

## Research Paper

# Factors affecting presence of vervet monkey troops in a suburban matrix in KwaZulu-Natal, South Africa

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## ABSTRACT

Globally with increased urban development, understanding spatial habitat requirements of urban-dwelling wildlife is increasingly important for conservation management. Consequently, we determined the factors that influence the presence of vervet monkeys (*Chlorocebus pygerythrus*) in urban landscapes. Firstly, we hypothesized that troop size is influenced by seasonality, residence type, proximity to water sources and food provisioning. Secondly, we hypothesized that the resting behaviour of vervet troops is influenced by natural factors, including the presence/absence of raptor nest(s) and man-made structures including the distance to the nearest main road. Thirdly, we hypothesized that resting by vervet monkey troops would be influenced by the seasons, the distance to the nearest main road (due to the relative openness) and the residence type. Fourthly, we hypothesized that foraging by vervet monkey troops is influenced by food provisioning and bird feeders. Finally, we hypothesized that playing by vervet monkey troops are influenced by the presence/absence of a raptor nest (s), a dog(s) and the residency type. From June 2013 through May 2014 observations were conducted on vervet monkey troops in 20 suburban gardens in the Ethekwini and Msunduzi municipalities of KwaZulu-Natal, South Africa, following a standardized group scan sample method. The observation data were analyzed to determine population-level patterns of landscape use and key suburban landscape features influencing seasonal behaviour, troop size and sex ratios of vervet monkey troops. Mean troop size ( $29 \pm 3.4$  (SE) individuals) was influenced by female and juvenile numbers and sex ratio varied across study sites. Behavioural observations (foraging, grooming, playing) were more frequent during winter in gardens with high tree density, and a preference for visitation was found in gardens closer to roads, and where food was provisioned. Probability of foraging, grooming and playing was higher in gardens with greater canopy cover, however this decreased with increasing troop size. Probability of resting decreased with increasing distance from indigenous forest patches and roads. Gardens experienced high levels of raiding. Understanding vervet monkey spatial ecology within a transformed landscape contributes to determining sustainable ways to mitigate conflict and manage their populations in suburbia.

## 1. Introduction

Urbanisation involves one of the most extreme forms of landscape change, in some cases leading to a complete restructuring of fauna and flora composition, and is thus a major concern in conservation biology (McKinney, 2002). In particular, local wildlife and vegetation diversity generally decline with increasing urbanisation (Lepczyk et al., 2008; McGill, Dornelas, Gotelli, & Magurran, 2015; McKinney, 2002; Villaseñor, Driscoll, Escobar, Gibbons, & Lindenmayer, 2014). Research on non-human primates (hereafter referred to as 'primates') shows that fragmentation and conversion of primate habitats increases in human-dominated landscapes (Strum 2010; Priston and McLennan 2013).

These changes are the primary driving forces behind human-primate conflicts and one of the greatest threats to primate survival worldwide (Laurance et al., 2002). Additionally, urbanization may compromise the conservation of urban-adapted primate species by spatially restricting and concentrating their urban populations, leading to increased intra-species conflicts and disease transmission (Patz et al., 2004). Despite these challenges, some species are able to adapt and persist in urban ecosystems (Aronson et al., 2014; Marzluff & Rodewald, 2008). Primates display a large diversity of traits, several of which enable disturbance-tolerance. In particular, behavioural and ecological flexibility in diet, home range and group size may explain their ability to thrive in human-dominated landscapes (Albert, McConkey, Savinni, & Huynen,

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2014; Marini et al., 2012). These factors may pre-adapt some Cercopithecine species for survival in regions with altered habitat structure, patchy resource distribution, and limited fruit resources (Isaac & Cowlishaw, 2004). Recently six key ecological traits associated with adaptability, and therefore disturbance-tolerance, were identified: a diet not dominated by fruit, use of multiple vegetation types, semi-terrestrial locomotion, frequent use of cheek pouches, large and variable home ranges and variable group size (Albert et al., 2014).

Most research on vervet monkeys (*Chlorocebus pygerythrus*) has focused on wild troops (Pasternak et al., 2013; Struhsaker, 1967). To date few urban ecological studies have been conducted on this species. Despite increasing urban development in KwaZulu-Natal (KZN), South Africa, important ecological factors in urban areas have allowed the indigenous vervet monkeys to persist, however urban sprawl has significantly increased human interactions with them, resulting in conflict (Wimberger, Downs, & Boyes, 2010; Wimberger, Downs, & Perrin, 2010). Vervet monkeys are habitat generalists and regularly roost and forage in office parks, along busy roads and in suburban gardens in the cities of Durban and Pietermaritzburg in KZN (Basckin & Krige, 1973). Therefore, their urban presence may be significant in urban wildlife ecology (Fuentes & Wolfe, 2002). Despite the loss of suitable natural habitat, vervet monkey urban persistence may be a consequence of alternative and/or accessible feeding opportunities in human-dominated landscapes, and increased availability and access to water within close proximity to anthropogenic food sources (Wolfheim, 1983; Wrangham, 1981). Negative human perceptions of urban vervet monkeys are generally based on the vervet monkeys' raiding of homes, gardens and refuse (Patterson, Kalle, & Downs, 2016; Patterson, Kalle, & Downs, 2017). This vervet monkey behaviour often leads to human-monkey conflict and with them often treated as pests by many urban residents, resulting in retaliatory killings in various documented cases (Wimberger, Downs, & Boyes, 2010; Wimberger, Downs, & Perrin, 2010). The health, safety and welfare (economic and social) of residents may also be undermined by conflicts with vervet monkeys sharing human resources (Barua, Bhagwat, & Jadhav, 2013). Therefore, vervet monkeys stand as a model species for understanding urban wildlife persistence within the context of continued human-dominated landscape transformation.

Given the lack of knowledge, our goal was to determine whether there are specific factors that influence the presence of vervet monkeys in urban landscapes. Understanding the factors that promote the success of urban species is necessary if we are to gain an understanding of the factors that shape urban wildlife communities and provide recommendations to urban planners and concerned citizens to allow retention or enhancement of urban wildlife communities (Stracey, 2011). Studying the behavioural aspects of problem wildlife aids in managing conflict issues in urban areas. To address our goal, we sought to test five hypotheses. Firstly, we hypothesized that troop size is influenced by seasonality, residence type, proximity to water sources and food provisioning. Based upon our prior vervet monkey studies (Patterson et al., 2016, 2017), we predicted that troop size would be higher in winter, housings, close to water sources and where food was provisioned. Secondly, we hypothesized that the resting behaviour of vervet troops is influenced by natural factors, including the presence/absence of raptor nest(s), and man-made structures including the distance to the nearest main road. We predicted that resting would decrease with increasing distance from indigenous forest patches and roads. Thirdly, we hypothesized that resting by vervet monkey troops would be influenced by seasons, the distance to the nearest main road (due to the relative openness), and the residence type. We predicted that resting would be higher in summer, further from main roads, and in houses with gardens. Fourthly, we hypothesized that foraging by vervet monkey troops is influenced by food provisioning and bird feeders. Considering Patterson et al. (2016, 2017) we predicted that foraging would increase with food provisioning and bird feeder presence. Finally, we hypothesized that playing by vervet monkey troops are influenced by the presence/

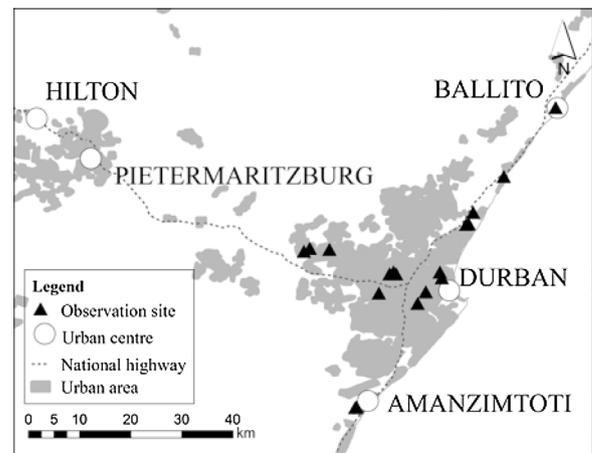


Fig. 1. Locations of observation sites of urban vervet monkey troops in urban areas of the KwaZulu-Natal Province, South Africa.

absence of a raptor nest(s), a dog(s), and the residency type. Based upon Patterson et al. (2016, 2017), we predicted that playing would be higher where raptor nests and dogs were absent, and in houses with gardens.

## 2. Materials and methods

The Ethekwini and Msunduzi municipalities of KZN (Ethekwini city 29°85'85. 30", 31°02'60. 02"; Msunduzi city 29°34'48. 82", 30°22'26. 91"; Fig. 1) are comprised of mosaics of natural greenbelts, conservancies (non-statutory forums that are formed by local people to manage and improve their living environments) and human-modified landscapes of varying housing density, all within informal human settlements, suburban residencies and public spaces (urban parks, markets). Despite the continued development of these municipalities, there is still a wide array of biodiversity to conserve (Roberts & Deiderichs, 2002). KZN is one of the smallest provinces, yet it contains the second largest human population of the nine provinces of South Africa (Statistics South Africa, 2007). The city of Durban supports one-third of the Province's human population of ~3.01 million (Statistics South Africa Demographics Profile, 2014), as well as 60% of its economic activity (Ethekwini Municipality, 2003).

From June 2013 through May 2014 (winter, June to August; spring, September to November; summer, December to February; autumn, March to May) observations were conducted on different urban vervet monkey troops in 20 residential gardens in the Ethekwini and Msunduzi municipalities. One free ranging troop of vervet monkeys was studied at each site (Fig. 1). Prior to the start of our study, great effort was made via online articles, email advertisements, and local conservancy meetings, with the intention to recruit volunteers (henceforth termed as "observer(s)") from the general public. The study sites were chosen based on the willingness and reliability of the observers who lived there, regardless of the frequency of vervet monkey presence or absence on their property. Eighteen observers were selected and trained to distinguish between adult males, adult females, juveniles and infants, and an additional trial month was employed prior to the beginning of the study period, in order for each observer to build confidence in accurate record taking and to assure that all observers recordings followed the standardized method. The principal investigator visited each site prior to commencement of the study and thereafter on a bi-monthly basis to monitor the troops and evaluate each observer's accuracy at record taking. The remaining two troops and their study sites were observed by the principal investigator who followed the same standardized method of recording as all the other observers. Vervet monkeys were classified as, adult males (possess a grey coat with long limbs, a long face and prominent, blue scrota), adult females (smaller than

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