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SHORT COMMUNICATION

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A camera trap survey in the community zone of Lobéké National Park (Cameroon) reveals a nearly intact mammalian community

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Abstract

Estimating the richness and abundance of animal species remains central to any conservation strategy of a given area. In remote and challenging environments such as tropical forests, camera traps have proven to be successful in documenting secretive wildlife communities compared to other survey methods, as they allow continuous monitoring without the presence of a human observer. Here, we used camera traps to characterise the community of medium and large terrestrial mammals in the community zone of Lobéké National Park, in southeastern Cameroon. We deployed a grid of 40 camera traps over a 5-week period, recording 5156 independent detection events over 1284 camera days. We recorded 35 species, many of them showing high detection rates compared to other sites in central Africa. These results highlight the little disturbance of the studied area within the park despite its accessibility to local communities. These results obtained from a standardised approach using an expanding technology offer valuable information about the wildlife community of Lobéké, and new insights for reconciling human activities with wildlife conservation.

KEYWORDS
camera traps, Congo Basin, detection rate, Lobéké, richness, wildlife communities

Résumé

Évaluer la richesse et l'abondance des espèces animales reste un élément clé de toute stratégie de conservation d'une zone donnée. Dans les environnements éloignés et difficiles tels que les forêts tropicales, les caméras-pièges se sont avérées efficaces pour documenter les communautés secrètes d'animaux sauvages par rapport aux autres méthodes d'enquête, car elles permettent un suivi continu sans la présence d'un observateur humain. Dans cette étude, nous avons utilisé des caméras-pièges pour caractériser la communauté des mammifères terrestres de taille moyenne et grande dans la zone communautaire du parc national de Lobeke, dans le sud-est du Cameroun. Sur une période de 5 semaines, nous avons déployé une grille de 40 caméras-pièges, enregistrant 5156 événements de détection indépendants sur 1284 jours de surveillance. 35 espèces ont été enregistrées, la plupart d'entre elles présentant des taux de détection élevés par rapport à d'autres sites d'Afrique centrale. Les résultats obtenus montrent que la zone étudiée est peu perturbée au sein du parc, malgré son accessibilité aux communautés locales. Grâce à ces résultats obtenus à partir d'une approche standardisée utilisant une technologie en expansion, nous disposons d'informations précieuses sur la communauté faunique de Lobéké et de nouvelles perspectives pour concilier les activités humaines et la conservation de la faune.

1 | INTRODUCTION

Estimating species richness and abundance is crucial to documenting species declines, understanding ecological and anthropogenic factors impacting wildlife communities and assessing the positive outcomes of wildlife management and conservation activities (Nichols & Williams, 2006). Wildlife monitoring techniques can differ according to the surveyed species, the spatial scale, the resolution and available financial means (equipment, field costs, analytical costs) and manpower (Ahrestani et al., 2018; Laguardia et al., 2021). Many survey methods, though essential to guiding management choices and identifying conservation priorities (Haurez et al., 2020), are subject to significant biases and potentially heterogeneous detection probabilities, either driven by the observers themselves or by environmental and species-specific factors (Silveira et al., 2003; Zwerts et al., 2021). Among them, camera traps are becoming a prominent tool for wildlife monitoring, as they allow data to be continuously captured in the absence of a human observer (Gessner et al., 2013; Griffiths & Van Schaik, 1993; Tobler et al., 2008). It is an interesting alternative, particularly in contexts where making direct observations is difficult, such as in the dense understorey and canopy of the rainforest of the Congo Basin (Agha et al., 2018; Fonteyn et al., 2021; Hongo et al., 2020; Trolliet et al., 2014).

In this study, we documented the ground-dwelling rainforest mammal community found in the Lobéké National Park (LNP) in South-East Cameroon using a standardised camera trap array. We computed the richness level (1) and the detection rates (2) for all detected terrestrial and semi-terrestrial species to quantify wildlife diversity in a zone accessible to local communities among a presumably species-rich forest protected area.

2 | MATERIALS AND METHODS

2.1 | Study site

Lobéké National Park is located in the Eastern Region of Cameroon, where the human population density (7.3 inhabitants/km^2, MINFOF, 2015) is lower than the average of the country (40.7 inhabitants/km^2, INS Cameroun, 2019). It is part of the Sangha Trinational (TNS) world heritage site (https://whc.unesco.org/en/list/1380/) and is located at the transition between the Dja evergreen forest and the semi-deciduous humid dense forest characterised by Ulmaceae and Sterculiaceae (Letouzey, 1985). Mean annual rainfall ranges between 1400 and 2000 mm distributed between two distinct wet seasons, mean annual maximum temperature between 27 and 30°C, and mean annual minimum temperature between 18 and 21°C. Varying between 400 and 700 m of elevation, the region is characterised by a relatively flat landscape, with nevertheless quite marked hills and valleys locally (Laclavère, 1979), as well as a diversity of natural forest clearings (Gessner et al., 2013). LNP is part of the Northwestern Congolian Lowland Forests ecoregion (Olson et al., 2001), namely the African ecoregion where forest mammal diversity is the highest (Burgess et al., 2004).

We focused our camera trap survey effort within the community zone of LNP. Covering 33,284 ha in the western part of the park, this zone represents about 15% of its surface and was delimited for the local communities to exercise their usage rights, such as fishing, gathering and medicinal plants harvesting, but which does not include hunting (Decree n° 2001/101/CAB/PM of 19 March 2001). It is crossed by a road which was formerly used to export timber from south of Lobéké and the northern Republic of Congo.

2.2 | Camera-trap survey

A systematic grid of 40 camera traps (Bolyguard SG 2060X, Boly) was set up east of the road crossing LNP's community zone covering an area of approximately 65 km^2. Individual camera traps were located between 1 and 11.5 km from the road, and at least 30 km from the nearest village (Figure 1). The grid was deployed at a density of one camera every 2 km^2, according to the TEAM network guidance for a multi-species survey (Jansen et al., 2014; TEAM Network, 2011). Following the recommendations of Howe et al. (2017), each of them was installed at a height of 70 cm and oriented north with a possible ±40° deviation. The herbaceous vegetation in front of the camera's field of view that could trigger the sensor was trimmed to a maximum of 3 m, leaving the rest of the undergrowth untouched. The cameras were programmed to take 30 s videos when triggered, and remained active 24 h a day in the forest for 4–5 weeks between February and March 2021 (which coincides with the end of the rainy season) to ensure sufficient data collection (O'Brien et al., 2010; Tobler et al., 2008).

2.3 | Species identification

Videos processing and species identification were made using the software *Timelapse2* (Greenberg & Godin, 2015). Only terrestrial and semi-terrestrial mammals were considered (Table 1). To ensure that events were independent, videos of the same species occurring within 30 min of a previous detection were not taken into account

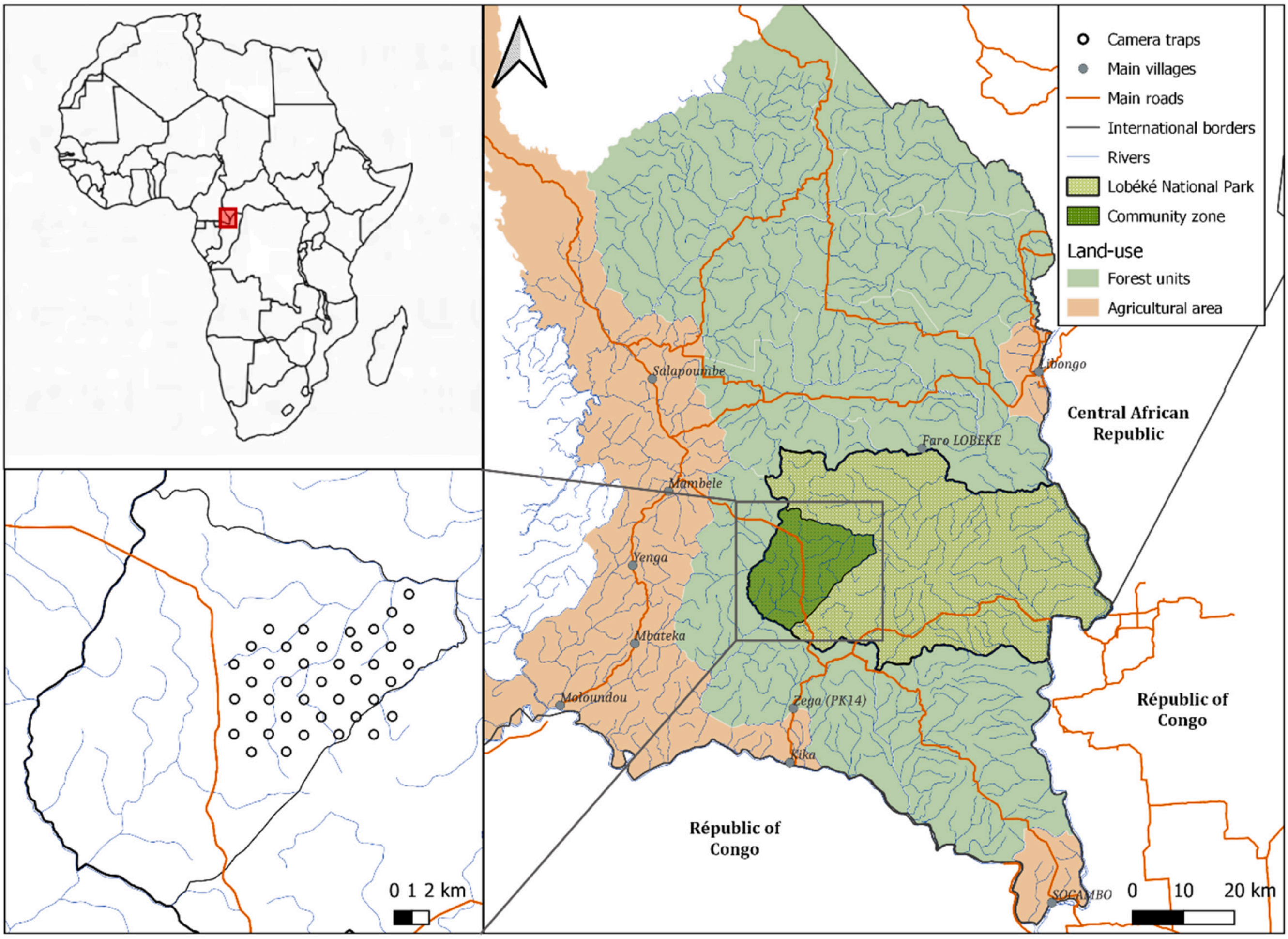

FIGURE 1 Study area and camera trap grid installed in Lobéké National Park's community zone.

(Meek et al., 2014). Five species complexes were defined, because of challenging identification: the large spotted genets complex (*Genetta servalina* and *Genetta maculata*), the mongooses complex (*Herpestes naso* and *Atilax paludinosus*), the small pangolins complex (*Phataginus tetradactyla* and *Phataginus tricuspis*), the forest squirrels complex (including seven species from four different genera of the Sciuridae family) and the galago complex (including the genus *Galagoides*, *Euoticus* and *Sciurocheirus*). These species complexes were treated as species in the following analyses.

2.4 | Data analysis

The number of terrestrial and semi-terrestrial mammal species detected provided a species richness estimate. A rarefaction curve showing the number of species as a function of the cumulated number of camera days was calculated in the R software using the *specaccum* function of the *vegan* package (Oksanen et al., 2019). The species detection rate was computed as the mean number of independent events occurring at one sampling point for 100 days (Rovero & Marshall, 2009). This index was chosen as it correlates to relative abundance and is frequently used when other methods to estimate abundance are too difficult to implement (Palmer et al., 2018). Beyond local abundance, a range of factors may however affect species' detectability including species' behaviour and biomass, micro-habitat characteristics, and methodology (Lijun et al., 2019; Sollmann et al., 2013). This introduces imperfect species detection, which makes this index more comparable to a micro-habitat use predictor, rather than a suitable proxy for species abundance (Broadley et al., 2019; Hofmeester et al., 2019). The mean number of individuals per detection was also calculated to reflect the gregarious behaviour of each species. All data analyses were conducted using R version R 4.1.0 (R Core Team, 2020) in RStudio version 1.4. (RStudio Team, 2019).

3 | RESULTS AND DISCUSSION

In total, 39 camera traps functioned properly and recorded 35 different species in 1284 camera days and 5156 detection events. Almost 95% of the species were detected after only 600 camera days, as shown on the accumulation curve (Figure 2), which confirms the exhaustiveness of the survey. Among all the species recorded, the presence of five species or species complexes with strong conservation concerns was recorded according to the IUCN Red List of

TABLE 1 Species detection rates resulting from the camera trap survey

Order	Family	Species	N	Rate	$\overline{N}$	IUCN
Artiodactyla	Bovidae	*Cephalophus callipygus*	1608	125.2	1.1	LC
		Cephalophus dorsalis	368	28.7	1.0	NT
		Cephalophus leucogaster	18	1.4	1.0	NT
		Cephalophus nigrifrons	12	0.9	1.1	LC
		Cephalophus silvicultor	91	7.1	1.1	NT
		Neotragus batesi	4	0.3	1.0	LC
		Philantomba monticola	1873	145.9	1.4	LC
		Syncerus caffer nanus	5	0.4	1.0	NA
		Tragelaphus eurycerus	23	1.8	2.0	NT
		Tragelaphus spekii	6	0.5	1.3	LC
	Suidae	*Hylochoerus meinertzhageni*	2	0.2	3.5	LC
		Potamochoerus porcus	23	1.8	4.9	LC
	Tragulidae	*Hyemoschus aquaticus*	51	4.0	1.0	LC
Carnivora	Felidae	*Caracal aurata*[a]	6	0.5	1.0	VU
		Panthera pardus	2	0.2	1.0	VU
	Herpestidae	*Bdeogale nigripes*	82	6.4	1.1	LC
		Mongooses	33	2.6	1.1	LC
		Crossarchus platycephalus[a]	24	1.9	2.4	LC
	Nandiniidae	*Nandinia binotata*[a]	20	1.6	1.0	LC
	Viverridae	Large spotted genets[a]	18	1.4	1.0	VU-LC
Pholidota	Manidae	Small pangolins	25	1.9	1.0	EN-VU
		Smutsia gigantea	9	0.7	1.0	EN
Primates	Cercopithecidae	*Cercocebus agilis*	185	14.4	3.2	LC
	Hominidae	*Gorilla gorilla*	86	6.7	2.5	CR
		Pan troglodytes	16	1.2	2.8	EN
	Galagidae	Galagos[a]	9	0.7	1.0	LC
Proboscidea	Elephantidae	*Loxodonta cyclotis*	66	5.1	2.0	CR
Rodentia	Hystricidae	*Atherurus africanus*[a]	257	20.0	1.1	LC
	Nesomyidae	*Cricetomys emini*[a]	39	3.0	1.0	LC
	Sciuridae	Forest squirrels[a]	160	12.5	1.1	–

Note: *N* represents the number of detections, rate is the species detection rate (mean number of detections per 100 camera days), $\overline{N}$ is the mean number of individuals per detection and the conservation status according to the IUCN red list of threatened species (CR, critically endangered; EN, endangered; LC, least concern; NT, nearly threatened; VU, vulnerable). The species showing the five highest detection rates are highlighted in grey.

[a]Species that were not detected during the last line transect survey in 2018.

Threatened Species (Table 1), namely the western lowland gorilla (*Gorilla gorilla gorilla*), the chimpanzee (*Pan troglodytes*), the African forest elephant (*Loxodonta cyclotis*), the giant ground pangolin (*Smutsia gigantea*) and small pangolins (*Phataginus* spp.).

In their last line transect wildlife survey report, Beukou et al. (2019) highlighted the outstanding biodiversity of the area of Lobéké, which is once more confirmed by our study showing a higher species richness than similar studies conducted elsewhere in the Congo Basin (Table 2). The closer National Parks, Boumba-Bek, Nki and Nouabalé-Ndoki, showed very similar richness, ranging from 32 to 37 detected species (Hongo et al., 2020; Mavinga, 2018). Conversely, only 26–31 species were detected in the Dja Biosphere Reserve (Bruce et al., 2018; Lhoest et al., 2020), 29 in production forests in Gabon (Fonteyn et al., 2020), 31 in the Batéké Plateau NP (Hedwig et al., 2018) and 21 in the forests of Kouilou Departement in Congo (Orban et al., 2018). Efforts vary slightly from one study to another, but accumulation curves show that the surveys are exhaustive, enabling us to compare them in terms of species richness.

Beyond species richness, the composition of the detected wildlife community suggests a low level of disturbance and a nearly intact mammalian community in the study area. With nearly 80% of detection events, artiodactyls are the most detected order (Table 1). While related to the high detection rates of the blue duiker (*Philantomba monticola*) and Peter's duiker (*Cephalophus callipygus*), the detection rate of all duikers recorded here is among the highest so far in the Afrotropical rainforest (Bruce et al., 2018; Fonteyn et al., 2020; Hedwig et al., 2018) and comparable with results from two nearby studies, such as in the Nouabalé-Ndoki National Park in the Republic of Congo that is also part of the TNS (Breuer et al., 2021). The red/blue duiker ratio, often considered as a good proxy for assessing the status of duiker populations, is similar to the ones obtained in the Nouabalé-Ndoki National Park, which is characterised by a particularly low level of hunting pressure (Breuer et al., 2021).

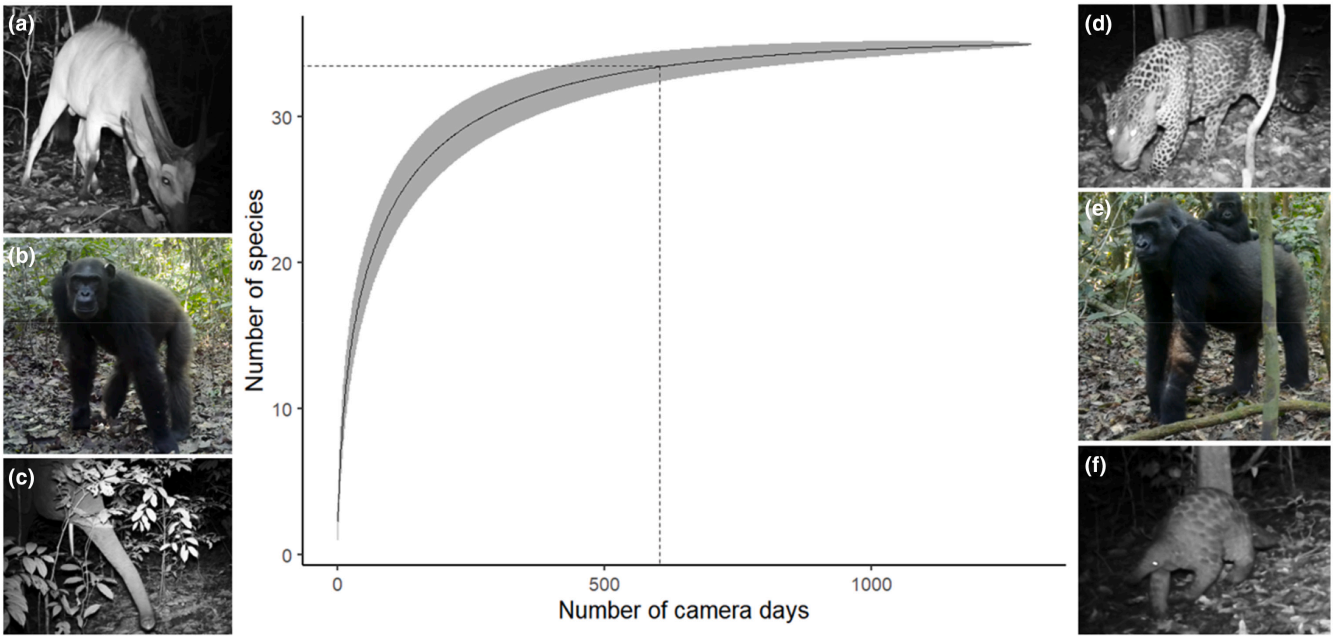

FIGURE 2 Rarefaction curve showing the number of detected mammal species as a function of the cumulated number of camera days, illustrated by some of the detected mammals: The bongo (a), the central African chimpanzee (b), the African forest elephant (c), the leopard (d), the western lowland gorilla (e) and the giant pangolin (f).

TABLE 2 Comparison of species richness and detection rates of some iconic species, resulting from this camera trap survey and similar studies in Cameroon and Gabon

		Dja Faunal Reserve (Bruce et al., 2018)		PWG-CEB (Fonteyn et al., 2020)
	PN Lobéké	Northern sector	Southern sector	
Effort (camera days)	1284	3725	3371	3159
Number of cameras	39	40	40	65
Cameras density (camera per km^2)	1 per 2 km^2	1 per 2 km^2	1 per 2 km^2	1 per 2 km^2
Camera orientation	Systematic	Trail	Trail	Systematic
Species richness	35	22	28	29
Detection rate (per 100 camera days)				
Cephalophus callipygus	125.2	14.1	71.5	19.5
Philantomba monticola	145.9	61.6	43.0	8.6
Cephalophus leucogaster	1.4	–	3.9	1.4
Loxodonta cyclotis	5.1	1.6	4.6	0.4
Gorilla gorilla	6.7	0.2	0.4	0.8
Pan troglodytes	1.1	0.8	1.8	2.4
Tragelaphus eurycerus	1.79	0.1	0.1	–
Panthera pardus	0.2	–	0.8	–

Iconic species, like the African forest elephant or the western lowland gorilla, particularly sensitive to anthropogenic pressure such as hunting and poaching, also presented high detection rates in comparison to other sites in central Africa. For those species, respectively 5.1 and 6.7 detections per 100 camera days were recorded during this study, while 1.9 and 0.4 were obtained in the least disturbed area of the Dja Faunal Reserve (Bruce et al., 2018) and 1.0 and 0.8 in the production forests of Gabon (Fonteyn et al., 2020) (Table 2). While this trend can be observed for many other species, it is important to remember that species detectability might vary across the compared studies due to animal-specific factors and heterogeneity of the micro-habitats sampled. Only specific surveys, accounting for imperfect species detection, might ultimately confirm the sizeable trend observed here.

These encouraging results demonstrating LNP's distinctiveness are particularly notable considering that the survey was led in an area where the communities are allowed to exercise their usage rights. While an impact of this accessibility might be expected, the wildlife community seems to have a conservation status comparable to other protected areas, with species richness and detection rates being higher than in other disturbed areas of the region. Many factors might explain these findings, such as a low population density (23,245 people living in the 28 villages of the park's periphery, MINFOF, 2015), the quite significant distance (about 30km) that separates the site from the nearest village, the barrier that stops vehicles from entering by road, the regular patrolling activities organised in the park to prevent poaching (which were recently intensified after Beukou et al. (2019) report) or the regular presence of researchers, as shown by Tagg et al. (2015) and Campbell et al. (2011). Although there is no evidence that local communities effectively exercise their usage rights in that part of the park, it remains the closest and most accessible area for the surrounding communities. Further studies among the local communities and surveys in other parts of the park would give a better understanding of the effects of management and other factors on wildlife populations in this National Park's community zone.

Considering that no human was recorded throughout the survey and no camera was damaged or stolen, it would be a cost-effective way to monitor mammal populations in LNP. Moreover, investing in a permanent grid of camera traps would enable the park managers to apply this methodology elsewhere in the park and repeatedly over time to study spatial and temporal variability of the wildlife community in the park and its periphery. This would add to our understanding of the community zone's effect on wildlife. Combined with deeper knowledge about the use of resources by local communities, LNP could illustrate how conservation and people can, under certain conditions, be compatible.

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CONFLICT OF INTEREST

There is no conflict of interest to declare.

DATA AVAILABILITY STATEMENT

Research data are not shared.

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