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Habitat selection of the Mauritian lowland forest day gecko at multiple spatial scales: A baseline for translocation

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ABSTRACT

Of 30 known subpopulations of *Phelsuma guimbeaui*, 18 are in patches of exotic forest and are predicted to disappear in the next decade. One possible means of mitigating the reduction in genetic diversity associated with the loss of subpopulations is to translocate "at risk" subpopulations to more secure habitats. Prior to any such intervention, it is important to identify a species' basic ecological needs. We had three main objectives: to calculate home range sizes of adult geckos; characterise habitat selection among age groups; and identify the order of importance of each habitat predictor. Habitat selection of *P. guimbeaui* was explored at the population, home range and microhabitat levels. Males had larger home ranges than females, and overlapped temporally with more females than males. We showed that habitat selection differed between age groups. In order of importance, tree diversity, tree species, tree height, trunk dbh and cavity density were important habitat predictors. We discuss how these data can be used to inform the choice of sites for the translocation of threatened subpopulations. Our results also highlight the importance of undertaking habitat restoration for the long-term conservation of the 12 subpopulations that survive in patches of endemic forest.

1. Introduction

Habitat selection is "the process of choosing a habitat" (Johnson, 1980) and is key to understanding animal behaviour, population dynamics (Strickland and McDonald, 2006), animal-habitat associations essential for reproduction and survival (Manly et al., 2002), and ultimately for informing species management. Identifying the critical spatial needs of threatened species allows more efficient management and conservation plans to be developed. Habitat selection is usually explored at hierarchical spatial scales (De La Cruz et al., 2014; Hódar et al., 2000; Oppel et al., 2004) because selection can

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vary with scale (Johnson, 1980). Thomas and Taylor (1990) identified three spatial scales: the population level, where habitat selection is inferred at a landscape level or within the study area; the home range level, which involves the selection of a home range within an area; and the microhabitat level, which represents selection of a particular habitat resource within the home range. The combined use of different hierarchical scales helps identify important predictors of habitat use (Beasley et al., 2007) and is essential for species management (Razgour et al., 2011).

In Mauritius, endemic reptiles provide a range of key ecological services such as pollination and seed dispersal, and are important prey species (Cheke and Hume, 2008; Hansen and Müller, 2009). Only five of 17 endemic reptile species still persist on mainland Mauritius (Arnold, 2000; Austin et al., 2004; Rocha et al., 2009), and of these *Phelsuma guimbeaui* (lowland forest day gecko) is the most vulnerable to extinction (Buckland et al., 2014a,b). It isrestricted to 30 small and isolated subpopulations (Supplementary data Fig. A1 in Appendix A). Effective population size (i.e. the number of individuals that can potentially breed in a randomly mating population) ranged between 44 and 167 for ten of these subpopulations (Buckland et al., 2014b). Based on habitat area, the other 20 subpopulations are likely to have effective population sizes within this range. Habitat loss appears to have been the main cause of the decline and fragmentation of *P. guimbeaui* populations.

Several invasive predators and competitors also threaten subpopulations of *P. guimbeaui* and other endemic species of *Phelsuma* (Cheke and Hume, 2008; Cole and Harris, 2011). The recent introduction of *Phelsuma grandis* (giant Madagascar day gecko), an ecologically similar introduced gecko predator/competitor (Cole, 2009; Buckland et al., 2014a), and continuing habitat degradation and genetic erosion (Buckland et al., 2014b), are likely to cause further population declines. Of the 30 remaining subpopulations, 18 are in patches of exotic forest and at imminent risk of extinction (Buckland et al., 2014b), while the other 12 are in patches of high quality native forest surrounded by unsuitable invaded forests (Supplementary data Fig. A1 in Appendix A). One potential management option is to translocate geckos from some or all of the 18 threatened subpopulations of *P. guimbeaui* to better quality habitats that are not at risk of further erosion or loss (Buckland et al., 2014b). However, matching habitat suitability and availability at a potential release site to a species' needs is central to a translocation or reintroduction programme (IUCN, 2012).

We quantified habitat selection by *P. guimbeaui* with a use-availability design at three hierarchical spatial scales (Thomas and Taylor, 1990) to inform potential management decisions. First, home range sizes and pattern of temporal overlap were compared between the sexes. We hypothesised that *P. guimbeaui* would be similar to other Mauritian *Phelsuma* species in that male home ranges would be larger, overlapping with several females but avoiding other males (Gerner, 2008). Since age may also influence habitat selection (Alldredge and Griswold, 2006), population-level habitat selection was compared between age groups. Since *P. guimbeaui* is arboreal, we expected that individual tree characteristics and species diversity would influence selection. Due to size differences between the age groups, we predicted adults would be selecting habitats with higher tree diversity, more cavities, and taller trees with a higher diameter at breast height (dbh) (Harmon et al., 2007). Finally, we investigated the order of importance of each habitat predictor for *P. guimbeaui* at the three different levels, as well as differences between sexes at the home range and microhabitat level. We hypothesised that *P. guimbeaui* would show a strong selection for habitat heterogeneity, particularly high tree diversity and tall trees with a large dbh and high cavity density (Bungard, 2000; Cole, 2005; Harmon et al., 2007). We then used these data to make recommendations for the conservation of *P. guimbeaui*.

2. Study area

The study was conducted between 1 June 2010 and 20 May 2011 in the Black River mountains in southwest Mauritius (Supplementary data Fig. A1 in Appendix A). The study site was selected because it is one of the most undisturbed dry forests (Page and d'Argent, 1997) in which *P. guimbeaui* still survives. The study site was 0.5 km^2 in size and the elevation ranged between 213 and 223 m; monthly rainfall varied from 0.0 to 357.4 mm and average monthly temperature from 21.7 to 27.6 °C. Based on monthly rainfall data, the dry season was from June 2010 to December 2010 (monthly mean ± SE 12.1 ± 4.2 mm, range 0.0–31.0 mm, $n = 7$), and the rainy season from January 2011 to May 2011 (mean ± SE 182.7 ± 60.2 mm, range 22.3–357.4 mm, $n = 5$).

3. Materials and methods

3.1. Study species

P. guimbeaui is sexually dimorphic. Adult males have a snout-to-vent length (SVL) of 45–60 mm, distinctive hemipenal swellings at the base of the tail and bright colouration. Adult females are smaller, with a SVL length of 40–50 mm, no hemipenal swellings, occasional calcium sac swellings on the neck, and a pear-shaped body with moderately bright colouration. Sub-adults have a SVL length of 40–45 mm with indistinct adult colouration and no sexual characteristics, and juveniles have a SVL length of <40 mm with dull greyish colouration. The different age groups were easily differentiated in the field using these features.

P. guimbeaui is restricted to the western part of mainland Mauritius. There are 30 known subpopulations occupying small isolated fragments of habitat ranging from 0.006 to 1.0 km^2, with a combined area of 10.3 km^2 (Buckland et al., 2014b). Some subpopulations occur in sympatry with *P. ornata* (ornate day gecko) and *P. cepediana* (blue-tailed day gecko).