Biological Conservation 194 (2016) 89–99

Contents lists available at ScienceDirect

Biological Conservation

journal homepage: www.elsevier.com/locate/bioc

# Birds of a feather flock together: Using trait-groups to understand the effect of macropod grazing on birds in grassy habitats

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ARTICLE INFO

*Article history:*
Received 14 March 2015
Received in revised form 23 November 2015
Accepted 30 November 2015
Available online 19 December 2015

*Keywords:*
Grazing
Kangaroos
Birds
Trait
Guild
Grass
Grassy habitats

ABSTRACT

Restoration of appropriate disturbance regimes is a high conservation priority. However, for most species, little is known about appropriate disturbance regimes to achieve defined conservation outcomes. In this context, trait-based approaches can offer a means to generalize responses to environmental change across multiple species. Here, we investigated the potential of a trait-based approach to predict the preference of birds utilizing the grassy layers for different levels of grazing by a native grazer within grassy habitats in south-eastern Australia. We tested three hypotheses: 1) birds with particular traits (i.e. large ground-foraging, small ground-foraging, aerial insectivore, and ground-nesting/concealment) will show preferences for certain levels of grazing: 2) species within the same trait group will show preferences for a similar level of grazing intensity: and 3) different bird trait groups will favor different grazing intensities Overall, we found a significant relationship between grazing intensity and the richness of aerial insectivore and large ground-foraging trait groups utilizing the grassy layer, but not for the richness of small ground-foraging and ground-nesting/concealment trait groups. We also found that the likelihood of 3/3 aerial insectivores, 4/7 large ground-foragers, 3/10 small ground-foragers, and 1/3 ground-nesting/concealment species using the grassy layer was significantly related to grazing intensity. However, we found no significant relationship between the probability of 12 species using the grassy layer and grazing intensity, with other environmental factors potentially masking grazing response. Importantly, species within the same trait group showed a preference for similar grazing intensities, and different trait groups showed preference for different grazing intensities. For example, aerial insectivores, and a single ground-nesting/concealment species were more likely to use the grassy layer at lower grazing intensities, whereas large ground-foraging birds and small ground-foraging birds were more likely to use the grassy layer at higher grazing intensities. To maintain optimal grass structure for birds with varying grass structure preferences, landscapes should contain a heterogeneous mosaic of grazing intensities.



## 1. Introduction

Anthropogenic changes to natural disturbance regimes are a major contributor to global biodiversity loss (Chapin et al., 2000; Woinarski et al., 2015). Consequently, the restoration of these regimes is a high priority for conserving biodiversity (Palmer et al., 1997; Landres et al., 1999; Mori, 2011; Halme et al., 2013). For most species, exactly what constitutes their ‘optimal’, or even ‘preferred’ disturbance regime is largely unknown (Hobbs and Huenneke, 1992; Lindenmayer et al., 2006), and quantifying optimal disturbance regimes for all species is often not feasible. One approach to solving this problem is to group species based on common ecological or life-history traits and tailor land management approaches to focus on conservation of trait groups rather than individual species.

The response of an individual organisms to environmental change is dependent on multiple life history traits (e.g. dispersal method, predator avoidance strategy, diet), with species that share similar traits expected to respond to environmental change in a similar way (Langlands et al., 2011). Linking species with shared traits (i.e. trait groups) to particular environmental conditions may enable managers to apply generic approaches to conserving multiple species and reduce the need for detailed species-specific knowledge. Despite the demonstrated value of forming species trait groups based on multiple traits for understanding the effects of disturbance on plants (e.g. McIntyre, 2008), the concept has been less frequently used for studies on fauna (although see Davies et al., 2010; Langlands et al., 2011; Cumming et al., 2012; Hanspach et al., 2012). As the number of threatened species increases in response to ongoing anthropogenic degradation, there is an

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http://dx.doi.org/10.1016/j.biocon.2015.11.033

urgent need to manage disturbance regimes for maximum biodiversity benefit despite a lack of autecological data.

Grassy habitats are a good system in which to investigate the utility of trait-based approaches for managing species. Grassy habitats are biodiverse, in many case have been dramatically altered by human activity, and support species with a range of disturbance tolerances (Milchunas et al., 1988; Bond and Parr, 2010). Anthropogenic impacts leading to changes in the abundance and type of grazers have a profound effect on biodiversity in these systems (Gordon et al., 2004; Mysterud, 2006; Foster et al., 2014). For example, the suppression of grazer abundance (e.g. overexploitation and fencing) can allow a few fast growing plants to competitively dominate, leading to a decline in plant diversity and reduction in habitat complexity (Milchunas et al., 1988; Gordon et al., 2004; Mysterud, 2006). Conversely, with a loss of population regulation (e.g. animal husbandry, loss of large predators, barriers to migration, provision of permanent water), grazer numbers may be inflated, resulting in increased consumption of plant matter, leading to a decline in grazing-sensitive plants, and simplification of vegetation structure (Milchunas et al., 1988; Gordon et al., 2004; Mysterud, 2006). Changes in the abundance and type of grazing animals can dramatically alter the structure, function and species composition of grassy habitats (Milchunas et al., 1988; Mysterud, 2006; Foster et al., 2014), with knock-on effects on biodiversity (Gordon et al., 2004; Foster et al., 2014). Surprisingly few studies have investigated the effects on biota of a native grazer across a range of grazing intensities (reviewed by Foster et al., 2014) despite the potential for such data to provide important insight into the restoration of 'natural' grazing regimes (Hester et al., 2000; Gordon et al., 2004). Importantly, the impact of native grazers may differ to those of domestic livestock or feral herbivores because native grazers are more likely to mimic the natural grazing regime under which ecosystems evolved (Foster et al., 2014). Addressing the lack of data from systems dominated by native grazers is a priority for land managers because good management relies on understanding the interactions among grazing, grass structure and biodiversity.

Birds are useful for investigating the utility of a trait-based approach because they are diverse, occupy many ecological niches, are mobile, and are well researched (Söderström et al., 2001; Derner et al., 2009; Davies et al., 2010). Importantly, some birds are sensitive to changes in grazing intensity (Martin and Possingham, 2005; Foster et al., 2014), but the effects of grazing may vary depending on bird life history characteristics and environmental conditions. For example, Davies et al. (2010) found that most bird species declined as grazing intensity increased in semi-arid grassy habitats in Australia, with the largest decreases found for ground-foraging and ground-nesting species, while shrub-dwelling species declined the least. In contrast, studies in grassy habitats in Australia have found that ground-foraging species may benefit from the open grass layer created with grazing, whereas shrub-dwelling species declined at high grazing intensities (Woinarski and Ash, 2002; Martin and Possingham, 2005; Martin and McIntyre, 2007) likely due to the negative effect of grazing on shrub occurrence. While these studies have made an important contribution to understanding effects of grazing by domestic livestock on birds in Australia, they have rarely provided quantitative measures of grass structure (e.g. grass biomass) needed by conservation managers to appropriately manage grazing pressure (Gordon et al., 2004). These previous studies also have been concerned with the effects of grazing by domestic livestock rather than a native grazer, which is the focus of this study. Importantly, the impacts of native large grazers on birds also may differ due to differences in feeding behavior and plant preferences (Tiver and Andrew, 1997). In south-eastern Australia, the dominant large native grazer is the eastern gray kangaroo, *Macropus giganteus* (hereafter: kangaroo) (Taylor, 1983).

Kangaroo abundance has increased in many areas (Grigg et al., 1989; ACT Government, 2010) as a consequence of anthropogenic changes such as the provision of permanent water (e.g. dams), removal of native predators, fragmentation of habitat, and increase in pasture quality and quantity. The impacts of kangaroo grazing on birds remain largely unknown, although impacts on other groups have been reported (e.g. plants; Meers and Adams, 2003; McIntyre et al., 2010; beetles; Barton et al., 2011; reptiles; Manning et al., 2013; Howland et al., 2014; Howland et al. in press). This lack of knowledge on the effects of kangaroo grazing on birds, limits effective management of grazing pressure for the conservation of birds.

We aimed to address this lack of knowledge by using a trait-based approach to investigate the impacts of a native grazer on birds occurring in the grassy ecosystems in south-eastern Australia. The main mechanism by which large grazers influence birds is through altering vegetation structure (Whittingham and Evans, 2004; Martin and Possingham, 2005) (notwithstanding more direct impacts, e.g. trampling of nests and habitat; Fondell and Ball, 2004). Changes in vegetation structure can affect bird survival through known effects on foraging efficiency, nesting success, and predation risk (see Table 1). Additionally, the impacts of grazing may vary depending on bird size, as body size affects both the size and quantity of food consumed (Brandle et al., 1994; Soderstrom et al., 2001). We surveyed birds along a gradient of kangaroo grazing intensity to test three hypotheses. First, birds with particular traits will show preference for certain levels of grazing intensity. We predicted that ground-foraging species, birds that forage in the air above the grassy layer and ground-nesting species would be vulnerable to changes in grazing intensity because species with these traits utilize the grass layer for food and shelter. Second, bird species within the same trait group will show preferences for a similar grazing intensity. We anticipate that species within the same trait group will show preferences for a similar grazing intensity due to shared life history and autecological characteristics. Third, different bird trait groups will favor different grazing intensities. We anticipate that ground-foraging species which rely on early detection of predators would be more likely to utilize the grassy layer at higher grazing intensities (where detection of prey and predators is higher due to sparse grass cover), whereas birds that forage in the air above the grass layer, ground-nesting species and species that rely on concealment to avoid predation would show preference for lower grazing intensities where there is more prey and cover. We also expect that larger birds will favor comparatively lower grazing intensities than smaller birds as they require more food and feed on larger food items, with both food abundance and food size potentially reduced by heavy grazing (Brandl et al., 1994; Söderström et al., 2001; Woodcock et al., 2009). We used these results to provide recommendations for the management of grazing pressure for the conservation of birds in grassy habitat in south-eastern Australia.

## 2. Materials and methods

### 2.1. Study system

Our study was conducted within temperate grasslands and box-gum grassy *Eucalyptus* woodland communities across south-eastern Australia (Fig. 1a). These habitat types are listed as critically endangered ecological communities (Department of the Environment and Heritage, 2014), and occur mostly as small patches (<100 ha), that are fragmented by roads, urban development and agricultural land-use (Prober and Thiele, 2005). We selected 18 large properties (>100 ha) across Australian Capital Territory (n = 14), New South Wales (n = 2) and Victoria (n = 2), where temperate grassland and grassy *Eucalyptus* woodland communities persist (Fig. 1b). The study area was dominated by temperate woodlands (dominant canopy spp.: *Eucalyptus blakelyi*, *Eucalyptus melliodora*, *Eucalyptus albens*) and dry forest (*Eucalyptus macrorhyncha*, *Eucalyptus mannifera*). Lower vegetation strata were simple, and dominated by native perennial grasses (*Austrostipa* spp., *Bothriochloa macra*, *Rytidosperma* spp., *Themeda triandra*) and forbs, with exotic perennial grasses (*Eragrostis curvula*, *Phalaris aquatica*) locally abundant. While properties were selected over a wide geographic area, many of the same species of bird occur throughout this region. We did not consider these geographic