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The relative importance of habitat quality and landscape context for reptiles in regenerating landscapes

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ABSTRACT

Restoration activities are limited by funding and logistics. To optimise restoration efforts, we need to evaluate the effects of management actions on wildlife populations. In general, site-scale habitat quality has a stronger influence on habitat use by fauna than the landscape context. However, this is yet to be empirically tested for reptiles. In this study, we used model averaging and hierarchical partitioning to compare the relative importance of site-scale habitat quality and landscape context for reptile communities and species in a regenerating woodland landscape in semi-arid Queensland, Australia. Reptiles were surveyed at 55 sites. Habitat quality was assessed using relevant variables based on published habitat-associations for each species or group. Landscape context was assessed using binary, mosaic and continuous descriptions of vegetation cover within 250 m of the survey sites. We found that, in comparison to site-scale habitat quality, the composition of the surrounding landscape had little influence on reptiles, despite testing three alternative approaches for describing landscape context. Nine out of eleven reptile species and groups responded to variation in habitat quality, whereas just one species responded to variation in landscape context. Species richness, diversity, and abundance were unaffected by landscape context, but were influenced by site-scale structural complexity and vegetation type. Our findings suggest that reptiles, in general, benefit from conservation and restoration activities that focus on improving site-scale habitat quality, with increasing the amount and connectivity of surrounding vegetation of lesser value. This study also highlights the importance of better understanding the drivers of reptile distributions and abundances in dryland landscapes.

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1. Introduction

Restoration activities are limited by their logistic capacity and funding availability (Sutherland et al., 2004). Therefore, to ensure that efforts are appropriately prioritised, the benefits of restoration and conservation options at the site (<1 ha) and landscape (10–1000s ha) scale need to be critically evaluated. Across taxa, site-scale habitat quality has a consistently greater influence on fauna than landscape context (Abensperg-Traun et al., 1996; Bergman et al., 2008; Bowen et al., 2009; Bowman et al., 2001; Weyrauch and Grubb, 2004). However, such comparisons are not currently available for reptiles. Atauri and de Lucio (2001); Fischer et al. (2004a) and Cunningham et al. (2007) indicate that site-scale habitat quality, in terms of the availability of resources, may also be more important for reptiles than the structure of the surrounding landscape. If so, then conservation and restoration activities will achieve greater benefits for reptiles by focusing on improving site-scale habitat quality, with increasing the amount and connectivity of habitat being a secondary priority.

Landscapes are spatially-defined mosaics of habitat elements that differ in quality and configuration (Wiens, 1999). Landscape context is the amount and spatial configuration of habitat elements in relation to a site. To study the effect of landscape context on reptiles, intact (or remnant) vegetation is generally used as a surrogate for suitable habitat, with species richness positively influenced by the amount of intact vegetation in the landscape (Cunningham et al., 2007; Lindenmayer et al., 2005; Mac Nally and Brown, 2001). However, the connectivity of intact vegetation and the spatial heterogeneity of vegetation cover generally have little influence on reptiles (Driscoll, 2004; Fischer et al., 2004a; Jellinek et al., 2004; Mac Nally and Brown, 2001). These findings, which are based on discrete landscape conceptualisations, suggest that the matrix may not be impermeable or hostile for many reptile species (Franklin and Lindenmayer, 2009; Kupfer et al., 2006; Ricketts, 2001), and/or discrete landscape models may poorly reflect how reptiles perceive and use the landscape (Franklin and Lindenmayer, 2009; Manning et al., 2004). To better understand the influence of landscape context on reptiles, it is imperative that, as suggested by Lindenmayer et al. (2007), multiple landscape conceptualisations (discrete and continuous) are considered during analyses, and that landscape patterns are mapped using land cover variables that are relevant to the ecology of reptiles (Bruton et al., 2015; Manning et al., 2004).

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For effective conservation and restoration planning, habitat quality should be defined from the point of view of the taxon of interest (Dennis et al., 2003; Manning et al., 2004; Mortelliti et al., 2010). Reptiles are typically hypo-metabolic (low-energy) specialists that require minimal amounts of food and water for survival (Pough, 1983). However, due to their inability to sustain or rapidly recover from aerobic activity, reptiles require reliable access to shelter resources to avoid predation (Pough, 1980, 1983); with shelters, such as burrows, and bushy shrubs, identified as key habitat resources (e.g. Beck and Jennings, 2003; Grillet et al., 2010; Lagarde et al., 2012). Reptile diversity and abundance are positively correlated with site-scale structural heterogeneity (Brown, 2001; Fischer et al., 2004a; Kanowski et al., 2006), and reptile species generally respond positively to the increased availability of shelter resources (Bonnet et al., 2012; Grillet et al., 2010; Souter et al., 2004). These findings suggest that the availability of suitable shelter resources may be an effective, but little used, proxy for reptile habitat quality.

Regenerating landscapes are landscapes containing vegetation patches that have been cleared and are now on a successional trajectory, through either passive or active regeneration (Parkes et al., 2012). Regenerating landscapes are usually created when agricultural lands are abandoned (Bowen et al., 2007; Hobbs and Cramer, 2007). Such landscapes offer an opportunity to assess the potential for alternative revegetation strategies to benefit fauna during regeneration, and once vegetation has reached maturity (Polyakov et al., 2011). Cunningham et al. (2007) found that the cover of planted trees had a negative relationship with reptiles in regenerating landscapes due to a lack of ground structure, whereas Bruton et al. (2013) found that the habitat value of passive regrowth vegetation in regenerating landscapes is high where ground-level habitat structures are retained. This suggests that the structure of vegetated areas, rather than vegetation status per se, may be the key determinant of habitat suitability for reptiles in regenerating landscapes.

In this study, we addressed the question: what are the relative importance of site-scale habitat quality and landscape context for reptile communities and species in regenerating landscapes? To address this question, we applied an information-theoretic model averaging approach, with variables derived from multiple alternative landscape conceptualisations (Bruton et al., 2015; Lindenmayer et al., 2007; Price et al., 2009). Our findings suggest that reptiles in regenerating landscapes will benefit from conservation and restoration activities that focus on improving site-scale habitat quality.

2. Methods

2.1. Study area

We assessed the relative importance of habitat quality and landscape context for reptiles in a regenerating semi-arid woodland landscape in subtropical Queensland, Australia (Fig. 1). The study area is a 34 000 ha conservation reserve. As a former cattle and sheep grazing property, it consists of a mosaic of cleared paddocks, areas of passive regrowth, and intact woodlands (Fig. 1). The woodlands can be broadly classified as *Acacia*- or *Eucalyptus*-dominated ecosystems (Bruton et al., 2015; Sattler and Williams, 1999). The *Acacia*-dominated ecosystems are relatively dense woodlands dominated by bendee *Acacia catenulata* and mulga *Acacia aneura*, with a sparse understory, limited ground cover, and abundant fallen timber. The *Eucalyptus*-dominated ecosystems are open woodlands dominated by poplar box *Eucalyptus populnea*, with a shrubby understory of false sandalwood *Eremophila mitchellii*, wilga *Geijera parviflora*, and/or cassia *Senna artemisioides*, abundant grass cover, and large hollow logs. For further details about the vegetation and the history of the study area see Bruton et al. (2013).

2.2. Reptile surveys

Reptiles were surveyed at fifty-five sites (Fig. 1) over twelve days (3 rounds of 4 days) during the warm seasons (Oct–Apr) of 2010/11 and 2011/12 as described in Bruton et al. (2013). We used a passive survey approach, with 4× unbaited pitfall and 4× unbaited funnel traps and 14 m of drift fences at each site (Fig. 2). Sites were randomly located with respect to natural and manmade features, and varied from 40 to

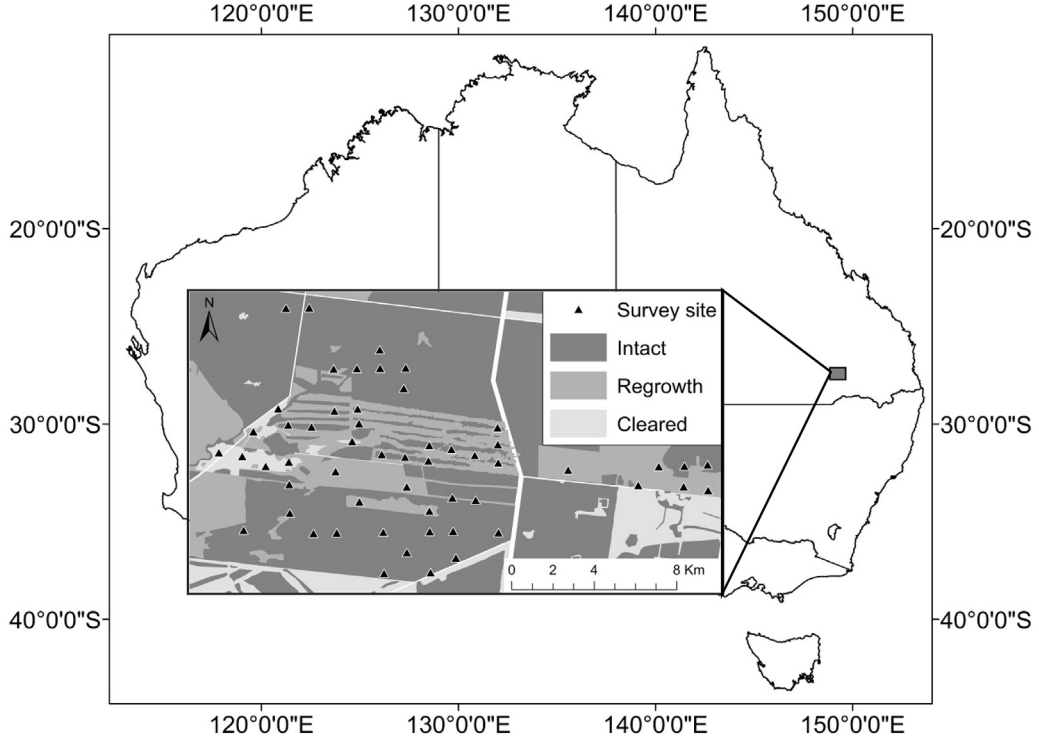

Fig. 1. Study site location in southern Queensland, Australia; with the survey sites. Here, the landscape is depicted using a landscape mosaic based on woodland clearing status, with polygons derived from Regional Ecosystem mapping (Queensland Government, 2010b) and aerial photography.

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