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Game over! Wildlife collapse in northern Central African Republic

Philippe Bouché · Roland Nzapa Mbeti Mange · Floride Tankalet · Florent Zowoya · Philippe Lejeune · Cédric Vermeulen

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Abstract The wildlife populations of northern Central African Republic (CAR) have long suffered intense uncontrolled hunting. Socio-political turmoil in northern CAR that started in 2002 resulted in a rebellion in 2006. An aerial sample count was carried out in northern CAR after the ceasefire to assess the impact of this troubled period on wildlife. The survey was flown at the end of the dry season in February–March 2010. It covered a landscape complex of 95,000 km² comprising national parks, hunting reserves and community hunting areas. Comparison with earlier surveys revealed a dramatic decline of wildlife: the numbers of large mammals fell by 94% in 30 years, probably due to poaching, loss of habitat and diseases brought by illegal movements of cattle. Elephant (*Loxodonta africana*), Reduncinae and topi (*Damaliscus lunatus*) populations showed the greatest decline (each over 90%). Other species declined by 70–80% during the same period. The future of wildlife in this area is dark without a strong commitment to provide adequate funding and quickly implement of determined field management. Reinforced cooperation with neighbouring Chad and Sudan is required since they are facing similar problems.

Keywords Aerial survey · Elephant · Giraffe · Lord's Derby eland · Illegal cattle transhumance · Northern Central African Republic · Wildlife collapse · Wildlife population trend

P. Bouché · R. Nzapa Mbeti Mange · F. Tankalet · F. Zowoya
Composante ZCV Nord RCA Programme ECOFAC IV, BP 1608 Bangui, Central African Republic

P. Bouché (✉) · P. Lejeune · C. Vermeulen
Unité de Gestion des Ressources Forestières et des Milieux Naturels, Université de Liège, Gembloux Agro-Bio Tech, Passage des Déportés, 2, B-5030 Gembloux, Belgium
e-mail: ph_bouche@yahoo.com

Introduction

The north of the Central African Republic (CAR) is a huge remote expanse of natural habitat with a sparse human population (<0.5 inhabitant/km^2; Bouché et al. 2010a) which gives the impression of guaranteeing optimum conditions for wildlife. In fact, the quasi absence of state authority and the very low human density left huge areas free of control and favoured illegal activities (Bouché et al. 2010a). Northern CAR experienced wildlife declines for several decades due to continuous uncontrolled hunting (Ruggiero 1984; Froment 1985; Delvingt & Lobão Tello 2004; Bouché et al. 2010a). As a consequence, the northern white (*Ceratoterium simum*

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cottoni) and black (*Diceros bicornis longipes*) rhino populations vanished in the mid-twentieth century and in 1986, respectively (Roulet 2004; Spinage 1986; Delvingt and Lobão Tello 2004; Bouché et al. 2010a).

Two European Union programmes (Programme de Développement de la Région Nord (PDRN) and the Conservation et Utilisation Rationelle des Ecosystèmes Forestiers d'Afrique Centrale (ECOFAC)) combine law enforcement and rural development activities. They support the Ministry in charge of wildlife to manage the national parks and reserves. They also established and supported a system of community hunting areas to reduce the pressure from illegal hunting. Local people rent community hunting areas to professional hunting guides who attract safari clients from abroad. Safari hunting fees and taxes are paid directly to communities. A portion also goes to municipalities and the state. This system provides directly to local communities a significant amount of money (around 150,000 Euros per year to the six active community hunting areas) that has been invested in social services (schools, health centres, pensions, employment, etc.; Bouché et al. 2010a, b).

The overall large mammals density of northern CAR decreased by 65% between 1985 and 2005. The question of the imminent wildlife extinction came up (Bouché et al. 2010a). Socio-political disturbances that started in 2002 in northern CAR culminated in a rebellion in 2006. This caused ECOFAC funds to be interrupted for 2.5 years starting in 2005. ECOFAC bases were abandoned and law enforcement lapsed. The ECOFAC phase IV activities re-started at the end of 2007 after the ceasefire. Anecdotal evidence indicates that during this troubled period, the wildlife populations suffered heavy losses due to the widespread availability of military weapons (Chardonnet and Boulet 2008; Bouché et al. 2010a). An assessment of the magnitude of the wildlife losses since 2005 was thus required.

Several well-designed surveys have covered the area since the 1970s (Spinage et al. 1977; Loevinsohn et al. 1978; Douglas-Hamilton et al. 1985; PDRN 1998; Bouché et al. 2010a). However, this study is the first attempt to compare all of them in order to evaluate wildlife trends. The purpose of this paper is to update wildlife densities, to assess for the first time wildlife population changes over the last 30 years and to discuss the threats that weigh on wildlife.

Material and methods

Study area

This study was conducted in northeastern CAR, mainly in the Chari Basin. It covered an area of 95,000 km^2. The study area is part of the 125,000 km^2 northern CAR savannah ecosystem that extends northwards into Chad. This area is a patchwork of two national parks (Bamingui-Bangoran and Manovo Gounda Saint Floris), a wildlife reserve (Vassako Bolo), hunting sectors and community hunting areas (Fig. 1). These lasts areas dedicated to safari hunting activities. Several rivers and streams cross the area. The major ones are tributaries of the Chari River that feeds Lake Chad from CAR (Delvingt and Lobão Tello 2004).

The study area lies in the Sudan–sahelian vegetation zone. Annual rainfall varies between 600 mm in the north of the study area and 1,200 mm in the south. Mean annual temperature varies from 25°C to 30°C with extremes of 17°C and 45°C (Bouché et al. 2010a).

Habitat is mainly composed of bushy to woodland savannah with *Vittelaria paradoxa*, *Combretum* spp., *Acacia* spp., *Anogeissus leiocarpa*, *Afzelia africana*, *Burkea africana*, *Isoberlinia doka*, *Terminalia* spp. and by forest galleries of *Danielia oliveri*, *Terminalia* spp., *A. leiocarpa*, *Khaya senegalensis*, *Rafia sudanica*, and *Borassus* spp. along main rivers. The forest cover gradient increases with rainfall volume from north to south. It is therefore likely that animal sightings could be missed in the thickest habitat especially in forest galleries.

Counting

An aerial sample count (Norton-Griffiths 1978) was carried out in February–March 2010. A high-wing Cessna 182 was used. Flight height was maintained at 91 m above ground level by means of a shadow metre device (Pennycuick 1973). The pilot navigated with a GPS. The front seat observer took charge of data recording and used another GPS for recording animal locations. He was also equipped with a high-resolution digital camera: large groups were photographed and then the animals were counted later on the photograph. Two rear seat observers were in charge of spotting and counting animals. All wild and domestic animals observed were recorded as well as human activities. However, it is likely that many smaller

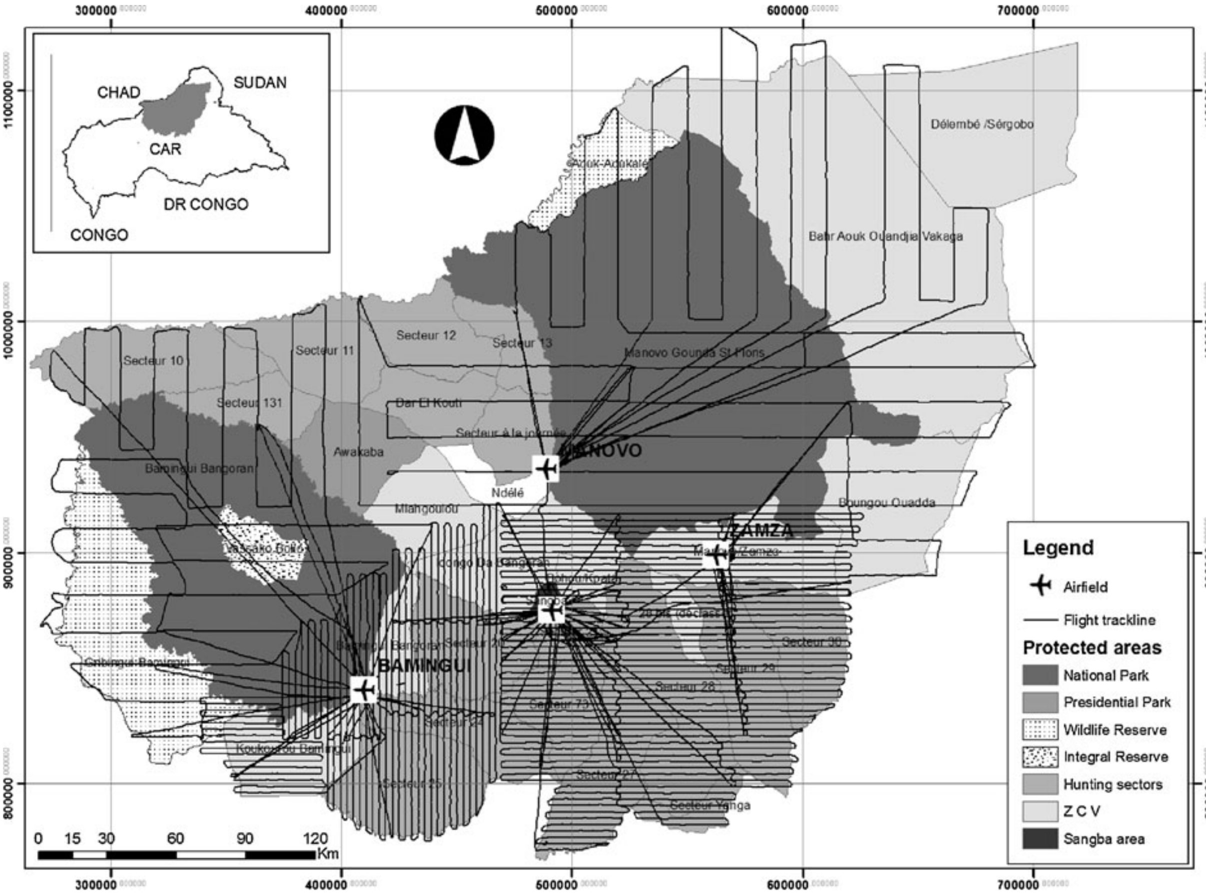

Fig. 1 Northern CAR ecosystem and study area

species' individuals be missed from the air and therefore underestimated.

Strip width calibration

Strips were calibrated to define a 200-m width on each side of the aircraft at an altitude of 91 m above the ground level. Strip widths on each side of the aircraft were calibrated by 20 repetitions of the count of a series of DIN A1 white sheets spaced 20 m apart along the airstrip. Each observer counted the number of sheets in the strip when the aircraft crossed it perpendicularly at an altitude of 91 m (Craig 2004)

Sampling plan

In this study, we used a different sampling plan from the earlier surveys (Bouché et al. 2010a) because: (1) the 1985 and 2005 surveys did not cover, or only partially covered, the community hunting areas and hunting sectors; (2) numerous reconnaissance flights led by the first author since 2008 showed that wildlife had already disappeared from large parts of the study area, and (3) wildlife was concentrated in community hunting areas and hunting sectors of the south of the study area.

Stratification followed the guidelines set by the MIKE aerial survey standards (Craig 2004). Two strata were distinguished: (1) a low-density stratum in the northernmost part of the ecosystem that included most of the national parks, wildlife reserves and the northernmost hunting sectors (Fig. 1); (2) a high density stratum in the southernmost part of the ecosystem composed of community hunting areas and hunting sectors as well as small parts of the national parks (Fig. 1.).

Each stratum was divided into blocks. The block sizes were arranged so that each could be surveyed in a single flight day. The boundaries of the blocks coincided with the boundaries of the basins of the main rivers. Transects were placed perpendicular to the main rivers (Fig. 1).

In total, 289 transects representing 15,090 km of flight yielded a total sample of 6,956 km^2 (mean sampling rate of 7.33%). A total of 138.25 h were flown, of which 92.50 h were necessary to cover the flight plan. The search rate was 74.93 km^2/h at an average ground speed of 163 km/h.

Data analysis

We used the Jolly II method (Norton-Griffiths 1978) to analyse the aerial count data. This method has been specifically designed for aerial sampling counts' data analysis. This method is simple to perform; therefore Microsoft Excel™ software has been used for data analysis. First, the data for each block were analysed separately. Next, the results for each block within each stratum were merged to give an estimate for each stratum. Finally, the results of the low- and high-density strata were combined to give the overall estimate.

Trend analysis

The aerial sample surveys have been flown since the 1970s in northern CAR (Spinage et al. 1977; Loevinsohn et al. 1978; PDRN 1998; Douglas Hamilton et al. 1985; Bouché et al. 2010a) have covered different areas. We assumed that the density estimates of the earlier surveys were representative of the densities at the scale of our study area in 2010 (Fig. 1). The 1977 and 1978 surveys (Spinage et al. 1977; Loevinsohn et al. 1978), each covered a part of the current study area. Their results were merged to produce a single density estimate per species for the year 1978. Species decline rates have been calculated by subtracting the e log estimates of year 1 and year n and divided by the number of years of interval ($n-1$).

For this study, only the densities of the larger species that are most visible from the air (ranging in size from elephants (*Loxodonta africana*) to Buffon kob (*Kobus kob*)) will be considered. Comparisons of the 1978 and 2010 results were made with a d test (Norton-Griffiths 1978; Bailey 1995) for the entire study area.

Results

Large mammal populations

A total of 1,241 animal groups were seen comprising 8,537 live or dead animals, consisting of 22 wild species and five domestic species (Table 1). The density of each wild species was low in each stratum (Table 1). As expected, the high-density stratum harbours a higher density and a larger number of wild animals than the low-density strata. This was particularly the case for Derby eland (*Taurotragus derbianus*), buffalo (*Syncerus caffer)* and hartebeest (*Alcelaphus buselaphus*) populations. The number of recent elephant carcasses was higher in the high-density stratum. Domestic animals and humans were more numerous in the low-density stratum (Table 1).

2005–2010 Large mammal population trends

Between 2005 and 2010, the population of large mammals decreased by about 72%, an average decline of 14.3%/year (Table 2). All species declined significantly since 2005 with the exception of the giraffe *Giraffa camelopardalis*, Derby eland and waterbuck *Kobus ellipsiprymnus*.

1978–2010 Large mammal population trends

Between 1978 and 2010, the population of large mammals decreased by about 94%, an average decline of 3.1%/year (Table 3). All species declined significantly since 1978, with the exception of the Derby eland for which the decline was significant at $P<0.10$ (Table 3). After 2005, all species declined to the low densities recorded in 2010 (Fig. 2a–c). Throughout the period covered by these surveys, from 1978 to 2010, cattle showed a linear increase in density (Fig. 2d). Derby eland shows a significant difference between mean numbers of 1978 and 2010 with a probability at level 0.10.

Discussion

The collapse of wildlife populations can be explained both by the increasing poaching of the early 1980s and by the rinderpest that decimated many of the larger antelopes and giraffe in 1984 (Ruggiero 1984; Delvingt and Lobão Tello 2004; Fig. 2a–c). Rinderpest is a viral

Table 1 Results of estimate numbers, density (*N*/100 km^2) and coefficient of variation in percent (CV%) for various wild species, domestic livestock and people observed in low- and high-density strata

Species	Scientific name	Low density stratum			High density stratum			Total		
		Estimate	*N*/100 km^2	CV%	Estimate	*N*/100 km^2	CV%	Estimate	*N*/100 km^2	CV%
Elephant	*Loxodonta africana*	0	0.0000	–	68	0.2294	84.54	68	0.0718	84.54
Giraffe	*Giraffa camelopardalis*	132	0.2028	124.81	30	0.0996	87.12	162	0.1705	103.23
Lord's Derby Eland	*Taurotragus derbianus*	0	0.0000	–	1,588	5.3462	46.80	1,588	1.6723	46.80
Buffalo	*Syncerus caffer*	0	0.0000	–	4048	13.6282	26.45	4,048	4.2630	26.45
Roan	*Hippotragus equinus*	240	0.3679	60.07	824	2.7755	27.57	1,065	1.1210	25.29
Hartebeest	*Alcelaphus buselaphus lelwel*	777	1.1901	38.48	2,035	6.8495	19.27	2,811	2.9604	17.53
Waterbuck	*Kobus ellipsiprymnus defassa*	0	0.0000	–	198	0.6672	43.12	198	0.2087	43.12
Buffon kob	*Kobus kob*	191	0.2930	84.46	225	0.7572	41.37	416	0.4382	44.79
Reedbuck	*Redunca redunca*	241	0.3689	42.71	8	0.0257	84.77	248	0.2616	41.48
Bushbuck	*Tragelaphus scriptus*	642	0.9832	35.37	861	2.8981	11.87	1503	1.5822	16.56
Warthog	*Phacochoerus africanus*	4,928	7.5512	13.26	800	2.6924	16.09	5,727	6.0313	11.62
Red hog	*Potamochoerus porcus*	0	0.0000	–	309	1.0406	36.36	309	0.3255	36.36
Giant forest hog	*Hylochoerus meinertzhageni*	0	0.0000	–	12	0.0397	110.01	12	0.0124	110.01
Oribi	*Ourebia ourebi*	1,110	1.7016	22.11	126	0.4250	37.10	1,237	1.3023	20.21
Yellow-backed duiker	*Cephalophus silvicultor*	66	0.1014	124.81	23	0.0778	56.18	89	0.0940	93.63
Common duiker	*Sylvicapra grimmia*	4,031	6.1770	13.77	1,304	4.3895	9.05	5,335	5.6178	10.64
Red flanked duiker	*Cephalophus rufilatus*	821	1.2582	25.42	1,704	5.7355	6.95	2,525	2.6587	9.50
Blue duiker	*Cephalophus monticola*	0	0.0000	–	13	0.0454	97.60	13	0.0142	97.60
Baboon	*Papio anubis*	10,568	16.1938	19.63	5,450	18.3481	10.85	16,018	16.8677	13.46
Red monkey	*Erythrocebus patas*	35	0.0538	77.00	233	0.7855	40.90	268	0.2827	36.95
Guereza Colobus	*Colobus guereza*	127	0.1951	79.50	258	0.8694	37.35	386	0.4060	36.26
Green monkey	*Cercopithecus tantalus*	91	0.1395	89.62	20	0.0681	73.82	111	0.1171	74.53
Total wild animals		24,478	37.5099	9.86	24,949	83.9902	7.29	49427	52.0494	6.11
Fresh elephant carcass		0	0.0000	–	0	0.0000	–	0	0.0000	–
Recent elephant carcass		0	0.0000	–	8	0.0269	84.90	8	0.0084	84.90
Old elephant carcass		35	0.0539	96.85	0	0.0000	–	35	0.0370	96.85
Very old elephant carcass		35	0.0539	96.52	0	0.0000	–	35	0.0370	96.52
Total elephant carcass		70	0.1078	68.37	8	0.0269	84.90	78	0.0825	62.00
People		3,842	5.8882	23.76	500	1.6838	55.01	4,343	4.5730	21.96
Cattle		222,661	341.2060	27.63	2,055	6.9179	63.29	224,716	236.6376	27.38
Sheep and goats		51,591	79.0586	78.97	0	0.0000	0.00	51,591	54.3284	78.97
Donkey		508	0.7780	51.19	0	0.0000	0.00	508	0.5346	51.19
Camel		391	0.5984	98.22	0	0.0000	1.00	391	0.4112	98.22
Total domestic livestock		275,150	421.6410	26.82	2,055	6.9179	63.29	277,205	291.9118	26.62

Table 2 Comparisons of mean densities (N/100 km^2), coefficient of variation (in %) (CV%), trend (in %), value of d test and probability (P) for selected species on the total study area during aerial sampling counts in 2005 and 2010

Species	2005		2010		Trends	*d* test	*P*
	N/100 km^2	CV%	*N*/100 km^2	CV%	2005–10 (%)	2005–10	
Elephant	1.24	45	0.07	85	−43.0	1.986	<0.05
Buffalo	17.55	25	4.26	26	−71.7	2.731	<0.01
Giraffe	0.71	42	0.17	103	−71.4	1.656	NS >0.05
Lord's Derby eland	5.50	40	1.67	47	−76.2	1.538	NS >0.05
Roan	5.39	21	1.12	26	−68.6	3.358	<0.01
Hartebeest	10.16	19	2.96	18	−75.3	3.378	<0.01
Waterbuck	0.40	53	0.21	43	−86.8	0.048	NS >0.05
Buffon kob	3.87	29	0.44	45	−56.4	2.932	<0.01
Total	44.82	20	10.91	14	−71.7	10.616	<0.001

disease affecting mainly wild ruminants that appeared during epidemic episodes in the study area. It causes only a mild disease in cattle, with minimal mortality. Wildlife plays an important role as sentinels of the disease, but although wildlife was important in the spread of the virus, they did not appear to act as reservoirs of infection (Kock et al. 1999). There is no asymptomatic carrier in this disease. After viral episodes of 10–15 days, cured animals do not keep the virus and are therefore not more a danger for other animals. Rinderpest is not endemic in CAR (Hendrikx et al. 2001). Eland recovered following the disappearance of rinderpest and the start in the late 1980s of PDRN's law enforcement efforts that continued up to 2000, while elephant, hartebeest and roan antelope (*Hippotragus equinus*) stabilised until the ECOFAC phase III ended in 2005 (Fig. 2a–c). Others never recovered even during the PDRN-ECOFAC project's interventions (giraffe, buffalo, waterbuck, topi (*Damaliscus lunatus*), Buffon kob).

National parks and reserves are managed by the Ministry in charge of Environment with the support of the ECOFAC Programme (Delvingt and Lobão Tello 2004). The study area covered by the national parks and reserves is huge. It is located along international frontiers and thus vulnerable to foreign incursions from Darfur and Chad (Fig. 1). The road networks are sparse and the guard forces are insufficient. No tourist has visited either national park for two decades. In contrast, hunting areas are managed by private operators with some help from ECOFAC, notably in terms of anti-poaching and building

Table 3 Comparisons of mean numbers (N/100 km^2), coefficient of variation (in %) (CV%), trend (in %), value of d test and probability (P) for selected species on the total study area during aerial sampling counts in 1978 and 2010

Species	1978		2010		Trends	*d* test	*P*
	N/100 km^2	CV%	N/100 km^2	CV%	1978–2010 (%)	1978–2010	
Elephant	36.94	6	0.07	85	−80.5	17.269	<0.001
Buffalo	32.13	43	4.26	26	−93.7	2.017	<0.01
Giraffe	1.30	0	0.17	103	−93.7	6.417	<0.001
Lord's Derby eland	5.60	39	1.67	47	−96.2	1.699	NS >0.05
Roan	10.37	7	1.12	26	−93.0	11.446	<0.001
Hartebeest	48.18	19	2.96	18	−91.3	4.857	<0.001
Topi	12.12	0	0.00	0	∞		–
Waterbuck	4.54	12	0.21	43	−90.4	7.856	<0.001
Buffon kob	27.20	29	0.44	45	−87.1	3.382	<0.001
Total	179.18	10	10.91	14	−91.3	8.981	<0.001

water ponds at the time of the survey. During the dry season, hunting areas concentrate far more management activities (road maintenance, safari hunting activities, anti-poaching) in a smaller area than National Parks (Roulet 2004).

While anti-poaching and community-based wildlife programmes (in community hunting areas) reduce local poaching, they do not prevent international intrusions. Giving CAR the ability to secure its own territory is thus crucial for biodiversity conservation in this area. Biodiversity will continue to decline if sub-regional armed conflicts are not tackled and CAR's national borders remain insecure. The recovery of wildlife is possible only if a strong regional political commitment is expressed and implemented in the field. The state, through land use planning and strong commitments, must take responsibility to regain its sovereignty over the area, re-establish security and manage biodiversity (Bouché et al. 2010a).

The absence of state authority explains also the socio-political troubles that evolved into a rebellion that resulted in the proliferation of weapons and the generalised lack of security. These problems were exacerbated by the recent troubles in the neighbouring Darfur and Chad. Then the interruptions of funds between the different phases of the ECOFAC project and the consequent irregular law enforcement efforts (Bouché et al. 2010a) further added to the uncertainty within the area. The consequence was the devastating loss of wildlife shown in Table 2 and Fig. 2. The viability of these areas for wildlife seems unlikely without projects and external funds.

Heavy poaching pressure since the end of the 1980s is responsible for most of the wildlife decline. Some poachers, mainly foreigners, target elephants for ivory. Others, mainly local, target all species for bush meat (Bouché et al. 2010a).

The elephants of northern CAR have suffered from the demand for ivory for more than 150 years (Bouché et al. 2010a). More recently, they have been afflicted by the ivory demand peaks of the 1980s (Douglas Hamilton et al. 1985; Froment 1985) and the last few years (Milliken et al. 2009; Wasser et al. 2010; Bouché et al. 2011). In 2007, hunting guides discovered about 200 elephant carcasses in hunting areas and community hunting areas. The total number of elephants killed by poachers was estimated at three times this figure (Chardonnet and Boulet 2008). A part of the poached ivory was also smuggled by some local authorities (Froment 1985, personal observation).

Due to the paucity of elephants in the study area, the rate of poaching seems to have dropped off since 2008. For example, in 2009, foreign poachers hunted elephant only sporadically. However, their caravans have been recorded in other regions of CAR that are several hundred kilometres westward and southward from the study area. These recent events seem to show that ivory poaching expeditions are no longer profitable in northern CAR and that attention has turned to other elephant populations that are more numerous and less shy.

Hunting pressure for bush meat remains intense even though local hunters are generally equipped only with muzzle loaders and 12-bore shotguns. Local hunting remains the second direct threat on wildlife. The goal is to produce bushmeat for markets in the towns. In CAR little meat is produced from domestic livestock. Meat from domestic animals remains unaffordable for common people and so most people in CAR consume bush meat (Fargeot 2004). If the domestic bushmeat consumption of the less-protected species is allowed, the commercial bushmeat trade of any species is forbidden. Weak law enforcement and the involvement of some local authorities in the bushmeat trade facilitate the availability of bushmeat in urban markets. In addition to local consumption, bushmeat is also traded across the border into Sudan and Chad (Bouché et al. 2010a).

Waza and Zakouma are two central African national parks (NP) that share the same habitat as north CAR (at least in the northernmost part of the study area), shelter similar large mammals species and have been recently surveyed (Foguekem et al. 2010; Potgieter et al. 2011). We assume that all these surveys are directly comparable (Table 4). North CAR aerial sample survey gave lower densities comparing to Waza and Zakouma aerial total count estimates except for few species (bushbuck, common duiker and oribi; Table 4). Contrary to Waza and Zakouma, north CAR's study area is several dozen times larger. Therefore, such large area is far more difficult to control, to manage and to fund appropriately than smaller ones. This contrasted situation (Table 4) should not make forget, that if Zakouma NP succeeds in conserving large antelopes and buffalo, the elephant population is collapsing too (Poilecot 2010; Bouché et al. 2011; Potgieter et al. 2011). Despite the relative high densities of elephant, giraffe, Buffon kob and topi in Waza NP (Table 4), all species are declining (Foguekem et al. 2010; Bouché et al. 2011). Some common species in other protected areas such as buffalo, hartebeest and bushbuck are extinct in Waza NP (Foguekem et al. 2010). As in north CAR, the wildlife declines can be attributed to the lack of appropriate law enforcement favouring illegal activities (poaching, illegal cattle and cultivations penetration etc.; Foguekem et al. 2010; Bouché et al. 2011; Potgieter et al. 2011).

Loss of habitat in a context of climate change

Since the 1980s, Sudan has built large dams to hold water on tributaries of the Chari. These dams were built without taking into account the ecological consequences downstream in CAR. The combination of the dams' effects downstream has been the drying of some lakes and rivers in northern CAR during the dry season (personal observation). This contributes to the disappearance of water-dependent species such as elephant, hippopotamus, reduncinae and topi in some parts of the study area.

The loss of habitat in the north of CAR is a major consequence of the transhumant cattle invasion. Cattle originally restricted to the Sahelian range (Haessler et al. 2003), appeared in the study area for the first time in the early 1980s, having come from Chad. Later, cattle herds came from Sudan. This was the consequence of repeated droughts, that have afflicted the Sahelian strip since the early 1970s, and the desiccation of the northern part of the Chari and Lake Chad Basin. Herders searched for better pastures and water during the dry season. The southward movement of cattle was also favoured by the trypanosomes' range decrease in the study area. At the same time, cattle numbers increased with the demand for meat (PNUE 2002; UNEP 2006). To reduce conflicts with cultivators, transhumant herders entered protected areas where they found good pastures and clean water for their cattle (Sam et al. 2002; Prins 1992; Bouché et al. 2010a). However, cattle movements are forbidden in the protected areas out of designated transhumance corridors.

Cattle may transmit diseases to wildlife. The decline recorded between 1978 and 1985 can be partially explained by the transmission of rinderpest from cattle to several wild species (giraffe, buffalo, antelopes; Delvingt and Lobão Tello 2004; Fig. 2d). Furthermore, cattle also compete for water and pasture (Bouché et al. 2007, 2010a; Hibert et al. 2010). This partly explains the massive reduction and extinction of the closest water-dependent species (elephant, buffalo, giraffe, reduncinae, topi etc.; Fig. 2a–c) in the areas that cattle colonised.

This collapse of wildlife populations can be explained both by the increasing poaching of the early 1980s and by the rinderpest that decimated many of the larger antelopes and giraffe (*Giraffe camelopardalis*; Ruggiero 1984; Delvingt and Lobão Tello 2004; Fig. 2a–c). Eland recovered following the disappearance of rinderpest and the start in the late 1980s of PDRN's law enforcement efforts that continued up to 2000, while elephant, hartebeest and roan antelope stabilised until the ECOFAC phase III ended in 2005 (Fig. 2a–c). Others never recovered even during the PDRN-ECOFAC project's interventions (giraffe, buffalo, waterbuck, topi, Buffon kob).

In addition, cattle herders poach wild animals and contribute to the ivory trade and the proliferation of light weapons. The effect of removing hippos *Hippopotamus amphibius* and elephants combined with increasing wood cutting by cattle herders has caused the beds of some of the large rivers to silt up. Grazing by hippos and elephants maintained some river channels and kept them open. Their removal resulted in the progressive invasion of vegetation that filled in the river channels. Combined with the wind and hydrologic erosion, some permanent rivers are finally drying up (personal observation). The consequence is the progressive drying of the most humid part of the Chari Basin. If this trend were to continue, then cattle herders will push their colonisation towards the Congo Basin. Another expected consequence is the progressive drying of the entire Chari Basin and what remains of Lake Chad. This lake has already lost 70–90% of its original area since the 1960s (PNUE 2002). This could result in more climatic refugees from Chad. In that case, many Chadians would try to migrate to CAR, as their transhumant compatriots already do in the dry season. Many Chadian ethnic groups live on both side of the Chad–CAR border where they maintain strong contacts with each other. As the current Chadian population number is three times higher than the CAR one, there is the risk that conflicts in this region could intensify.

To the question: *Is the final countdown to wildlife extinction begun?* we addressed recently (Bouché et al. 2010a), the answer is: the final countdown seems almost over for many large mammals, and for several species (rhinos, topi) it was over long ago. The future

Fig. 2 Long-term trends of large mammals between 1978 and 2010. *Vertical bars* represent confidence interval; **a** elephant, buffalo, hartebeest and buffon kob; **b** Lord's Derby eland, Roan and Topi; **c** giraffe and waterbuck; **d** large cattle ▶

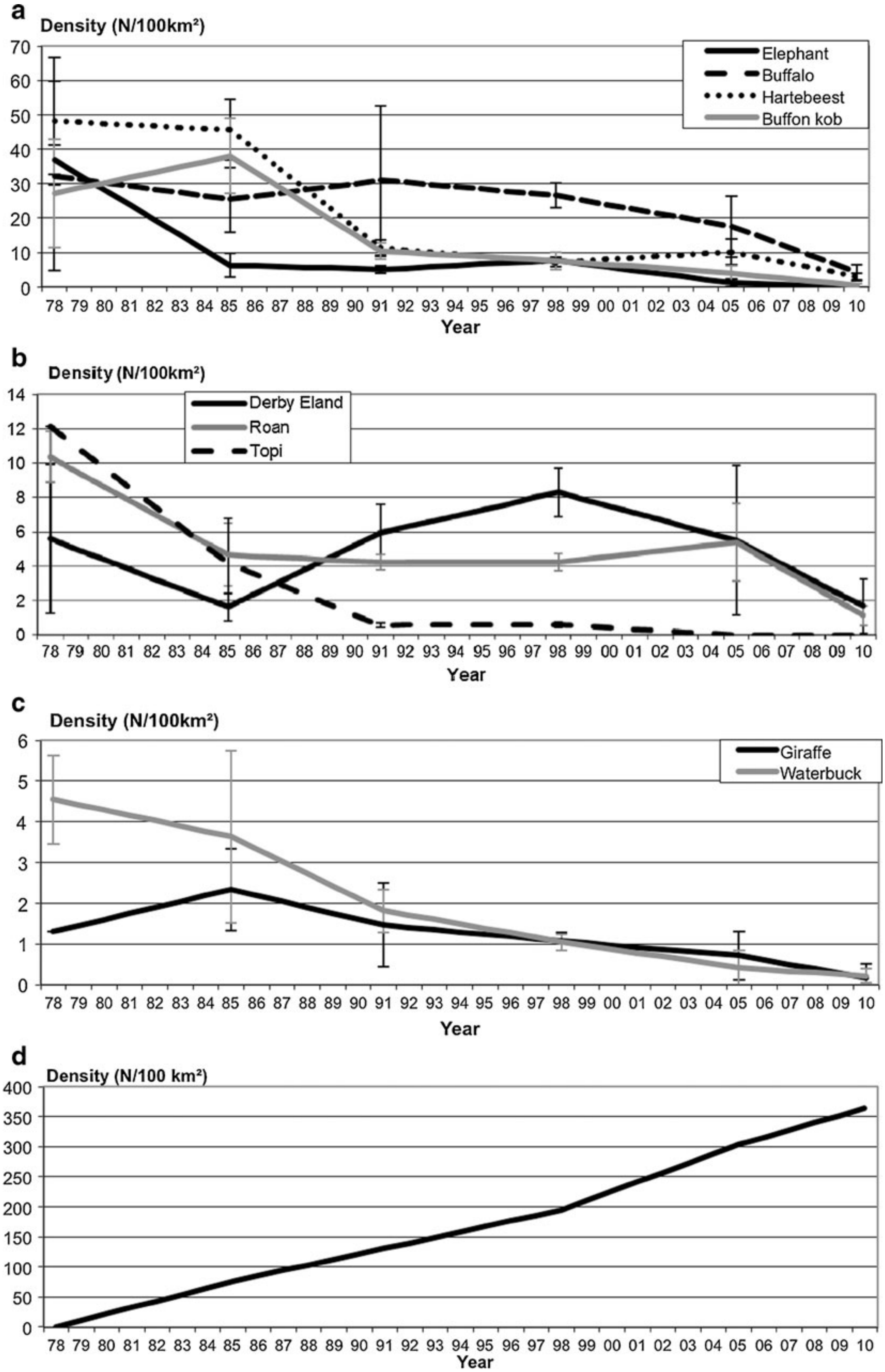
a
Density (N/100km²)
70
60
50
40
30
20
10
0
Elephant
Buffalo
Hartebeest
Buffon kob
78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10
Year
b
Density (N/100km²)
14
12
10
8
6
4
2
0
Derby Eland
Roan
Topi
78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10
Year
c
Density (N/100km²)
6
5
4
3
2
1
0
Giraffe
Waterbuck
78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10
Year
d
Density (N/100 km²)
400
350
300
250
200
150
100
50
0
78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10
Year

Table 4 Savannah large mammals densities' comparison of North CAR, Waza and Zakouma National Parks (NP)

Area	North CAR	Waza NP	Zakouma NP
Year of survey	2010	2007	2011
Area size (km^2)	95,000	1,700	3,326
Aerial count method	Sample	Total	Total
Rainfall (mm)	600–1,200	600	560
Reference	This study	Foguekem et al. (2010)	Potgieter et al. (2011)
Species	N/100 km^2	N/100 km^2	N/100 km^2
Buffalo	0.368	EXT	228.803
Bushbuck	1.190	EXT	0.421
Common Duiker	5.618	–	0.481
Elephant	0.072	14.471	13.650
Elephant carcass (recent)	0.008	0.118	–
Elephant carcass (old)	0.037	0.235	16.597
Elephant carcass (very old)	0.037	0.059	–
Gazelle	–	1.647	2.345
Giraffe	0.171	35.529	22.640
Hartebeest	2.960	EXT	52.676
Kob	0.101	91.882	14.131
Lord's Derby Eland	1.672	NP	NP
Oribi	1.302	EXT	0.060
Reedbuck	0.262	–	4.871
Roan	1.121	8.706	21.467
Topi	EXT	49.882	35.388
Warthog	6.031	1.235	22.610
Waterbuck	0.209	EXT	28.352

EXT extinct, *NP* naturally not present, *VL* very low density (Foguekem et al. 2010; Potgieter et al. 2011)

of the rest of the wildlife spectrum in this area is gloomy without a strong commitment to provide adequate funding and quickly implement determined field management. If turmoil and uncontrolled poaching can cause this level of loss in CAR, it could happen elsewhere too.

Several conservation measures have been described elsewhere (Bouché et al. 2010a). Among these, future surveys are required to monitor wildlife numbers and distribution in order to assess the efficiency of law enforcement. The phase IV of the ECOFAC project published a strategic plan for protected areas in northern CAR. It proposes to reinforce the management of the current core areas for wildlife and to progressively manage the parts outside the core areas until the entire ecosystem has been recovered. It also proposes to establish or reinforce cooperation with Chad and Sudan since they are facing similar problems (Poilecot 2010; Potgieter et al. 2011; UNEP 2006). This plan includes the possibility to split the parks into blocks of more manageable size. The blocks could then be rented to private operators. This would enable the state to regain control and then manage areas that have been effectively abandoned.

Despite this grim situation, the European Union will fund another conservation project that should start in early 2012. Nevertheless, additional donors are required to secure wildlife conservation in this huge area. If not, the 25 years of funding by the European Union will collapse with the wildlife that it was supposed to secure.

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