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SHORT COMMUNICATION

The diurnal activity budgets of extralimital giraffe (*Giraffa camelopardalis giraffa*) in the Western Cape Province, South Africa

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Abstract

Despite being an extralimital species in the region, South African giraffes (*Giraffa camelopardalis giraffa*, Schreber 1784) are continuously being introduced into the Albany Thicket Biome of the Western Cape Province of South Africa. This study aimed to determine the diurnal activity budgets of two extralimital giraffe populations in the Western Cape of South Africa. Diurnal activity budgets are important to provide baseline information on the adaptability of species in newly introduced areas and for more detailed ecological studies such as those relating to habitat suitability, animal–plant interactions and interactions with other resident animals.

Résumé

Bien qu'il s'agisse d'une espèce externe à la région, les girafes d'Afrique du Sud (*Giraffa camelopardalis giraffa*, Schreber 1784) sont continuellement introduites dans le Biome de l'Albany Thicket de la province du Cap Occidental en Afrique du Sud. Cette étude visait à déterminer les budgets d'activité diurne de deux populations de girafes externes dans le Cap Occidental en Afrique du Sud. Les bilans d'activité diurne sont importants pour fournir des informations de base sur l'adaptabilité des espèces dans les zones nouvellement introduites et pour des études écologiques plus détaillées telles que celles relatives à l'adéquation de l'habitat, aux interactions entre animaux et plantes et aux interactions avec les autres animaux résidents.

1 | INTRODUCTION

Within the Western Cape of South Africa, there has been a rapid transition from agriculture and livestock farming to conservation and game farming. While the expansion of existing reserves for conservation and the establishment of game farms may potentially increase the natural diversity of these regions, private game farm and wildlife owners, many for tourism and hunting purposes, continue to introduce extralimital species to satisfy the expectations of potential clients (Castley et al., 2001; Parker, 2004).

Extralimital species have been regarded as species that potentially negatively influence areas into which they are introduced (Jacobs, 2008; Parker & Bernard, 2005), whether it be through the displacement and extinction of local indigenous populations, or the overall loss of biodiversity (Castley et al., 2001; Clavero & Garcia-Berthou, 2005; Cornelius, 2010; Naeem et al., 1994). Giraffe (*Giraffa camelopardalis giraffa*, Schreber 1784) are considered one of these extralimital species in the Western Cape (Parker & Bernard, 2005), with their natural distribution tending to be mostly in dry savanna areas, throughout the northern parts of South Africa, Namibia,

Botswana, Mozambique and Angola (Cornelius, 2010; Dagg & Foster, 1976; Jacobs, 2008; Skead, 1987; Skinner & Chimimba, 2005).

These potential impacts may be particularly problematic for sensitive vegetation types not adapted to the influence of extralimital species. This can be seen in the case of the Albany Thicket biome, which has been transformed substantially (60%) through overgrazing, because of extensive commercial and subsistence pastoralism, and the continuously growing wildlife industries (e.g., ecotourism, breeding and hunting; Vlok & Euston-Brown, 2003). However, to determine impacts, as well as to determine adaptability and to initiate long-term monitoring, the ecology of these species needs to be fully understood. The ecology of an animal is important, as it aims at understanding the interaction of an animal with their surrounding environment, as well as other organisms', which can be observed through their general behaviour. In addition to observing the general behaviour of an animal, other behavioural traits can be studied in more detail, such as foraging, social and/or unique behaviour with their surrounding environments, and/or with other individuals of the same or other species.

This study therefore aimed to assess the general behaviour of extralimital giraffe at two study sites by (1) describing their general diurnal activity budgets, (2) comparing the diurnal activity budgets of male and female giraffe and (3) investigating if seasonal changes had an influence on their diurnal activity budgets.

2 | STUDY AREA

The study was conducted from August 2014 to May 2015 (for four seasons inclusive of winter, spring, summer and autumn) on two privately owned farms, namely Kareesbos Private Game Reserve (KPGR – 900 ha) and Tsumkwe Private Game Reserve (TPGR – 1500 ha), within the Albany Thicket biome area of the Little Karoo region in South Africa. Average rainfall experienced within the region ranges between 100–300 mm per annum, with mean daily maximum and minimum temperatures being greater than 30°C and ranging between 14 and 16°C respectively in summer and mean daily maxima and minima temperatures ranging between 20 and 22°C and 4 and 8°C respectively in winter. At the time of the study, a total of 10 giraffes (four males, four females and two juveniles) were present at KPGR, with six giraffes being present, yet reduced to five (two males, two females and one juvenile) at TPGR.

3 | METHODS

3.1 | Field observations

Prior to the commencement of field observations, familiarisation with individuals was done using photo identification. Field observations were conducted from a vehicle and occasionally on foot, at an approximate distance of 100–400 m where animals were observed to continue with 'natural' behaviour (such as browsing). The herd was followed, with the number of individuals, estimated age and sex being noted. Observations were conducted using a modified version of the interval scan sampling method (Altmann, 1974). The method involved observations being conducted on the same herd every 5 min from 06:00–18:00 on all visible individuals. An observation was defined as the first activity being conducted by one individual during one scan (Deacon, 2015; Parker & Bernard, 2005; Table 1).

These activities (Table 1) were further classified into energy-conserving (such as rumination, vigilance and resting) and energy-consuming (such as walking/galloping and browsing; Fennessy, 2004).

TABLE 1 Observations were grouped into the displayed behaviours (Deacon, 2015; Fennessy, 2004).

Behaviour	Definition
Browsing	An individual foraging on a plant. Foraging to the point of chewing (not ruminating) and swallowing was included
Vigilance	An individual focussing on external stimuli such as predators or other animals. Individuals are seen as vigilant when eyes and ears are focused on the direction of the stimulus
Resting	Different to vigilance and can be defined as an individual resting in a standing position without doing any specific activity
Walking	An individual walking without foraging or ruminating
Rumination	An individual standing or walking and ruminating simultaneously and should not be confused with chewing
Galloping	An individual running
Other	• Defecation • Urination • Grooming (an individual licking itself or scratching against plants or other objects) • Sexual behaviour (Includes flehmen response, sniffing or mounting displayed by males) • Suckling (Juvenile individuals nursing from any female) • Oesteophagia (An individual feeding on the bones of carcasses)

3.2 | Statistical analysis

The frequency of each activity was determined by expressing the number of each record for each activity as a percentage of the frequency of occurrence per season. In addition, seasonal and sex differences were evaluated using generalised linear mixed models to cater for non-normal distributions (IBM Corporation, 2012). The Poisson-loglink model was applied for count data, with pairwise comparisons being tested at a 5% significance level.

Due to a low number of observations of juveniles (some being born during the study period and some still suckling on mothers), their results have been excluded from the study.

4 | RESULTS AND DISCUSSION

4.1 | Overall activity budgets

The diurnal activity budgets for males and females and juveniles in KPGR and TPGR during the study period (Table 2).

Browsing was shown to be the dominant behaviour displayed by males (37% vs. 37%) and females (46% vs. 47%) in KPGR and TPGR respectively (Table 2), with females tending to browse more than males. However, this has been shown to be similar with regard to giraffe populations in various other locations (Adolfsson, 2009; Blomqvist & Renberg, 2007; Deacon, 2015; Fennessy, 2004; Pellew, 1983) and other African herbivores (Ben-Shahar & Fairall, 1987; Leuthold & Leuthold, 1978; Spinage, 1968). According to Ginnett and Demment (1997), sexual dimorphism and reproductive concerns are the two main factors influencing foraging differences in males and females. In terms of sexual dimorphism, Ginnett and Demment (1997) explained that total basal metabolism increases as a fractional exponent of body mass. Therefore males, who tend to be larger than females, require more energy per unit time. In addition, a linear function exists between the gut capacity of herbivores and body mass. Herbivores with a greater body mass will have a higher gut volume to metabolic requirement ratio (food processing capacity), thus having the capability to retain food in the gut for longer periods of time, and in turn increasing the efficiency of nutrient extraction per unit of intake (Ginnett & Demment, 1997). Therefore, males have the ability to incorporate low-quality forage within their diet and meet metabolic and energy requirements in shorter time periods than females by increasing feeding rates (Ginnett & Demment, 1997). Reproductive requirements of either sex may also play a role in foraging differences (Parker, 2004).

Other activities were displayed to a lesser extent in both study sites. In KPGR (Table 2), males (6% vs. 4%) were shown to rest ($F_{2,199} = 3.3346$, $p = 0.031$), walk (24% vs. 21%; $F_{2,199} = 14.598$, $p < 0.001$) and ruminate (20% vs. 16%; $F_{2,199} = 28.119$, $p < 0.001$) more than females (Table 2). Similarly, in TPGR (Table 2), males were shown to walk more than females (19% vs. 18%; $F_{1,127} = 11.174$, $p = 0.001$). However, males and females spent relatively the same amount of time on resting ($F_{1,127} = 2.088$, $p = 0.151$), rumination ($F_{1,127} = 0.41$, $p = 0.523$) and vigilance ($F_{1,127} = 0.915$, $p = 0.341$) throughout the study period. By spending less time on browsing, more time is available to males for different activities. Fennessy (2004) indicated that increased vigilance comes at a cost to foraging and reduces the risk of predation. However, large predators are no risk to giraffes in KPGR and TPGR, due to their absence. Therefore, increased vigilance by males may be socially related (Ginnett & Demment, 1997). Older males may be more vigilant to compete with females, whereas smaller males may be more vigilant to avoid aggression (Artiss & Martin, 1995; Cameron & Du Toit, 2007; Pellew, 1984). Furthermore, males tend to ruminate more than females due to their increased feeding rates and their need to extract more nutrients (Leuthold & Leuthold, 1978; Pellew, 1984). No differences in resting, rumination and vigilance in TPGR can possibly be attributed to the area in which the giraffes are able to roam in the reserve, as well as their comfortability with humans (constant visitors in the reserve). Although TPGR is larger in size compared to KPGR, mountainous areas (comprising approximately two-thirds) in the reserve prohibit giraffes from utilising the entire reserve. These giraffes were observed to not roam far from each other and tended to walk less between vegetation patches when browsing.

TABLE 2 Total diurnal activity budgets, expressed in percentages, of adult male, adult female and juvenile giraffes observed in the Kareesbos Private Game Reserve and Tsumkwe Private Game Reserve from August 2014 to May 2015.

	Kareesbos private game reserve			Tsumkwe private game reserve		
Activity	Males ($n = 3006$) (%)*	Females ($n = 2346$) (%)*	Juveniles ($n = 725$) (%)*	Males ($n = 3101$) (%)*	Females ($n = 2090$) (%)*	Juveniles ($n = 160$) (%)*
Browse	37	46	19	37	47	10
Vigilance	10	10	29	11	7	47
Rest	6	4	8	10	9	16
Walk	24	21	28	19	18	26
Rumination	20	16	12	22	18	0
Other	3	3	4	1	1	1

Note: n = Sample size/number of observations.

*Percentage values rounded-off to the nearest whole number.

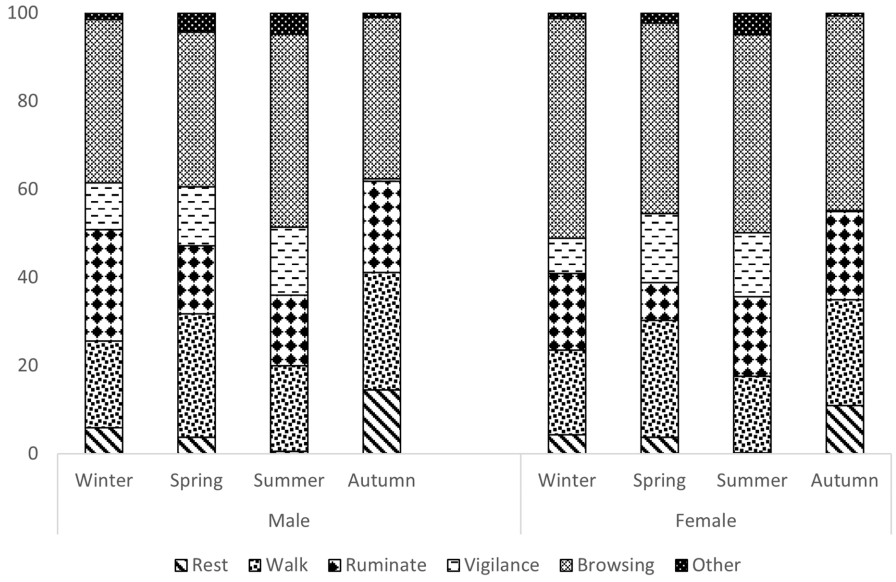

FIGURE 1 The diurnal activity budgets of males and females throughout winter, spring, summer and autumn in Kareesbos Private Game Reserve.

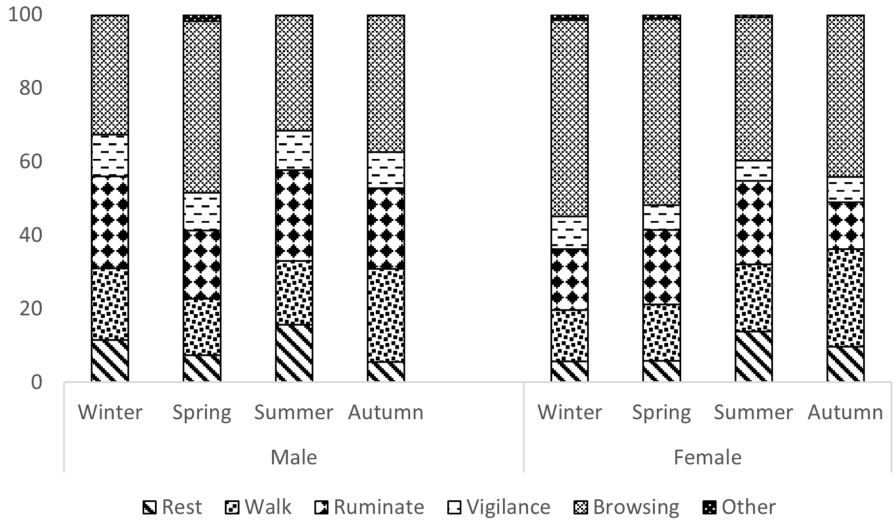

FIGURE 2 The diurnal activity budgets of males and females throughout winter, spring, summer and autumn in Tsumkwe Private Game Reserve.

Contrasting seasonal differences were also shown between the two study sites (Figures 1 and 2). In KPGR (Figure 1), males and females spent more time on energy-conserving activities, such as resting and rumination during the cooler seasons, whereas these activities occurred more during the warmer seasons in TPGR (Figure 2). Females, however, spent more time on energy-consuming activities, such as browsing during the cooler seasons, whereas males browsed more during the warmer seasons in both study sites. Regarding browsing, it is not only dependent on factors such as body size, metabolic and energetic requirements of species and individuals, but also on the availability of digestible food, food intake rates, habitat, as well as abiotic factors such as ambient temperatures and wind (Knight, 1991) which may differ between seasons. Seasonal variation in giraffe browsing has been frequently documented (Berry & Bercovitch, 2016; Cornelius, 2010; Deacon, 2015; Parker, 2004; Theron, 2005) and act as proof for changes in nutritional needs during certain times of the year. These variations have been associated with the change of the phenology of deciduous plant species that dominate these regions, with food quantity and quality decreasing during the drier seasons whilst time spent on foraging increases (Janecke & Smit, 2011). However, in this study, browsing by males increased from the cooler to the warmer seasons (winter to summer), whereas female browsing decreased from the cooler to the warmer seasons. This trend may be explained not by the quantity of available forage, but the quality. In both study sites, the majority of available forage species are evergreen, except for small patches of *Vachellia karroo* (Banfi & Galasso, Atti Soc. Ital. Sci. Nat. Mus. Civico Storia Nat. Milano 149(1): 149 (2008)) and *Lycium cinereum* (Prod. Pl. Cap. 57, 1794). Since quality was not investigated within this study, it is suggested that differences in food quantity may be minimal between the different seasons. It is suggested that changes in the quality of these plant species may cause a change in browsing frequency between seasons.

Females in TPGR were shown to rest more during the warmer seasons (summer) than in the cooler seasons (Figure 2). This may be explained by ambient temperatures, with giraffes often resting more when ambient temperatures are high (Deacon, 2015; Fennessy, 2004). In addition, males ruminated more during winter

than in the rest of the seasons in TPGR (Figure 2). This increase in rumination may be due to their browsing patterns and possible lower quality of browse during the winter seasons, thus compensating for their need to extract more nutrients.

5 | CONCLUSION

The shown opportunistic behaviour of giraffes within the study region has provided scope for future studies regarding the potential impacts of these populations on sensitive vegetation types and other wildlife species. In addition, browsing has been shown to be of great importance, particularly due to the extralimital status of giraffe within the area, therefore the identification and understanding of forage species, browsing behaviour and forage availability are essential. These, together with calculated browsing capacities, may allow farmers to reap the benefits this species brings (if managed correctly), and if stronger policies (which are currently lacking in the Western Cape with regard to extralimital species and giraffe in particular) are put in place to avoid potential and negative effects on indigenous flora and fauna.

AUTHOR CONTRIBUTIONS

Conceptualisation: Jamie Paulse, Vanessa Couldridge, and Clement Cupido Francois Deacon; methodology: Jamie Paulse, Vanessa Couldridge, Clement Cupido, and Francois Deacon; investigation: Jamie Paulse; resources: Vanessa Couldridge and Clement Cupido; writing—original draft preparation and Jamie Paulse; writing—review and editing: Jamie Paulse, Vanessa Couldridge, and Clement Cupido Francois Deacon. All authors have read and agreed to the published version of the manuscript.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request. Full thesis of this study is openly available in UWCScholar-ETD Repository at http://etd.uwc.ac.za/xmlui/handle/11394/6747.

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REFERENCES

Adolfsson, U. G. (2009). *Diurnal behaviour and utilization of shade in Masai giraffes (Giraffa camelopardalis tippelskirchi)*. [Degree project, Swedish University of Agricultural Sciences]. Retrieved from https://stud.epsilon.slu.se/12346/1/adolfsson_u_171018.pdf

Altmann, J. (1974). Observational study of behaviour: Sampling methods. *Behaviour*, *49*, 227–267. https://doi.org/10.1163/156853974x00534

Artiss, T., & Martin, K. (1995). Male vigilance in white-tailed ptarmigan, *Lagopus leucurus*: Mate guarding or predator detection? *Animal Behaviour*, *49*, 1249–1258. https://doi.org/10.1006/anbe.1995.0157

Ben-Shahar, R., & Fairall, N. (1987). Comparison of the diurnal patterns of blue wildebeest and red hartebeest. *South African Journal of Wildlife Research*, *17*, 49–54. https://doi.org/10.10520/AJA03794369_3498

Berry, P. S. M., & Bercovitch, F. B. (2016). Seasonal and geographical influences on the feeding ecology of giraffes in the Luangwa Valley, Zambia: 1973–2014. *African Journal of Ecology*, *55*, 80–90. https://doi.org/10.1111/aje.12324

Blomqvist, P. A., & Renberg, L. (2007). *Feeding behaviour of giraffe (Giraffa camelopardalis) in Mokolodi reserve, Botswana*. University of Uppsala. Minor Field Study, 1653-5634. Retrieved from http://files.webb.uu.se/uploader/858/MFS-128blomqvist-peranders-renberg-linda.pdf

Cameron, E. Z., & Du Toit, J. T. (2007). Winning by a neck: Tall giraffes avoid competition with shorter browsers. *American Naturalist*, *169*, 130–135. https://doi.org/10.1086/509940

Castley, J. G., Boshoff, A. F., & Kerley, G. I. H. (2001). Compromising South Africa's natural biodiversity-inappropriate herbivore introductions. *South African Journal of Science*, *9*, 344–348 Retrieved from http://reference.sabinet.co.za/document/EJC97379

Clavero, M., & Garcia-Berthou, E. (2005). Invasive species are a leading cause of animal extinctions. *Trends in Ecology and Evolution*, *20*, 110. https://doi.org/10.1016/j.tree.2005.01.003

Cornelius, A. J. (2010). *The management of extralimital giraffe (Giraffa camelopardalis) in the mosaic thicket of the southern cape, South Africa*. [MSc thesis, Nelson Mandela Metropolitan University]. Retrieved from http://www.secheresse.info/spip.php?article65657

Dagg, A. I., & Foster, J. B. (1976). *The giraffe, its biology, behaviour, and ecology*. Van Nostrand Reinhold Company.

Deacon, F. (2015). *The spatial ecology, habitat preferences and diet selection of giraffe (Giraffa camelopardalis giraffa) in the Kalahari region of South Africa*. [PhD thesis, University of the Free State]. Retrieved from http://hdl.handle.net/11660/1205

Fennessy, J. (2004). Home range and seasonal movements of *Giraffa camelopardalis angolensis* in the northern Namib Desert. *African Journal of Ecology*, *47*, 318–327. https://doi.org/10.1111/j.1365-2028.2008.00963.x

Ginnett, T., & Demment, M. W. (1997). Sexual segregation in giraffe foraging behavior at two spatial scales. *Oecologia*, *110*, 291–300. https://doi.org/10.1007/s004420050162

IBM Corp. (2012). *IBM SPSS statistics for windows, version 21.0*. IBM Corp.

Jacobs, E. P. (2008). *Diet and feeding effects of introduced giraffe in the eastern cape*. [MSc thesis, Nelson Mandela Metropolitan University]. Retrieved from http://vital.seals.ac.za:8080/vital/access/services/Download/vital:10703/SOURCEPDF

Janecke, B. B., & Smit, G. N. (2011). Phenology of woody plants in riverine thicket and its impact on browse availability to game species. *African Journal of Range & Forage Science*, *28*, 139–148. https://doi.org/10.2989/10220119.2011.642075

Knight, M. H. (1991). *Ecology of the gemsbok Oryx gazella gazella (Linnaeus) and blue wildebeest Conno-chaetes taurinus (Burchell) in the southern Kalahari*. [PhD thesis, University of Pretoria]. Retrieved from https://repository.up.ac.za/handle/2263/24345?show=full

Leuthold, B. M., & Leuthold, W. (1978). Ecology of the giraffe in Tsavo east National Park, Kenya. *East African Wildlife Journal*, *16*, 1–20. https://doi.org/10.1111/j.1365-2028.1978.tb00419.x

Naeem, S., Thompson, L. J., Lawler, S. P., Lawton, J. H., & Woodfin, R. M. (1994). Declining biodiversity can alter the performance of ecosystems. *Nature*, *386*, 734–736. https://doi.org/10.1038/368734a0

Parker, D. M. (2004). *The feeding biology and potential impact of introduced giraffe (Giraffa camelopardalis) in the eastern Cape Province, South Africa*. [MSc thesis, Rhodes University]. Retrieved from https://library.giraffeconservation.org/download/the-feeding-biology-and-potential-impact-of-introduced-giraffe-giraffa-camelopardalis-in-the-eastern-cape-province-south-africa/

Parker, D. M., & Bernard, R. T. F. (2005). The diet and ecological role of giraffe (*Giraffa camelopardalis*) introduced to the eastern cape, South Africa. *Journal of Zoology*, *267*, 203–210. https://doi.org/10.1017/S0952836905007399

Pellew, R. A. (1983). The impacts of elephant, giraffe and fire upon the *Acacia tortilis* woodlands of the Serengeti. *African Journal of Ecology*, *21*, 41–74 Retrieved from https://library.giraffeconservation.org/download/the-impacts-of-elephant-giraffe-and-fire-upon-the-acacia-tortilis-woodlands-of-the-serengeti/

Pellew, R. A. (1984). Food consumption and energy budgets of the giraffe. *Journal of Applied Ecology*, *21*, 141–159. https://doi.org/10.2307/2403043

Skead, C. J. (1987). *Vol. 2. Historical mammal incidence in the Cape Province (Eastern half of the Cape Province)*. Chief Directorate of Nature and Environmental Conservation.

Skinner, J. D., & Chimimba, C. T. (2005). *The mammals of the southern African subregion*. 3rd edition. Cambridge University Press.

Spinage, C. A. (1968). *The book of the giraffe*. Collins.

Theron, M. E. (2005). *Voedingsgedrag van kameelperde (Giraffa camelopardalis) in die sentrale Vrystaat*. [MSc thesis, University of the Free State]. Retrieved from http://hdl.handle.net/11660/1563

Vlok, J. H. J., & Euston-Brown, D. I. W. (2003). *Biological survey report (plants and birds). Unpublished report for the subtropical thicket ecosystem planning project (STEP)*. Terrestrial Ecology Research Unit, Department of Zoology. University of Port Elizabeth Retrieved from www.zoo.upe.ac.za/step

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