

A preliminary survey of the presence and distribution of small carnivores in the Lower Zambezi Protected Area Complex, Zambia

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Abstract

An interview questionnaire survey of tour guides and game rangers in the Lower Zambezi National Park and Chiawa Game Management Area in south-eastern Zambia received credible reports of 15 small carnivore species of five taxonomic families (Canidae, Felidae, Herpestidae, Mustelidae and Viverridae). Two other species are considered likely to occur, and two more to be possible. Meller's Mongoose *Rhynchogale melleri* (previously unrecorded for the area) and a form of genet of unknown taxonomic significance were photographed. Bushy-tailed Mongoose *Bdeogale crassicauda* and Selous's Mongoose *Paracynictis selousi* (also previously unrecorded) were fairly convincingly reported. Reports of Spotted-necked Otter *Lutra maculicollis* were equivocal. Two highly nocturnal species (Zorilla *Ictonyx striatus* and African Striped Weasel *Poecilogale albinucha*) expected to be present were not reported and might thus, if predictions are accurate, be of local conservation concern. Side-striped Jackal *Canis adustus* displayed unusual behaviour in its highly diurnal activity and expressed obvious competitive release in almost exclusive use of open plains. Camera-trapping is recommended to complement our current interview methods, which nonetheless are an inexpensive and effective way to capture much-needed data on some poorly-known small carnivore species.

Keywords: interviews, Felidae, Herpestidae, Mustelidae, questionnaires, *Rhynchogale melleri*, Viverridae

Une enquête préliminaire sur la présence et la répartition des petits carnivores dans le Complexe d'Aires Protégées du Bas-Zambèze, en Zambie

Résumé

Une enquête par questionnaire basée sur des entretiens avec des guides touristiques et des gardes-chasse a été entreprise dans le Parc National du Bas-Zambèze et la Zone de Gestion du Gibier de Chiawa dans le sud-est de la Zambie. Elle a permis de mettre en évidence la présence crédible de 15 espèces de petits carnivores appartenant à cinq familles taxonomiques (Canidae, Felidae, Herpestidae, Mustelidae et Viverridae). La présence de deux autres espèces est considérée comme probable, et celle de deux autres est regardée comme peu probable, mais possible. La Mangouste de Meller *Rhynchogale melleri* (préalablement non observée dans la région) ainsi qu'une forme de genette de signification taxonomique inconnue ont été photographiés. La présence de la Mangouste à queue touffue *Bdeogale crassicauda* et celle de la Mangouste de Selous *Paracynictis selousi* (deux espèces également non reportées au paravant) ont été enregistrées de manière relativement convaincante. Des observations de la Loutre à cou tacheté *Lutra maculicollis* étaient équivoques. La présence de deux espèces essentiellement nocturnes (le Zorille commun *Ictonyx striatus* et la Belette rayée d'Afrique *Poecilogale albinucha*) est aussi suspectée, mais ces espèces n'ont pas été enregistrées. Si nos prédictions sont correctes, ces deux espèces pourraient nécessiter des mesures de conservation à l'échelle locale. Le Chacal à flancs rayés *Canis adustus* a affiché un comportement inhabituel de par son activité hautement diurne et exprimé une libération concurrentielle évidente au travers de l'utilisation presque exclusive des plaines ouvertes. Alors que le photo-piégeage est recommandé comme un outil de recherche complémentaire à nos méthodes d'entrevue actuelles, ces dernières offrent malgré tout un moyen peu coûteux et efficace pour obtenir des données plus que nécessaires sur certaines espèces de petits carnivores qui ont été sous-étudiées.

Mots clés: entrevues, félins, mangoustes, mustelidés, questionnaires, *Rhynchogale melleri*, viverridés

Introduction

Many large carnivore species are well researched and documented, but there are significant gaps in the state of knowledge among small carnivores. There is a severe paucity of data on them for much of Africa, as for Latin America (Schipper *et al.* 2009). Small-bodied carnivores (taken here, except where otherwise stated, as those weighing <15 kg) are ecologically diverse, and changes in their community structure and population growth rates can impact ecosystem dynamics (Terborgh 1988, Schreiber *et al.* 1989, Crooks & Soulé 1999, González-Maya *et al.* 2009). 'Mesocarnivores' (those weighing <25 kg) far outnumber large carnivores in species richness and are

much more diverse in their behaviour and ecology (Roemer *et al.* 2009), but their often nocturnal and secretive habits make them difficult to monitor (Blaum *et al.* 2008). Of those small carnivore species (defined for this statistic as all species of land Carnivora except cats [Felidae], hyaenas [Hyaenidae], dogs [Canidae] and bears [Ursidae]) with sufficient information to assess their extinction risk, 22% are considered globally threatened by *The IUCN Red List of Threatened Species* (Schipper *et al.* 2008). Effective conservation relies on accurate current data regarding status and distribution, thus surveys in areas where few or no data exist are conservation and management priorities for small carnivores. Determining the current local distribution of carnivores can also help identify

possible corridors for movement, to ensure long-term viability and assist management decisions (Purchase *et al.* 2007).

In Zambia, until recently few coherent studies had focussed on small carnivore research (see White 2013). After Ansell's (1978) major work on Zambian mammal distributions, few further data were recorded systematically until 2007, when The Zambezi Society reviewed extensively the status, distribution, and levels of human–carnivore conflict for carnivores in the protected areas and surrounds of the Zambezi Basin, based on a mail-out questionnaire survey (Purchase *et al.* 2007). Large areas within the Zambian protected area network had no or only limited current data regarding status and distribution of many carnivore species.

Within the Zambezi basin, the Lower Zambezi National Park (Lower Zambezi NP) and adjacent Chiawa Game Management Area (Chiawa GMA) (here collectively called the Lower Zambezi Protected Area Complex; Lower Zambezi PAC) are two protected areas located in south-eastern Zambia along the Zambezi River, which are part of the Mana Pools–Lower Zambezi Complex extending into Zimbabwe. This complex was identified as the second most important area for Zambian carnivore conservation, and as an urgent priority area for more detailed survey given the paucity of data for many species, combined with the relatively high expected species richness and presence of some rare species (Purchase *et al.* 2007). In addition, Chiawa GMA is at risk of degradation and habitat loss through human presence and activities. Species data can help determine potential risks to small carnivores there.

Monitoring animal populations in changing environments is crucial to wildlife conservation and management, but the insufficiency of resources poses a recurring problem throughout Africa (Blaum *et al.* 2008). Questionnaire-based methods provide an inexpensive way to obtain information in scenarios where considerable resources would be required for more precise population assessment (Gese 2004). Questionnaires are especially useful when little is known about the biology of the species in question, or for collecting data on rare and elusive species that might otherwise require intensive or long-term camera-trapping efforts (Fanshawe *et al.* 1997, Gese 2001, Llaneza & Núñez-Quirós 2009).

In-depth questionnaire surveys and/or personal interviews of people with intimate knowledge of an area, and who spend much time afield (e.g. hunters, game wardens, rangers and guides) have been used to assess distribution, status and abundance of many animal species and in many ecosystems; Gese (2001) reviewed, briefly, such carnivore studies. Interviews have been used to determine the status of mammals (Gandiwa 2012), carnivores (De Luca & Mpunga 2005, Purchase *et al.* 2007, Kent 2011), and species such as Asian Black Bear *Ursus thibetanus* (Sathyakumar & Choudhury 2007) and Cheetah *Acinonyx jubatus* (Gros 2002). Mail-out methods have been used to assess the local status of Western Polecat *Mustela putorius* (Baghli & Verhagen 2003, Birks 2008), Wild Cat *Felis sylvestrus sylvestrus* (Balharry & Daniels 1998), Long-tailed Weasel *Mustela frenata longicauda* (Proulx & Drescher 1993, Showalter 2000), African Wild Dog *Lycaon pictus* (Fanshawe *et al.* 1997, Breuer 2003), Grey Wolf *Canis lupus* (Llaneza & Núñez-Quirós 2009) and Pine Marten *Martes martes* (Poulton *et al.* 2006).

We carried out a questionnaire-based survey in 2009 to record small carnivore sightings in the Lower Zambezi PAC

over the previous five years. The survey's main aims were to determine the species present in the Zambian side of the complex, to compare with the findings of Purchase *et al.* (2007) and previous records, and to gather preliminary information on small carnivores as a baseline for further research in this area.

Methods

Study area

Lower Zambezi NP covers 4,092 km² and has six tourist lodges, while to the west of the park, Chiawa GMA covers 2,344 km², with more than ten lodges and a number of villages. Both protected areas lie adjacent to the Zambezi River (Fig. 1), and all tourism lodges are lined along the north river bank running west to east. North of the valley is a steep escarpment, bordered by a plateau. Most of the park's wildlife is concentrated along the valley floor, the escarpment acting as a natural barrier. Valley floor elevations range from 370 to 500 m. Given the methods used and the time available, this survey concentrated on the valley floor (approximately 900 km²), where guides and rangers usually drive and patrol.

The area covered, a long, narrow riverside strip of about 130 km, was divided from west to east into four sections: West and East Chiawa GMA, and West and East Lower Zambezi NP (Fig. 2). East Chiawa GMA includes several safari lodges but very few villages, whereas West Chiawa GMA holds most of the villages but only two lodges. West Lower Zambezi NP is here taken to include a small stretch containing two lodges close to, but outside, the park gate, because this area showed very little obvious difference from the park proper in habitat or human disturbance. In addition, separate sections were recorded for the northern hills and escarpment, and for sightings within villages: species recorded in the villages of West Chiawa GMA were not thereby automatically also recorded for the West Chiawa GMA recording section.

Vegetation and habitats

The edge of the Zambezi River (i.e. the Lower Zambezi PAC river bank) is overhung with a fringe of thick riverine woodland, dominated in some places by Natal Mahogany *Trichilia emetica*.



Fig. 1. Location of the Lower Zambezi Protected Area Complex (Lower Zambezi PAC), Zambia.

Grassy marshes spread out into the Zambezi. Further inland are terraced alluvial floodplains, the higher ones being almost bare for most of the dry season. These are interspersed with *Combretum* thickets, palm thickets and open munga woodland, dominated towards the east with Winter Thorn *Faidherbia albida*. The escarpment is covered with miombo woodlands (mainly *Brachystegia manga*).

For the most part, the Lower Zambezi PAC straddles two woodland savannah eco-regions, distinguished by the dominant tree types: miombo, mopane, and southern miombo woodlands on higher ground (in the north); and Zambezian and mopane woodlands on the lower southern slopes. At the edge of the river is floodplain habitat.

Data collection

Small carnivore data were collected over a period of five weeks in October–November 2009. We used a structured questionnaire (Appendix 1) to interview safari guides, camp managers and other staff in all tourist lodges and camps in the park and most of those in Chiawa GMA, following similar methods used by De Luca & Mpunga (2005). Guides all had at least two years of working experience in the area.

Interviewees were shown a pre-prepared booklet including unnamed photographs of 21 small carnivore species possibly present in the area and a few more less likely to be present (see below). They were asked to identify each species, then were asked about the species’s presence, and the location, time

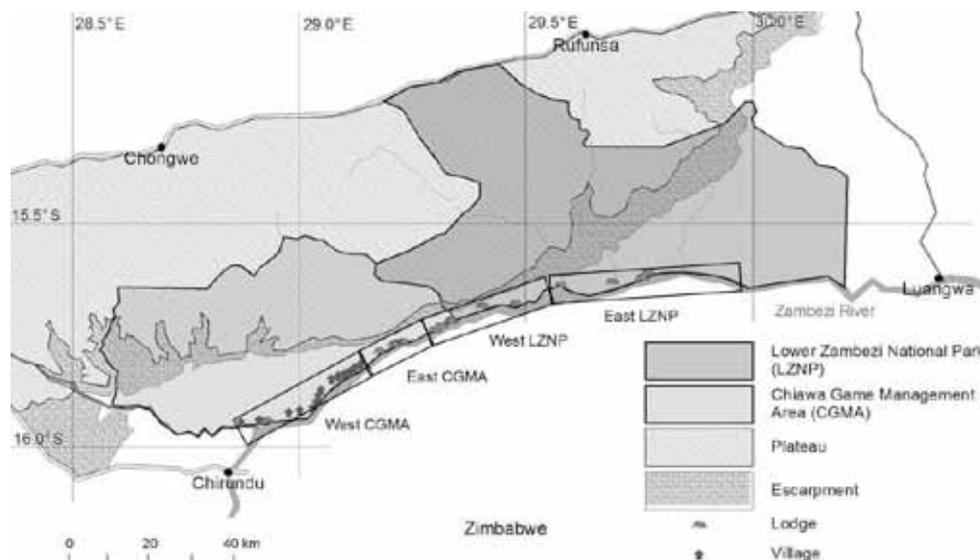


Fig. 2. The Lower Zambezi Protected Area Complex, Zambia, showing geographical sections used in the analysis.

Table 1. Distribution and occupation of interviewees across the Lower Zambezi Protected Area Complex (Lower Zambezi PAC), Zambia.

	Guide	Spotter/ Trainee Guide	Boat driver	Driver	Camp Manager	Camp Owner	Patrol Officer	Total
Kiambi Safari Lodge			3					3
Kanyemba Lodge	4							4
Mvuu Lodge			4		1			5
Baines River Camp	1							1
Kasaka River Lodge	2							2
Royal Zambezi Lodge	3	1			1			5
Community Camp	1							1
Conservation Lower Zambezi				1			3	4
Chongwe River Camp	6							6
Chongwe River House	1							1
Chiawa Camp	3					1		4
Sausage Tree Camp	4				1			5
Mwambashi River Lodge	4				1			5
Old Mondoro	2				1			3
Kulefu Camp	6	1						7
Ana Tree Lodge		1						1
Total	37	3	7	1	5	1	3	57

Sites are arranged west to east.

of day and frequency of sightings. They were also asked open-ended questions about human–carnivore conflict and hunting/poaching, the frequency of problem animal occurrences, and the methods they or others (e.g. village members) used to deal with these species. If an interviewee did not know the identity of a species from the photograph but knew it by name, their data for that species were collected but not included in the analysis. Hereafter ‘interviewees’ are all people interviewed, while ‘respondents’ are only the interviewees who reported seeing the relevant species.

In total, 57 people from 16 lodges and camps, and three anti-poaching patrol officers, were interviewed (Table 1). Most interviewees work only along the valley floor, so their data were restricted to this area; but the three officers patrolled the escarpment, so could comment on small carnivores there. Lodges are listed from West to East along the banks of the Lower Zambezi. All camps to the east of the Conservation Lower Zambezi (CLZ) headquarters are considered to be inside the national park (although Chongwe House and Chongwe River Lodge are on the outside edge of the boundary; Fig. 2). Staff at the CLZ headquarters were predominantly Zambian Wildlife Authority or CLZ patrol officers who regularly patrol the foothills as well as the escarpment across East Chiawa GMA to West Lower Zambezi NP and who provided some data on species presence in these difficult-to-reach areas. Additional data were obtained through the authors’ direct observation during day and night drives between the lodges during the few weeks of field work.

Each lodge or camp within the park runs daily and nightly tour drives east and west of their camp, overlapping with the neighbouring camps’ tours, allowing a continuous coverage of Lower Zambezi NP until the furthestmost camp in the East Lower Zambezi NP. Camps in the East Chiawa GMA run game drives into the West Lower Zambezi NP section as well. Thus, observation effort is higher in the latter sector than in the other sectors, and so species are less likely to have been overlooked there. After the last camp, heading eastwards in the park, the road running parallel to the river ends after a few kilometers. The eastern-most area of the park is accessible only by boat. No guides frequent this area, so carnivore sightings were too few for the area to be included in the analysis. Village residents (in West Chiawa GMA) were not directly interviewed: pilot interviews with a local women’s group showed that their ability to differentiate between species was limited. Local guides endorsed this view, but several gave accounts of their own sightings in these villages. These guides live in the camps and go home to their village for their monthly leave days.

Species of interest

Background knowledge on small carnivore species in the area was based on respected mammal guides (Ansell 1978, Kingdon 1988, Skinner & Smithers 1990, Skinner & Chimimba 2005), distribution maps in *The IUCN Red List of Threatened Species* (IUCN 2012), and the recent review of the status and distribution of carnivores in the Zambesi basin by Purchase *et al.* (2007). Most small carnivore species in Zambia are listed as Least Concern on the *IUCN Red List* (see Schipper *et al.* 2008); but most listings are based on limited information about status and distribution and some may need revision (Purchase *et al.* 2007).

Several small carnivores have been highlighted as priority species for the Lower Zambezi PAC because they are at the edge of their range, little is known about their status or they are considered at risk. Mills *et al.* (2001) quantified conservation priorities for African carnivores. Three of the small carnivore species expected to inhabit the Lower Zambezi PAC were ranked within that region’s twenty carnivores of most conservation concern: Serval *Leptailurus serval*, Bushy-tailed Mongoose *Bdeogale crassicauda* and Cape (or African) Clawless Otter *Aonyx capensis*. Purchase *et al.* (2007) also identified Meller’s Mongoose *Rhynchogale melleri* and Spotted-necked Otter *Lutra maculicollis* as of high conservation concern. With their status in Lower Zambezi NP unknown, they are also considered to be species of interest. In total, 21 small carnivore species were investigated. Data about large carnivores (Leopard *Panthera pardus*, Lion *Panthera leo* and Spotted Hyaena *Crocuta crocuta*) are not presented here.

Analyses

Qualitative assessments were carried out for each species according to habitat, activity patterns, perceived frequency and rarity, latest sightings, and interactions or conflict with humans. Habitat types, decided by the interviewees, were categorised into four main groups: open/grassland, forest, riverine and thicket. Activity times were categorised in the questionnaire as active during day, night, dusk, dawn or some combination. Frequency of each respondent’s sighting of each species was assessed by combining their frequency of drives (per day or per any other stated time period) with how often they reported seeing each species per drive or per time period: an average per drive was then calculated accordingly. This is an approximation, given that all information came from recall. Interviewees were also asked whether they thought a species was common, occasional or rare. Possible monotonic correlation between the percentage of respondents who perceived a species as rare (i.e. ‘perceived’ rarity) and the average number of sightings per drive (i.e. ‘actual’ rarity) was tested with Spearman rank correlation. Statistical analyses were performed with IBM SPSS Statistics 20.

Results

Species sightings

In total, 19 of the 21 small carnivore species in the questionnaire were reported in the Lower Zambezi PAC. Reflecting uncertainty over otter and genet identification to species, records of the two potential species of each were grouped and treated as unidentified otter(s) and unidentified genet(s) respectively. The two species in the questionnaire not recorded by any interviewee were Zorilla (or Striped Polecat) *Ictonyx striatus* and African Striped Weasel *Poecilogale albinucha*. Hence, 17 ‘species’ are considered hereafter. All 17 were sighted in Lower Zambezi NP, 16 in Chiawa GMA, and 11 in or near villages.

Table 2 shows the percentages of interviewees who reported each species, based on the number who visit each section. For example, 100% of interviewees who visit the East Lower Zambezi NP section ($n = 27$) reported seeing Side-striped Jackal *Canis adustus* there, and of the 25 interviewees who frequent the villages, 44% (i.e. 11 respondents) reported seeing African Civet *Civettictis civetta* there. These figures do

Table 2. Number of respondents recording each species in each section of the Lower Zambezi PAC, Zambia, represented as a percentage of the *n* interviewees using that section, ranked by number of respondents (i.e. interviewees reporting the species)¹.

Species name	Scientific name	Percentage of respondents ² among interviewees visiting the section ³							Total number of respondents in the PAC
		West GMA (<i>n</i> = 17)	East GMA (<i>n</i> = 22)	West Park (<i>n</i> = 46)	East Park (<i>n</i> = 27)	Hills (<i>n</i> = 3)	Plateau (<i>n</i> = 3)	Villages (<i>n</i> = 25)	
Banded Mongoose	<i>Mungos mungo</i>	35	59	89	78	67	33	20	55
Genet ⁴	<i>Genetta</i>	53	73	83	93	33	0	28	55
Side-striped Jackal	<i>Canis adustus</i>	6	9	93	100	0	0	0	52
African Civet	<i>Civetticus civetta</i>	94	77	83	85	67	33	44	51
Wild Cat	<i>Felis silvestris</i>	71	9	59	81	0	0	36	49
Honey Badger	<i>Mellivora capensis</i>	24	45	74	70	33	33	24	49
Common Slender Mongoose	<i>Galerella sanguinea</i>	29	55	76	74	33	33	36	48
Serval	<i>Leptailurus serval</i>	59	32	46	74	0	0	16	46
Common Dwarf Mongoose	<i>Helogale parvula</i>	24	23	83	70	33	33	20	46
White-tailed Mongoose	<i>Ichneumia albicauda</i>	6	23	70	89	0	0	0	46
Otter ⁴	<i>Aonyx capensis</i> and/or <i>Lutra maculicollis</i>	59	32	33	11	0	0	20	29
Water Mongoose	<i>Atilax paludinosus</i>	6	0	30	15	0	0	4	19
Large Grey Mongoose	<i>Herpestes ichneumon</i>	6	0	20	33	0	0	4	18
Caracal	<i>Caracal caracal</i>	6	5	20	15	0	0	0	14
Bushy-tailed Mongoose	<i>Bdeogale crassicauda</i>	0	0	22	15	0	0	0	12
Selous's Mongoose	<i>Paracynictis selousi</i>	0	0	15	4	0	0	0	8
Meller's Mongoose	<i>Rhynchogale melleri</i>	0	0	9	0	0	0	0	4
Total number of species in section		14	12	17	16	6	5	11	

¹ Note that these figures do not reflect the frequency of sightings per respondent.

² Cell shading indicates the percentage of respondents among interviewees:

1–25	26–50	51–75	76+
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³ GMA = Chiawa Game Management Area; Park = Lower Zambezi National Park.

⁴ Genet and otter records were pooled, respectively, because species identifications were uncertain; the genets definitely included Rusty-spotted Genet *Genetta maculata* and the otters probably included Cape Clawless Otter *Aonyx capensis*.

not incorporate information on the frequency of sightings per respondent, and any single respondent could report each species from multiple sections. Also, respondents may have reported seeing a species in a village but not within the rest of the West Chiawa GMA section (where the villages are), and the village data are therefore considered separately from the rest of the sections. Conclusions for the hills and plateau should be regarded as preliminary due to low sample size. Some species were reported as seen 'everywhere' by some respondents, but these records were removed from this section of the analysis to avoid assumptions regarding distribution.

Habitat

Most species were found to have a wide habitat range, although a few showed a strong bias towards one or two habitat types (Fig. 3). As with the distribution data, a single respondent could report seeing a species in more than one habitat type. Several respondents reported seeing particular species in 'all habitats'. To avoid possibly unjustified assumptions, those records were removed from this analysis.

Activity

Fig. 4 shows the reported activity times for each species. The score reflects the number of respondents indicating activity at each time, not sighting frequency per respondent. Banded Mongoose *Mungos mungo* and Common Dwarf Mongoose

Helogale parvula were the most diurnal species (>90% of respondents reporting daytime activity), while Bushy-tailed Mongoose and Meller's Mongoose were the most nocturnal, with 100% of respondents reporting only night-time activity. Side-striped Jackal is, surprisingly, reported to be relatively diurnal (60% of records).

Frequency and rarity

Fig. 5 depicts the perceived rarity and absolute frequency of species observations as assessed by recall. Genets were by far the most frequently sighted survey taxon, with a mean of 3.42 sightings per drive. Wild Cat *Felis silvestris* ('African Wild Cat' *F. s. lybica*), Side-striped Jackal and Honey Badger *Mellivora capensis* were apparently sighted more often than perceived, i.e. their ranking in average sightings did not match their ranking of perceived rarity. While perceived rarity did not perfectly match actual frequency of sightings, overall there was still a highly correlated inverse relationship between these two variables ($r_s = -0.901$, $P < 0.001$). Frequency differences between Lower Zambezi NP and Chiawa GMA were not quantified, but for most species frequencies seemed higher inside the park.

Latest sightings

All 17 species reported had been seen at least once within the last year by at least one respondent. Nine had been seen in this period by over 50% of the interviewees. Meller's Mongoose

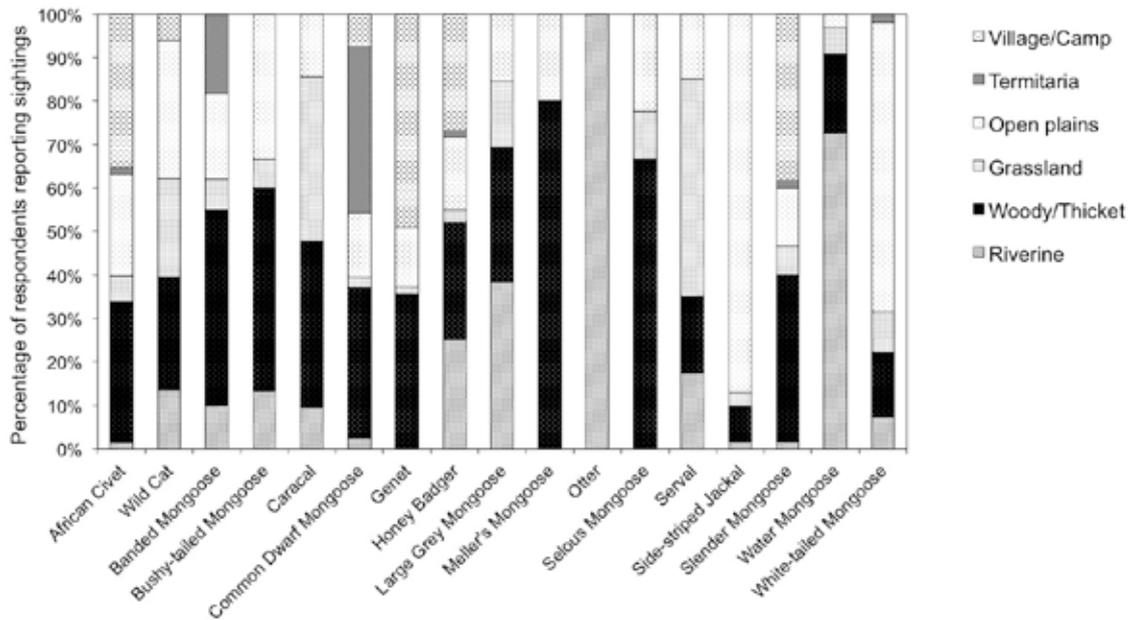


Fig. 3. Habitat-use reports for small carnivores in the Lower Zambezi PAC, Zambia. Scientific names and the number of respondents for each species are given in Table 2.

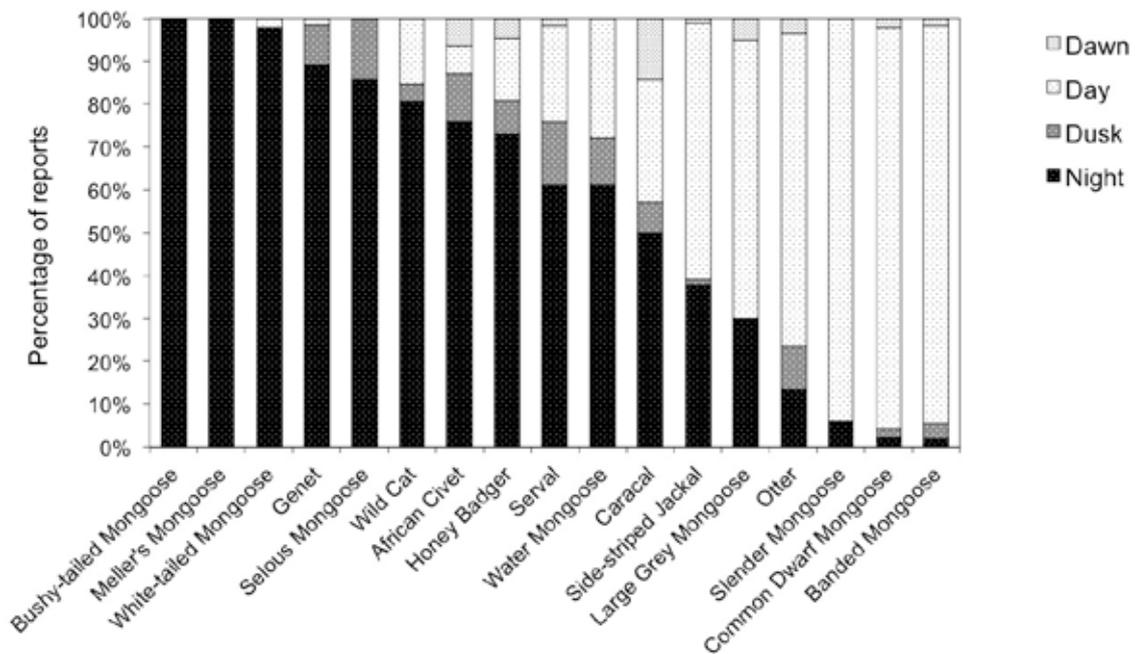


Fig. 4. Reported activity patterns for small carnivores in the Lower Zambezi PAC, Zambia. Scientific names and the number of respondents for each species are given in Table 2.

and Caracal *Caracal caracal* had only been seen by 2% of the interviewees in the last year, suggesting that these species might be rare; although these low rates might also reflect misidentification of rarer species for more common ones, limited overlap between species occurrence and interviewee activity, or various other factors.

Conflict with humans

Human-wildlife conflict was reported for ten species of small carnivores (Table 3), ranging from depredation of livestock to killing of wildlife. The most commonly reported type of con-

flict was chicken depredation within villages in Chiawa GMA, followed by small carnivores taking food from camp kitchens. Otters were reported to be problematic for fishermen by taking fish out of nets; this may have lead to otter entanglements and mortalities. The most common response by villagers was to kill the animal on site.

Species of previously unsuspected or uncertain occurrence in the Lower Zambezi PAC

Substantial evidence was found for two species first reported for the Lower Zambezi PAC in the 2007 interview survey (Pur-

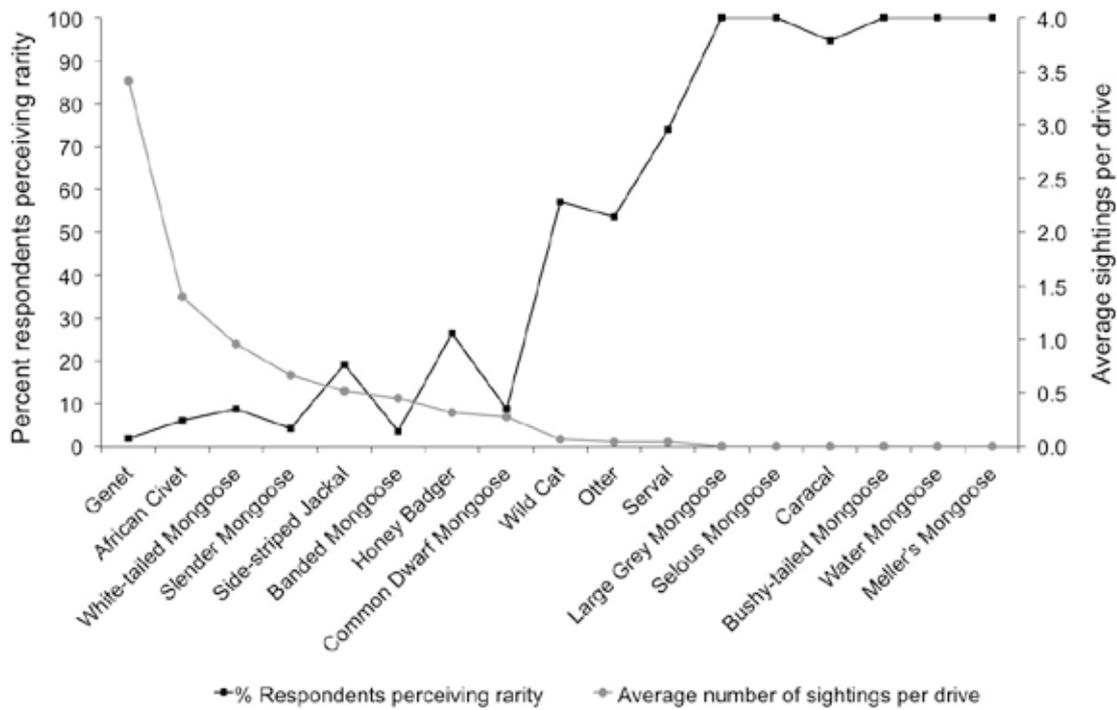


Fig. 5. Comparison of frequency of sightings with perceived rarity of species for each species in the Lower Zambezi PAC, Zambia. Scientific names and the number of respondents for each species are given in Table 2.

Table 3. Summary of human–small carnivore conflicts and currently used responses, as reported by respondents in the Lower Zambezi PAC, Zambia.

Species	ISSUES								SOLUTIONS									
	Snared	Possible poaching	Eaten by villagers	Conflict with domestic dogs & cats	Conflict with fishermen	Kill chickens	Kill livestock	Take food from camp kitchens/bins	Nothing/ little done	Chased away by villagers	Killed by villagers	Deterred/ killed by village dogs	Protect camp kitchens/ bins	Build strong chicken houses	Keep camp food packed away	Villagers kill hybrid kittens	Removal of snares/ patrols by CLZ/ ZAWA	Number of different types of conflict reported for species
Wild Cat	1			7		22			3	3	10	3		1		2		9
Serval	3	2				8	2		1	1	3						1	8
African Civet			2			7		2		2	1	2	1		3			8
Genet	1					6					2							3
Water Mongoose					1													1
Slender Mongoose						8			4		2	1						4
Banded Mongoose						1					1							2
Side-striped Jackal	1	1		1		1	1											5
Otter			1		7				1		1							4
Honey Badger						11	12		2	3	2	1	10	1	1			9
Total number of species in each conflict type	6	3	3	8	8	64	3	14	11	9	22	7	11	2	4	2	1	17

Scientific names are given in Table 2.

CLZ = Conservation Lower Zambezi; ZAWA = Zambian Wildlife Authority

chase *et al.* 2007): Large Grey Mongoose *Herpestes ichneumon* and Water Mongoose *Atilax paludinosus*. Cape Clawless Otter, reported for the area by both Ansell (1978) and Purchase *et al.* (2007) but considered absent by Skinner & Chimimba (2005), was widely reported. Although it was difficult to be sure that any given otter report was reliable to species, the overall balance strongly indicated the presence of Clawless Otter. Five further species, for which Ansell (1978) traced no records in the area, and for which we traced no specific post-Ansell records, were reported, although the validity of some is open to question. Of the five, we confirmed Meller's Mongoose by photograph, consider Bushy-tailed Mongoose and Selous's Mongoose *Paracynictis selousi* likely to occur, recorded the possible presence of Spotted-necked Otter, and documented a second genet type of unclarified taxonomic significance. Table 4 summarises the historical and current evidence for all eight species, which are discussed in more detail below.

Discussion

The carnivore community of the Lower Zambezi PAC faces an unusual challenge through its confinement by the escarpment to the north, the river to the south and human pressure to the west. Further to the east is another game management area, although not as densely populated as Chiawa GMA. Nevertheless, species richness in the Lower Zambezi PAC appears to be quite high, and most species are still sighted in Chiawa GMA albeit by relatively fewer people than in the park.

Banded Mongoose, African Civet and genet were seen by the highest number of respondents and reported in the greatest number of sections across the Lower Zambezi PAC (i.e. from all sections of Chiawa GMA and Lower Zambezi NP). Differences between Chiawa GMA and Lower Zambezi NP in sighting rates reported by respondents suggest population densities may vary between the sections. Most of the rarely seen species were reported only from the park. This could reflect higher visitation densities in the park, but some level of disturbance avoidance (from the villages in West Chiawa GMA) is likely to be occurring for several species.

Species of particular distributional or ecological interest

Rarely-recorded mongooses

The numbers of interviewees seeing Bushy-tailed, Meller's and Selous's Mongooses remain somewhat unclear: there was some confusion over them, in particular between Bushy-tailed and Meller's. Originally no-one reported seeing Meller's, while 16 respondents reported seeing Bushy-tailed, in thickets mainly in the West Lower Zambezi NP. We opportunistically photographed a Meller's Mongoose in the West Lower Zambezi NP after most of the interviews were finished (Fig. 6), and sent the image by email to the respondents for follow-up consultation. After seeing our photograph, all four respondents who replied changed their identification of their sightings from Bushy-tailed to Meller's. We did not have a good diagnostic photograph of Meller's Mongoose during the interviews, and most guides had not heard about Meller's Mongoose occurring in the Lower Zambezi PAC; and at least one reported that Selous's Mongoose "was not meant to occur in the area", based on field-guide literature. Therefore, if seeing Meller's or Selous's, respondents



Fig. 6. Meller's Mongoose *Rhynchogale melleri* in Lower Zambezi National Park (31 October 2009, 19h33; 15°41'3.22"S, 29°23'56.08"E; recorded altitude: 363 m a.s.l.).

Table 4. Historical and current evidence for small carnivore species not consistently listed as present in the Lower Zambezi PAC, Zambia.

Species	Ansell 1978 (definite records)	Purchase <i>et al.</i> 2007 (reported observations)	Skinner & Chimimba 2005 (range map)	IUCN 2012 (2008 Red List range map)	This study	Conclusion
Bushy-tailed Mongoose	None	None	In range	In range	12 reports, but see text	Likely
Cape Clawless Otter	Yes	Yes	Out of range	In range	21 reports, including 1 of prints	Highly likely
Large Grey Mongoose	None	Yes	In range	In range	18 reports	Highly likely
Meller's Mongoose	None	None	In range	In range	4 reports, but see text; photographed	Confirmed
Selous's Mongoose	None	None	In range	In range	8 reports	Likely
Spotted-necked Otter	None	None	Out of range	Out of range	2 reports	Unlikely
Water Mongoose	None	Yes	Out of range	In range	19 reports	Highly likely
Second genet species	None	None	None	None	6 reports of '2nd type'; photographed	Possible (P. Gaubert verbally 2012)

Scientific names are given in Table 2

may have assumed they were seeing another species. Nevertheless, two guides, who did not reply to the email with the photograph, were “very sure” that they had seen Bushy-tailed, on more than one occasion. Eight respondents reported seeing Selous’s Mongoose, three of whom also reported having seen a different rare mongoose (either Bushy-tailed or Meller’s). Two respondents claimed to be very sure of the identity as Selous’s Mongoose, and three gave detailed descriptions of the species. All but one of the 21 respondents who reported seeing any of these three apparently rare species had been guiding or working in the park for at least four years, some as many as 20 years. Thus, they seem likely to differentiate correctly how many species they see, even if they misname them. Meller’s and Bushy-tailed Mongooses were camera-trapped frequently in Zambia’s Luangwa Valley (White 2013), suggesting that their presence in the Lower Zambezi PAC may be much underestimated by interviewees. Meller’s and Bushy-tailed Mongooses were also recently recorded in Tanzania’s Udzungwa Mountains (De Luca & Mpunga 2005), with surprisingly high capture rates for Bushy-tailed, suggesting that these species may be more widely distributed than originally thought. Bushy-tailed is associated with mopane woodland and rocky outcrops (Skinner & Smithers 1990), possibly making the Lower Zambezi PAC’s combination of valley floor and escarpment a highly suitable area for this species. In sum, all three species plausibly occur within this area, but further research (such as camera-trapping) is needed to clarify their status there.

Cape Clawless Otter

Cape Clawless Otter was reported by 21 respondents, supporting the view of Purchase *et al.* (2007) that it occurs between Victoria Falls and the Mozambique Zambezi delta. Eight other respondents reported otters but were unsure of species identification. There were several reports of conflict with fishermen; otters eat fish in the nets, causing loss to fishermen, and can become entangled and drown in the nets. One local guide reported that villagers have been known to eat them. De Luca & Mpunga (2005) reported high levels of illegal hunting of otters in the Udzungwa Mountains, more often for traditional medicine and ceremonial purposes. Given the relatively high-quality habitat available for them in Lower Zambezi PAC and the high likelihood of fishing impacts and consumptive mortality (Skinner & Chimimba 2005), measures are warranted to reduce impacts of local fishing and traditional practices on this population.

Spotted-necked Otter

Two respondents reported seeing Spotted-necked Otter. They could have been misidentifying Cape Clawless Otter or Water Mongoose, although both said that they had also seen Clawless Otter and one claimed also to have seen Water Mongoose. One boatman not interviewed formally, working in the Rufunsa Game Management Area east of Lower Zambezi NP for more than 17 years, said he had heard two different types of call from otters he sees in Rufunsa GMA, leading him to believe both species are present; but this could be misidentification of Water Mongoose or variation of calls within Clawless Otter.

Water Mongoose

Water Mongoose was reported for both Chiawa GMA and Lower Zambezi NP by Purchase *et al.* (2007) but not recorded

previously (Ansell 1978, Skinner & Chimimba 2005). Nineteen respondents reported seeing Water Mongoose, of whom only two were doubtful of its identity. Of these 19, 12 also reported seeing at least one otter species, suggesting that most could distinguish between the two. In Congo’s Dzanga-Sangha Reserve, Water Mongoose and Congo Clawless Otter *Aonyx congicus* do not frequent the same small streams within the forest (Ray 1997), and in the Udzungwa Mountains Water Mongoose was not captured in the same vicinity as Cape Clawless Otter (De Luca & Mpunga 2005). Water Mongoose was not reported from Chiawa GMA, while Clawless Otter was reported across the Lower Zambezi PAC. Within the Lower Zambezi NP, both species were reported in the same areas, but the sampling units used might be too coarse to measure any real separation.

Large Grey Mongoose

Large Grey Mongoose, while expected to be in the Lower Zambezi PAC (Skinner & Chimimba 2005, Cavallini & Palomares 2008), had not been reported there until recently. Ansell (1978) noted the lack of records, but suggested that it probably occurred there. Purchase *et al.* (2007) reported it from both Lower Zambezi NP and Chiawa GMA. Eighteen respondents reported seeing it in this study, making its presence in the LZPAC highly likely, especially as no confusion with other species was apparent. All respondents reported the species as rare, seeing it on average only 0.2 times a year; 68% of interviewees had never seen it. This species is largely diurnal and distinctive in appearance, so its low reporting rate suggests genuine scarcity. Only one report came from outside Lower Zambezi NP. The species’s local conservation status might, therefore, be a cause for concern.

Serval and Caracal

De Luca & Mpunga (2005) suggested that high densities of Leopards and Spotted Hyaenas in the Udzungwa Mountains could cause intra-guild competition to the detriment of Serval and Caracal. While Caracals were considered very rare in the Lower Zambezi PAC, Servals were reported to be relatively widespread across it, with a surprisingly high number of respondents in the West Chiawa GMA section. This could stem from higher domestic prey (chickens) availability in the village sections, where conflicts were reported, than in the relatively undisturbed East Chiawa GMA section. Nevertheless, most Serval sightings were reported inside the Lower Zambezi NP. Here, larger predator species also seemed more common than in Chiawa GMA (TLFB & CWM own data), indicating that if such competition occurs, it is not intense enough to prevent Serval being common.

Genets

To test interviewees’ knowledge of genets in the area, we included photographs of Rusty-spotted Genet *Genetta maculata*, Small-spotted Genet *G. genetta* and Angolan (or Miombo) Genet *G. angolensis*, although the latter two are unlikely to occur near the Lower Zambezi PAC (Gaubert *et al.* 2005, Purchase *et al.* 2007). Of the interviewees who saw a genet, most identified the species as *G. maculata* (the expected species), but 13% of respondents claimed to be seeing a second form in the park as well, which (based on survey photographs we showed them and their own perusal of field guide books), they considered to be most similar to *G. genetta*.

In response to these speculations we undertook several



Fig. 7. Rusty-spotted Genet *Genetta maculata* (typical appearance) in Lower Zambezi National Park.



Fig. 8. Genet *Genetta* of unresolved identity ('second form') in Lower Zambezi National Park (9 November 2009, 19h47; approximately 15°38'S, 29°34'E; altitude: approximately 350 m a.s.l.).

night drives and took photographs of what appear to be two different forms (Figs 7–8). Several respondents described *G. maculata* (Fig. 7) as larger, more heavily built, and of darker base-colour with larger spots, and the second form (Fig. 8) as smaller, of leaner build, of paler base colour and with smaller, more linear spots. Our photographs of this second type show a black-tipped tail, ruling out both *G. genetta* and *G. angolensis*; but it is unclear whether the animal is an unusual form of *G. maculata* or possibly a pale form of Servaline Genet *G. servalina*, which sometimes occurs in East Africa (Tanzania) (P. Gaubert verbally 2012). The Lower Zambezi PAC lies far south of Servaline Genet's currently known range, from Cameroon to Kenya (Gaubert *et al.* 2005). No positive identification can be made of our few night images: genets in this area warrant further investigation.

Side-striped Jackal

Canis adustus is not considered to be of conservation concern, but its reported behaviour in the Lower Zambezi PAC is of interest; nearly all respondents reported it as highly diurnal or

as nocturnal and diurnal, and almost exclusively sighted it in open plains and other open areas. Observations were mainly reported from Lower Zambezi NP and rarely in Chiawa GMA, perhaps depending more on the availability of open plains in these respective areas rather than avoidance of people. It is typically considered highly nocturnal or occasionally crepuscular (Kingdon 1988, Stuart & Stuart 2001, Loveridge & Macdonald 2002, 2003, Skinner & Chimimba 2005, Brown & Peinke 2007). It is scarce in open areas where it is sympatric with Black-backed Jackal *C. mesomelas* and/or Golden Jackal *C. aureus*, reflecting competition and aggressive exclusion by the smaller *C. mesomelas* (Fuller *et al.* 1989, Loveridge & Macdonald 2003, Skinner & Chimimba 2005). These latter two jackal species seem not to inhabit the Lower Zambezi PAC, and regular use by *C. adustus* of open areas there echoes Loveridge & Macdonald's (2003) demonstration of its competitive release.

Other species

In spite of expectations that they occur in the area, neither Zorrilla nor African Striped Weasel were recorded by any interviewee, even though some had worked there for 20 years. This zero result could reflect these species' entirely nocturnal nature (Larivière 2002, Skinner & Chimimba 2005) rather than their absence from the area. The latest night drives finished by 20h00, so species active only after this time were unlikely to be observed. Skinner & Chimimba (2005) also stated that owing to African Striped Weasel's small size, short legs and low-slung body, observations in the field were meagre. Both species are widespread in Africa, and the Lower Zambezi PAC is within their expected ranges and habitats (Skinner & Smithers 1990). Further investigation should use other survey methods, such as camera-trapping, to assess their status in this area.

Using questionnaires to capture data

Certain assumptions and biases, reflecting the interview methods used, may have affected results and conclusions. Nocturnal and/or cover-haunting species are less easily spotted than diurnal and/or open habitat ones. To maximise animal sightings for tourists, most guides were more active during daylight and in open areas near roads, a pattern exacerbated by the need for Chiawa GMA guides to leave the park by 20h00, when the gates close. Skulking, nocturnal and forest species are much less likely to be observed so warrant survey by methods such as camera-trapping.

A major concern when investigating species status by questionnaires is the reliability of identification. As well as the challenges of sometimes poor visibility and fleeting glances, many guides use books that include range and behaviour information. This is sometimes incomplete and even inaccurate, misleading interviewees into false species identifications of their sightings. For example, Meller's Mongoose is poorly described in most field guides, often without a photograph. In this survey a few species unlikely on known range to inhabit the Lower Zambezi PAC were added to test interviewees' knowledge of species in the area, as well as to allow for the possibility of unexpected occurrence: Small-spotted and Angolan Genets, and Aardwolf *Proteles cristatus*. The first was reported by seven (13%) interviewees, but neither of the other two were reported by anyone. Given the presence of genets

of genuinely confusing appearance (see below), these results suggest generally good recognition skills among interviewees.

White (2013) surveyed nocturnal species using camera-traps, but this method alone would not necessarily have been more effective for our study. It requires intensive sampling effort and is much more expensive, is highly restricted in information it can collect on topics like human-wildlife conflicts and on pre-survey population trends, and its results are highly dependent on camera placement. Interviews of guides and patrol officers, who collectively spend hundreds of hours a week in the field sighting animals, generated much information not obtainable from camera-traps. Camera-trapping detected 15 carnivore species in Tanzania's Udzungwa mountains out of the 26 assessed as present through interviews, live traps and direct observations (De Luca & Mpunga 2005). Similarly, TAWIRI (2010) camera-trapped only 35 of mammal species in an area where "after eliminating species that were obviously incorrectly identified" (p. 9) there were a further 26 species reported by villagers that were not camera trapped – although several more of these were also felt to be dubious, and several others were not particularly well suited to camera-trapping but were seen directly by the survey team. Thus, camera-trapping provides verifiable evidence and data more easily quantified, but interviewing local wildlife professionals is an efficient source of species status information that is more likely to identify human impacts on these species.

Anthropogenic impacts on small carnivore distributions

Our initial interest was to compare Lower Zambezi NP with Chiawa GMA for relative abundance and distribution, but because most guides, even in Chiawa GMA, went straight into the park for game drives, this comparison was challenging and the results should be interpreted with care. Nevertheless, populations of most species seem larger within the park than in Chiawa GMA. This statement is based on various assumptions and may not reflect the true pattern within the Lower Zambezi PAC. Nonetheless, this fits a well documented pattern of some carnivores avoiding human-populated areas. This could reflect habitat change to offer less shelter, or less (and/or less diverse) food (De Luca & Mpunga 2005, Martinoli *et al.* 2006), or direct persecution, and/or mortality from domestic dogs and cats.

Human-carnivore conflict is often associated with large carnivores given the danger they pose to human life and livestock (Treves & Karanth 2003). However, several species of small carnivores were considered to be problem animals in the Lower Zambezi PAC, including Wild Cat, which reportedly often killed chickens in villages, and Honey Badger, which raided camp kitchens and rubbish bins. In addition, otters may die from conflicts with fishermen, either as a direct target or indirectly through entanglement in nets.

Conclusion

This study was a pilot to determine knowledge gaps, species status and future research needs for the Lower Zambezi PAC. Small carnivores' roles in ecological ecosystems remain poorly known despite greater attention recently (Crooks & Soulé 1999, Prugh *et al.* 2009, Roemer *et al.* 2009). An ecologi-

cal study of the Lower Zambezi PAC's overall carnivore guild would clarify small carnivores' ecological roles there. Camera-trapping would complement interviews, particularly with rare mongooses and with genets. There is a pressing need to clarify the status of Zorilla and African Striped Weasel in the Lower Zambezi PAC, both predicted to inhabit the area but not reported in the present interviews. Whilst they might simply be overlooked, or the predictions might be wrong, the lack of reports might indicate a so-far overlooked conservation issue.

Current trends in human population growth and habitat loss mean that the persistence of many carnivore species is likely to depend on their survival outside protected areas, where they may come into conflict with humans (Kent 2011). In this study few small carnivore species were reported in significant levels of such conflict. Protection of undisturbed areas and prevention of encroachment of the park will assist long-term conservation of these species in particular.

Scientific knowledge of these species' populations and of the perceptions and attitudes of the people living in the same area is therefore of great importance to their continued existence. Local knowledge can serve as a valuable source of ecological information to complement scientific information for wildlife conservation and management (Gandiwa 2012). Further research focusing on local (village) knowledge, perceived population trends, and attitudes towards small carnivores, will assist informed conservation practices for these species in the Lower Zambezi PAC.

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Appendix 1. Questionnaire used in surveys of carnivores in the Lower Zambezi Protected Area Complex.

Interviewees were shown photographs of 28 species of carnivores, most of which were expected to occur in the area. These included 21 species of small carnivores.

Information about Interview and Interviewee

1	Name of interviewee		
2	Location of interview		
3	Occupation of interviewee		
4	Other places worked		
5	Years lived in LZPAC		
6	Area regularly visited		
7	Frequency of drives		
8	Date interviewed		
9	Name of researcher conducting interview		

Species information

10	Species photo ID number (from photo booklet)	1	2	...	28
11	Species Name (given by interviewee)				
12	Have you ever seen this species in the wild in this area?				
13	If yes, when was the last time you saw this species (month and year)?				
14	What time of day do you normally see it (Day/Night/Dusk/Dawn)?				
15	Where do you see the species?				
16	What habitat have you seen it in (open grassland/forest/river/road, etc.)?				
17	How many do you see in together?				
18	What is the largest number you have seen in a group?				
19	Have you seen young/sub-adults/juveniles? How many?				
20	How many times have you seen this species in the last year (or per week or month)?				
	Opinion				
21	How abundant do you think the species currently is in the area (rare/occasional/common/don't know)?				
22	Over the last 5 years, do you think that this species numbers in the area are increasing/decreasing/the same?				
23	Do you like this species (yes/no/don't know)?				
24	Would you like this species to increase/ stay the same/ decrease/ don't care? Why?				
	Conflict issues				
25	Do you know of any problems involving this species or any conflict issues? Explain.				
26	How do you or your community deal with the problems - e.g. fencing/chasing away/killing/reporting to Zambia Wildlife Authority				
27	Any other comments				