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SHORT COMMUNICATION

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Leopards living at the farmland-protected area interface prefer wild prey but consume high biomass of livestock

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Abstract

In much of southern Africa, the leopard (*Panthera pardus*) is the last remaining large carnivore outside protected areas. We collected leopard scat ($n=82$) opportunistically to determine the diet of leopards on small livestock farms and an adjacent national park in semi-arid Namaqualand, South Africa. We quantified prey availability using camera traps ($n=163$ stations) in an 810 km^2 grid. Leopards strongly preferred ($D>0.5$) rock hyrax (*Procavia capensis*), red hartebeest (*Alcelaphus buselaphus*) and klipspringer (*Oreotragus oreotragus*), but goats (*Capra hircus*) were consumed in highest biomass. Conservation strategies to decrease livestock losses and minimise leopard persecution are needed in Namaqualand and more broadly on livestock farmland neighbouring-protected areas.

Abstract

Dans une grande partie de l'Afrique australe, le léopard (Panthera pardus) est le dernier grand carnivore qui subsiste en dehors des zones protégées. Nous avons collecté des excréments de léopards (n = 82) de manière opportuniste afin de déterminer le régime alimentaire des léopards dans de petites fermes d'élevage et dans un parc national adjacent de la région semi-aride du Namaqualand, en Afrique du Sud. Nous avons quantifié la disponibilité des proies à l'aide de pièges photographiques (n = 163 stations) dans une grille de 810 km2. Les léopards préféraient fortement (D > 0,5) le hyrax des rochers (Procavia capensis), le bubale roux (Alcelaphus buselaphus) et le klipspringer (Oreotragus oreotragus), mais les chèvres (Capra hircus) étaient consommées dans la biomasse la plus élevée. Des stratégies de conservation visant à réduire les pertes de bétail et à minimiser la persécution des léopards sont nécessaires dans le Namaqualand et, plus généralement, sur les terres agricoles d'élevage voisines des zones protégées.

1 | INTRODUCTION

With increasing human population sizes and the associated expansion of development, wildlife species including mammalian carnivores have been extirpated in historical ranges or forced to adapt to continue to live near humans (Kiffner et al., 2014; Treves & Karanth, 2003). Many large carnivores persist only in and near protected areas, but buffer zones between protected land and local communities are becoming smaller or are non-existent (Gusset et al., 2009). Additionally, because large carnivores are wide-ranging, they often move beyond the boundaries of small, protected areas and into neighbouring unprotected land (Woodroffe, 2000). If the land bordering protected areas is used for farming livestock, then the movement of large predators out of the protected land will greatly increase the chances of livestock depredation (Bagchi & Mishra, 2006; Li et al., 2013) and with that conflict between the farmers and managers of the protected areas.

Leopards (*Panthera pardus*), the world's most widespread large felid, are known to have a flexible diet, mostly using prey that are commonly available (Ott et al., 2007; Rautenbach, 2010). For example, a total of 92 prey items have been recorded for leopards in sub-Saharan Africa (Bailey, 1993; Hayward et al., 2006), ranging from invertebrates to adult eland (*Taurotragus oryx*). In southern Africa, the leopard's historical range loss is estimated to be between 28% and 51%, but only 8%–13% of potential leopard range is inside protected areas (Balme et al., 2010; Jacobson et al., 2016). Historically, ecological research on leopards has been biased towards protected land and although most investigations have focused on understanding the feeding ecology of leopards, there is an imperative need to study the diet of this species outside protected area boundaries (Balme et al., 2013). Analyses of carnivore diet in areas with livestock farming are useful to document the extent of depredation and the possible need for conflict mitigation but also to get an indication of whether wild prey resources may be adequate (Chattha et al., 2015).

We studied the diet of leopards in relation to prey availability in a semi-arid region of South Africa within and outside a national park, in a system with no protected area buffer zone and where livestock farming is the primary land use immediately outside the park perimeter. We focused our investigation on leopard diet to understand whether data support the leopard's feeding habits in this system as a proximate cause for human–wildlife conflict. Leopard habitat in Namaqualand is largely contiguous (Swanepoel et al., 2012), and if leopards include a large proportion of livestock in their diet and prefer livestock over wild prey, then depredation incidents could affect farming operations and impact the leopard population through lethal control. Researching the leopard's diet to help farming practices and the conservation of the leopard population is therefore critical in this region.

2 | MATERIALS AND METHODS

2.1 | Study area

The study occurred in the Namaqualand region, Northern Cape, South Africa, a semi-arid landscape characterised by moderately rugged terrain, the dominance of shrubland, and winter rainfall (Cowling et al., 1999). Summers are hot and reach mean maximum temperatures of 30°C and above, while temperatures can drop to 5°C in the winter months (Mucina & Rutherford, 2006). The area includes the eastern section of the Namaqua National Park (hereafter, NNP; S30.16, E17.79) and surrounding commercial livestock farms to the North, East and South of the park (Text S1). The park is delineated by an electrified fence and livestock do not enter the park to forage. One exception for a brief period of the year is a small livestock flock accompanied by herders and a livestock guardian dog, which grazes a narrow eastern section of the park near the main park office as part of vegetation management. Persecution of potentially depredating animals including leopards is a conservation challenge on this landscape with commercial livestock farming and led to a broader project to test depredation mitigation techniques which were implemented primarily outside the area of sample collection for this study (The Cape Leopard Trust unpublished data).

2.2 | Leopard diet

To quantitatively assess leopard diet, we collected leopard scat samples that we analysed macroscopically and microscopically to identify food items in scats. Leopard scats were collected opportunistically across seasons, primarily when accessing areas to set up and maintain camera traps (see the section on 'Prey abundance and preference') and to a lesser extent along road transects from March 2014 to April 2015. Transects were conducted on foot to supplement opportunistic scat collection, which occurred throughout the study area on and off roads. Transect locations were selected along randomly chosen park roads and on farms that were monitored in a broader predator ecology study in the region (Cristescu et al., 2020; de Satgé et al., 2017; Jansen et al., 2019).

We identified mammals to species level by means of cross-sections of hairs and identification of macroscopic remains. Macroscopic and microscopic presence and absence were recorded for each scat for the following prey categories: large mammals (>40 kg), medium- to large-sized mammals (10–40 kg), medium-sized mammals (1–10 kg), small mammals (<1 kg) (Mann, 2014), livestock, birds, reptiles, invertebrates, fruit/seeds and herbaceous material. In some cases an item could be recorded as 'unknown ungulate' or 'unknown small mammal'; however, these were all grouped under an 'unknown' category to simplify results.

The frequency of occurrence (per prey type) [FO], corrected frequency of occurrence (frequency of occurrence per scat) [CFO] and percentage biomass were calculated (Ackerman et al., 1984; Klare et al., 2011; Mann, 2014) (Text S2). To estimate the biomass consumed by leopards, we used correction factors to account for different digestibility among food items and their effect on the volume of prey found in scat (Text S2).

2.3 | Prey abundance and preference

We used camera trapping to obtain data for estimating relative abundance indices (RAIs) (Jenks et al., 2011) of potential leopard prey species. From February 2014 to October 2015, one unbaited Cuddeback Ambush Black Flash camera trap operated per sampling station located at a junction of linear features in a grid of 810 km^2 (Text S1 and S2). Ninety 3 km × 3 km grid cells (cell area = 9 km^2) were sampled, with two sampling stations to monitor each cell. Cell size was selected to

TABLE 1 Biomass consumed calculated from leopard scat ($n = 82$) collected on farmland and in Namaqua National Park, Northern Cape, South Africa.

Prey item	Prey weight (kg)[a]	Correction factor (kg/scat)[b]	Number of occurrences ($n = 93$)	Prey item occurrence	Biomass consumed (kg)[c]	Biomass consumed as % of all scats	Total biomass consumed (kg)[d]	Relative biomass consumed (%)
Goat (*Capra hircus*)	50	3.73	14	15.05	700	35.34	56.15	21.77
Hyrax (*Procavia capensis*)	3.03	2.09	22	23.66	66.66	3.37	49.35	19.13
Sheep (*Ovis aries*)	40	3.38	8	8.60	320	16.16	29.08	11.27
Lagomorpha	2.35	2.06	11	11.83	25.85	1.31	24.39	9.46
Duiker (*Sylivapra grimmia*)	16.1	2.54	8	8.60	128.80	6.50	21.88	8.48
Klipspringer (*Oreotragus oreotragus*)	11.9	2.40	7	7.53	83.30	4.21	18.04	6.99
Red Hartebeest (*Alcelaphus buselaphus*)	140.26	6.89	2	2.15	280.52	14.16	14.82	5.74
Cattle (*Bos taurus*)	123	6.29	2	2.15	246	12.42	13.52	5.24

Note: Both the biomass consumed and the total biomass consumed are presented. This table only represents prey items that contributed ≥5% of the relative biomass consumed. For a table listing all prey species, see Table S2.

[a] From Skinner and Chimimba (2005).

[b] From Ackerman et al. (1984), $Y = 1.98 + 0.035x$; only for prey >2 kg.

[c] Prey weight *x* Number of occurrences.

[d] Correction factor *x* Prey item's occurrence.

correspond to female caracal home range size (Avenant & Nel, 1998; Martins, 2010), with caracal being the most widely distributed carnivore capable of depredation in the region (Jansen et al., 2019). When recording prey species, we used a time interval of 30 minutes between consecutive camera trap images of the same species as a cut-off to minimise the chance that we re-counted the same individual within a short timeframe (Jenks et al., 2011).

We estimated the leopard's preference for specific prey using Jacobs' index (*D*) calculated based on both the CFO and relative biomass consumed (Jacobs, 1974) (Text S2).

3 | RESULTS

3.1 | Leopard diet

We collected 86 leopard scats; however, only 82 scats were used for diet analysis. The four scats that were excluded lacked signs of leopard hair and/or discrete bone shards. More scats ($n = 54$) were analysed from farmland than from NNP ($n = 28$).

We recorded 24 prey species consumed by leopards in Namaqualand, with mammals representing >95.1% of the total diet. According to the CFO, medium-sized mammals (35.0%), livestock (27.8%) and medium- to large mammals (21.7%) occurred most frequently in leopard diet. Rock hyrax (22.4%) was the most frequently occurring prey, which together with goat (*Capra hircus*) (16.3%) and Lagomorpha (10.8%) made up the three main prey items (Table S1).

The total biomass ingested based on the 82 scats was 1980.7 kg (Table S2). Domestic goats (35.3%) comprised the largest biomass consumed, followed by sheep (16.2%), red hartebeest (*Alcelaphus buselaphus*) [14.2%] and cattle (*Bos taurus*) [12.4%] (Table 1). When correction factors were applied, the total biomass consumed based on our sample of leopard scats was 257.9 kg. Goats maintained the top rank as the most consumed prey item in terms of relative biomass ingested by leopards (21.8%), but rock hyrax (19.1%) was higher than sheep (11.3%).

3.2 | Prey abundance and preference

Overall, of 179 camera stations set, 163 (91.1%) remained active and were used in the analyses. Failure of 16 stations was a result of SD card malfunction, battery explosion due to high ambient temperature, or tampering of cameras by animals, particularly baboons and cattle, after deployment.

From 19,320 camera trapping nights, 12,756 photographs of mammals were obtained. This included 958 photographs of large mammals, 4153 of medium-large mammals, 4242 photographs of medium mammals, 218 photographs of small mammals, 159 of equines (wild and domestic) and 3026 of livestock (562 cattle, 604 goats and 1860 sheep). Twenty-nine mammal, four bird and one reptile (tortoise) species were identified. Three small mammal taxa (hairy-footed gerbil, *Otomys* spp., Soricidae) as well as birds, reptiles and invertebrates were not included in RAI calculations due to the small body size that was not expected to trigger the camera sensor.

Lagomorpha, sheep, duiker, steenbok and porcupine (*Hystrix africaeaustralis*) were the main prey items potentially available to leopards in the study area across both land uses (Text S3). Based on the trail camera data in conjunction with the leopard diet information from scat, leopards displayed a strong preference ($D > 0.50$) for rock hyrax, yellow mongoose, goat, small spotted genet, red hartebeest, striped polecat (only when analysing with CFO) and klipspringer (Figure 1). Caracal and porcupine were the only two prey species consumed that had $D < 0$ for both CFO and biomass calculations (Table S3).

4 | DISCUSSION

In Namaqualand, South Africa, where leopards are the only surviving large carnivore, we showed that their diet most frequently includes rock hyrax, a medium-sized mammal (3.0 kg) associated with rugged and rocky habitats (Estes, 2012). Our work supports previous research showing that hyrax are a major prey source for leopards in South Africa's Cape region (Bothma & Le Riche, 1994;

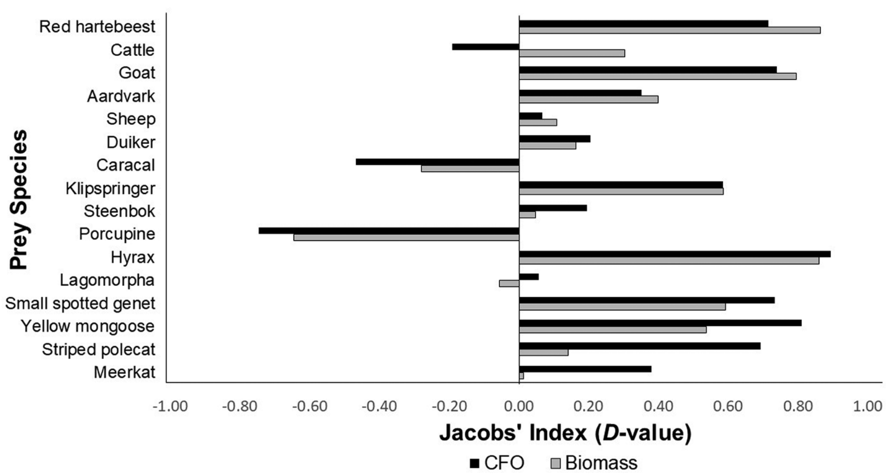

FIGURE 1 Jacobs' index (*D*) showing leopard preference and avoidance of potential prey for consumption in Namaqualand, Northern Cape, South Africa. Index values calculated based on biomass consumed and corrected frequency of occurrence (%) are illustrated. Prey species are arranged according to prey weight categories.

Martins et al., 2011; Mann et al., 2019), although this is not always the case for leopards in the Cape (Drouilly et al., 2018). Hyrax were also the main prey item of caracal in our study system (Jansen et al., 2019).

Although disproportionately selecting for certain prey items, leopards in our semi-arid study region showed opportunistic feeding behaviour, which has also been documented in other systems (Bothma & Le Riche, 1984; Mann, 2014). This is evident from the variety of prey items consumed (i.e. 24 prey items recorded), as well as the fact that there was no largely disproportionate use of one specific prey species compared with the others. In South Africa's Cape region, leopards have persisted by finding safety in mountainous areas (Mann et al., 2020) where wild prey are diverse but mostly small-bodied (Mann et al., 2019). Although rugged areas serve as refugia from habitat loss through urbanisation and crop cultivation, they can result in local extinction if leopards are persecuted on free-ranging livestock farms (Martins & Martins, 2006; Swanepoel et al., 2012).

Previous work has suggested that livestock predation by leopards occurs mostly opportunistically (Chattha et al., 2015; Ott et al., 2007). Livestock might be easier to capture than wild prey, due to poor antipredator response of domestic animals compared with their wild counterparts (Dwyer, 2008; Flörcke & Grandin, 2013); but see Laporte et al. (2010). Leopards range widely in semi-arid and arid ecosystems (Mann et al., 2020), and in our study system they move across park boundaries (Cristescu et al., 2020). When on farms, the likelihood of leopards encountering livestock is probably substantial due to their abundance and visibility. Vantage points afforded by the rugged terrain, sparse tree cover that does little to obstruct views, congregating behaviour and pelage colour (often white) mean that goats and sheep can be detected from great distances. Goats (Boer goat breed) in particular are agile climbers venturing into rugged terrain where they are likely exposed to high risk of predation by leopards. Indeed, goats were a preferred prey item in leopard diet in Namaqualand, more so than sheep. As sheep use flatter terrain, preying on sheep would require a leopard to travel further from the refuge of mountains and therefore incur more risk, even though sheep are more abundant in our study system and subduing a sheep might be easier than a goat (Rafiq et al., 2010).

To reconcile the need to minimise depredation while conserving leopards as the last remaining large carnivore in Namaqualand and many other systems, we emphasise the need for non-lethal mitigation of livestock depredation. Livestock guardian animals and enclosures (kraaling) can be effective if applied appropriately (Khorozyan & Waltert, 2021). A suitable and healthy wild ungulate prey base that complements smaller prey such as rock hyrax could possibly also contribute to depredation mitigation for leopards on farms. Lethal management of large felids to reduce livestock losses has had only mixed successes both locally (McManus et al., 2015) and elsewhere in the world (Herfindal et al., 2005; Teichman et al., 2016), and thus non-lethal alternatives are currently being widely explored as potential win-win scenarios for wildlife and commercial farmers living close to protected areas. Financial incentives (Dickman et al., 2011) and creative non-lethal solutions backed by strong experimental designs (van Eeden et al., 2018) are required for conservation and economic successes.

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CONFLICT OF INTEREST STATEMENT

The authors declare that they have no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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REFERENCES

Ackerman, B. B., Lindzey, F. G., & Hemker, T. P. (1984). Cougar food habits in southern Utah. *The Journal of Wildlife Management*, *48*, 147–155.

Avenant, N. L., & Nel, J. A. J. (1998). Home-range use, activity, and density of caracal in relation to prey density. *African Journal of Ecology*, *36*, 347–359.

Bagchi, S., & Mishra, C. (2006). Living with large carnivores: Predation on livestock by the snow leopard (*Uncia uncia*). *Journal of Zoology*, *268*, 217–224.

Bailey, T. N. (1993). *The African leopard: Ecology and behavior of a solitary feli*. Columbia University Press.

Balme, G., Lindsey, P. A., Swanepoel, L. H., & Hunter, L. T. B. (2013). Failure of research to address the rangewide conservation needs of large carnivores: Leopards in South Africa as a case study. *Conservation Letters*, *7*, 3–11.

Balme, G. A., Slotow, R., & Hunter, L. T. B. (2010). Edge effects and the impact of non-protected areas in carnivore conservation: Leopards in the Phinda-Mkhuze complex, South Africa. *Animal Conservation*, *13*, 315–323.

Bothma, J. D. P., & Le Riche, E. A. N. (1984). Aspects of the ecology and behaviour of the leopard *Panthera pardus* in the Kalahari Desert. *Koedoe*, *84*, 259–279.

Bothma, J. D. P., & Le Riche, E. A. N. (1994). Scat analysis and aspects of defaecation in northern cape leopards. *South African Journal of Wildlife Research*, *24*, 21–25.

Chattha, S. A., Hussain, S. M., Javid, A., Abbas, M. N., Mahmood, S., Barq, M. G., & Hussain, M. (2015). Seasonal diet composition of leopard (*Panthera pardus*) in Machiara National Park, Azad Jammu and Kashmir, Pakistan. *Pakistan Journal of Zoology*, *47*, 201–207.

Cowling, R. M., Esler, K. J., & Rundel, P. W. (1999). Namaqualand, South Africa – An overview of a unique winter-rainfall desert ecosystem. *Plant Ecology*, *142*, 3–21.

Cristescu, B., Teichman, K. J., Puls, S., Jansen, C., & O'Riain, M. J. (2020). Spatial distribution of leopards on farmland and Namaqua National Park, South Africa. *African Journal of Wildlife Research*, *50*, 190–196.

de Satgé, J., Teichman, K., & Cristescu, B. (2017). Competition and coexistence in a small carnivore guild. *Oecologia*, *184*, 874–884.

Dickman, A. J., Macdonald, E. A., & Macdonald, D. W. (2011). A review of financial instruments to pay for predator conservation and encourage human–carnivore coexistence. *Proceedings of the National Academy of Sciences of the United States of America*, *108*, 13937–13944.

Drouilly, M., Nattrass, N., & O'Riain, M. J. (2018). Dietary niche relationships among predators on farmland and a protected area. *Journal of Wildlife Management*, *82*, 507–518.

Dwyer, C. (2008). Environment and the sheep. In *The welfare of sheep. Animal welfare* (Vol. *6*). Springer. https://doi.org/10.1007/978-1-4020-8553-6_2

Estes, R. D. (2012). *The behaviour guide to African mammals*. The University of California Press.

Flörcke, C., & Grandin, T. (2013). Loss of anti-predator behaviors in cattle and the increased predation losses by wolves in the northern Rocky Mountains. *Open Journal of Animal Sciences*, *3*, 248–253.

Gusset, M., Swarner, M. J., Mponwane, L., Keletile, K., & McNutt, J. W. (2009). Human–wildlife conflict in northern Botswana: Livestock predation by endangered African wild dog *Lycaon pictus* and other carnivores. *Oryx*, *43*, 67–72.

Hayward, M. W., Henschel, P., O'Brien, J., Hofmeyr, M., Balme, G., & Kerley, G. I. H. (2006). Prey preferences of the leopard (*Panthera pardus*). *Journal of Zoology*, *270*, 298–313.

Herfindal, I., Linnell, J. D. C., Moa, P. F., Odden, J., Austmo, L. B., & Andersen, R. (2005). Does recreational hunting of lynx reduce depredation losses of domestic sheep? *Journal of Wildlife Management*, *69*, 1034–1042.

Jacobs, J. (1974). Quantitative measurement of food selection: A modification of the forage ratio and Ivlev's electivity index. *Oecologia*, *14*, 413–417.

Jacobson, A. P., Gerngross, P., Lemeris, J. R., Jr., Schoonover, R. F., Anco, C., Breitenmoser-Würsten, C., Durant, S. M., Farhadinia, M. S., Henschel, P., Kamler, J. F., Laguardia, A., Rostro-García, S., Stein, A. B., & Dollar, L. (2016). Leopard (Panthera pardus) status, distribution, and the research efforts across its range. *PeerJ*, *4*, e1974.

Jansen, C., Leslie, A. J., Cristescu, B., Teichman, K. J., & Martins, Q. (2019). Determining the diet of an African mesocarnivore, the caracal: Scat or GPS cluster analysis? *Wildlife Biology*, *2019*(1), 1–8.

Jenks, K. E., Chanteap, P., Damrongchainarong, K., Cutter, P., Cutter, P., Redford, T., Lynam, A. J., Howard, J., & Leimgruber, P. (2011). Using relative abundance indices from camera-trapping to test wildlife conservation hypotheses – An example from khao Yai National Park, Thailand. *Tropical Conservation Science*, *2*, 113–131.

Khorozyan, I., & Waltert, M. (2021). A global view on evidence-based effectiveness of interventions used to protect livestock from wild cats. *Conservation Science and Practice*, *3*, e317.

Kiffner, C., Wenner, C., La Violet, A., Yeh, K., & Kioko, J. (2014). From savannah to farmland: effects of land-use on mammal communities in the Tarangire–Manyara ecosystem, Tanzania. *African Journal of Zoology*, *53*, 156–166.

Klare, U., Kamler, J. F., & Macdonald, D. W. (2011). A comparison and critique of different scat-analysis methods for determining carnivore diet. *Mammal Review*, *41*, 294–312.

Laporte, I., Muhly, T. B., Pitt, J. A., Alexander, M., & Musiani, M. (2010). Effects of wolves on elk and cattle behaviors: Implications for livestock production and wolf conservation. *PLoS One*, *5*, e11954.

Li, X., Buzzard, P., Chen, Y., & Jiang, X. (2013). Patterns of livestock predation by carnivores: Human–wildlife conflict in Northwest Yunnan, China. *Environmental Management*, *52*, 1334–1340.

Mann, G. (2014). *Aspects of the ecology of leopards (Panthera pardus) in the little Karoo, South Africa*. Dissertation. Rhodes University, South Africa.

Mann, G., O'Riain, M., & Parker, D. (2020). A leopard's favourite spots: Habitat preference and population density of leopards in a semi-arid biodiversity hotspot. *Journal of Arid Environments*, *181*, 104218.

Mann, G. K. H., Wilkinson, A., Hayward, J., Drouilly, M., O'Riain, M. J., & Parker, D. M. (2019). The effects of aridity on land use, biodiversity and dietary breadth in leopards. *Mammalian Biology*, *98*, 43–51.

Martins, Q. (2010). *The ecology of the leopard Panthera pardus in the Cederberg Mountains*. Dissertation. University of Bristol.

Martins, Q., Horsnell, W. G. C., Titus, W., Rautenbach, T., & Harris, S. (2011). Diet determination of the Cape Mountain leopards using global positioning system location clusters and scat analysis. *Journal of Zoology*, *283*, 81–87.

Martins, Q., & Martins, N. (2006). Leopards of the cape: Conservation and conservation concerns. *International Journal of Environmental Studies*, *63*, 579–585.

McManus, J. S., Dickman, A. J., Gaynor, D., Smuts, B. H., & Macdonald, D. W. (2015). Dead or alive? Comparing costs and benefits of lethal and non-lethal human–wildlife conflict mitigation on livestock farms. *Oryx*, *49*, 687–695.

Mucina, L., & Rutherford, M. C. (Eds.). (2006). *The vegetation of South Africa, Lesotho and Swaziland*. South African National Biodiversity Institute.

Ott, T., Kerley, G. I. H., & Boshoff, A. F. (2007). Preliminary observations on the diet of leopards (*Panthera pardus*) from a conservation area and adjacent rangelands in the Baviaanskloof region, South Africa. *African Zoology*, *42*, 31–37.

Rafiq, M. K., Afzal, J., Jasra, A. W., Ahmad, I., Khan, T. N., & Farooq, M. U. (2010). Foraging preferences of free-ranging sheep and goats on the native vegetation of rangelands of Pubbi Hills in Pakistan. *International Journal of Agriculture and Biology*, *12*, 944–946.

Rautenbach, T. (2010). *Assessing the diet of the cape leopard (Panthera pardus) in the Cederberg and Gamka mountains, South Africa*. Masters Thesis. Nelson Mandela Metropolitan University.

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

Swanepoel, L. H., Lindsay, P., Somers, M. J., van Hoven, W., & Dalerum, F. (2012). Extent and fragmentation of suitable leopard habitat in South Africa. *Animal Conservation*, *16*, 41–50.

Teichman, K. J., Cristescu, B., & Darimont, C. T. (2016). Hunting as a management tool? Cougar-human conflict is positively related to trophy hunting. *BMC Ecology*, *16*, 44.

Treves, A., & Karanth, K. U. (2003). Human-carnivore conflict and perspectives on carnivore management worldwide. *Conservation Biology*, *17*, 1491–1499.

van Eeden, L. M., Eklund, A., Miller, J. R. B., López-Bao, J. V., Chapron, G., Cejtin, M. R., Crowther, M. S., Dickman, C. R., Frank, J., Krofel, M., Macdonald, D. W., McManus, J., Meyer, T. K., Middleton, A. D., Newsome, T. M., Ripple, W. J., Ritchie, E. G., Schmitz, O. J., Stoner, K. J., … Treves, A. (2018). Carnivore conservation needs evidence-based livestock protection. *PLoS Biology*, *16*, e2005577.

Woodroffe, R. (2000). Predators and people: Using human densities to interpret declines of large carnivores. *Animal Conservation*, *3*, 165–173.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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