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Wild meat hunting levels and trade in a West African protected area in Togo

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Abstract

We assessed numbers and biomass of species hunted and sold for wild meat in 12 park-adjacent settlements in the Fazao Malfakassa National Park (FMNP), Togo. From hunter interviews and market carcass counts, 33 species, 28 from hunter interviews and 26 from market surveys were taken, respectively. A total of 2605 animals were recorded in the study, 18 species during the wet season (740 animals) and 26 species in the dry season (1865 animals). In markets, 754 carcasses of 19 species were traded during the wet season, and 1896 carcasses of 24 species in the dry season. Most species were relatively small-bodied mammals (62% of total numbers of animals reported), the rest large ungulates. Species were generally of minor conservation concern (LC or NT) with only three EN and NE. From the gathered field data, we estimated that an average of 9095 ± 5613 animals per study village were hunted per year, amounting to a biomass of 198,334 ± 191,930 kg. Despite efforts to protect the wildlife within the FMNP, reported level of hunting, particularly of large ungulates within the park, the reported level of hunting is likely to have severe consequences on the long-term viability of this important protected area.

KEYWORDS
biomass, hunters, income, prey species, wildlife trade

Résumé

Nous avons évalué le nombre et la biomasse des espèces chassées et vendues pour la viande sauvage dans 12 établissements adjacents au parc dans le parc national de Fazao Malfakassa (FMNP), au Togo. À partir des entretiens avec les chasseurs et des décomptes de carcasses du marché, 33 espèces, 28 des entretiens avec les chasseurs et 26 des enquêtes sur le marché ont été prises, respectivement. Au total, 2,605 animaux ont été enregistrés dans l'étude, 18 espèces pendant la saison des pluies (740 animaux) et 26 espèces pendant la saison sèche (1,865 animaux). Sur les marchés, 754 carcasses de 19 espèces ont été commercialisées pendant la saison des pluies et 1896

carcasses de 24 espèces pendant la saison sèche. La plupart des espèces étaient des mammifères au corps relativement petit (62 % du nombre total d'animaux signalés), le reste étant de grands ongulés. Les espèces étaient généralement préoccupantes pour la conservation (LC ou NT) avec seulement trois EN et NE. À partir des données de terrain recueillies, nous avons estimé qu'une moyenne de 9,095 ± 5,613 animaux par village d'étude étaient chassés par an, ce qui équivaut à une biomasse de 198,334 ± 191,930 kg. Malgré les efforts pour protéger la faune dans le PNFM, le niveau de chasse signalé, en particulier de grands ongulés dans le parc, le niveau de chasse signalé est susceptible d'avoir de graves conséquences sur la viabilité à long terme de cette importante zone protégée.

1 | INTRODUCTION

Well-managed protected areas anywhere in the world are fundamental for the conservation of biodiversity (Coad et al., 2015). If adequately managed, these can also play a significant role as a source of wildlife, important as food for park-adjacent communities. Indirect benefits from such wildlife include income and employment (Angelsen & Wunder, 2003). However, even though these communities are nominally excluded from nearby protected areas, illicit extraction of wildlife remains a main threat. Understanding the role that protected areas play in supplying wild meat to adjacent communities is essential to resolve or even prevent conflict between policymakers, local communities, managers and conservationists (Oldekop et al., 2016).

Unsustainable hunting of wild animals is the most reported danger to wildlife populations globally (Coad et al., 2019), and the permeability of protected areas remain the main threat to natural resources within their boundaries. Hunting of species within protected areas, particularly mammals, have impacted many species especially taxa with large body sizes, slow reproductive rates and little behavioural adaptability (Abernethy et al., 2013; DiMarco et al., 2014; Wilkie et al., 2011). As a result, wildlife populations continue to decline (Campbell et al., 2008; Craigie et al., 2010) and there are reports of the probable extinction of species like the West African Miss Waldron's red colobus monkey, *Procolobus badius waldroni* (McGraw, 2005; Oates et al., 2000).

Despite its importance, West African environments are arguably among the most critically fragmented regions on the planet (Mallon et al., 2015). Logging, mining, hunting and human population growth threaten all habitats, particularly the region's tropical forests where only 10% of its original cover remains (Ola & Benjamin, 2019). Today, most endangered species and highly biodiverse habitats in West Africa are confined to protected areas, where close to 2000 nationally designated protected areas cover around 9.6% of the region (CILSS, 2016). Most protected areas are small, varying from <1 km^2 to over 97,000 km^2 and only 53 have international designations, including 17 Biosphere Reserves (CILSS, 2016). Large protected areas, including clusters of sites, are however critical to support viable populations of larger species or to ensure fully functioning, dynamic ecosystems (Mallon et al., 2015).

Within the Dahomey Gap in West Africa, a biogeographically distinct corridor of a forest–savannah mosaic separating the Upper and Lower Guinean rain forest blocks (Demenou et al., 2016; Salzmann & Hoelzmann, 2005), the Fazao Malfakassa National Park (FMNP) in Togo is one of the largest protected areas. Despite being one of the most important protected areas in the country (Atsri et al., 2018; MPTHU, 2001; Segniagbeto et al., 2017), information on the conservation status of this protected area (as well as others in the region) is largely absent. As noted in Tranquilli et al. (2014), little is known of the status of their fauna (Mallon et al., 2015). Such dearth on zoological information has been highlighted by Amori et al. (2012, 2016), where the first systematic inventory of mammals in Togo (Matschie, 1893a, 1893b, 1893c) was only updated in 2016 (Amori et al., 2016), 120 years later.

Degradation and fragmentation of closed-canopy forest and tree savannah habitats in southern-central Togo (Atsri et al., 2018) and in northern Togo (Folega et al., 2014; Polo-Akpisso et al., 2020) have continued unabated since the 1980s. In Northern Togo, forests, savannahs and wetlands decreased at an average of 5.74%, 3.94% and 2.02%, respectively, annually and croplands increased at an average annual rate of 285.39% between 1987 and 2013 (Polo-Akpisso et al., 2020). During a similar time period, closed-canopy forest and tree savannah in the FMNP decreased by 40% and 20%, respectively, as agroforestry, shrub savannah and savannah woodland increased (Atsri et al., 2018). Not only did the total percentages change, but also habitat fragmentation increased in all vegetation types. Despite its protected status, anthropogenic activities alongside bush fires (Atsri et al., 2018) have caused major degradation of habitats, where 60% of the 10-km wide buffer zone has been affected (Atsri et al., 2020).

Togo´s human population increased more than fivefold between 1960 and 2020 with an average annual increase of 2.8% (min: 0.9%, max: 4.8%) between 1961 and 2019 (The World Bank, 2021). Whilst hunting was limited to small animals, poaching was intensively repressed up to 1990 by conservation authorities responsible for protected areas in the country, after which the civil unrests led to extensive wild meat hunting of all species. For example, some local populations not only started to hunt for themselves but also seem to have encouraged and protected illegal hunters from neighbouring countries (Tchamiè, 1994). After 1999 at the end of political unrest,

Togo´s restructuring of the protected areas system aimed at balancing the need for protecting biodiversity and the needs of the local populations whilst rehabilitating the revised protected areas system with the consensus of local people. By 2018, the area of 10 priority-protected areas was consolidated to 85% of the original area, and progress towards a more sustainable protected areas management system resulted in increases of the elephant population in the FMNP (Roby, 2018). However, limited funding, continuing agricultural expansion and encroachment and human–wildlife conflicts (especially human–elephant conflicts) still endanger the management of the protected areas system (Roby, 2018).

Hunting, mostly targeting mammals, especially ungulates, has been reported in undisturbed and degraded areas of the FMNP buffer zone (Atsri et al., 2020), and illegal offtake of animals for wild meat, traditional medicine and the international exotic pet trade occurs within the boundaries of the park (Segniagbeto et al., 2020). Camera trap studies by Assou et al. (2021) in the FMNP captured images of poachers, local community members, domesticated dogs and cattle within the boundaries of the park. However, direct assessment of the levels of wildlife extraction within the FMNP has not been undertaken.

In this study, we assessed hunting and sale of wildlife for their meat in a sample of park-adjacent villages around the FMNP. The area is currently affected by illegal activities such as hunting, cattle grazing, timber exploitation, bush fires and agricultural encroachment (Assou et al., 2021; Atsri et al., 2018, 2020; Segniagbeto et al., 2017). Using semi-structured interviews applied to 185 hunters in 12 park-adjacent villages, we documented the species hunted as well as numbers hunted and traded. From these data, we then estimated the numbers and biomass of animals extracted by all study villages in a year. Our results allow us to estimate the levels of hunting affecting the FMNP. Based on these findings, we propose ways of further documenting dependence on wild animals for food and recommend ways of balancing wildlife conservation in FMNP and the needs of food security of park-adjacent local communities.

2 | MATERIALS AND METHODS

2.1 | Study area

In the centre west of the country, close to the international border with Ghana, the FMNP holds the most extensive area of undisturbed vegetation in Togo (Figure 1). Terrain is rugged and includes the 'Monts de Malfakassa' in the north and the 'Monts du Fazao' in the centre; it also incorporates the 'Falaise de Boulowou' cliffs along its western edge. Located at the limit between the Sudanian and the Guinean ecological zones, FMNP is characterised by dense semi-deciduous forests and scattered savannah woodlands, the latter occurring in the southern part of the park (Segniagbeto et al., 2017). Habitats include savannah woodland (*Afzelia africana*, *Anogeissus leiocarpus* and *Isoberlinia doka* communities and *Monotes kerstingii–Uapaca togoensis* communities), significant stands of gallery forest (*Dialium guineense*, *Antiaris africana*, *Berlinia grandiflora*), submontane forest and grass-covered hilltops. Annual rainfall ranges between 1200 and 1500 mm, with most rainfall between April and October (Atsri et al., 2018). Mean temperature in the dry season is approx. 27.5°C, while mean temperature in the wet season is around 25°C (Adjoussi, 2000).

The FMNP was created in 1975 by combining the Fazao Forest Reserve (1620 km^2) and the Malfakassa Forest Reserve (300 km^2). It was first managed by Togo Ministry for the Environment and Forest Resources (MERF), by the Swiss Franz Weber Foundation from 1990 to 2015, and since 2015 again by the MERF (Assou et al., 2021; Atsri et al., 2018). It was added to the UNESCO World Heritage Site Tentative List in 2012 (UNESCO, 2021) in the mixed

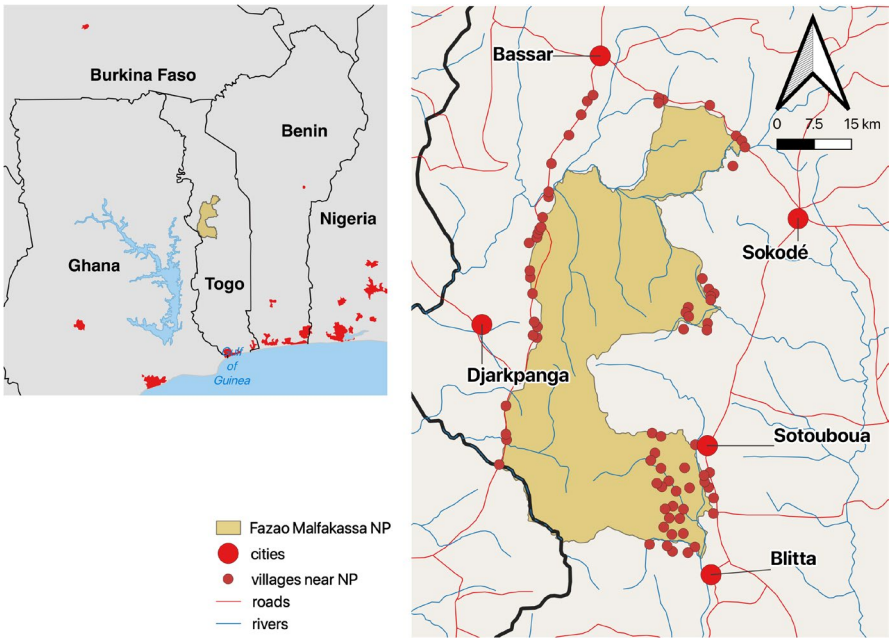

FIGURE 1 Map of the study area showing the Fazao Malfakassa National Park in Togo and the location of the 12 study villages around the park. The map was created using QGIS version 3.22-Białowieża (https://qgis.org/en/site/) from public domain map datasets from Open Street Map (www.opens treet map.org), diva-gis (diva-gis.org) and UNEP-WCMC and IUCN (2021) for the boundaries of the National Park. Villages near or in the National Park were digitised according to the map in Atsri et al. (2018)

(cultural + natural) category. After the social upheavals of the 1990s that led to human encroachment into the park, eco-guard brigades and checkpoints were re-established in the south-eastern part in 2014 (Assou et al., 2021).

Historically, as many as 57 mammal species (excluding bats) were historically recorded in the FMNP (Assou et al., 2021). Recent observations, including camera trapping by field staff, confirm 33 species present including five previously unreported (Assou et al., 2021; Segniagbeto et al., 2020). Noteworthy species include the recently described Walter's duiker (*Philantomba walteri*), African savannah (*Loxodonta africana*) and forest elephants (*Loxodonta cyclotis*), Western hartebeest (*Alcelaphus buselaphus major*), and the white-bellied pangolin (*Phataginus tricuspis*) (Assou et al., 2021; Segniagbeto et al., 2020). The apparent absence of previously recorded IUCN-Red Listed threatened species in the camera trapping data, such as the critically endangered White-thighed Colobus monkey (*Colobus vellerosus*) and the vulnerable African golden cat (*Caracal aurata*), is notable (Assou et al., 2021).

2.2 | Human populations

The FMNP is surrounded by 11 municipalities encompassing a total of 55 villages; around 120,000 inhabitants according to the 2010 general population census (Atsri et al., 2018). These villages are inhabited by several different ethnic groups: Tem, Kotokoli, Agnanga, Adélé, Bassar, Losso and Kabyè (Tchamiè, 1994).

The 10-km-wide buffer zone around the park is not legally constituted and no management plan exists. This buffer zone is largely degraded and the continuing rise in human population continues to damage habitats due to increases in agriculture as well as charcoal and firewood production (Atsri et al., 2020). Human–wildlife conflicts, land conflicts and ecoguard–farmer conflicts are widespread, reported by 50%, 25% and 10% of interviewed local communities, respectively in Atsri et al. (2020).

According to Saparapa (2018), only 42% of villagers living near the FMNP said that they knew the boundaries of the park, but a larger percentage of respondents (58%) believed they should have access to the park. Most (84%) do not want the park to be abolished. Although a large majority (89%) considered there were benefits of living close to the park, almost three quarters of the respondents (73%) mentioned inconveniences, where almost all respondents (91%) referred to continued conflict with wildlife.

In all villages surrounding the FMNP, hunting is still the most important activity after agriculture (Atsri et al., 2018). Regular hunters target smaller prey, in particular greater cane rat (*Thryonomys swinderianus*) and African savannah hare (*Lepus microtis*), more common in the more disturbed areas inside and outside the park, and larger mammals such as kob (*Kobus kob*), Walter's duiker and bushbuck (*Tragelaphus scriptus*) within the more intact portions of the buffer zone (Atsri et al., 2020) and within the park. Hunting is also undertaken by persons who do not identify as hunters, such as farmers, women and children, or people who set snares occasionally.

2.3 | Data collection

For our study, we selected villages that contained markets that sold wild meat, since our study focused on trade as well as on hunter activity. Hunters lived in all villages that traded wild meat.

Out of a total of 14 villages that possessed wild markets, eight were situated in the north-western of the park and six villages along the western border (Figure 1). Permission was not granted by two western villages because of suspicion generated by past conflict between ecoguards and hunters. We therefore conducted hunter interviews and market surveys in the remaining 12 villages, representing a sampling effort of 22% of all villages surrounding the park. Population sizes of villages in the periphery of the park (data from H. Atsri, pers. comm.) averaged 478.7 ± 360.7 ($n = 49$) inhabitants, and slightly lower for our study villages (389.4 ± 122.8, $n = 7$). Data on the ethnic composition of the study villages was not available. Distance to the park was similar for all villages since all were located along the perimeter of the protected area.

We focussed on those persons, all men, who considered themselves hunters. A hunter was defined as someone who killed animals for food to provide meat for his family and/or to sell during every month of the year. In each village, we first approached the chief or the leader of the local hunters. After introducing the project and the purpose of our work, if he consented, he was then interviewed and asked to introduce us to other hunters in his village to interview. Using this snowball method, we estimated the total number of hunters resident in each village.

Hunter interviews were carried out during the dry (5 Feb. to 3 Mar. 2020) and wet season (1–15 Jun. and Jul. 21–5 Aug. 2020). In each hunter interview, we first asked for basic demographic information (location, education, gender, age, residency time in the village, ethnicity) followed by details of hunting practices (where, when, which species, which weapons, economic importance). Although we attempted to contact the same hunters during each season, this was not always possible. Each hunter was questioned about his hunting activities over a total of 14 days (a seven-day period for each season). To obtain these data, we asked the hunter to recall the total numbers and species hunted during the 7 days prior to the interview.

We followed the principle of free, prior and informed consent (FPIC) and guidelines on ethical research of the British Sociological Association (BSA, 2017) when conducting hunter interviews. Ethical approval was obtained from the University of Lomé. All potential interviewees were fully apprised of the study aims and were notified that any information given would remain confidential. Team members, A.S-O, A.H. and D.A, applied a structured interview questionnaire (Appendix S1), which was presented to each interviewee in French or in the dominant local language.

Interviewees provided common names of animals hunted in their local language (Table 1). We translated the common names to scientific names as in Kingdon et al. (2013) and Amori et al. (2016) for mammals, Borrow and Demey (2014) for birds and Trape et al. (2012), Segniagbeto et al. (2011, 2014 and 2015) for reptiles. For some taxa (*Cephalophus dorsalis*/*C. rufilatus*; *Mungos mungo*/*M. gambianus*), we

TABLE 1 List of species used as wild meat in villages surrounding the Fazao Malfakassa National Park in Togo reported in hunter interviews and observed in markets in each village. Asterisks indicate species that were only recorded in markets

Order	Family	Common name	Scientific name	Local name (Bassar/Téme)	Body mass (kg)
Mammals					
Primates	Cercopithecidae	Mona monkey	*Cercopithecus mona*	Ilintinye	3.77
		Patas monkey	*Erythrocebus patas*	Ulintinye mane	7.00
		Olive baboon	*Papio anubis*	D'kpaatre	17.55
Rodentia	Nesomyidae	Gambian pouched rat	*Cricetomys gambianus*		1.84
	Hystricidae	Crested porcupine	*Hystrix cristata*	Ussonk	20.00
	Thryonomyidae	Greater cane rat	*Thryonomys swinderianus*	D'ngôssikri	4.05
Lagomorpha	Leporidae	African savannah hare	*Lepus microtis*	K'wung	2.31
Pholidota	Manidae	White-bellied pangolin	*Phataginus tricuspis*	Aparaou	2.48
Erinaceomorpha	Erinaceidae	Four-toed hedgehog	*Atelerix albiventris*	K'labunsang	0.42
Artiodactyla	Bovidae	Bushbuck	*Tragelaphus scriptus*		35.00
		Buffon's kob	*Kobus kob kob*	Upélmaïn	54.5
		Waterbuck	*Kobus ellipsiprymnus*	N'bouloum	208.75
		Western hartebeest	*Alcelaphus major*	Ussoub	134.35
		Walter's duiker	*Philantomba walteri**	Ukônï	5.00
		Bay duiker	*Cephalophus dorsalis*	Upilfou	20.25
		Red-flanked duiker	*Cephalophus rufilatus*		10.00
		Roan antelope	*Hippotragus equinus koba*	Oukpil	277.8
		West African savannah buffalo	*Syncerus brachyceros*	Oumônaa	598.7
	Suidae	Common warthog	*Phacochoerus africanus*	Oumôgbéti	68.05
		Red river hog	*Potamochoerus porcus*		53.25
Carnivora	Viverridae	African civet	*Civettictis civetta*	Bâat	12.60
		Common genet	*Genetta genetta*	K'nghôkômang	1.90
		Rusty-spotted genet	*Genetta maculata**		1.80
	Felidae	African wildcat	*Felis silvestris*	K'moowuin tontô	4.30
	Herpestidae	Egyptian mongoose	*Herpestes ichneumon**	Gbaatcha	3.25
		Gambian mongoose	*Mungos gambianus*		2.82
		Banded mongoose	*Mungos mungo*		2.82
Reptiles					
Crocodilia	Crocodylidae	West African crocodile	*Crocodylus suchus*	Ougnibou	180.00
Squamata	Varanidae	Nile monitor	*Varanus niloticus*	Oulô	8.00
Birds					
Galliformes	Phasianidae	Double-spurred spurfowl	*Francolinus bicalcaratus*	Oudjikpal	0.444
	Numididae	Helmeted guineafowl	*Numida meleagris*	Oumôkpaan	1.30

were not able to distinguish between separate species but denote these species pairs as single species forthwith.

Wild meat on sale in markets in each village was recorded during 7 days in each season. Only displayed carcasses were counted. We asked the stall owners to show us all animals sold during our visit. Identification of animal carcasses for sale was made also by team members A.S-O, A.H. and D.A who undertook the market surveys. All team members were trained zoologists who could identify all species. Each market was visited for a total of 7 separate days each, during the wet and dry season. Days were chosen on an ad hoc basis.

2.4 | Data analyses

Estimates of number of animals hunted or sold in markets has been undertaken before from counts of animals taken by a sample of hunters over a set period (Avila Martin et al., 2020), and from carcass numbers observed in market stalls for a period (Fa et al., 2006) in Nigeria and Cameroon. From these counts, it is possible to estimate numbers hunted or sold over a year. In this study, to estimate the total number of animals extracted per village for all interviewed hunters per year, we first estimated the average

number of animals hunted per interviewed hunter per day per season (wet season: 184 days, dry season: 120 days) and then multiplied the result by the total number of hunters recorded in each village (see Appendix S2).

The total number of traded animals per species in each village per season was calculated as the product of the number of observed animal carcasses per day (averaged over the seven observation days) and the number of days in each season (see above). The total annual number of traded animals was the sum of the values for the wet and dry seasons (see Appendix S3).

We converted the estimated number of animals hunted or traded per species to biomass. Biomass was calculated by multiplying the estimated number of carcasses per species by the average body mass (kg) of each species (see Appendix S4). The average body mass for each species was the average of adult males and females of the species (Table 1). Body mass data for mammals were taken from Kingdon et al. (2013), for birds from Dunning (2007) and for reptiles from Trape et al. (2012), Segniagbeto et al. (2011, 2014 and 2015).

All descriptive statistics including ANOVA, Spearman's rank correlation and Student *t*-test were carried out using the software PAST, version 3.25 (Hammer et al., 2021).

3 | RESULTS

3.1 | Hunters

We interviewed a total of 185 hunters in the 12 sampled villages. All were males aged between 25 and 62 years old and were resident in the sampled villages. We recorded a total of 352 local hunters in all villages. The average number of hunters interviewed per village was 15.4 ± 29.3 (range 5–32; median = 14; $n = 185$) and the average total number of hunters estimated in each village was 29.3 ± 14.7 (range 9–57; median = 33; $n = 352$). Our sampling effort was 55 ± 18% per study village (range 29–86%; median = 51; $n = 12$).

Interviewed hunters belonged to four main ethnicities: Kotokoli (55%, $n = 102$), Bassar (43%, $n = 79$) and Losso and Kabyè (2%, $n = 4$); these are the predominant ethnic groups in the region. Most hunters had no formal education (58%, $n = 107$), but 36.2% ($n = 67$) had finished primary schooling and only 6% ($n = 11$) had completed secondary school.

Most hunters (86%, $n = 159$) reported hunting to provide meat for their families, but it was also the main source of income for 65% ($n = 121$). Hunting was the primary activity for earning a living for 42% ($n = 78$) of respondents, and a secondary activity for 58% of these ($n = 107$). All hunters confirmed that they hunted chiefly within the park boundaries, both day and night.

3.2 | Species and overall numbers hunted and traded

A total of 33 species were recorded, 28 in hunter interviews and 26 in the market surveys (Table 1). Overall, the most common taxa hunted and traded were ungulates ($n = 10$), followed by carnivores ($n = 6$), rodents ($n = 3$), primates, reptiles and birds ($n = 2$) and one species of pangolin, lagomorph, and insectivore each. Most (85%) of all recorded species were of minor conservation concern (least concern, LC or near threatened,NT, categories according to the IUCN Red List) (Appendix S5). One species, the white-bellied pangolin, was listed as endangered, EN, and two others, the West African crocodile and the African savannah hare near endangered, NE.

For all villages pooled, hunters reported killing a total of 2605 animals (wet season = 740; dry season = 1865) of 18 species during the wet season, but 26 in the dry season (Table 2). The mean number of animals hunted per village (Table 2) was significantly higher during the dry season (Student *t*-test: $t = 2.09$, $p = 0.042$). The mean number of hunted animals did not vary significantly among villages (Appendix S3) in the wet season (one-way ANOVA: $F_{11,228} = 1.58$, $p = 0.104$), but there was a significant difference among villages in the dry season (one-way ANOVA: $F_{11,300} = 2.07$, $p < 0.05$).

In the markets, 19 species (754 carcasses) were recorded as traded during the wet season, and 1,896 carcasses belonging to 24 species in the dry season (Table 3). There were no statistical differences in the mean number of traded carcasses among villages (Appendix S4) during the wet season (Kruskal–Wallis ANOVA: H (χ^2) = 11.26, H_c (tie corrected) = 13.77, $p = 0.131$). On the other hand, the among-villages difference was statistically significant for the dry season (Kruskal–Wallis ANOVA: H (χ^2) = 29.47, H_c (tie corrected) = 30.28, $p < 0.0001$).

3.3 | Estimated numbers and biomass of animals hunted

Overall, we collected data on 2590 hunter days from 185 interviewed hunters. From these, we estimated that an average of 9095 ± 5613 animals per study village is hunted per annum (Table 2). The five most hunted species, Gambian rat (*Cricetomys gambianus*), greater cane rat, African savannah hare, double-spurred spurfowl (*Francolinus bicalcaratus*) and helmeted guineafowl (*Numida meleagris*), contributed 62% ($n = 1615$) of all individuals hunted. The lowest average number of animals hunted per year was for the roan antelope (*Hippotragus equinus koba*). Over 61% of all animals were hunted in the dry season, representing 77% of the biomass extracted. Characteristically, the 11 hunted species of <4 kg contributed three-quarters of all the animals estimated to be hunted in a year by the 12 study villages; over 1400 individuals per species per annum of large rodents (average weight 0.98 kg), savannah hares (2.3 kg) and the greater cane rats (4.1 kg) (Table 2). The three largest species, all ungulates (*Syncerus caffer*, *H. equinus koba* and *Kobus ellipsiprymnus*) only contributed 3% of all animals hunted. There was some evidence that body size negatively correlated with number of animals extracted per species (Spearman´s rho = −0.38, $R^2 = 0.15$, $p = 0.051$; $n = 23$).

As much as 198,334 ± 191,930 kg of animal biomass was extracted by all villages (Appendix S5) per year (see Table 2). The four most hunted species in terms of number of individuals only contribute 5.9% of the annual extracted biomass (Figure 2). There was a

TABLE 2 Numbers of animals recorded, estimated mean numbers and biomass for each species hunted per season per study village

Species	Body mass (kg)	Total numbers reported		Estimated numbers			Estimated biomass (kg)		
		Total wet	Total dry	Total wet	Total dry	Total per year	Total wet	Total dry	Total per year
				Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
Alcelaphus major	134.35	9	42	37.89 ± 51.90	128.52 ± 117.23	166.42 ± 156.16	5090.77 ± 6972.91	20,626.08 ± 19,365.45	25,716.85 ± 23,018.50
Atelerix albiventris	0.42	–	58	–	175.47 ± 99.48	175.47 ± 99.48	–	74.05 ± 41.98	74.05 ± 41.98
Cephalophus dorsalis/C. rufilatus	20.25	–	43	–	139.86 ± 157.58	139.86 ± 157.58	–	3593.08 ± 3910.13	3593.08 ± 3910.13
Cercopithecus mona	3.77	17	20	80.07 ± 50.12	58.86 ± 34.16	138.94 ± 75.26	301.62 ± 188.79	221.72 ± 128.65	523.33 ± 283.50
Civettictis civetta	12.60	3	18	12.09 ± 22.45	55.81 ± 36.89	67.89 ± 39.04	152.32 ± 282.93	703.14 ± 464.78	855.46 ± 491.89
Cricetomys gambianus	0.98	135	320	640.93 ± 434.63	938.29 ± 541.38	1579.22 ± 953.08	625.17 ± 423.94	915.21 ± 528.06	1540.37 ± 929.63
Crocodylus suchus	180.00	3	5	15.15 ± 27.78	17.74 ± 22.93	32.89 ± 45.21	2727.47 ± 5000.63	3193.07 ± 4126.88	5920.54 ± 8138.67
Erythrocebus patas	7.00	10	12	47.08 ± 26.95	41.38 ± 54.93	88.45 ± 76.06	329.54 ± 188.66	289.63 ± 384.51	619.17 ± 532.45
Felis silvestris	4.30	–	12	–	34.05 ± 25.84	34.05 ± 25.84	–	146.43 ± 111.09	146.43 ± 111.09
Francolinus bicalcaratus	0.444	111	152	505.82 ± 263.71	480.61 ± 376.46	986.43 ± 625.67	224.59 ± 117.09	213.39 ± 167.15	437.97 ± 277.80
Genetta genetta	1.90	1	17	5.07 ± 17.55	52.46 ± 33.96	57.52 ± 36.33	9.62 ± 33.34	99.67 ± 64.52	109.30 ± 69.02
Hippotragus equinus koba	277.80	–	4	–	16.45 ± 36.02	16.45 ± 36.02	–	2466.18 ± 5814.75	2466.18 ± 5814.75
Hystrix cristata	20.00	–	49	–	142.63 ± 69.12	142.63 ± 69.12	–	2852.61 ± 1382.37	2852.61 ± 1382.37
Kobus ellipsiprymnus	208.75	8	73	40.44 ± 60.41	216.39 ± 205.63	256.82 ± 257.41	12,464.95 ± 14,499.21	54,057.30 ± 47,549.43	66,522.25 ± 60,138.56
Kobus kob	54.50	–	98	–	287.18 ± 256.55	287.18 ± 256.55	–	18,384.35 ± 14,485.15	18,384.35 ± 14,485.15
Lepus microtis	2.31	128	297	594.80 ± 336.35	881.63 ± 478.09	1476.43 ± 785.85	1373.99 ± 776.97	2036.57 ± 1104.38	3410.56 ± 1815.31
Mungos mungo/M. gambianus	1.41	15	20	72.83 ± 112.10	61.34 ± 47.36	134.18 ± 127.19	135.12 ± 174.18	93.75 ± 66.41	228.87 ± 202.93
Numida meleagris	1.30	50	103	249.66 ± 277.86	331.22 ± 270.87	580.88 ± 515.31	324.56 ± 361.22	430.58 ± 352.13	755.15 ± 669.90
Papio anubis	17.55	12	12	57.18 ± 43.33	35.68 ± 24.78	92.87 ± 66.26	1003.60 ± 760.42	626.25 ± 434.87	1629.85 ± 1162.84
Phacochoerus africanus	68.05	17	27	87.65 ± 168.17	80.79 ± 71.71	168.45 ± 227.21	7530.02 ± 11,831.84	5323.04 ± 5047.75	12,853.06 ± 16,178.52
Phataginus tricuspis	2.48	–	27	–	80.31 ± 55.85	80.31 ± 55.85	–	199.17 ± 138.52	199.17 ± 138.52
Potamochoerus porcus	53.25	15	13	63.99 ± 75.44	41.97 ± 35.06	105.96 ± 88.01	4632.18 ± 5003.08	2364.23 ± 2689.13	6996.40 ± 7275.81
Syncerus brachyceros	598.70	–	8	–	30.91 ± 51.94	30.91 ± 51.94	–	15,515.04 ± 26,947.47	15,515.04 ± 26,947.47
Thryonomys swinderianus	4.05	128	321	605.37 ± 425.73	951.70 ± 570.52	1557.07 ± 957.12	2451.76 ± 1724.22	3854.38 ± 2310.61	6306.13 ± 3876.33
Tragelaphus scriptus	35.00	68	90	300.89 ± 184.93	277.78 ± 214.05	578.67 ± 386.59	10,531.18 ± 6472.60	9722.13 ± 7491.84	20,253.31 ± 13,530.65
Varanus niloticus	8.00	10	24	42.45 ± 55.40	76.15 ± 63.93	118.59 ± 98.72	339.58 ± 443.20	609.17 ± 511.41	948.75 ± 789.75
Total (calc)		740	1865	3459.38 ± 2193.46	5635.18 ± 3447.94	9094.56 ± 5612.69	49,946.41 ± 55,066.43	1,48,388.49 ± 1,45,490.78	1,98,334.90 ± 1,91,930.01

TABLE 3 Total number of animals recorded as traded of all species and mean (±SD) number of carcasses per season per study village

	Total numbers reported		AVG ± SD over villages		
			Total wet	Total dry	Total per year
Species			Mean ± SD	Mean ± SD	Mean ± SD
Alcelaphus major	9	156	19.71 ± 27.74	222.86 ± 136.95	242.57 ± 146.32
Cercopithecus mona	17	20	37.24 ± 13.54	28.57 ± 11.17	65.81 ± 16.75
Civettictis civetta	3	18	6.57 ± 11.89	25.71 ± 13.68	32.29 ± 16.95
Cricetomys gambianus	135	320	295.71 ± 127.36	457.14 ± 161.53	752.86 ± 252.87
Crocodylus suchus	3	5	6.57 ± 11.89	7.14 ± 8.83	13.71 ± 19.04
Erythrocebus patas	10	12	21.90 ± 10.23	17.14 ± 17.91	39.05 ± 24.27
Felis silvestris	–	12	–	17.14 ± 10.34	17.14 ± 10.34
Francolinus bicalcaratus	111	152	243.14 ± 70.11	217.14 ± 124.55	460.29 ± 186.24
Genetta maculata	1	17	2.19 ± 7.59	24.29 ± 11.46	26.48 ± 12.44
Herpestes ichneumon	18	22	39.43 ± 50.75	31.43 ± 19.11	70.86 ± 54.98
Hippotragus equinus koba	2	84	4.38 ± 10.23	120.00 ± 79.07	124.38 ± 77.11
Kobus ellipsiprimnus	11	90	24.10 ± 26.19	128.57 ± 71.06	152.67 ± 88.92
Kobus kob	–	58	–	82.86 ± 29.99	82.86 ± 29.99
Lepus microtis	128	297	280.38 ± 95.98	424.29 ± 150.36	704.67 ± 224.72
Numida meleagris	50	103	109.52 ± 110.29	147.14 ± 102.98	256.67 ± 180.06
Papio anubis	12	12	26.29 ± 15.85	17.14 ± 10.34	43.43 ± 24.57
Phacochoerus africanus	20	26	43.81 ± 68.48	37.14 ± 33.36	80.95 ± 93.41
Phataginus tricuspis	–	27	–	38.57 ± 22.08	38.57 ± 22.08
Philantomba walteri	–	51	–	72.86 ± 65.02	72.86 ± 65.02
Potamochoerus porcus	18	13	39.43 ± 36.32	18.57 ± 17.08	58.00 ± 48.88
Syncerus brachyceros	–	7	–	10.00 ± 17.08	10.00 ± 17.08
Thryonomys swinderianus	128	321	280.38 ± 115.03	458.57 ± 197.65	738.95 ± 279.62
Tragelaphus scriptus	68	49	148.95 ± 72.06	70.00 ± 25.80	218.95 ± 85.31
Varanus niloticus	10	24	21.90 ± 29.30	34.29 ± 23.12	56.19 ± 42.45
	754	1896	1651.62 ± 655.74	2708.57 ± 1099.21	4360.19 ± 1716.40

positive and significant relationship between body mass of the species hunted and their contribution to the overall hunted biomass in all village (Spearman's rho = 0.79, $R^2 = 0.61$, $p < 0.001$).

4 | DISCUSSION

Togo's original PA estate (gazetted between 1939 and 1958) included 83 sites and covered, until the late 1980's, approximately 793,000 ha (or 14% of the country's land surface). Of these, 628,000 ha were composed of large areas, that is national parks and wildlife reserves, and represented 11% of the land surface (UNDP, 2011). These reserves were designed for the protection of large mammal species, such as elephants, buffalo, hippopotamus, hartebeests and antelope and were managed such that the diversity of flora and fauna were restored throughout the 1970s and 1980s (UNDP, 2011). Since the socio-political upheavals of the 1990s and the near-total withdrawal of international development cooperation, Togo's protected areas system has been severely affected (UNDP, 2011). Consequently, protected areas in the country have suffered from poor management where boundaries are not respected, and invasions by local communities have affected habitats and wildlife through unsustainable exploitation (bushfires, fuelwood and charcoal production, hunting).

Our study is the first to attempt to assess the levels of hunting of wildlife that occur within a sample of villages around the park. We recorded as many as 33 animal species hunted and sold, of which 26 were mammals, almost all the mammal species reported by Assou et al. (2021). Biomass extracted was greater for the larger species, as expected, even though actual numbers hunted were less than for smaller species. Data on hunting obtained from our interviews suggest that all hunters killed animals within the park, although we were not able to determine what proportion of game was hunted inside and outside the park. It is likely that large animals were taken within the park, since the park serves as refuge area for large-bodied species, but a larger proportion of smaller game (particularly hare and large rodents) could be hunted in modified habitats around the

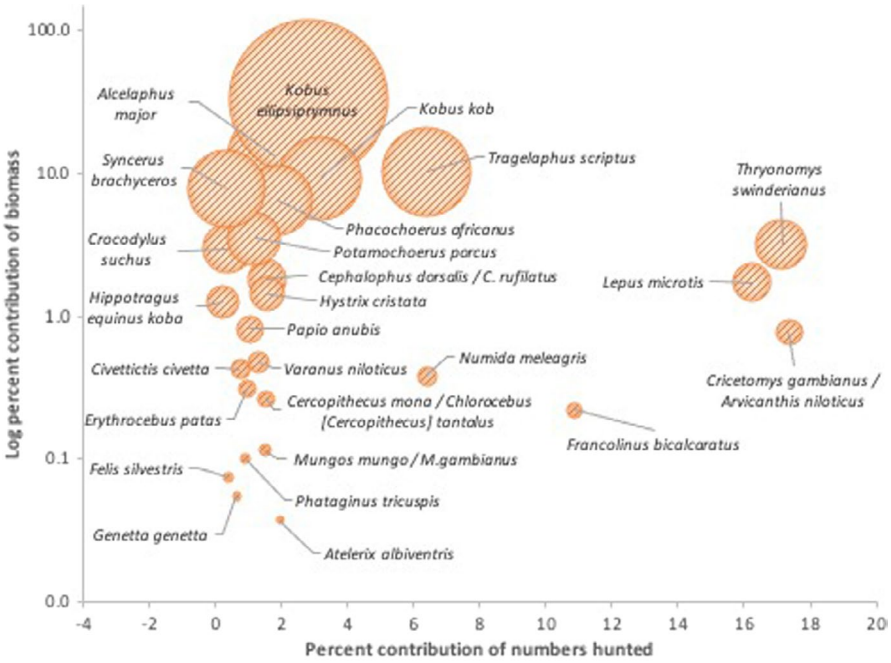

FIGURE 2 Percent contribution of numbers of individual animals hunted and the percent contribution to the overall biomass for all animal species recorded in the 12 study villages around the Fazao Malfakassa National Park, Togo. The relative body size of each species is indicated by the size of the circle in the graph

villages. In terms of biomass and numbers of animals taken by our study villages, the figures obtained in our study are likely to be significantly affecting wildlife populations, especially the large-bodied species, in the FMNP. Nonetheless, we are aware that our estimates of animals extracted or sold are not exhaustive, even for our study villages, since we do know that there is informal trade within communities, and other trade networks bypass markets. Therefore, our assessments of numbers and biomass should be treated as a minimum estimate and only represent around a quarter of wildlife extraction undertaken by the park-adjacent villages since more than 50 villages are known to exist. To better understand the impact of hunting on the resident wildlife in the FMNP it is necessary to determine population levels of the hunted species within the park; these data are currently not available. Further studies that include more hunters and villages in the region could improve our estimates, but we are confident that our study which covered 14 days of hunter recalls and 14 days observations of animals on sale in the 12 study villages (close to 3000 hunter days and 168 market days) are likely to be realistic even though we have no way of determining the level of accuracy of these estimates. There may have been biases when extrapolating from short-term recalls, extending the recall period beyond a week is impractical since it will increase the inability of the interviewee to detect an event of interest. Thus, 7-day recalls may be short enough for recall to remain vivid. Designing future studies that applied more recalls over a year may be more accurate but fraught with difficulty in terms of time and costs.

Seasonal differences in numbers of animals hunted, though not in diversity, were clearly found in our study. This is because most hunting occurred between the months of December and April corresponding to the dry season as opposed to the wet season (June–September). From our own observations, hunters in the wet season take less animals because grasses are taller in the open areas from the rains, making it difficult to see animals. In the dry season, especially after fires, animals are more visible thus allowing hunters to stalk and kill their prey more easily. As a result, our estimates of game extracted reflect the seasonality of the ecosystem. Such difference in the number and size of hunted species is typical of other wild meat hunting systems in Sub-Saharan Africa (see e.g. Fa et al., 2016), where most species taken are smaller game animals, and the most abundant. The universal relationship between body size and animal density can explain the fact that, in our studied system, greater cane rats, hares and Gambian rats are naturally more common than the larger ungulates and therefore more likely to be hunted. More importantly, the pursuit of smaller prey by rural or indigenous hunters is easier given that these species can be procured using cheaper hunting methods such as hunting dogs, snares and traps. Although in our study we did not record the hunting methods used for each species, we did informally observe that shotguns were only employed to take down large ungulates.

In our work, we calculated the number of animals traded in markets only, so the numbers of animals sold by hunters to neighbours or middlemen was not known. The difference between the number of animals estimated as hunted, from hunter interviews and observed to be sold in markets is considerable. This means that a substantial number and biomass of hunted animals remain in the villages to be consumed by the hunter families or sold to non-market buyers. Although there are no figures, given the large amounts of extracted wild meat we calculated in our study, this resource from inside the park is likely to be significantly important for the food security and livelihoods of all the communities surrounding the protected area. From the average number of hunters observed per village in our study, we can deduce that there are likely to be around 1600 hunters in the 75 villages surrounding the park (Atsri et al., 2018). There is roughly one hunter per every 74 inhabitants, in view that around 120,000 inhabitants live in all the park-adjacent villages. Given the size of the FMNP, about 2000 km^2, hunter density is approx. one

per km^2. Comparisons of these figures with other protected areas in West Africa are not yet possible, but the impact of these hunters on the FMNP wildlife is likely to be significant.

The future of the protected areas system in Togo jointly requires a continuation of dialogue with the local population and reinforcement of protection measures. Biological data are needed to determine whether hunting, particularly of large ungulates, is sustainable, is urgently needed. From other studies in West Africa, there is evidence that poaching is a serious and ubiquitous problem, with most suggesting that the observed decline in the ungulate fauna in PAs are the result of lack of any effective conservation and management activities, sometimes over decades (Fischer & Linsenmair, 2001; Taïga et al., 2021). Conservation of the parks in West Africa, not just those in savannah environments, must combine law enforcement and increase of revenues for the local park-adjacent peoples unrelated to poaching. Importantly also, well-motivated, trained and properly equipped wardens must be ensured. The MERF as part of the Project to Strengthen the Conservation Role of the National System of Protected Areas of Togo has set up a provisional version of a Development Plan and Management Plan (PAG) of FMNP for a period of 2018–2027. This plan has not yet taken effect, which poses a real problem in terms of defining the management option of the protected area. Moreover, the national management strategy, available and validated in December 2018 for a period of 2019–2029 has not yet been implemented since its validation, as well as the specific ecological management and monitoring system for the management of protected areas still in its infancy, pose serious problems for the implementation of the PAG. This leads to the absence of data on the availability and distribution of species, on populations of species and the number of individuals of each species in the park.

We reemphasise here that even though, as shown in our study, most species hunted are highly productive that is small animals which are of least conservation concern (and provide an important source of protein and other nutrients to many people), focus on the protection of large herbivores and primates must be greater. After all, the FMNP is of national and international importance for iconic species such as the hartebeest and roan antelope, other ungulates and also of primates (Assou et al., 2021).

CONFLICT OF INTEREST

We have no conflicts of interest to disclose.

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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