Commercial bushmeat hunting in the Monte Mitra forests, Equatorial Guinea: extent and impact

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Abstract

Commercial bushmeat hunting in the Monte Mitra forests, Equatorial Guinea: extent and impact.— Understanding the exploitation of bushmeat by commercial hunters is fundamental to resolving hunting sustainability issues in African rainforests. The objective of this study was to examine the impact of hunters operating from the village of Sendje in the Monte Mitra region, Republic of Equatorial Guinea. Offtake patterns of 42 hunters were studied over a period of 16 months. A total of 3,053 animals of 58 species were hunted during 1,914 hunting days. This represented around 11,376 kg of bushmeat or 2,219 animals extracted per annum. Most captures were mammals (43 species, 79%), constituting 90% of the biomass hunted, of these 30% were ungulates and 27% were rodents. Hunters used 17 hunt camps within the 1,010 km^2 total study area. Hunting activity fell from the start to the end of the study, with fewer hunting days, biomass and captures being recorded per month. Captures fell from 700 animals in the first month to less than 100 during the last month. Per hunter, returns diminished from 21 in the first month to around 13 animals from the third month. Average body mass of prey also declined throughout the study period. The principal hunting method was cable snaring —over 100 million snare nights were estimated. An average hunter extracted around 50 animals or 271 kg of bushmeat per annum. Hunter and camp differences were significant. Most carcasses were sold for the city market or to villagers, and the proportion of carcasses sold to market was positively correlated with the species body mass. Capture rates and vulnerability were dependent on prey size since medium–sized animals were more vulnerable to be caught than small or large–bodied animals. Harvest sustainability was calculated for 14 mammals and it was seen that the situation was unsustainably for 5 species due to the extent and impact of hunting. The bay duiker (*Cephalophus dorsalis*) was by far the most heavily exploited species. Conservation of the Monte Mitra region is impossible unless the hunting for profit issue is resolved in Sendje and adjoining villages.

Key words: Bushmeat hunting, Hunters, Sustainability, Monte Mitra, Equatorial Guinea.

Resumen

Caza comercial en los bosques de Monte Mitra, Guinea Ecuatorial: alcance e impacto.— Entender la explotación de la carne de selva por parte de cazadores comerciales es fundamental para resolver las cuestiones de sostenibilidad referentes a la caza en los bosques húmedos de África. El objetivo de este estudio fue examinar el impacto de la actividad de los cazadores de la aldea de Sendje, en la región del Monte Mitra, República de Guinea Ecuatorial. Se estudiaron los patrones de caza de 42 cazadores durante un periodo de 16 meses. Se cazaron un total de 3.053 animales de 58 especies en 1.914 jornadas de caza, lo que representa aproximadamente 11.376 kg de carne de selva o 2.219 animales extraídos por año. La mayoría de capturas fueron mamíferos (43 especies, 79%), que constituyeron el 90% de la biomasa cazada, y entre ellos un 30% de ungulados y un 27% de roedores. Los cazadores utilizaron 17 campos de caza dentro de un área de estudio con una extensión total de 1.010 m^2. La actividad de caza fue disminuyendo desde el inicio del estudio hasta al final del mismo, con menos días de caza, biomasa y capturas registradas por mes. Las capturas disminuyeron desde 700 animales durante el primer mes a menos de 100 en el último. Por cazador, el rendimiento diminuyó de 21 animales en el primer mes a 13 en el tercero. La media de masa corporal de las presas también disminuyó a lo largo del periodo de estudio. El método de caza más utilizado

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fue el cepo (se estimó la existencia de alrededor de 100 millones de cepos noche). En promedio, cada cazador extrajo alrededor de 50 animales o 271 kg de carne de selva por año. Las diferencias entre campos de caza y cazadores fueron significativas. La mayoría de piezas fueron vendidas al mercado de la ciudad o a los aldeanos, y la proporción de piezas vendidas al mercado estuvo correlacionada positivamente con la masa corporal de las mismas. Los índices de captura y vulnerabilidad dependieron del tamaño de las presas ya que los animales de tamaño medio resultaron más vulnerables que los pequeños o grandes. Se calculó la sostenibilidad de la caza para 14 mamíferos en los bosques de Monte Mitra, Guinea Ecuatorial, resultando insostenible para cinco especies por su extensión e impacto. *Cephalophus dorsalis* fue la especie explotada con mayor intensidad. La conservación de la región del monte Mitra es imposible a no ser que el problema de la caza de carne de selva para su comercialización se resuelva en Sendje y pueblos vecinos.

Palabras clave: Caza de carne de selva, Cazadores, Monte Mitra, Guinea Ecuatorial.

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Introduction

In tropical areas world–wide the meat of wild animals has long been part of the staple diet of forest–dwelling peoples. However, in recent years, there has been an important transition from subsistence to commercial hunting and trading of wildlife because of accelerating population growth, modernisation of hunting techniques, and greater accessibility to remote forest areas (APE ALLIANCE, 1998; WILKIE & CARPENTER, 1999).

In Africa, bushmeat is sold for public consumption either fresh or smoked. Bushmeat remains the primary source of animal protein for the majority of forest families, and can also constitute a significant source of revenue (JUSTE et al. 1995). The high demand for bushmeat and the lucrative trade associated with it is the main reason for the high extraction rates estimated for many West and Central African countries (FA & PERES, 2001). Although changes from subsistence to commercial hunting have been occurring for some time (see HART, 2000), many more hunters currently supplement their incomes with the sale of meat. Such commerce increases the amount of hunting and reduces the sustainability of numerous wildlife species largely because it enlarges the effective human population density of consumers eating meat from an area of forest (BENNETT & ROBINSON, 2000).

Commercial hunters and traders supply urban markets for profit to meet the increasing demand for animal protein in urban centres. Markets in towns and cities are the main sales–point for species extracted from natural areas (FA, 2000; FA et al., 1995). Interest in markets, for estimating game extraction rates from the surrounding areas is growing (FA et al., 2000). Investigations at the supplier end are also necessary to understand the extent and limits of the commercial hunting (ROBINSON et al., 1999). From this informed perspective, it may be possible to propose sound management policies. However, despite the importance of commercial hunting in African moist forests, few studies have documented temporal and spatial activities of multiple hunters operating in a known area. Here, the extent and impact of commercial hunters in the Monte Mitra forests is examined, Rio Muni, Republic of Equatorial Guinea. Wildlife harvests were documented for a total of 42 hunters over a period of 16 months. Destination of the bushmeat, whether consumed locally or sold is also assessed. By estimating hunt catchments for a selection of hunt camps we then describe the overall impact of such hunting pressure on densities and biomass of selected mammal species in the area.

Study Area

Río Muni (26,000 km^2), located just north of the equator, is part of the Republic of Equatorial Guinea (fig. 1). The city of Bata (population 55,000) is the major urban centre in the region. From the coast, elevation rises to 1,200 m at the highest peak Monte (Mount) Mitra. The Monte Mitra region (44 km^2), is now part of the Monte Alén National Park (FA, 1991; GARCÍA YUSTE & ENEME, 2000), within the Niefang mountains (fig. 1). Elevations of just over 1,000 m are typical. Relief is abrupt with some flat areas along river valleys. Climate is typically hot humid equatorial (average temperature 25°C but 2–5°C lower in the highlands), with 3,000–3,500 mm annual rainfall. Most precipitation occurs from September to December and from March to May; less rain falls from June through August.

The region's vegetation forms part of the Guineo–Congolian forest (SAYER et al., 1992). The Monte Mitra forests are dominated by *Xylopia*, *Anthocleista, Barteria, Morinda,* and *Uapaca* (BEUDELS, 1998). In flooded areas along river valleys, *Mitragina ciliata, Anthostema aubreyanum* and *Raphia* spp. are typical, with oil palm (*Elaeis guineensis*) being commonest. Secondary formations of *Aframomum* spp., bushes of the Rubiaceae family, and some lianas especially *Tetracera* and *Cissus,* predominate in the more disturbed areas. Intact dense tropical rainforest covers most of the study area. This forest has a closed upper canopy of *Gilbertiodendron dewevrei, Brachystegia, Piptadeniastrum, Pterocarpus, Coula edulis, Santiria, Staudtia, Strephonema pseudocola, Berlinia, Dialium*, and *Desbordesia*. Around 400 m, Olacaceae, Irvingiaceae, Myristicaceae and Euphorbiaceae are common plant families. There are some small seasonal swamps and lakes dominated by *Nitragina ciliata, Pandanus candelabrum* and *Anthocleista*. Between 400 and 700 m, the vegetation changes and *Lovoa trichilioides*, *Guarea cedrata,* members of the Meliaceae, as well as some Cesalpinaceae (*Tetraberlinia bifoliata, Anthonotha cladantha* and *Anthonotha ferruginea*) are common. *Begonias*, diverse species of *Canthium*, *Acanthonema* and *Trachystigma* are likewise characteristic. Above 700 m, one of the most abundant species is *Tetraberlinia bifoliata* in association with *Irvingia rubur*, *Garcinia couriana*, *Staudtia sp*, *Pentadesma butyracea*.

The human population, around 1,500 inhabitants, is concentrated along the Senye–Cogo road in the villages of Sendje, Binguru, Miton and Emangos to the north and Ncoho, Basilé and Mitong in the south (fig. 1). In the past, there were human settlements within the forest interior, but these are nowadays abandoned although some are used as hunt camps, e.g. Bisun. Until recently most of the population was employed in cocoa and coffee plantations, as well as in the logging businesses in the zone. With the abandonment of plantations and cessation of logging operations due to political instability and economic decline, the population has had to turn to hunting and subsistence agriculture. Villages in the south also fish along the headwaters of the Muni River Estuary.

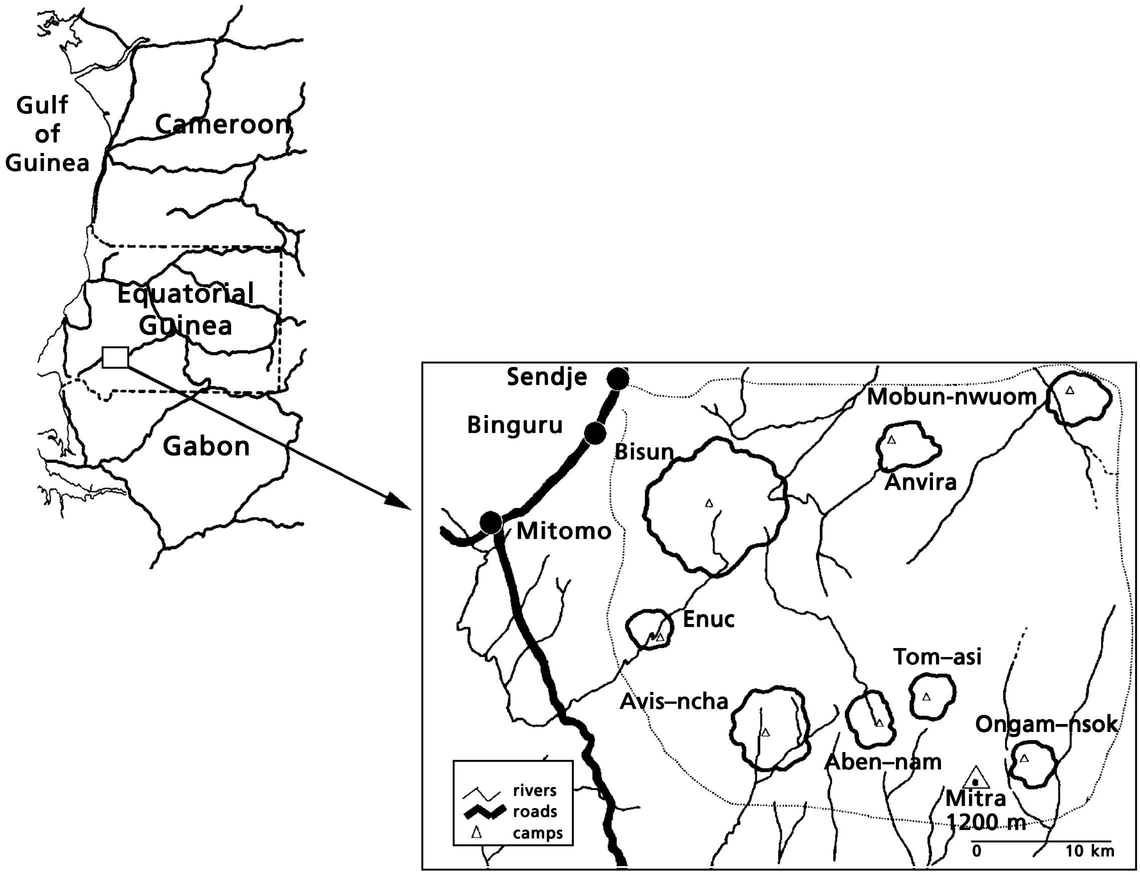

Fig. 1. Geographical location of Rio Muni region, Equatorial Guinea, showing the position of the Monte Mitra study area, and hunt catchments for eight camps.

Fig. 1. Localización geográfica de la región de Río Muni, Guinea Ecuatorial, mostrando la situación del área de estudio de Monte Mitra y las zonas de captura de ocho campos de caza.

Methods

Over 16 months (1 January 1998–26 April 1999) we collected data on cable snaring and shooting activities of 42 hunters from Sendje. Hunters operated in an area approx. 1,010 km^2 within 17 different hunt camps. Areas furthest away from the village were unhunted before our study. Harvested bushmeat was taken from camps to the village to be transported by intermediaries to the main city market in Bata. An assistant, a local villager, recorded all carcasses arriving in Sendje and interviewed hunters on duration of *hunting trips* (defined as a hunting excursion undertaken by a hunter), *hunting days* (days spent by the hunter in the forest), number of snares set, and hunting camp operated from.

All hunted animals were identified to species, but no attempt was made to weigh or measure animals. It was possible to determine for age class (juvenile or adult) and sex for 99% and 97% of carcasses respectively. Whether the animal had been shot, snared or caught by other means (by hand, machete or dogs) was also documented. Capture rate per species (Noss, 1998) was calculated as the number of snare nights required to capture one animal of a particular species. Animals that were scavenged or decomposed were not recovered by hunters and were recorded as wastage. Information on whether the carcass was consumed in camp, consumed by the hunters'family, sold in the village or destined for the Bata market was also recorded.

Hunt camps were geo–referenced with the aid of a GPS and altimeter. Camps were subsequently

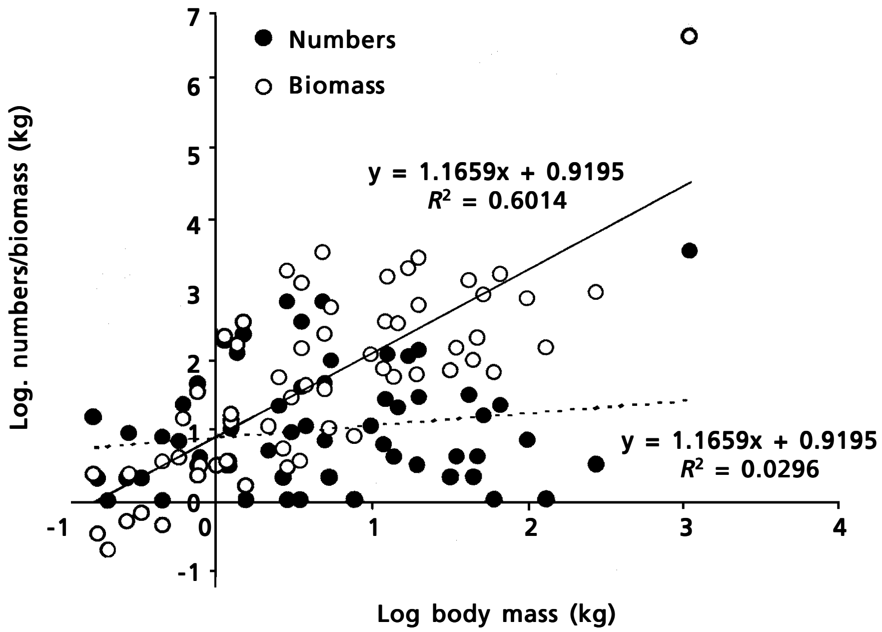

Fig. 2. Relationship between the body mass (kg) of the hunted bushmeat species, the number of animals captured and the total biomass (kg) of each species extracted.

Fig. 2. Relación entre la masa corporal (kg) de las especies de carne de selva cazadas, el número de animales capturados y la biomasa total (kg) de cada especie extraída.

mapped onto a 1/100,000 land use map from the CUREF Project ("Conservación y Utilización Racional de los Ecosistemas Forestales de Guinea Ecuatorial ", *http://www.internetafrica.com/curef/)* based in Bata. CUREF maps are based on radar, Spot XS and Landsat TM (1988–1995) images. Hunt catchments, defined as the area (in km^2) operated by hunters during the study, were estimated for only eight camps (Aben–nam, Anvira, Avis–ncha, Bisun, Mobun–nwuom, Enuc, Ongam–nsok, Tom–asi). This was undertaken by accompanying hunters for periods of 2 to 20 hunting days and geo-referencing the limits of their hunting territories (fig. 1).

Species names follow KINGDON (1997). Biomass extracted per species was calculated by multiplying the recorded number of carcasses of a species by the mass of an "average" individual. Body masses were taken from FA & PURVIS (1997) for adults, and halved for juveniles. By using productivity and population density data in FA et al. (1995) for the same region, it was possible to evaluate sustainability of hunting for 14 mammal species (2 rodents, 6 ungulates, 5 primates, 1 pangolin) for the estimated hunt catchments. Harvest rates were calculated by FA et al. (1995) using the method of ROBINSON & REDFORD (1991).

Statistical analyses were carried out using S–plus (VENABLES & RIPLEY, 1999). All means are reported with one standard deviation (±1 SD).

Results

Prey Species

During the study period, hunters caught 3,053 individuals of 58 species (43 mammals, 8 birds, 6 reptiles, 1 snail) or 15,169.1kg. Mammals accounted for 79% of total captures, reptiles 16%, birds 5% and snails 0.03%. By weight, 90.0% of the hunted biomass consisted of mammals, 9.2% reptiles, 0.86% birds and 0.03% of snails.

Over 30% of captures were made up of ungulates (884 carcasses, 12 species), followed by rodents (27%, 826 carcasses, 7 species), reptiles (16%, 490 carcasses, 6 species) and primates (11%, 329 carcasses, 11 species). Pangolins (2 species) were represented by 224 carcasses (7%), birds by 142 (5%, 8 species), carnivores by 112 (10 species, 4%), and Tubulidentates by one animal of a single species. Nine species (2 species each of rodents, ungulates, and primates, and one species of reptile, bird and pangolin) were represented by >100 captures, but 33 species (56.89%) had less than 10 carcasses each. The most–captured species was the blue duiker, *Cephalophus monticola*, which represented 21.6% (658 carcasses) of all captures and 15.3% by weight. The brush–tailed porcupine, *Atherurus africanus*

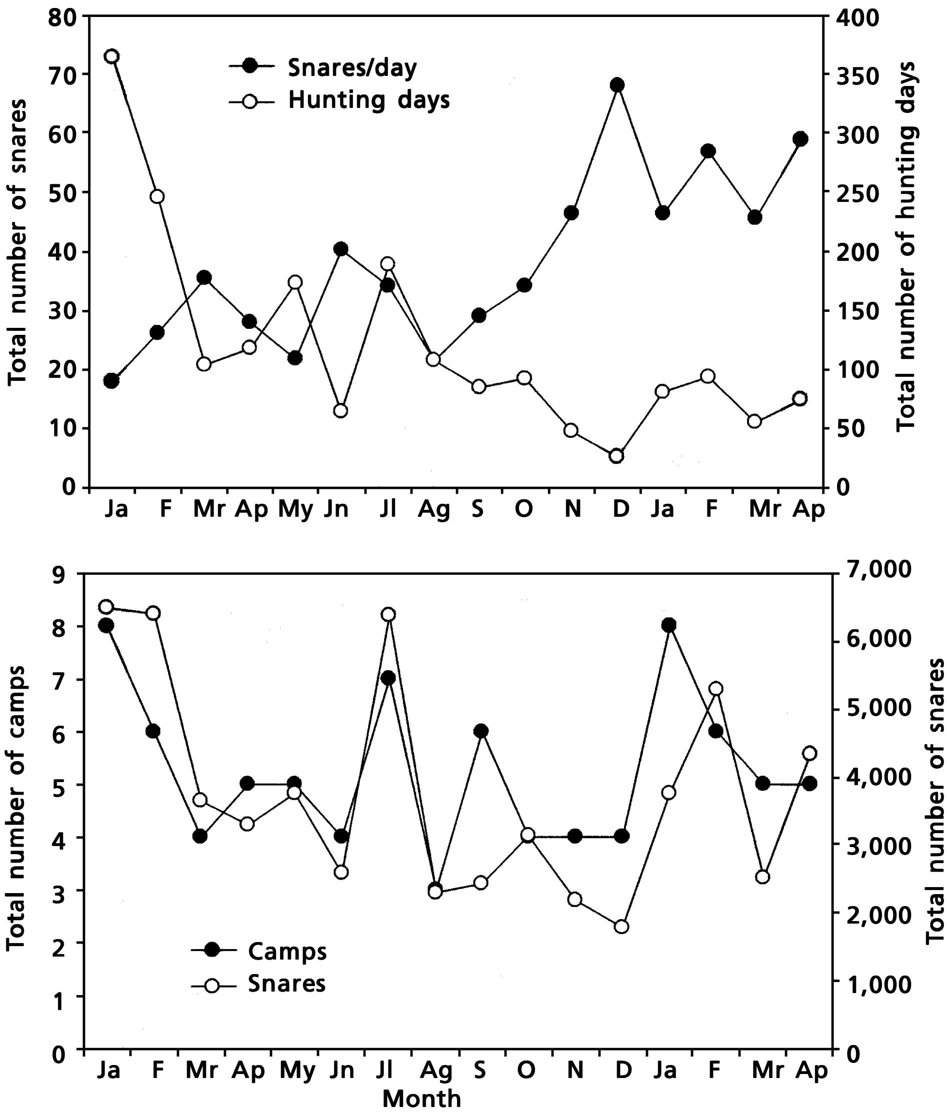

Fig. 3. Monthly changes (I 98–IV 99) in the numbers of hunting days recorded and number of camps used by hunters in Monte Mitra, Equatorial Guinea: Ja. January; F. February; Mr. March; Ap. April; My. May; Jn. June; Jl. July; Ag. August; S. September; O. October; N. November; D. December.

Fig. 3. Cambios mensuales (I 98–IV 99) en el número de días de caza registrados y el número de campos usados por los cazadores en Monte Mitra, Guinea Ecuatorial. (For abbreviations see above.)

appeared in almost the same proportion (20.3%, 619 carcasses), but represented only 8.3% by weight. The bay duiker, *Cephalophus dorsalis*, contributed 12.4% of the total hunted biomass although it comprised only 4.09% (128 carcasses) of total captures. Larger–bodied species contributed most to hunted biomass but there was no correlation between body mass and number of animals hunted (fig. 2).

A monthly average of 25.90±44.42 hunters (range 19–34) were active in the entire study area, an average of 31.50±13.90 hunting days month^{-1}. A total of 1,914 hunting days were recorded, but number of hunting days month^{-1} dropped significantly from 364 in the first month to around 100 after the eighth month (R^2 = 0.50; d.f. = 14; P = 0.000) —a minimum of 26 hunting days was recorded in December 1998 (fig. 3A).

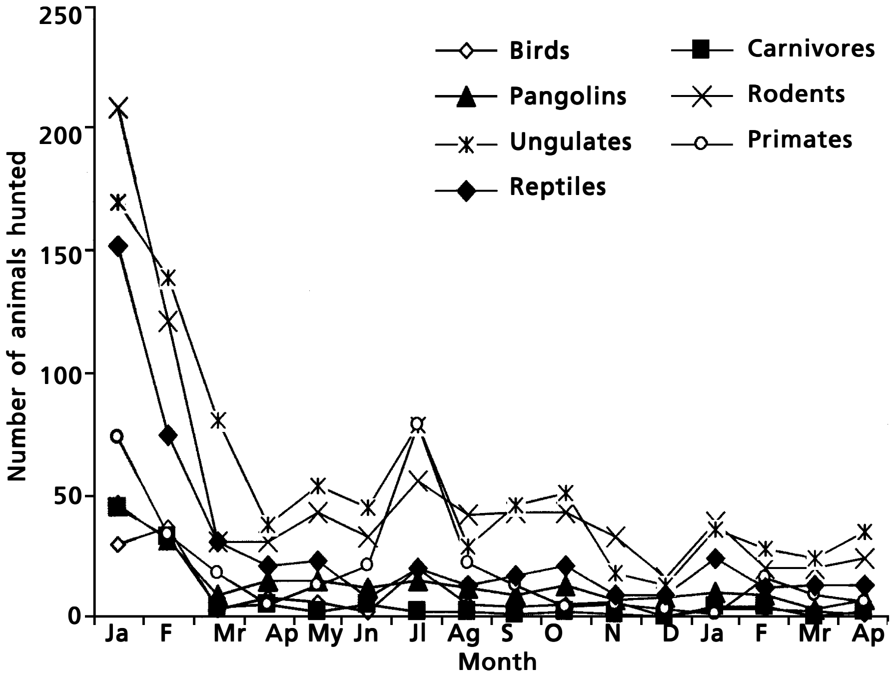

Fig. 4. Monthly changes (I 98–IV 99) in number of hunted animals within the main taxonomic groups in Monte Mitra, Equatorial Guinea. (For abbreviations see fig. 3.)

Fig. 4. Cambios mensuales (I 98–IV 99) en número de animales cazados de los principales grupos taxonómicos en Monte Mitra, Guinea Ecuatorial. (Para las abreviaturas ver fig. 3.)

In contrast, the average number of snares set per month increased significantly from the start to the end of the study (R^2 = 0.61; d.f. = 14; P = 0.0003). Hunters used a total of 17 camps during the study, an average of 5.25±1.48 camps per month^{-1}. The number of camps used ranged from 3 in August 1998 to 8 in January 1998, and the total number of snares set per month correlated with the number of camps used (fig. 3B). There was a significant positive correlation between the number of operational camps and the total number of hunting days per month^{-1} (R^2 = 0.36; d.f. = 14; P = 0.000).

Temporal changes in bushmeat numbers and biomass

Captures fell from around 700 in the first month (January 1998) to less than 100 during the last month (April 1999). This amounted to 2,663.2 kg extracted in January 1998 and 321.5 kg in April 1999. The drop was significant in the number of animals snared (R^2 = 0.25; d.f. = 173; P = 1.163e–012), numbers shot (R^2 = 0.06; d.f. = 83; P = 0.02) and animals killed by other means (R^2 = 0.158; d.f. = 26; P = 0.04). A fall in animals hunted between the first and the third month was observed in all main taxonomic groups (fig. 4). Number of captures per hunter also declined from 20.73±12.53 animals hunter^{-1} in the first month to around 10.52±4.93 animals hunter^{-1} by the third month (fig. 5A). Mean numbers fluctuated between 4 to 13 animals after the third month. Corresponding with captures, biomass dropped steeply from 126.82±117.44 kg hunter^{-1} in the first month to 20.65±20.18 kg hunter^{-1} in the third month (fig. 5B). Average body mass of hunted animals also declined throughout the study period (fig. 5C); larger–bodied animals were more prevalent during the earlier months of the study.

Hunter differences

All hunters used firearms and cable snares, but snare hunting was the principal method used. The main type of snare is a noose made out of wire cable that is set along an animal trail. When the animal steps on a pressure pad, it releases a bent–over pole, which springs up to tighten the noose around the animal's leg. During the study period, hunters deployed a total of 56,398 snares. This amounted to 107,945,772 snare–nights (the number of snares

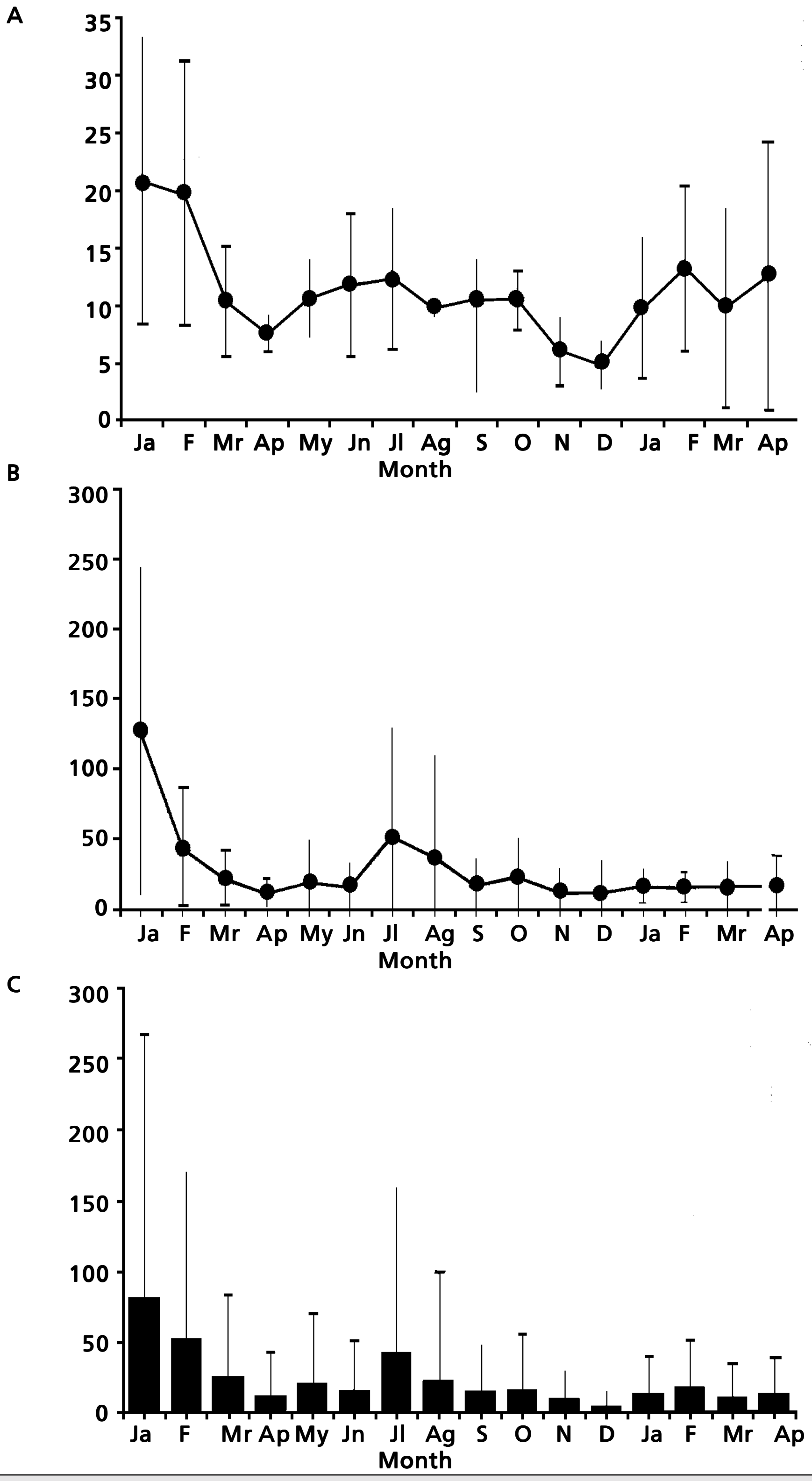

Fig. 5. Mean (± SD) monthly changes (I 98–IV 99) in: A. Number of animals; B. Total animal biomass (kg) extracted per hunter per hunting day; C. Body mass (kg) of hunted animals. (For abbreviations see fig. 3.)

Fig. 5. Cambios medios mensuales (± SD) (I 98–IV 99) en: A. Número de animales; B. Biomasa animal total (kg) extraída por cada cazador por día de caza; C. Masa corporal (kg) de los animales cazados. (Para abreviaturas ver fig. 3.)

times the number of nights set), an average of 1,927,603 snare–nights per hunter. An average of 112.06±57.34 snares (136,358.31±118,441.48 snare nights ranging from 28,303 snare nights in June 1998 to 408,192 snare nights in July 1998) were operational every month throughout the study area, with no significant monthly variation being detected. However, number of snares set in each camp differed significantly, from 50.0±70.7 snares hunting trip^{-1} in Sendje to 222.4±106.9 snares hunting trip^{-1} in Aben–nam (Goodness of fit test, R^2 = 286.35; d.f. = 15; P = 1.7e–51). Per camp, the number of snares set was not correlated with the number of hunters operating in the area (R^2 = 0.002; d.f. = 40; NS) or with the size of the hunt catchment area (R^2 = 0.0002; d.f. = 6; NS).

A total of 563 hunting trips was recorded for the 42 hunters in the area. Each hunter undertook 13.73±13.96 (range 1–52) hunting trips during the study period, and spent an average of 46.27±54.49 (range 1–233 days) total hunting days (table 1). Hunting trips lasted 3.81±3.21 days per hunter (range 1.00±0.00–9.43±4.34 days) during which 1,484.16±1723.92 snares were operated per hunter (range 80–5,459 snares). The hunting trip duration did not differ significantly among hunters (R^2 = 12.11; d.f. = 40; P = 0.74). However, the number of snares operated per hunter varied significantly (R^2 = 80025.98; d.f. = 40; P = 0.000).

Number of animals hunted and biomass extracted per hunter were positively correlated with total number of hunting days (fig. 6). Biomass extracted and captures per hunter were also positively correlated with number of snares set (R^2 = 0.48; d.f. = 40; P = 0.000). However, the total number of camps used was not correlated with number of hunting trips completed by each hunter.

Hunters extracted 66.29±66.51 animals or 270.87±219.35 kg of animal biomass hunter^{-1} during the study period or a mean of 50 animals or 203.18 kg hunter^{-1} annum^{-1}. Number of animals hunted (R^2= 2736.22; d.f. = 40; P = 0.000) and biomass extracted (R^2= 7282.53; d.f. = 40; P = 0.000) varied significantly among hunters. The most productive hunter was Hunter 8, who captured a total of 276 animals on 52 hunting trips whilst Hunter 42, the least prolific, caught a single animal on any one hunting trip. Most animals were caught by snares (60.83±67.23 animals hunter^{-1}), and significantly fewer animals were shot (5.45±10.27 animals hunter^{-1}). Number of animals extracted per hunting day by each hunter averaged 0.83±1.72 for the study period. The lowest monthly extraction figure was for April 1998 (0.53±0.41 animals hunter^{-1} hunting day^{-1}) whilst the highest (1.78±1.82 animals hunter^{-1} hunting day^{-1}) was in January 1999. There was no significant inter–monthly difference in number of animals extracted by hunters (R^2= 3.74; d.f. = 14; P = 0.999).

Hunters used from one to six camps, 2.29±1.50 camps per hunter (median 2 camps). Most (n = 19 hunters; 45.24% of all hunters) used only one camp, eight (19.05%) used two camps, 14 (33.33%) from three to five camps, but a single hunter (2.38%) operated in six different camps. Only one hunter used Esua–asas and Eto–mbeng, but a maximum of 20 hunters entered Bisun (table 2). Number of snares set per trip in each camp varied from 50.0±57.74 in Sendje to 222.35±106.85 in Aben–nam. An average of 112.96±54.25 snares per hunt catchment was set during each hunting trip.

Camp differences

For the camps surveyed, regular hunt catchments were an average of 28.3**±**8.9 km from the village**,** ranging from 11.7 km (Bisun) to 41.7 km (Ongam–nsok) (table 2). Hunt catchments varied significantly in size from 6.2 km^2 in Ongam–nsok to 314.2 km^2 in Bisun, with the larger areas being found closer to the village (R^2 = 0.63; d.f. = 6; P = 0.019). The size of the hunted areas was correlated with the number of hunters operating within them (R^2 = 0.59; d.f. = 6; P = 0.020).

Per camp, annual harvests varied from 5 animals (4.77 kg) in Esua–asas to 764 animals (4,413.53 kg) in Bisun. Biomass extracted per hunter differed significantly between camps (R^2 = 957.5; d.f. = 15; P = 1.4e–193). Biomass extracted per camp per hunting day also varied significantly (R^2 = 29.7; d.f. = 15; P = 0.013). For those camps for which hunt catchment area was measured, number of animals and biomass extracted per km^2 differed significantly between camps (table 3). Ongam–nsok was by far the most productive with 224.47 kg of bushmeat km^{-2}, whereas Bisun, which was also the most hunted camp, produced 14.05 kg bushmeat km^{-2} (R^2 = 667.5; d.f. = 15; P = 1.6e132).

Proportion of species sold and consumed

Although some meat is for home consumption (22.87%), the largest proportion of animals hunted (67.77%) was either sold in Sendje (34.05%) or in the Bata market (33.72%). Bushmeat consumed by the hunters'families was 16.26%, and hunters themselves would consume 6.61% in forest. Only 9.35% of the total number of recorded animals was unsuitable for consumption. The number of animals sold (R^2 = 0.02; d.f. = 56; NS) or consumed (R^2 = 0.02; d.f. = 56; NS) was not correlated with the number of carcasses per species hunted. Similarly, biomass was not correlated with proportion sold (R^2 = 0.02; d.f. = 56; NS) or consumed (R^2 = 0.03; d.f. = 56; NS). Per hunter, an average of 39.02±26.98% of the animals hunted were sold to the Bata market.

For the subsample of species with >100 carcasses (7 mammals, 2 reptiles, 1 bird), the proportion of animals sold to the Bata market

Table 1. Recorded activity and offtake of hunters in the Monte Mitra area (I 98–IV 99), Equatorial Guinea. The number of carcasses recorded with hunter information was lower than the total number (3,053 carcasses) noted during the study: H. Hunter; Ht. Duration of hunting trips (in days). Thd. Total hunting days; Tht. Total hunting trips; C. Number of camps; Sno. Number of snares operated; Sph. Number of species hunted; Ahsh. Number of animnals hunted with shotgun; Ahsn. Number of animals hunted with snares; Tah. Total animals hunted; Be. Biomass extracted (in kg).

Tabla 1. Actividad registrada y productividad de los cazadores en el área de Monte Mitra (I 98–IV 99), Guinea Ecuatorial. El número real de piezas registrado mediante información de los cazadores fue inferior que el número total (3.053 piezas) anotado durante el estudio: H. cazador; Ht. Duración de las salidas de caza (en días). Thd. Total de jornadas de caza; Tht. Total de salidas de caza; C. Número de campos; Sno. Número de cepos utilizados; Sph. Número de especies cazadas; Ahsh. Número de animales cazados con armas de fuego; Ahsn. Número de animales cazados con cepo; Tah. Total de animales cazados; Be. Biomasa extraída (en kg).

	Ht										
H	Mean	SD	Thd	Tht	C	Sno	Sph	Ahsh	Ahsn	Tah	Be
1	4.18	2.53	71	18	6	1,478	21	3	86	89	424.23
2	9.43	4.39	66	9	2	1,645	22	3	75	78	532.67
3	3.17	2.71	19	6	4	264	12	25	16	41	346.75
4	6.13	3.28	233	39	3	4,192	31	5	238	243	712.48
5	4.11	1.62	37	15	3	1,898	23	2	84	86	469.40
6	6.63	3.01	179	28	4	2,555	25	2	189	191	828.71
7	5.78	2.05	104	23	5	1,998	33	0	175	175	599.53
8	2.80	2.81	137	52	4	5,459	30	6	246	252	668.91
9	6.14	1.35	43	8	3	712	17	3	67	70	362.50
10	4.25	1.44	68	18	4	2,631	22	2	101	103	329.11
11	2.36	2.09	66	28	1	2,469	19	0	108	108	398.30
12	4.40	1.82	22	5	2	437	13	0	32	32	116.16
13	2.00	–	2	2	1	197	4	0	9	9	23.89
14	3.35	1.23	104	37	1	5,955	21	0	166	166	498.46
15	5.00	3.10	30	6	3	512	11	0	35	35	127.06
16	3.10	1.86	130	44	4	3,615	19	6	159	165	455.33
17	2.80	2.33	84	34	1	4,812	19	20	107	127	505.56
18	6.75	1.89	27	5	2	612	14	6	36	42	311.37
19	4.67	1.53	14	8	1	1,012	20	2	66	68	240.89
20	3.75	2.25	30	10	4	747	10	0	61	61	191.61
21	5.00	–	5	2	2	70	8	0	16	16	85.97
22	2.63	1.19	21	10	4	353	14	16	24	40	103.56
23	5.11	6.85	92	19	3	2,829	13	0	68	68	146.32
24	3.00	1.00	9	4	1	356	9	4	14	18	128.31
25	4.33	2.52	13	5	1	472	6	0	17	17	48.79
26	4.00	1.41	8	3	1	440	7	0	17	17	42.84
27	3.39	5.09	129	43	1	5,216	18	0	133	133	486.34
28	4.00	–	4	1	1	80	3	0	4	4	68.91
29	1.30	0.48	13	14	5	–	10	55	1	56	221.56
30	4.00	–	4	1	1	120	5	0	11	11	37.54

Table 1. (Cont.)

H	Ht Mean	Ht SD	Thd	Tht	C	Sno	Sph	Ahsh	Ahsn	Tah	Be
31	1.86	1.07	13	8	2	124	10	25	7	32	531.23
32	4.33	2.31	13	3	1	600	3	0	15	15	22.51
33	1.50	0.71	3	3	2	140	5	0	4	4	153.83
34	2.20	1.10	11	6	2	80	8	15	2	17	270.90
35	1.35	1.14	27	22	1	1,772	13	6	53	59	169.57
36	2.20	1.64	11	5	1	50	8	9	7	16	182.90
37	3.00	–	3	1	1	130	3	0	4	4	11.90
38	1.00	–	1	1	1	–	3	0	6	6	97.01
39	1.00	0.00	2	2	1	276	6	0	10	10	22.15
40	3.75	1.24	60	16	1	–	15	9	85	94	332.56
41	1.25	0.50	5	4	2	–	3	5	0	5	34.90
42	3.00	–	3	1	1	90	1	0	1	1	33.97
Totals	3.80	3.21	1,916	563	17	56,398	58	229	2,555	2,784	11,376.49

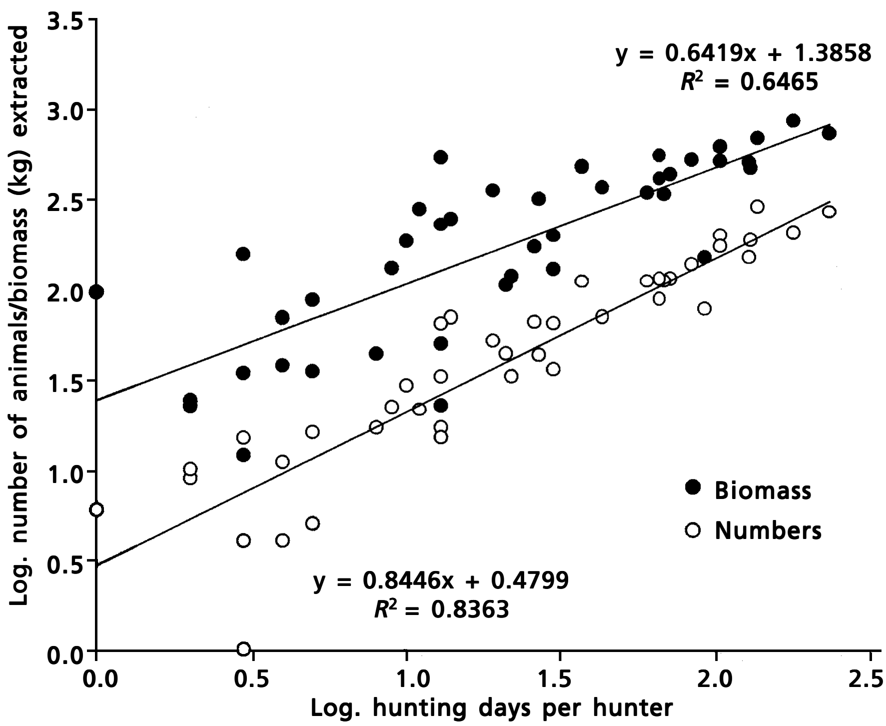

Fig. 6. Relationship between number of hunting days per hunter and number of animals captured, and total animal biomass (kg) extracted per hunter.

Fig. 6. Relación entre el número de días de caza por cada cazador, el número de animales capturados y la biomasa animal total (kg) obtenida por cada cazador.

Table 2. Details of hunting intensity within camps in the Monte Mitra area, Equatorial Guinea: Hd. Hunting days hunter^{-1}; Sht. Snares hunting trip^{-1}; Dv. Distance from village (in km); Hc. Hunt catchment (in km^2); N. Species recorded; A. Average body mass of recorded prey (in kg); H. Hunters.

Tabla 2. Detalles de la intensidad de caza en los campos del área de Monte Mitra, Guinea Ecuatorial: Hd. Días de caza para cada cazador; Sht. Salidas para colocación de cepos; Dv. Distancia hasta el pueblo (en km); Hc. Área de caza (en km^2); N. Especies registradas; A. Masa corporal media de las presas registradas (en kg); H. Cazadores.

						Hd		Sht	
Camp	Dv	Hc	N	A	H	Mean	SD	Mean	SD
Aben–nam	30	9.08	19	48.8	3	3.89	1.23	222.35	106.85
Anvira	20.83	38.48	33	28.7	16	4.48	2.94	86.16	41.85
Avis–ncha	27.50	75.43	39	27.1	14	5.05	1.82	105.71	47.34
Bisun	11.67	314.16	41	26.6	20	3.18	3.91	125.88	47.93
Ebang	–	–	5	26	3	1.20	0.45	80.60	13.99
Echun–ndje	–	–	11	25.8	2	3.60	0.70	175.10	75.61
Enuc	28.33	12.57	19	24.8	9	3.28	2.26	75.41	48.72
Esua–asas	–	–	5	23.4	1	1	–	70	–
Eto–mbeng	–	–	9	23.3	1	–	–	78	–
Evuadulu	–	–	11	23.1	5	3.25	3.17	53.35	34.45
Kong	–	–	13	22	2	5.67	2.31	94.67	4.16
Mandjana	–	–	2	21.5	1	4.00	–	120	–
Mitong–evina	–	–	9	21.1	1	6.18	5.40	140.91	15.14
Mobun–nwuom	33.33	50.27	18	20.6	6	6.93	1.46	100.64	32.65
Ongam–nsok	41.67	6.16	35	19.0	5	6.98	2.62	108.26	41.74
Sendje	–	–	8	10.3	2	2	0	50	57.74
Tom–asi	32.50	7.07	14	9.7	4	4.17	1.99	109.13	39.30
Grand total	–	–	58	23.9	42	4.20	3.38	112.96	54.25

was significantly positively correlated with body mass of the species. The relationship was polynomial ($y = 0.0209x^3 - 0.9194x^2 + 11.769x + 4.3471$; $R^2 = 0.80$; d.f. = 8; $P = 0.000$).

The total percentage of animals sold per camp averaged 71.67±14.15%. The proportion sold varied from 33.3% in Mandjana to 88.2% in Ebang. The proportion of game sold or consumed was not related to the distance of the camp to the village (Sold $R^2 = 0.28$; d.f. = 6; $P = 0.1818$; Consumed $R^2 = 0.28$; d.f. = 6; $P = 0.1818$). There was no correlation between the number of animals hunted and percentage sold. The number of animals consumed in forest was correlated with wastage ($R^2 = 0.74$; d.f. = 15; $P = 9.288e–006$). The number of animals sold in the village was also correlated with the number sold in Bata market ($R^2 = 0.78$; d.f. = 15; $P = 2.661e–006$).

Capture rates and vulnerability

Most animals (n = 2,636; 86.3%) were caught by snares, 7.9% (n = 241) were killed with shotgun, and 5.8% (n = 176) were taken by other methods. Per hunting day, 15.5±16.17 animals were snared, but significantly fewer were shot (4.2±3.5) or taken by other methods (2.9±2.2). The proportion of animals shot was significantly lower during all months of the study (fig. 7).

Over one–half of all species (32 species) encountered was caught only in snares (table 4). Of 42 species (73.68%), over 50% of individuals caught were snared. Ungulates, rodents and carnivores were relatively more vulnerable to snares than to firearms; 10 of the 12 ungulates, 6 of the 7 rodents, and 7 of the 9 carnivores were caught exclusively with snares. The species most

Table 3. Captures, wastage and hunting method for bushmeat species in Monte Mitra, Equatorial Guinea: Hm. Hunting method (%); C. Captures; Sn. Snares; Sh. Shotgun.

Tabla 3. Capturas, piezas desaprovechadas y métodos de caza para carne de selva en Monte Mitra, Guinea Ecuatorial: Hm. Método de caza (%); C. Capturas; Sn. Cepos; Sh. Armas de fuego.

Groups	Capture rate		Wastage			Hm (%)		
Species	Mean	SD	C	N	%	Sn	Sh	Other
Snails								
Achatina spp.	–	–	1	0	0	0	0	100
Reptiles								
Bitis gabonica	2,991.25	2,292.82	6	0	0	100	0	0
Chamaleo cristatus	4,333	2,907.62	3	0	0	33.3	0	66.7
Kynixis erosa	211.92	219.63	337	0	0	60.2	0	39.8
Osteolaemus tetraspis	1,095.93	1,367.91	45	3	6.7	50	50	0
Python sebae	7,272.83	3,845.01	4	0	0	100	0	0
Varanus niloticus	1,028.78	994.66	92	3	3.3	95.7	0	4.3
Group total	2,822.29	2,650.63	487	6	1.2	66.6	4.6	28.8
Birds								
Ceratogymna atrata	2,209.67	3,619.46	3	0	0	33.3	66.7	0
Francolinus lathanmi	3,562.75	2,026.69	9	2	22.2	100	0	0
Gypohierax angolensis	–	–	1	0	0	0	100	0
Haliaetus vocifer	–	–	1	0	0	0	100	0
Numida meleagris	908.47	1,117.57	118	17	14.4	97.5	2.5	0
Obom (unidentified bird)	29,975	–	1	0	0	100	0	0
Psittacus erithacus	551.93	714.55	8	0	0	100	0	0
Stephanoaetus coronatus	29,975	–	1	0	0	100	0	0
Group total	11,197.14	14,583.91	143	19	13.3	94.4	4.9	0.7
Carnivores								
Bdeogale nigripes	3,375.67	2,738.74	3	0	0	100	0	0
Civicttis civetta	3,667.58	6,331.87	26	4	15.4	100	0	0
Crossarchus obscurus	5,452.19	6,419.79	10	1	10	100	0	0
Felis aurata	4,744.46	6,009.13	11	1	9.1	100	0	0
Genetta tigrina/servalina	1,822.29	790.6	26	2	7.7	100	0	0
Herpestes sanguinea	7,394.83	6,644.5	7	1	14.3	100	0	0
Lutra maculicolis	5,837.50	779.94	2	0	0	100	0	0
Panthera pardus	9,091	8,338.91	4	1	25	66.7	33.3	0
Poiana richardsoni	2,555.46	2,438.79	23	6	26.1	90.9	9.1	0
Group total	4,882.33	2,340.02	112	16	14.3	96.9	3.1	0
Hyrax								
Dendrohyrax dorsalis	4,150.44	570.72	9	1	11.1	100	0	0
Group total	4,150.44	570.72	9	1	11.1	100	0	0
Pangolins								
Phataginus tricuspis	276.13	302.86	222	32	14.4	100	0	0
Smutsia gigantea	–	–	2	0	0	0	100	0
Group total	–	–	224	32	–	99.1	0.9	0

Table 3. (Cont.)

Groups / Species	Capture rate Mean	Capture rate SD	Wastage C	Wastage N	Wastage %	Hm (%) Sn	Hm (%) Sh	Hm (%) Other
Primates								
Cercocebus torquatus	–	–	1	0	0	0	100	0
Cercopithecus cephus	2,192.93	2,221.31	39	0	0	17.9	82.1	0
Cercopithecus nictitans	1,452.37	1,537.8	43	1	2.3	30.2	69.8	0
Cercopithecus pogonias	6,118.79	10,597.63	11	0	0	36.4	63.6	0
Colobus satanas	434.49	521.4	111	0	0	22.5	77.5	0
Galago alleni	3,194.5	–	2	1	50	100	0	0
Gorilla gorilla	–	–	1	0	0	0	100	0
Mandrillus sphinx	601.13	479.94	103	4	3.9	47.6	52.4	0
Miopithecus onguensis	3,003.59	1,964.32	13	0	0	46.2	53.8	0
Pan troglodytes	17,630.5	17,457.76	2	0	0	75	25	0
Perodicticus potto	4,907.67	1,339.97	3	0	0	99.5	0.5	0
Group total	4,392.89	5,307.74	329	6	1.8	33.6	66.4	0
Rodents								
Atherurus africanus	90.78	43.2	619	75	12.1	100	0	0
Cricetomys emini	437.61	446.17	177	21	11.9	100	0	0
Funisciurus lemniscatus	4,496.55	3,460.15	15	0	0	100	0	0
Heliosciurus rufobrachium	17,264.5	17,975.36	2	0	0	100	0	0
Myosciurus pumilio	4,920	517.6	2	0	0	100	0	0
Protoxerus stangeri	–	–	4	0	0	0	0	100
Thryonomys swinderianus	1,317.42	1,125.89	7	0	0	100	0	0
Group total	4,754.48	6,462.1	826	96	11.6	99.5	0	0.5
Tubulidentate								
Orycteropus afer	6,389	–	1	0	0	35.6	2.2	62.2
Group total	6,390	–	1	0	–	35.6	2.2	62.2
Ungulates								
Cephalophus callipygus	1,707.34	1,678.91	28	5	17.9	100	0	0
Cephalophus dorsalis	665.34	1,041.98	128	15	11.7	98.4	1.6	0
Cephalophus montícola	82.19	39.46	658	78	11.9	99.1	0.9	0
Cephalophus nigrifrons	1,138.5	–	4	0	0	100	0	0
Cephalophus ogilbyi	3,374.67	2,701.5	3	1	33.3	100	0	0
Cephalophus sylvicultor	3,425.5	913.27	15	2	13.3	100	0	0
Hyemoschus aquaticus	2,143.94	1,064.01	20	4	20	100	0	0
Neotragus batesi	5,471.5	1,297.54	2	1	50	100	0	0
Potamochoerus porcus	2,814.98	2,358.77	22	1	4.5	100	0	0
Syncerus caffer	8,843.75	8,688.57	3	0	0	100	0	0
Tragelaphus scriptus	6,472.46	13,146.1	29	0	0	100	0	0
Tragelaphus spekei	6,941.38	781.18	7	2	28.6	100	0	0
Group total	3,590.13	2,761.09	919	109	11.9	99.1	0.9	0
All groups	19.16	11.18	3,050	285	9.3	86.3	7.9	5.8

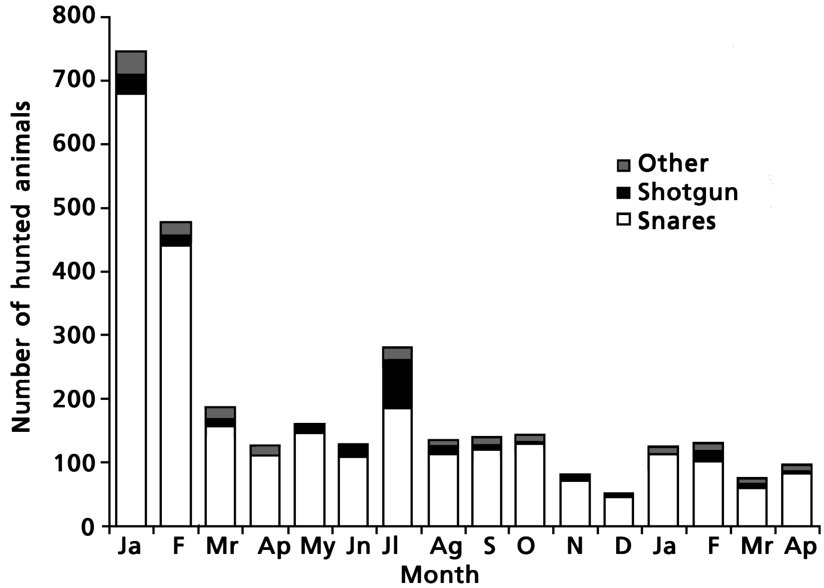

Fig. 7. Monthly changes (I 98–IV 99) in number of animals hunted by cable snaring and shotgun in the Monte Mitra, Equatorial Guinea.

Fig. 7. Cambios mensuales (I 98–IV 99) en número de animales cazados mediante cepos y armas de fuego en el Monte Mitra, Guinea Ecuatorial.

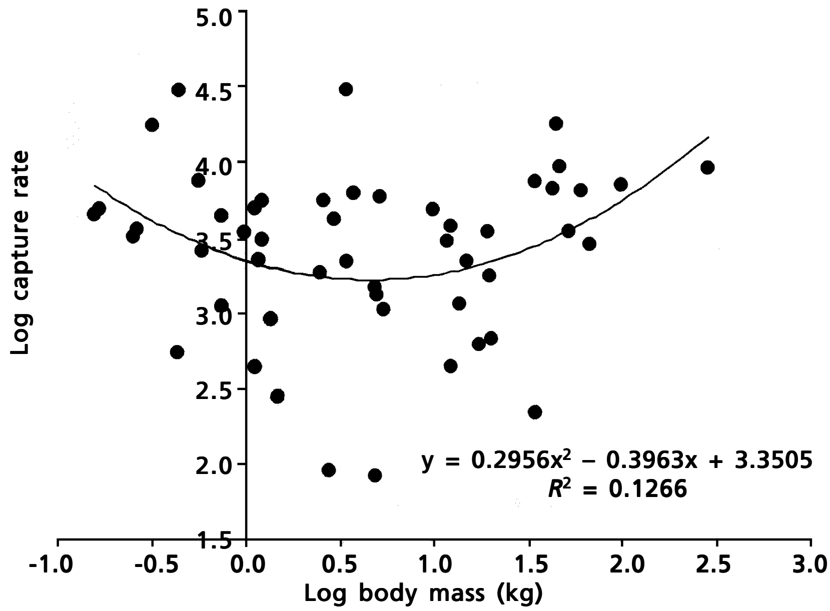

Fig. 8. Relationship between body mass (kg) and estimated mean snare capture rate for bushmeat species hunted in Monte Mitra, Equatorial Guinea.

Fig. 8. Relación entre masa corporal (kg) e índice estimado de capturas medias con cepo para especies cazadas y comercializadas como carne de selva en Monte Mitra, Guinea Ecuatorial.

Table 4. Details of hunting output within hunt camps in the Monte Mitra area, Equatorial Guinea: Taa. Total annual of animals; Tab. Total annual biomass (in kg); Bh. Biomass hunter^{-1}; Bhd. Biomass hunting day^{-1}; B. Biomass km^{-2}; N. Number of animals km^{-2}.

Tabla 4. Detalles de producción cinegética en el área de Monte Mitra, Guinea Ecuatorial: Taa. Total anual de animales; Tab. Biomasa total anual (en kg); Bh. Biomasa por cazador; Bhd. Biomasa por día de caza; B. Biomasa por km^{-2}; N. Número de animales por km^{-2}.

	Taa	Tab	Bh	Bhd	B	N
Aben–nam	95	420.49	140.16	6.01	10.44	46.21
Anvira	273	1,348.92	84.31	5.31	7.09	35.04
Avis–ncha	396	1,868.85	133.49	6.87	5.25	24.79
Bisun	764	4,413.53	220.68	7.30	2.43	14.05
Ebang	13	37.92	12.64	6.32	–	–
Echun–ndje	32	128.02	64.01	3.56	–	–
Enuc	131	716.79	79.64	5.19	10.4	56.89
Esua–asas	5	4.77	4.77	4.77	–	–
Eto–mbeng	13	71.75	71.75	–	–	–
Evuadulu	44	167.17	33.43	4.78	–	–
Kong	35	149.37	74.69	8.79	–	–
Mandjana	2	4.75	4.75	1.19	–	–
Mitong–evina	46	144.31	144.31	2.12	–	–
Mobun–nwuom	86	317.6	63.52	3.27	1.71	6.31
Ongam–nsok	233	1,391.73	278.35	5.01	37.58	224.47
Sendje	16	64.06	32.03	16.02	–	–
Tom–asi	31.70	4.37	5.21	17.86	–	–
Grand total	2,219	11,376.8	270.88	5.94	–	–

vulnerable to snaring was the blue duiker (table 4) and the least the crowned eagle (*Stephanaeotus coronatus*). The proportion of animals snared or shot was not correlated with body mass of the species. However, mean capture rates were correlated with body mass; smaller and larger–bodied species were significantly less vulnerable than medium–sized animals (fig. 8). All taxonomic groups, except reptiles and primates, were caught mainly with snares. A significant proportion (28%) of reptiles was caught by other means (gathered by hand). In the case of primates, most individuals were shot (66.4%), but number of animals snared varied among species; nocturnal primates (Allen's squirrel galago *Galago alleni* and potto *Perodictus potto*) being vulnerable only to snares.

Because snares are non–selective, captures should reflect sex and age ratios in the population (Alvard, 1994). For the most hunted species (>100 captures)–two duikers (*C. montícola*, bay duiker *Cephalophus dorsalis*), two rodents (*A. africanus,* giant pouched rat *Cricetomys emini*), two primates (black colobus *Colobus satanas,* mandrill *Mandrillus sphinx*), a reptile (hinged tortoise *Kynixis erosa*), pangolin (tree pangolin *Phataginus tricuspis*) and a bird (guinea fowl *Numida meleagris*) —sex ratios were not significantly different to 1:1 in any species (table 5). In contrast, the age class ratios were significantly biased towards juveniles in all species (table 5).

Sustainability of harvests

For the 14 mammal species for which harvest information could be calculated, mean total extraction rate was 41.75±45.56 animals km^{-2} ranging from 10.27 animals km^{-2} in Bisun, to 148.2 animals km^{-2} in Ongam–nsok. In all camps, *A. africanus* and *C. dorsalis* were extracted at significantly higher rates than other species (table 6). The average extraction rates for these species were 12.22±14.50 for *A. africanus* and 10.44±11.05 for C. dorsalis. In four camps, *A.*

Table 5. List of bushmeat species recorded in the Monte Mitra area, Equatorial guinea, indicating average individual body mass (Abm, in kg) and numbers of animals of each age: J. Juveniles; A. Adults; T. Total; R. Ratio; Gt. Grand total.

Tabla 5. Relación de las especies de carne de selva registradas del área de Monte Mitra, Guinea Ecuatorial, con indicación de la masa corporal individual media (ABM, en kg) y número de animales de cada edad: J. Jóvenes; A. Adultos; T. total; R. Ratio; Gt. Gran total.

Groups		Age class				Sex				
Species	Abm	J	A	T	R	♀	♂	T	R	Gt
Snails										
Achatina spp.	–	1	0	1	–	–	–	–	–	**1**
Reptiles										
Bitis gabonica	12	6	0	6	–	3	3	6	1	6
Chamaleo cristatus	0.7	3	0	3	–	1	2	3	0.5	3
Kynixis erosa	3.5	259	55	314	4.7	140	193	333	0.7	339
Osteolaemus tetrapis	31.8	34	11	45	3.1	33	8	41	4.1	45
Python sebae	35.2	2	2	4	1	3	1	4	3	4
Varanus niloticus	5.5	71	18	89	3.9	45	46	91	1	92
Total		376	86	462	4.4	225	253	478	0.9	490
Birds										
Ceratogymna atrata	1.2	2	0	2	–	2	0	2	–	3
Francolinus lathanmi	0.3	7	2	9	3.5	4	4	8	1	9
Gypohierax angolensis	1.5	1	0	1	–	0	1	1	0	1
Haliaetus vocifer	2.8	–	–	–	–	–	–	–	–	1
Numida meleagris	1.4	104	10	114	10.4	70	44	114	1.6	118
Psittacus erithacus	0.4	4	4	8	1	4	4	8	1	8
Stephanoaetus coronatus	0.8	1	0	1	–	1	0	1	–	1
Unidentified spp.	0.5	1	0	1	–	1	0	1	–	1
Total		120	16	136	7.5	82	53	135	1.5	142
Carnivores										
Bdeogale nigripes	1	2	1	3	2	1	2	3	0.5	3
Civicttis civetta	12.4	18	8	26	2.3	13	13	26	1	26
Crossarchus obscurus	1.3	8	2	10	4	2	8	10	0.3	10
Felis aurata	10	7	4	11	1.8	5	6	11	0.8	11
Genetta servalina	2.2	19	2	21	9.5	10	11	21	0.9	21
Genetta tigrina	2.5	5	0	5	–	3	2	5	1.5	5
Herpestes sanguinea	0.6	7	0	7	–	3	4	7	0.8	7
Lutra maculicolis	5.3	2	0	2	–	2	0	2	–	2
Panthera pardus	47.5	–	3	1	4	3.0	2	2	4	1
Poiana richardsoni	0.6	22	1	23	22	9	14	23	0.6	23
Total		93	19	112	4.9	50	62	112	0.8	112
Hyrax										
Dendrohyrax dorsalis	3	7	1	8	7	5	4	9	1.3	9
Pangolins										
Phataginus tricuspis	1.5	179	41	220	4.4	120	101	221	1.2	222
Smutsia gigantea	32.5	2	0	2	–	1	1	2	1	2
Total		181	41	222	4.4	121	102	223	1.2	224

Table 5. (Cont.)

Group		Age class				Sex				
Species	Abm	J	A	T	R	♀	♂	T	R	Gt
Primates										
Cercocebus torquatus	7.8	1	0	1	–	0	1	1	0	1
Cercopithecus cephus	3.5	36	3	39	12	22	20	42	1.1	39
Cercopithecus nictitans	5	33	5	38	6.6	18	22	40	0.8	43
Cercopithecus pogonias	3.8	9	2	11	4.5	6	5	11	1.2	11
Colobus satanas	12.5	84	26	110	3.2	57	53	110	1.1	111
Galago alleni	0.3	2	0	2	–	0	2	2	0	2
Gorilla gorilla	133	0	1	1	0	0	1	1	0	1
Mandrillus sphinx	17.4	26	75	101	0.3	48	53	101	0.9	103
Miopithecus onguensis	1.3	8	5	13	1.6	6	7	13	0.9	13
Pan troglodytes	45	1	1	2	1	1	1	2	1	2
Perodicticus potto	1.2	3	0	3	–	1	2	3	0.5	3
Total		203	118	321	1.7	159	167	326	1	329
Rodents										
Atherurus africanus	2.8	501	100	601	5	326	285	611	1.1	619
Cricetomys emini	1.1	129	45	174	2.9	94	79	173	1.2	177
Funisciurus isabella	0.2	15	0	15	–	9	6	15	1.5	15
Heliosciurus rufobrachium	0.3	2	0	2	–	0	2	2	0	2
Myosciurus pumilio	0.2	0	2	2	0	2	0	2	–	2
Protoxerus stangeri	0.8	4	0	4		2	2	4	1	4
Thryonomys swinderianus	5.1	6	1	7	6	7	0	7	–	7
Total		657	148	805	4.4	440	374	814	1.2	826
Tubulidentate										
Orycteropus afer	61.0	1	0	1	–	1	0	1	–	1
Ungulates										
Cephalophus callipygus	20.1	20	8	28	2.5	14	14	28	1	28
Cephalophus dorsalis	20.4	100	20	120	5	66	62	128	1.1	128
Cephalophus montícola	4.9	558	85	643	6.6	337	320	657	1.1	658
Cephalophus nigrifrons	13.9	2	2	4	1	2	2	4	1	4
Cephalophus ogilbyi	19.5	2	1	3	2	1	2	3	0.5	3
Cephalophus sylvicultor	52.5	13	2	15	6.5	9	6	15	1.5	15
Hyemoschus aquaticus	15	18	2	20	9	14	6	20	2.3	20
Neotragus batesi	2.7	2	0	2	–	2	0	2	–	2
Potamochoerus porcus	67.5	14	8	22	1.8	13	9	22	1.4	22
Syncerus caffer	285	1	2	3	0.5	1	2	3	0.5	3
Tragelaphus scriptus	43	23	5	28	4.6	17	12	29	1.4	29
Tragelaphus spekei	100	4	3	7	1.3	2	5	7	0.4	7
Total		757	138	895	5.5	478	440	918	1.1	919
All groups										
Grand total		2,395	567	2,962	4.2	1,562	1,455	3.17	1.1	3,052

Table 6. Estimated productivity of mammal species in hunt camps in the Monte Mitra area, Equatorial Guinea. Comparisons of the extraction rates for all camps and production figures estimated in FA et al. (1995) are also given: *Species considered to be hunted unsustainably; Abn. Aben–nam; An. Anvira; Avn. Avis–ncha; Bi. Bisun; En. Enuc; Mon. Mobun–nwoum; Onn. Ongam–nsok; Toa. Tom–asi; Ahr. Annual harvest rate (Nos km^2 yr^{-1}); Cps. All camp ps; P. Production (Nos km^2 yr^{-1})

*Tabla 6. Productividad estimada de especies de mamíferos en campos de caza de Monte Mitra, Guinea Ecuatorial. También se incluyen valores estimativos comparativos: *Especies cuya caza se considera insostenible; Abn. Aben–nam; An. Anvira; Avn. Avis–ncha; Bi. Bisun; En. Enuc; Mon. Mobun–nwoum; Onn. Ongam–nsok; Toa. Tom–asi; AHR. Índice de captura anual (número km^2 yr^{-1}); Cps. Todos los campos ps; P. Producción (número km^2 yr^{-1}).*

	Ahr								Cps		
Species	Abn	An	Anv	Bi	En	Mon	Onn	Toa	Mean	SD	P
Ungulates–Red duikers											
Cephalophus callipygus	0.88	0.62	0.21	0.06	0.96	–	*3.25	0.57	0.82	1.12	1.31
Cephalophus ogilbyi	–	0.1	–	–	–	–	0.65	–	*0.09	0.24	2.02
Cephalophus sylvicultor	0.44	0.21	0	0.14	0	–	*0.65	–	*0.18	0.25	0.29
Ungulates–Blue duiker											
Cephalophus monticola	7.93	4.26	3.87	1.27	6.37	0.48	25.35	6.23	6.97	8.47	8.57
Rodents											
Atherurus africanus	18.51	10.4	5.52	2.39	10.83	2.07	*43.55	4.53	12.22	14.5	27.12
Cricetomys emini	2.64	0.94	1.38	1.26	–	0.16	9.1	1.7	2.15	3.16	81.49
Monkeys											
Cercopithecus cephus	0.44	0.42	0.05	0.22	0.64	0.24	0.65	–	0.33	0.22	1.18
Cercopithecus nictitans	0.44	0.62	0.27	0.09	*2.23	0.08	1.3	–	0.63	0.79	1.55
Colobus satanas	1.32	2.18	1.43	1.36	*2.87	0.72	*11.7	3.96	*3.19	3.86	2.72
Mandrillus sphinx	0.44	1.35	*1.33	0.57	*2.23	0.8	*8.45	0.57	*1.97	2.84	0.79
Pangolins											
Phataginus tricuspis	1.76	1.66	0.8	0.2	4.14	0.32	5.85	1.7	2.05	2.12	6.63
Pigs											
Potamochoerus porcus	0.88	0.1	0.05	0.1	0.64	–	3.9	–	0.71	1.4	1.89
Apes											
Gorilla gorilla	–	–	–	0.01	–	–	–	–	0.001	–	0.03
All species	49.34	30.14	20.06	10.27	45.56	7.26	148.2	23.22	41.751	50.02	136.09

africanus was the most harvested species, but rates differed significantly from 5.52 animals km^{-2} in Avis-ncha to 43.55 animals km^{-2} in Ongam-nsok. In two camps, Bisun and Enuc, *C. dorsalis* was the most heavily extracted species followed by *A. africanus*. Comparison between extraction rates and estimated production (table 6) showed that *C. dorsalis* was hunted unsustainably in all camps, the mandrill *Mandrillus sphinx* in four camps, black colobus *Colobus satanas* in two camps, and three other species (Peter's duiker *Cephalophus callipygus,* yellow–backed duiker *Cephalophus sylvicultor*, and spot–nosed guenon *Cercopithecus nictitans*) in one camp.

Discussion

The aim of this study was to document the process of faunal extraction in a representative area of African moist forest. Through relatively unobtrusive and cost–effective means we were able to gather data for an unprecedented number of hunters in an equally unprecedented number of hunting areas. This study also examines the impact of hunting on forest vertebrate communities over a reasonably long period and offers a new insight into ways of collecting valuable data for assessing sustainability.

Our results point to trends in hunting performance and outcomes which have been observed elsewhere. For example, the number of captures and biomass extracted per hunter were correlated with the amount of time dedicated to hunting by each hunter and to size of areas operated by them. Equally, extraction rate was positively correlated with distance from the village since interference levels and hunting pressure decreases as distance from human habitation increases (INFIELD, 1988; LAHM, 1993; MUCHAAL & NGANDJUI, 1999). Animals killed per hunter per hunting day did not vary significantly throughout the study but total numbers killed declined during the same period. This effect can be explained by the amount of time hunters spent in the forest. During the early part of the study, number of days dedicated to hunting was high but this declined later on. Biomass extracted per month was observed to drop dramatically from the start to the end of the study. Whether there is overt feedback between returns during one month and the number of days spent hunting the following month is difficult to know. However, it is likely that this is happening, given that hunters knew each other and would discuss the state of the game in the forest. Perhaps an indication that previous knowledge of the possible condition of prey populations was present is the fact that number of snares set per day increased dramatically as number of days spent in the forest declined. Hunters would be attempting to maximise or keep constant their daily hunting returns by intensifying snaring activities.

One of the most pervasive conclusions of our study is the importance of cable snares in supporting commercial hunting activities in the Monte Mitra region. Cable snares are probably the most widely used hunting method in African forests today (NOSS, 1998, 2000) because the method is affordable, easy to implement and very effective. Hunter return rates are high as a result, but not without severe consequences. Cable snares are indiscriminate and wasteful. Prey–selectivity exercised by other methods of hunting, especially more traditional techniques, is severely reduced. Species of any age or sex, exhibiting any terrestrial activity, of any speed and of mid–range body size are vulnerable to capture by cable snare. Only very small species, with insufficient body mass to trip the cable wire, and very large species, likely to overpower the mechanism, are left non–targeted. Large animals may be injured by the snare, which may in turn have implications for their survival and reproduction. Elephants, for example, may trigger the cable snare with their trunks. Estimated wastage in our study was 9.7%, substantially lower than the 26.7% reported by NOSS (1998) for Bayanga hunters in the CAR.

In the 1,010 km^2 of the Monte Mitra study area, we estimated bushmeat offtake of over 2,000 total captures, around 10,000 kg of animal biomass annum^{-1}. This amounts to 56 captures or 10 kg of bushmeat km^{-2} annum^{-1}. This is a substantially larger extraction rate than elsewhere in Central African forests. For example, for a similar–sized hunting range, NOSS (1998) estimated only 9 captures km^{-2}. The explanation for this, may be found in the density of cable snares used, since this was significantly higher in the entire Monte Mitra area (56 snares km^{-2}) than in Bayanga (4.2 snares km^{-2}). However, considerable between–hunt catchment differences existed in biomass and number of animals extracted. What determines variation in game productivity, within what is apparently the same forest, is not known and requires further investigation. Between–site disparity in hunter–kill profiles may be influenced by both the effort of hunters and the "catchability" of their prey (FA et al., submitted). Investigating human hunting behaviour may shed light on patterns of prey selectivity and how variations in habitat, prey availability and hunting methods influence the impact of hunting on prey populations. Studying the social organisation and behaviour of prey may enable predictions to be made concerning the response of species to different levels of harvesting (FITZGIBBON, 1998).

Most studies report that hunters prefer large or medium–sized prey (FITZGIBBON, 1998; FA & PERES, 2001). Hunting in this study occurred throughout the year and no clear seasonal patterns in harvest rates were detected (although more long–term data are required). Furthermore, number of animals killed and biomass extracted declined dramatically in the first three months and then gradually until the end of the study. There was a clear decline in average body mass of prey since the start of the study. Even though overall hunter effort dropped during the study, biomass and number of animals per hunter also declined. This is indicative of depletion of the sites since extraction rates per hunter would have increased with a decline in hunter pressure. Hunters would select large animals in order to maximize the quantity of meat extracted from an area, per unit of hunter effort, in accordance with models of optimal foraging. The pattern emerging from this study indicates that larger prey is indeed taken first, but this is not hunter–led since most animals are caught by snares (although there is a body mass effect on vulnerability to snaring). Large prey are generally more profitable to hunters, as long as handling costs do not increase in proportion to body mass. With increasing hunting pressure, more of the smaller sized species are depleted (NEWING, 2001). The loss of these species, important in seed dispersal, will have serious long–term consequences on the forest ecosystem (Wright et al., 2000; Moore, 2001).

Inter–hunter variation in number of animals hunted was considerable in the Monte Mitra area. Essentially, extraction of game was directly proportional to the amount of time dedicated to hunting. All hunters in the study hunted game for profit and were dedicated full–time to this activity. An average of around 70% of all game hunted was sold by the hunter. Because of the detrimental effects of cable snares on wildlife, most Central African nations have banned this method. In the case of Equatorial Guinea this is not the case, but if cable snares had not been used in Monte Mitra during this study, only less than 9% of the documented prey would have been taken. The importance of snare hunting in increasing profitability for the hunter is then clear.

Wildlife populations in Monte Mitra declined under the heavy hunting pressure during the study period. If they stabilised at new and lower levels, then current hunting may be sustainable, although this is unlikely given the emphasis on selling the meat to the Bata market. Alternatively, if hunting pressure of a site is not too intense, adjacent large tracts of undisturbed forest can buffer and replenish hunted areas, restocking game populations and therefore contributing to the sustainability of hunting in an area (Fa & Peres, 2001). However, heavy hunting pressure, deforestation and habitat fragmentation of many areas disrupt the source-sink dynamics (Novaro et al., 2000), leading to potential over–exploitation of populations. Our estimates of sustainability of a number of game species indicate that currently most species are overharvested.

Conservation of the Monte Mitra region is impossible unless the hunting for profit issue in Sendje and adjoining villages is resolved. Conservationists will need to work with local residents, who have few alternative methods for finding food and earning an income, to find a solution to game exploitation. Bans on cable snares may be totally unenforceable by the reduced number of park guards operating in the Monte Alén national park, and equally such measures will generate considerable antagonism. Firearms may be permissible but are not a good alternative because of the costs involved and because of the much lower returns. The challenge is to reduce current levels of hunting and integrate human needs and expectations within conservation objectives for the region (Noss, 1997; Eves & Ruggiero, 2001).

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