a semi-aquatic grass that occurs in rivers, floodplains and riparian zones. This paper reviews some of the findings of this work and considers the effects of grass invasions on native plant communities, habitat structure and invertebrates.
METHODS
Over the past seven years we have taken a comprehensive approach to examine the effect of gamba grass and para grass invasion on aspects of biodiversity and ecosystem processes in savanna woodland and floodplain habitats. Table 1 summarises the focus of these studies. Details of the methods are given in the references cited in Table 1, but our work has generally been done as comparative studies in replicated areas with and without the exotic grasses. Work on gamba grass was done mostly in Wildman Reserve and Litchfield National Park and work on para grass was done on the Magela Creek floodplain in Kakadu National Park.

RESULTS AND DISCUSSION
Para grass impacts  Plant community composition shows major changes in response to para grass invasion (Douglas et al. 2002). Para grass communities are distinct from the native hymenachne (Hymenachne acutigluma Steud.) and wild rice (Oryza australiensis Domin.) communities which they displace. Para grass dominates where it invades and has consistently lower plant species richness than either of the native plant communities (Douglas et al. 2002).

Despite the marked effects on plant communities, there is no evidence that para grass invasion affects aquatic invertebrates (Douglas and O’Connor 2003). Aquatic invertebrate richness in para grass was similar, and certainly no lower, than that in wild rice or hymenachne sites and there was no evidence of any differences in invertebrate community composition between the three grasses. Douglas and O’Connor (2003) attributed this apparently paradoxical finding to two things. Firstly, the habitat structure of para grass is not consistently different to that of the native grasses. Para grass has similar total surface area to wild rice and similar biomass to hymenachne. Secondly, stable isotope analysis has revealed that the aquatic food webs in this system are driven largely by epiphytic algae growing on the grasses (Douglas et al. 2002, 2005). The grasses themselves are not directly contributing to the food web and all three grasses represent similar environments to support algal growth.

The finding for aquatic invertebrates is in stark contrast to that found for the terrestrial invertebrates inhabiting the emergent parts of these grasses in the wet season. Douglas and O’Connor (2004a) found that invertebrate species richness in hymenachne was about double that of both para grass and wild rice. They attributed this difference to the fact that although all three grass species had similar emergent cover, they differed in their nutritional quality (with hymenachne having much higher Nitrogen content) and that the terrestrial invertebrate fauna was dominated by groups that were directly consuming the grasses, such as grasshoppers and caterpillars.

Gamba grass impacts  Gamba grass invaded areas have distinctive plant communities that have about half the plant species richness of native grass sites (K. Brooks unpublished data). Aspects of habitat structure are altered with gamba grass invasion as it has much higher biomass than native grasses and, unlike the native annual grasses, it remains vertical throughout the dry season (Rossiter et al. 2003).

Despite these major changes in the plant communities, the composition and species richness of the ant fauna in sites with high and low density gamba grass is not substantially different to that in native grass sites.

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<tr>
<th>Focus of study</th>
<th>Para grass</th>
<th>Gamba grass</th>
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<td>Plant community</td>
<td>Douglas et al. 2002</td>
<td>Setterfield et al. in prep.</td>
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<td></td>
<td>Douglas et al. in prep.</td>
<td>K. Brooks (unpublished)</td>
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<td>Ferdinands et al. 2005</td>
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<td>Invertebrate community</td>
<td>Douglas and O’Connor 2003 (Aquatic)</td>
<td>Ryan 2005 (Ants)</td>
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<td>Douglas and O’Connor 2004b (Terrestrial)</td>
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<td>Vertebrate community</td>
<td>Douglas et al. 2002 (Fish)</td>
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<td>Ferdinands et al. 2005 (Birds)</td>
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<td>Habitat structure</td>
<td>Douglas and O’Connor 2003 (Surface area)</td>
<td>Rossiter 2001 (Surface area)</td>
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<td>Douglas and O’Connor 2004a (Biomass)</td>
<td>Rossiter et al. 2003 (Biomass)</td>
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<td>Ecosystem processes</td>
<td>Douglas et al. 2002 (Nutrient cycling)</td>
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<td>Rossiter et al. 2004 (Water cycling)</td>
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Ryan (2005) attributed this to the fact that whilst the vertical habitat structure had been altered by gamba grass invasion, there was no difference in canopy cover and components of the ground cover (e.g. litter, bare ground, and grass cover of some kind) were very similar between native and exotic grass sites. The similarity in ground cover variables is particularly relevant given that the pitfall trapping used in the study would be biased towards collecting epigaeic ants.

CONCLUSION
The studies reviewed above add to a growing body of evidence demonstrating that exotic grass invasion has a number of negative impacts on native plant communities. These include the immediate effects such as the loss of native plant biodiversity and a shift in plant composition, but there also likely to be longer-term effects brought about by the increase in dry season biomass and hence fuel loads and the negative effects of this on the tree canopy cover (Douglas and O’Connor 2004b, Rossiter et al. 2003). These effects of exotic grass invasion on the native plant communities were consistent in both the floodplain and the savanna woodland.

The effects of exotic grasses on invertebrate fauna were variable and appear to depend on the effect of grass invasion on habitat structure and on the functional relationship between the invertebrates and the grass community. The shift from native grasses to exotic grass had no effect on ants or benthic or aquatic invertebrates, whereas invertebrates inhabiting emergent floodplain vegetation were more abundant and diverse on one of the native grasses. Para grass invasion had little effect on submerged biomass or surface area and gamba grass had little effect on ground cover.

So, from an invertebrate’s point of view, the displacement of native grass by exotic grass probably represents a fairly subtle change in habitat structure. Unless the exotic grass is nutritionally poorer than the native species and the invertebrates are directly consuming grass, it appears that many invertebrates will be insensitive to this sort of weed invasion.

Therefore, despite dramatic negative effects on the native flora, it cannot be assumed that exotic grass invasion will lead to direct flow-on effects on all components of the fauna.

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REFERENCES


