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A trade-off in conservation: Weed management decreases the abundance of common reptile and frog species while restoring an invaded floodplain

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ABSTRACT

Responsible conservation decisions are made when managers consider the benefits provided by an action in relation to the potential negative effects incurred. Some introduced grasses can be managed using fire and grazing, but experiments, replicated in time and space, are required to determine the relative costs and benefits of this action on native biodiversity. We aimed to experimentally determine the effect on reptile and amphibian assemblages of repeated burning and grazing of the invasive weed para grass (*Urochloa mutica*) over three years in a north Queensland conservation reserve in Australia. We measured the diversity and abundance of reptiles and amphibians, and quantified temperature and humidity during an experiment that repeatedly grazed, burnt, or burnt and grazed para grass in a replicated series of experimental plots. All burnt plots were drier and sites that were both burnt and grazed were hotter. The frog and reptile community was dominated by a few common species. Richness changed seasonally and was strongly related to the distance from the nearest woodland and free water, but it was unaffected by the management treatments. Abundance of the skink (*Lampropholis delicata*) and frog (*Limnodynastes convexiusculus*) decreased with burning and grazing, while a closely related frog (*Limnodynastes tasmaniensis*) remained unaffected. There was a clear trade-off between decreasing the abundance of a few common species to increase the overall suitability of habitat for a diversity of native species. We suggest that, in this case, it is reasonable to make the value judgement that this trade-off is acceptable.

1. Introduction

Responsible conservation decisions are made when managers weigh the benefits provided by management actions against any negative effects those actions may cause (Wilson et al., 2009). Few conservation actions universally benefit all species and consequently, effective management requires clear, predetermined goals to measure success (Slocombe, 1998). Reducing weeds in ecosystems is generally considered beneficial to native biodiversity, but few studies have examined the influence of weed-control measures on the non-target biodiversity and assemblage composition (Zavaleta et al., 2001). There can be knock-on effects to faunal assemblages in the wake of large-scale weed control. For example, the process of weed removal can further damage already disturbed habitat (Zavaleta et al., 2001). Control measures often change physical properties of an area, such as vegetation structure and growth rate, altering microhabitat and shelter availability (Thomson and Leishman, 2005), which may cause a shift in the faunal assemblage (Braithwaite, 1987; Valentine and Schwarzkopf, 2009). To make informed management decisions about weed removal, we must quantify the response of faunal assemblages to weed control, and understand how species and assemblages are impacted by weeds and their removal.

When invasive plant species reach high abundances, they can transform ecosystems and reduce biodiversity (Groves and Willis, 1998; Slobodchikoff and Doyen, 1977). This is particularly catastrophic in freshwater systems such as wetlands, which harbour a disproportionately high proportion of the world's biodiversity (Dudgeon et al., 2006). The propensity for human impacts to focus around wetlands (Sala et al., 2000), in addition to their high agricultural value, leave these systems highly vulnerable to introduced plants such as pasture grasses, which invade and monopolise

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extensive areas (Humphries et al., 1991). Monocultures of invasive grasses increase vegetation biomass beyond that of most native grass assemblages (Pettit et al., 2011) and reduce biodiversity by out-competing native vegetation (Douglas et al., 2006; Ferdinands et al., 2005). For instance, the decline in plant species richness and cover reduces the number and abundance of bird species, nest density and hatchling success, probably via a reduction in food resources and conspecific visibility (reviewed by Kantrud, 1985). Finding cost effective and practical solutions to these invasions is, therefore, imperative to conservation of wetland birds.

Fire and grazing are widely used for land management purposes making them logistically and economically viable control methods for reducing the biomass of introduced grasses (Williams et al., 2005). However, studies of the impacts of these control methods typically lack well-replicated experimental design and temporal replication. Frequent, application of otherwise benign management strategies, such as fire in fire-adapted systems, eventually causes unforseen ecosystem changes (Valentine et al., 2012b; Zavaleta et al., 2001). In addition, the high biomass of many weeds increases the fuel load and so the intensity of fires, changing the magnitude of the disturbance (Douglas and O'Connor, 2004; Silvério et al., 2013; Williams et al., 2005). In many systems the direct impacts of fire are dictated by fire intensity (Smith et al., 2012) while indirect impacts are caused by successional changes in the vegetation, affecting variables important to fauna such as temperature, soil moisture and habitat structure (D'Antonio and Vitousek, 1992; Valentine et al., 2012a). Similarly, grazing has direct impacts on many species of wildlife through trampling and indirectly through selective feeding and vegetation removal (Kutt and Gordon, 2012; Kutt and Woinarski, 2007). The specific physiological thermal and hydric requirements of many reptile and amphibian species make communities sensitive to changes in habitat structure (Heatwole and Taylor, 1987; Martin and Murray, 2011). It is this sensitivity that causes many species to decline after weed invasion which reduces the availability of suitable shelter and access to optimal microclimates (Valentine et al., 2007; Valentine and Schwarzkopf, 2009).

Our objective was to assess potential para grass management techniques using an experiment to assess the response of reptiles and amphibians to burning, grazing and a combination of both, over time. In northern Queensland, Australia, para grass dominates many wetland habitats, invading previously open water bodies and degrading habitat of wetland birds, such as the brolga (*Grus rubicunda*) and magpie goose (*Anseranas semipalmata*) (Boyden et al., 2007; Ferdinands et al., 2005). Although grazing is controversial owing to its negative environmental impacts, management of para grass by burning and grazing in such wetlands was perceived as a solution likely to benefit waterbirds overall (Grice et al., 2006). While previous studies have assessed the impact on some frog species at a single point in time (Bower et al., 2006), the current study aimed to explore community responses over time. We aimed to quantify the effect on the reptile and amphibian assemblage as well as the response of individual species of reptiles and amphibians to repeated experimental burning and grazing of para grass, with a view to making better informed recommendations regarding the influence of these weed removal strategies on wildlife.

2. Method

2.1. Study site

The Townsville Town Common Conservation Park (hence forth referred to as the Town Common; 19°14′S 145°44′E) is in the state of Queensland in north eastern Australia. It covers 3245 ha and contains a seasonal wetland, significant for its large population of water birds (Grice et al., 2006). It was used from the 1800s to 1970s for common grazing of cattle, became a conservation park managed by Queensland Parks and Wildlife Service in 1985, and was destocked by 1990. The structure of this seasonal wetland changed when para grass was introduced over 40 years ago. Prior to the introduction of para grass the flood plain vegetation was dominated by native species including saltwater couch (*Paspalum distichum*), native sedges (*Eleocharis dulcis, Cyperus scariosus*) and grasses (e.g., *Leersia hexandra*).

The Town Common experiences two distinct seasons: a warm wet season (September to March) and a cool dry season (April to August). Climate data were obtained from the Bureau of Meteorology, station 032040 (accessed 26 June 2008), 1.8 km from the study site. The mean maximum temperature for each year ranged from 27.79 °C to 30.14 °C between 1941 and 2007. The years when this project was conducted were warm, with a mean maximum temperature of 29.21 °C between January 1st 2005 and December 31st 2007. Annual rainfall ranged from 464.2 to 2399.8 cm between 1941 and 2007 with ~80% of this falling between December and March. The study period received comparatively low annual rainfall with 513.6 cm, 993.8 cm, 1295.4 cm of rainfall in 2005, 2006 and 2007 respectively.

2.2. Weed species

Para grass strongly alters vegetation structure by establishing a monoculture of tall (>1 m high) grass with a thick mat of thatch and stolons, which reduces vegetation biodiversity by out competing native vegetation and reducing habitat quality for water birds by reducing the amount of free standing water (Boyden et al., 2007; Ferdinands et al., 2005; Low, 1997). The invasion of para grass also increases fuel loads and intensity of fires (Douglas and O'Connor, 2004).

2.3. Experimental design

Para grass-dominated habitat was divided into 12 plots, each 200 m by 300 m. These plots were different distances from adjacent woodland and four treatments were randomly assigned to give three replicates of each treatment (Fig. 1). Plots were either: burnt and grazed; burnt and ungrazed; unburnt and grazed; or left as a control – unburnt and ungrazed. Burnt plots were burnt three times: August 2004, September 2005 and November 2006. Grazing took place following each fire; plots were intensely grazed by cattle, *Bos indicus,* until mid December from September in 2004; October in 2005; and November in 2006.

The number of cattle in a plot was set by assuming that an individual animal would consume 9 kg of forage per day. Each plot was stocked with sufficient cattle to consume an estimated 50% of the grass biomass present at the start of the grazing period. To obtain estimates of vegetation biomass we used the double-ranked sampling technique BOTANAL (Tothill et al., 1978). Each plot was sampled by two observers, who each visually estimated biomass and composition in 50 1 m × 1 m quadrats along two transects parallel to the long axis of the plot. Visual estimates of biomass were calibrated by harvesting, drying and weighing all herbage from nine 1 m × 1 m quadrats.

2.4. Study methods

To assess responses to burning and grazing, we sampled reptile and frog communities four times between 2005 and 2007 (Fig. 1). During the second sampling period, grazed plots were excluded, as they were being grazed at the time, and in the fourth sampling period, one grazed plot was too wet to trap. Sampling of each plot took place over 21 days in each sampling period. Each plot contained