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The effect of land-use on small mammal diversity inside and outside the Great Fish River Nature Reserve, Eastern Cape, South Africa

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ABSTRACT

This study investigated small mammal species diversity at 10 paired contrast sites along a fence line inside and outside the Great Fish River Nature Reserve (GFRNR), Eastern Cape, South Africa. The sites outside the GFRNR are used for subsistence land-based activities including livestock production and fuelwood harvesting. From 145 live captures, a total of 114 unique individuals of five small mammal species (four rodents and one elephant shrew) were recorded over 1170 trap nights. Average small mammal species diversity and abundance were significantly higher inside the reserve than outside. Human activities such as livestock grazing seemed to explain low levels of small mammal diversity and abundance at the communal sites. Vegetation variables showed a complex interplay with small mammal diversity. In general, high vegetation diversity had a positive influence on small mammal diversity though the influence of some environmental variables was species-dependent. We conclude that the GFRNR is effective in protecting small mammals but the findings raise questions around the influence of land use practices such as livestock grazing on biodiversity, especially given that local communities in South Africa are continuously seeking greater access to reserves for livestock grazing and other provisioning services.

1. Introduction

Land use practices such as crop farming and livestock production affect habitat characteristics through changes in vegetation structure (Eccard et al., 2000; Pedó et al., 2010), with subsequent implications on other elements of biodiversity such as small mammal species. Over the last few decades, protected areas have been considered key in conserving biodiversity from these anthropogenic impacts – a rationale that has been used to extend areas under protection and restrict extractive use of natural resources (Hansen and DeFries, 2007; Miller et al., 2011; Pimm et al., 2014). However, given that protected areas need to be ecologically connected to the landscapes around them (Harvey et al., 2008), they should not be viewed as or become islands of biodiversity in a sea of degraded land (Chazdon et al., 2009; Salafsky, 2011). In some cases, perceiving protected areas as conservation islands may be a misconception as demonstrated by Fabricius et al. (2003) who found that communal areas perceived as having low plant diversity, do sustain a considerable diversity of reptile species (see also Caro, 2001). Given the empirical evidence of high biodiversity outside of protected areas, there has been a renewed interest in integrative management strategies between protected areas and surrounding landscapes (Hirsch et al., 2011; Miller et al., 2011; Minteer and Miller, 2011).

However, the debate around possibilities for integrated management of protected areas and surrounding areas is often undermined by a deficit of information regarding the status of biodiversity in human-modified landscapes (Chazdon et al., 2009). In South Africa, approximately a third of protected areas are under land claims (Paterson, 2011; Cundill et al., 2013) by local people and most of these claims are motivated by the need for extractive use of reserve resources such as fuelwood harvesting, medicinal plant collection and livestock grazing (Cundill et al., 2013). However, there is a lack of quantitative information on the biodiversity status of these areas and the impact these extractive land uses may have on protected areas. Most biodiversity surveys have predominantly focussed on vegetation surveys, specifically plant species diversity and community compositions (e.g. Lechmere-Oertel et al., 2008; Hanke et al., 2014) primarily in protected areas (Fazey et al., 2005 cited in Chazdon et al., 2009) and as fence-line contrasts between

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protected areas and inhabited areas (Todd and Hoffman, 1999; Lechmere-Oertel et al., 2008). Therefore, the various potential integrated conservation options in these areas can be better evaluated when the biodiversity status is fully investigated and understood to make informed conservation decisions (Hirsch et al., 2011; Miller et al., 2011; Salafsky, 2011).

One approach to assessing biodiversity would be via small mammal species surveys. As with plant diversity surveys, small mammal species surveys are increasingly being used to determine the influence of various land use regimes and practices on this aspect of biodiversity (i.e. small mammal diversity) (Joubert and Ryan, 1999; James, 2003; O'Farrell et al., 2008; Pedó et al., 2010). The rationale behind choosing small mammal surveys is that there are considerably fewer species to identify than plant species (Bergh et al., 2014).

It is imperative to keep in mind that small mammal surveys, as with other faunal surveys, assess another aspect of biodiversity and cannot be viewed as a substitute for plant species surveys. Further, while it is possible that small mammal surveys could be used as a proxy for comparing protected areas and communal areas, generalisations may be problematic because species respond differently and species response is dependent on the length of time since the habitat was altered and the type of disturbance (Caro, 2001). For example, in the area under study, the Great Fish River Nature Reserve (GFRNR), fence-line diversity studies by Fabricius et al. (2002, 2003) showed mixed results. Arthropod diversity was greater inside the reserve than outside, while reptile diversity was similar between the two land uses yet there was a greater diversity of snakes and lizards outside than inside the reserve. Moreover, the type of organisms that occurred in each land use differed, with the protected area having more mesic adapted lizards and herbivorous arthropods, while the communal rangelands had predatory arthropods and xeric adapted reptiles (Fabricius et al., 2003). Therefore, fence-line contrasts of small mammal diversity could provide valuable insights relating to this particular facet of biodiversity in the reserve and on surrounding communal land.

The objectives of this study were two-fold; first, to measure species diversity, richness and abundance of small mammals inside and outside the GFRNR using live trapping and; second, to explore the influence of various vegetation characteristics on small mammal diversity, richness and abundance. We hypothesized that small mammal diversity would be greater inside the reserve than the surrounding communal areas.

2. Methods

2.1. The study area

The sites for this study were inside and outside the GFRNR at approximately 33°08′52″S, 26°94′70″E in the Eastern Cape province of South Africa. The GFRNR - a designated conservation area of approximately 45 000 ha is situated between the towns of Grahamstown and Fort Beaufort (Fig. 1). The area forms part of the Albany Thicket biome which falls between two climatic regions, namely the all year rainfall zone in the west and the summer-rainfall zone in the northeast, thus rainfall is highly variable with an average of 420 mm per annum (Fabricius et al., 2002; Mucina and Rutherford, 2006). There are 14 vegetation units which form part of the Albany Thicket Biome and the area contains primarily Great Fish thicket which has a high level of heterogeneity with short, medium and tall thicket types all occurring (Mucina and Rutherford, 2006). Woody trees, shrubs, many of which are spinescent, as well as the succulent component are represented, with Great Fish Noorsveld occurring to a lesser extent (Mucina and Rutherford, 2006).

Land uses around the GFRNR include privately-owned land and communal land (Glenmore, Ndwavana, Tyefu, Qamnyana, Sheshegu, Gwabeni and Gcabasa) for livestock farming (Fabricius and Burger, 1997; Fabricius et al., 2003). The GFRNR itself was designated in 1976 and expanded in 1986 from land that was originally privately-owned commercial farmland which stocked livestock such as cattle (*Bos taurus*), goats (*Capra aegagrus hircus*) and sheep (*Ovis aries*) (Fabricius et al., 2002). However, currently resource use in the reserve such as fuelwood harvesting, grass cutting and livestock grazing is strictly prohibited though this is contested by local communities (Odindi and Ayirebi, 2010). Studies by Fabricius and Burger (1997) and Fabricius et al. (2002) warn that the greatest threat to the vegetation in this area is overgrazing by livestock on commercial farms and overgrazing combined with overharvesting of natural resources such as fuelwood by people in the communal areas. According to Fabricius and Burger (1997), overgrazing on the communal land adjacent to the reserve may be linked to the high population density (70 people per km^2), and high stocking rates of cattle reported to be less than 2 ha/LAU (Forbes and Trollope, 1991 cited in Fabricius et al., 2002). Unlike livestock farming, crop production is not practiced in this region. Social challenges, similar to many communities living adjacent to reserves in South Africa, include unemployment and land claim grievances (Fabricius and Burger, 1997; Cundill et al., 2013). These land claim grievances originate from forced removals that took place during the apartheid regime, from land that is now part of the GFRNR (Fabricius and Burger, 1997).

2.2. Small mammal trapping

Study sites depicting differences in the intensity of grazing on each side of the fence-line were selected after discussions with reserve officials, local community leaders and based on ‘ground truthing’ of potential sites. Small mammals were trapped over the course of four months from April to July 2014 with sampling at 10 paired contrast sites for three consecutive nights at each site (Caro, 2001; O'Farrell et al., 2008). At each site, a trap grid was laid out with 19/20 traps (in a 2 × 10 m configuration) with 1 m separating the two columns and 5 m separating each row (Caro, 2001; Avenant, 2011). Each of the 10 reserve sites was placed 100 m away from the fence line and paired with an identically laid out communal site. Small mammals were trapped using PVC live traps (Kryštufek et al., 2008). Throughout the sampling process traps were baited with a mixture of peanut butter and roasted oats (Caro, 2001; Kok et al., 2012). In line with accepted ethical standards, cotton wool balls were added to the traps during colder periods to serve as nesting material (Kok et al., 2012). Traps were opened and baited between 15:00 and 17:00 in the afternoon and checked and closed between 7:00 and 9:00 the following morning (O'Farrell et al., 2008).

All the individuals captured were weighed using a spring-loaded scale and photographed and their tail and body length measurements were recorded for later identification (Stuart and Stuart, 2001; Skinner and Chimimba, 2005). We used a permanent marker to mark captured individuals on the reserve and communal sites, with three and two stripes on their tail respectively to avoid double counting from recaptures and to allow for verification of the independence of the two sites (Caro, 2001; Kok et al., 2012).

2.3. Measurement of environmental variables

At each 50 m × 10 m trap grid inside and outside the reserve, two 10 m × 10 m plots at either end of the trap grid were surveyed for environmental variables. Four variables for three types of