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Endangering the endangered: Are protected areas save havens for threatened species in Cameroon? Case of Banyang-Mbo Wildlife Sanctuary, South Western Cameroon

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A hunting survey was conducted in the Banyang-Mbo Wildlife Sanctuary and support zones to estimate bushmeat off-take as a means to understand the current conservation status of protected species in that important area of biodiversity in Cameroon. A total of 756 protected animal carcasses with a total biomass of 6,815 kg, in six taxonomic groups constituted 24% of the total off-take of animals killed or captured by two adjacent ethnic groups of Banyang-Mbo Wildlife Sanctuary. Hunters caught more than 30 individuals of each of the red eared monkey (*Cercopithecus erythrotis camerunensis*), squirrel sp. (*Protexerus stangeri, Funisciurus pyrropus*), brush-tailed porcupine *(Atherurus africanus),* Water chevrotain (*Hyemoschus aquaticus*) African dwarf crocodile (*Osteolaemus tetraspis*), red river hog (*Potamoschus porcus*) and bay duiker (*Cephalophus dorsalis)* which together accounted for 75% of all protected species captures and 89% of the biomass. There was significant variation in the number of protected species exploited with the most captured taxonomic group, the rodents, comprising 37% of the kills or captures and 13% of the total biomass. The ungulates followed with 28% of the captures and 68% of total biomass. Proportionately, the much larger-bodied ungulates contributed more to biomass off-take than the comparatively smaller primates, reptiles and rodents. Carnivores and birds were least harvested taxonomic groups of protected species accounting for 9 and 4% of total protected species off-take respectively. Final results indicate that threatened animals do not have enough protection within BMWS and the conservation value of the sanctuary is highly compromised.

Key words: Threatened species, off-take, conservation status, Banyang-Mbo Wildlife Sanctuary, Cameroon.

INTRODUCTION

A protected area is defined as a geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values (IUCN PACO, 2011a; Noss, 1998). Protected areas are essential for biodiversity conservation and are the cornerstones of virtually all national and international conservation strategies. They are areas set aside to maintain functioning natural ecosystems, to act as refuges for species and to maintain ecological processes that cannot survive in most intensely managed landscapes and seascapes (Bennett and Robinson,

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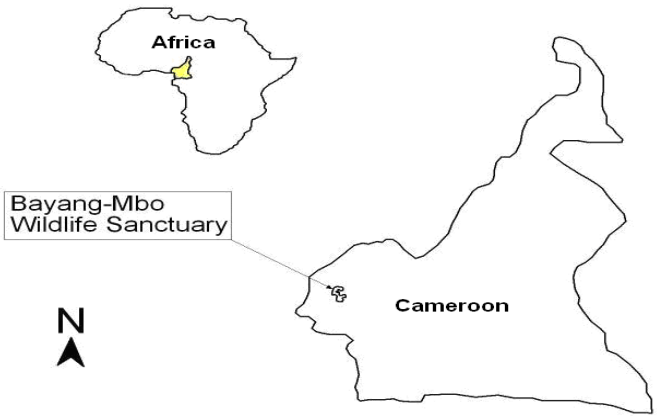

Figure 1. Maps of Africa and Cameroon showing location of BMWS adapted from Wilcox and Zouango (2000 unpublished).

2000; Wilkie et al., 1998b; Nasi et al., 2008; Slade et al., 1998). Protected areas act as benchmarks against which we understand human interactions with the natural world (Lahm, 1993; Cardillo et al., 2008; Wilkie et al., 1998a, b; Noss, 1998). Today, they are often the only hope we have of stopping many threatened or endangered species from becoming extinct (Robinson and Redford, 1991; Slade et al., 1998; Swanson and Barbier, 1992; Robinson and Bennett, 2000a). They are understood to be those areas in which human occupation or at least the exploitation of resources is limited (Cannon, 2003; Wilkie et al., 2005; Robinson and Bennett, 2000a, b).

Though protected areas are designated with the objective of conserving biodiversity and providing an indicator for that conservation's progress, the extent to which they defend resources and ecosystem dynamics from degradation are slightly more complex (Robinson and Redford, 1991, Bowen-Jones and Pendry, 1999; Fa and Yuste, 2001; Milner-Gulland and Akçakaya, 2001; Van Vliet and Nasi, 2008a*;* Ajonina et al., 2012 unpublished). Enforcing protected area boundaries is a costly and labour-intensive endeavour, particularly if the allocation of a new protected region places new restrictions on the use of resources by the native people which may lead to their subsequent displacement. This has troubled relationships between conservationists and rural communities in many protected regions the Banyang-Mbo Wildlife Sanctuary not being an exception in this regard and is often why many Wildlife Reserves and National Parks face the human threat of poaching for the illegal bushmeat or trophy trades, which are resorted to as an alternative form of substinence (Hill et al., 2003; Ngandjui and Blanc, 2000; de Brooks et al., 2009; Wilkie et al., 2005; Foguekem et al., 2010; IUCN PACO, 2011a; IUCN, 2012). At the Banyang-Mbo Wildlife Sanctuary, large mammals have been surveyed and those of conservation interest include the leopard (*Panthera pardus*), African elephant (*Loxodonta africana*), giant pangolin (*Smutsia gigantean*), chimpanzee (*Pan troglodytes*), drill (*Mandrillus leucophaeus*), water chevrotain (*Hyemoschus aquaticus*), forest buffalo (*Syncerus caffer nanus*), the dwarf, long-snouted and Nile crocodiles (*Osteolaemus tetraspis*, *Crocodylus cataphractus*, *Crocodylus niloticus*), and all tortoises (Chelonia) (Hart and Upoki, 1997; IUCN PACO, 2011a; MINFOF, 2012; Wilcox and Diangha, 2007; Ajonina, 2009). Hunting is one of the major causes of the decline of species of conservation concern in Afrotropical rainforest areas. The BMWS and its support zone have been listed as a center of primate endemism and one fifth of all African primate species live in this area. These species however, may be locally threatened by over hunting or continuous encroachment (WCS, 2012). According to law N°94/01 of 20th January 1994 establishing the regime for forests, wildlife and fisheries in Cameroon, class "A" are species with the highest degree of protection which includes endangered or extinct species as the black rhino, chimpanzee and the drill. The ministerial Order N°649/ MINFOF of 18/12/2006 gives the repartition of wildlife species into groups and the extent of slaughter corresponding to each type of hunting license (MINFOF, 2012). Whereas class "B" are partially protected and may also not be killed without hunting license.

There is increasing and justifiable pressure to take proper account of human needs when setting up protected areas and these sometimes have to be "traded off" against conservation needs. Whereas in the past governments often made decisions about protected areas and informed local people afterwards, today the emphasis is shifting towards greater discussions with stakeholders and joint decisions about how such lands should be set aside and managed. Such negotiations are never easy but usually produce stronger and longer-lasting results for both conservation and people. The populations of many endangered species within protected areas in Cameroon are fast declining due to anthropogenic activities and accurate, current information on the status of these populations is essential for the design of effective conservation strategies within a human-dominated landscape.

Site description

The BMWS and the surrounding area covers an area of about 662 km², between 05°08' and 05°34' N and 09°30' and 09°47 E (Figure 1). It spans an altitudinal range of 120-1760 m. The mean annual rainfall is 4082.7±486 mm with heavy rains in July-September. The mean annual maximum temperature is 30.2°C and the minimum 23.7°C (Nchanji and Plumptre, 2001). The northern zone of the sanctuary is characterized by flat areas and gentle hills. The southern zone is hillier, with steep slopes and narrow ridges. A network of streams, some seasonal, and rivers that originate from the south, drain the forest (Wilcox and Zouango, 2000; Wilcox and Diangha, 2007; Ajonina, 2009).

The BMWS is located within the northwestern part of the Lower Guinea forest; this forest formation is one of the world's greatest lowland rainforest in terms of both

extent and biodiversity (Myers et al., 2000). According to reports by Philips and Miller (2002), the sanctuary possesses the highest plant diversity anywhere in Central Africa. A total of 543 species (trees, herbs, shrubs), representing 75 taxonomic families, have been recorded so far at this site. Of this total, 405 species of 53 taxonomic families are tree species with a diameter greater than 10 cm. This total includes 13 species, which have IUCN Red Data categories ascribed to them. Three plant species new to science and only known from the Sanctuary have recently been described (*Rothmania ebamutensis, Aulacocalyx mapiana* and *Tricalysia lejolyana* (Rubiaceae) (Sonke et al., 2002; Sonké, 2000).

The BMWS is also classified as an Important Bird Area (IBA) (Fotso et al., 2001). The avifauna is extremely rich with 325 species recorded and includes Mount Kupe Bush Shrike (*Telophorus kupeensis*), a rare endemic species at risk of extinction (Ajonina et al., 2012 unpublished; Tchamba and Elkan, 1995). This bird is only known from three contiguous sites: Banyang-Mbo, Mount Kupe, and the Bakossi mountains, of which the BMWS is the only area currently with a clearly defined protection status (IUCN PACO 2011a; IUCN 2012). Two of the six species that make up the "Cameroon Gabon Lowlands Endemic Bird Area (EBA)" have been recorded at this site (Rachel's Malimbe *Malimbus racheliae* and the grey-necked Picathartes *Picathartes oreas*) (Ajonina et al., 2012 unpublished). In addition, 11 of the 27 species that make up the Cameroon montane EBA have been recorded at this site and 20 of the 44 species characteristic of the Afrotropical Highlands biome that occur in Cameroon have been recorded in the Sanctuary.

The BMWS gazetted in 1996 was designed specifically to protect its populations of large mammals, particularly of forest elephant (*L. cyclotis*) where numbers recorded are higher than anywhere else in Western Cameroon (Blanc et al., 2003). The sanctuary is home to at least 38 species of large and medium-sized mammals (average adult body mass ≥1 kg), including the chimpanzee (*Pan troglodytes vellerosus*) and the drill (*Mandrillus leucophaeus*), both of which are endemic to SE Nigeria and SW Cameroon and are endangered species according to the IUCN criteria. The forest buffalo (*S. caffer nanus*), yellow-backed duiker (*Cephalophus sylvicultor*) and the water chevrotain (*Hyemoschus aquaticus*), all recorded as threatened species, are also present within and around the sanctuary (Table 1). However, it is feared that the leopard (*Panthera pardus*), and the giant pangolin (*Manis gigantean*), formerly known from the area may have already been locally extirpated through indiscriminate hunting (Wilcox and Zouango, 2000; Forbosoh et al., 2005; Wilcox and Diangha, 2007; Redford 1992, Ajonina, 2009).

Historically, there have been periods of significant human population within the BMWS area. These date back to the late iron-age period of the 9th to 18th Centuries AD, and evidence suggests that these settlements strongly influenced the current landscape (Oslisy et al., 2000). Today, there are 54 villages situated within 10 km from the BMWS boundaries, with a total population estimate of about 50,000 people partitioned into four major ethnic groups; the Banyangi, Bakossi, Bassosi and Mbo (MINFOF, 2012). Like elsewhere in Cameroon, communities adjacent to the BMWS, rely on forest resources for their livelihoods. This dependence has led to the development of cultural values with strong affinities to the forest which, over many generations, have regulated access to essential natural resources. For example, the Banyangi ethnic group's *ekpé* traditional society which is based around a "leopard dance" is held in high esteem as the institution plays a cardinal role in conflict resolution (Noss, 1998; Bruner et al., 2001; Robinson and Bennett, 2004; Forbosoh et al., 2005 unpublished). The traditional costume of the dance group includes the skin of a leopard, but the catastrophic decline in the local leopard population obliged the institution to switch to genet pelt. Similarly, elephant parts, notably the tusk and tail, constitute an integral part of the traditional costume of many institutions in the Mbo area and beyond. Moreover, belief in "totem" animals, especially among the Mbo and Banyangi ethnic groups is rife. But faced with the challenges of globalization and the associated collapse of traditional social structures, respect for the forest and other natural resources has deteriorated, and unsustainable harvesting of forest products is spreading fast as people are struggling to meet their growing livelihood needs. Where there are no alternative income generating activities, people turn to the sale of bushmeat, as it is easy to preserve through drying and smoking and can easily be carried long distances to suitable markets. Indeed the hunting of wildlife remains a common livelihood activity to all ethnic groups and the decree conferring the legal status of the sanctuary recognizes and maintains the usufruct rights of the adjacent population, particularly the right to hunt wildlife species that are not covered by National and International legislation. Typically, bushmeat is sold in local weekly markets, principally to non-resident intermediaries from major consumption centers in the adjacent Littoral and West Provinces (WCS, 2011, 2012; Fitzgibbon et al., 2000). Occasionally, the urban intermediaries go to the villages few days before the market day and pile-up bushmeat to be transported on the market day, taking advantage of the availability of vehicle transport. At the urban centers, they sell the meat directly to consumers or restaurant operators. Ordinarily, the hunter deals directly with local residents before the market day.

MATERIALS AND METHODS

Data collection

The BMWS and its support zone have been listed as a center of primate endemism and one fifth of all African primate species live in this area. At the Banyang-Mbo Wildlife Sanctuary, large mammals have been surveyed and those of conservation interest include the leopard (*P. pardus*), African elephant (*L. africana*), giant pangolin

Table 1. List of species known to live in the Banyang-Mbo Wildlife Sanctuary.

Common name	Scientific name	Legal status	Keyang name	Mbo name	Pidgin name
Primates	**Primates**		**Nstik**	**Nkem**	**Monkey**
Greater white nose monkey	*Cercopithecus nictitan*		Ekai	seeh	White nose
White -collared mangabey	*Cercocebus torquatus*		Ekasso	Nkakum	Gendarme
Crown red guenon	*Cercopithecus pogonia*			Souboum	
Mona monkey	*Cercopithecus mona*		Ngai	Pouing	
Red-eared monkey	*Cercopithecus erythrotis*	Protected	Nchwei	Sunkw uon	
Drill	*Papio leucophaeus*	Protected	Nsongnya	Sunkwuon	Sumbu
Chimpanzee	*Pan troglodytes*	Protected	Ekirikak	Mebange	Chimpanzee
Golden potto	*Arctocebus catabarensis*	Protected	Ebow	Medubambe	Bush baby
Allen's galago	*Galago alleni*		Ebow	Oboah	Bush baby
Preuss'monkey	*Cercopithecus preussi*	Protected			
Artiodactyla	**Artiodactyla**				**Deer**
Blue duiker	*Cephalophus monticola*		Reteh	Mehsen	
Bay duiker	*Cephalophus dorsalis*	Protected	Ngukenow	Dembin	Frotambo
Yellow-black duiker	*Cephalophus sylvicultor*	Protected	Nkongho	Nzii	Sleeping deer
Ogilby's duiker	*Cephalophus ogilby*		Nso	Mbin	Bush deer
Red river hog (Bush pig)	*Potamoschus porcus*	Protected	Njiwi	Ngwuo	Bush swine
Water chevrotain	*Hyemoschus aquaticus*	Protected	Seku	Sukum	Water beef
Bush buck	*Tragelaphus scriptus*	Protected	Mfon	Nya'a	Antelope
Forest buffalo	*Syncerus caffer nanus*	Protected			
Pholidota	**Pholidota**				**Catah beef**
Tree pangolin	*Manis tricuspis*		Njie	Saih	Catah beef
Long -tailed pangolin	*Manis tetradactyla*		Njie	Saih	Catah beef
Giant pangolin	*Manis gigantean*	Protected	Njie Nsok	Saih nzo	
Rodentia	**Rodentia**				
Brush- tailed porcupine	*Atherurus africana*	Protected	Nnyok	Gwuon	Tchuku- Tchuku beef
Cane rat	*Thryonomis swinderianus*		Njuinok	Nzibi	Cutting grass
Giant rat	*Cricetomys gambianus*		Ngumbok	Kwenyam	Grumbeef
Brown rat	*Crecetomys spp.*			Pou'oh	Brown rat
African giant squirrel	*Protexerus stangeri*	Protected	Mbarichkat	Mbouyam	Squirrel
Red footed squirrel	*Funisciurus pyrropus*			Mekwa'a	Squirrel
Fying squirrel	*Anomalurus derbianus*			ngwing	Fying squirrel
Carnivore	**Carnivore**				
African palm Civet	*Nandinia binotata*	Protected	Mbay	Mbpeh	Bush pussi
African civet	*Viverra civetta*	Protected	Resem	Eswuah	Bush dog
Forest genet	*Genetta spp.*	Protected		Meshing	Bush pussi
Dark mongoose	*Crossarchus obscurus*		Sebioh	Mezuing	20 in line
Marsh mongoose	*Atilax paludinosus*		Mbak	Ebubuh	
Black-legged mongoose	*Bdeogale nigripes*		Mbak	mbunyam	
Otter sp.				Ebohlong	
Leopard	*Panthera pardus*	Protected	Nkwoh	Ngwo'o	
Hyracoidea	**Hyracoidae**				
Tree hyrax				kehnyam	
Reptiles					
Gabon viper	*Bitis gabonica*			Ejung	Viper

Table 1. Contd.

Cobra	*Naja spp.*		Meri	Ehubi	Black snake
Green mamba	*Dendroaspis jamensoni*		Mbam	Nkonwe'eh	Green snake
African rock python	*Python sebae*	Protected	Ngem	Ngem	Python
Nile monitor lizard	*Varanus niloticus*		Remak	Nguanweh	Ngombe
Nile crocodile	*Crocodylus spp.*	Protected	Nyong	Ngan	Crocodile
African dwarf crocodile	*Osteolaemus tetraspis*	Protected	Ebu	Nkwbrin	Alligator
Tortoise sp.		protected	Rewen	Kubuh	Trokey
Birds					
Palm -nut Vulture	*Gypohierax anglolensis*	Protected		Jung	Eagle
Guinea fowl	*Gutera plumifera*		Ehang	Kehngweh	Bush fowl
Black casqued hornbill	*Ceratogymna atrata*	Protected	Ngond	Nkwon	Hornbill
Parrots	*Parrots erythacus*	Protected	Euneng	Quing	parrot
Red king fisher				Ugne'eh	king fisher
Francolin	Francolin				
Green turaco	*Turaco persa*	Protected			
Chiroptera	**Chiroptera**				
Bats sp.	Bats		Waku	Njame	Blind bat
Proboscidea	**Proboscidae**				
Elephant	*Loxodonta africana cyclotis*	Protected	Nsok	Nzo	Elephant
Hyracoidea	**Hyracoidae**				
Tree hyrax	*Dendrohyrax dorsalis*	Protected		Kehnyam	Stone beef
Rock hyrax	*Procavia capensis*				

Adapted from WCS (1999/ 2000) and Ajonina et al. (2012).

(*S. gigantean*), chimpanzee (*P. troglodytes*), drill (*M. leucophaeus*), water chevrotain (*H. aquaticus*), forest buffalo (*S. caffer nanus*), the dwarf, long-snouted, and Nile crocodiles (*O. tetraspis*, *C. cataphractus*, *C. niloticus*), and all tortoises (Chelonia).

From November 2006 to June 2007, we recorded off-take and hunting practices in 10 of the 14 villages originally earmarked for the survey (Figure 2) located < 10 km from the BMWS. We also used a semi-structured questionnaire to interview 84 hunters about their hunting techniques, the species hunted, and the spatial and temporal distribution of their hunting activities (Appendix 1). Apprehension about probable policy implications of the research outcomes restricted the survey to the most receptive villages. Generally, the study was conducted in five Banyangi (Bara, Ebeagwa, Tinto 1 and 2, Tembang and Akribah) and five Mbo (Elumba, Etodi, Nzoa, Tangang and Ndom) villages, respectively.

Within each village we identified hunters through village council and negotiated a collective agreement on keeping all registered data anonymous and effectively motivating them to take all animal carcasses to specified locations for examination. Prior to the commencement of the survey, research assistants received intensive training on species identification, weighing carcasses and record keeping using the Kingdon (1997) nomenclature. Off-take was recorded for all 84 hunters in the study villages every other day. We documented: the hunting location (name of the camp or river); the time spent hunting; the hunting technique used; and the species hunted, including the sex, estimated age and type of forest in which the individual was killed or captured and information on the disposition of the carcass. The investigator regularly inspected the data collected in order to ensure consistency and continuity. This information was used to generate data on: the proportion of gun and snare hunters, the proportion of protected species in harvested, trends of monthly harvest, proportion of game used for self-consumption or sold for income, the number of active hunters and the biomass extracted each month, and the preferred habitat types for hunting activities. A participatory mapping exercise was conducted in two of the most notorious hunting villages to map the hunting territory, including hunting trails and camps. Several field visits allowed us to reference the trails and camps using a Global Positioning System. The map was then used to position all hunting trips from the village. This allowed us to assess the spatial heterogeneity of hunting pressure in these villages by comparing hunting pressure at different distances from the village and calculating an index of hunting pressure for each habitat as the ratio of kills per habitat to the availability of each habitat:

$$I_n = (n_h/N)p_h$$

Where n_h is the number of kills in habitat h; N is the total number of kills; and p_h is the proportion of each habitat within the hunted area, calculated using MapInfo 6.5.

We used two different approaches to assess the impact of hunting on mammal species. First, assuming that as the impact of hunting increases, mammal species are killed farther away from the village, we measured kills in relation to the distance from the village. The index of kills was calculated as the ratio of kills per protected species at various distance classes to the proportion of hunting trips

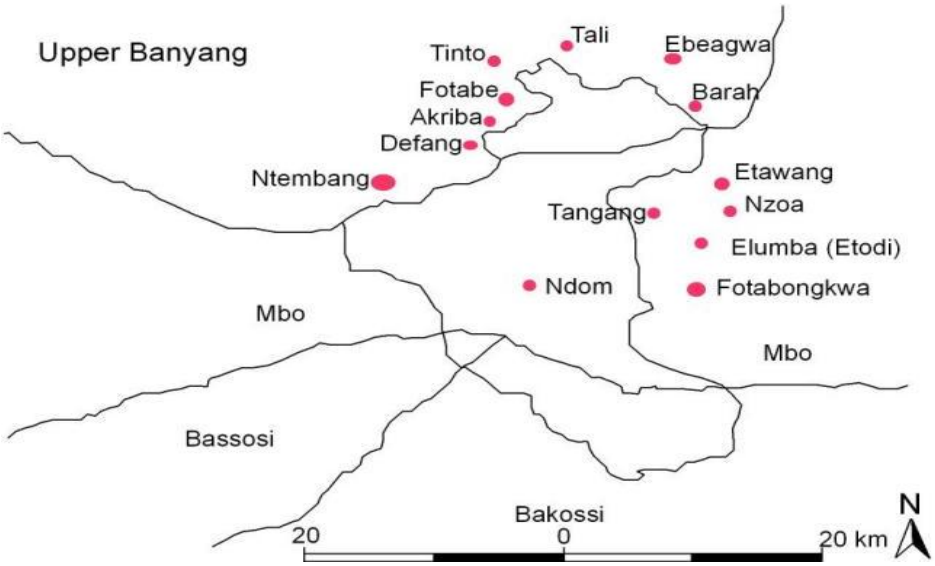

Figure 2. Study area within BMWS and adjacent villages.

that occurred at each distance class:

$I_d = (n_d/N)/(t_d)$

Data analysis

Qualitative interview data were analyzed using a textual approach focusing on words and meanings (Dey, 1993). Responses were thematically grouped and within each group the data were categorized. Qualitative categories were eventually quantified and input as nominal or ordinal data into SPSS version 17, along with quantitative demographic variables for each respondent. Basic frequencies were calculated for all categorical data and appropriate charts produced. Further analysis using cross tabulations and clustered bar graphs was conducted in an attempt to identify confounding variables. Continuous data were analyzed in SPSS or Microsoft Excel and descriptive statistics calculated. The nonparametric Kruskal-Wallis test was used to determine the significance of differences between villages and the Mann-Whitney U-test was used to investigate differences between hunters and trappers. Differences between nominal variables were tested using Chi square and the likelihood ratio (Field, 2005). Significance was set at $p < 0.05$. Associations between ranked and other scale variables were correlated using Spearman's correlation coefficient. One-sampled t-tests and ANOVA were used to analyze variance of means between datasets.

RESULTS

Off-take of protected species

During the eight month period of data collection in 2006/2007, a total of 756 protected animal carcasses with a total biomass of 6,815 kg, in six taxonomic groups constituted 24% of the total off-take of animals killed or captured by two adjacent ethnic groups of Banyang-Mbo Wildlife Sanctuary (Appendix 1). Hunters caught more than 30 individuals of each of the red eared monkey (*Cercopithecus erythrotis camerunensis*), squirrel sp. (*Protexerus stangeri, Funisciurus pyrropus*), brush-tailed porcupine *(Atherurus africanus*), Water chevrotain (*Hyemoschus aquaticus*) African dwarf crocodile (*Osteolaemus tetraspis*), red river hog (*Potamoschus porcus*), and bay duiker (*Cephalophus dorsalis)* which together accounted for 75% of all captures and 89% of the biomass. There was significant variation in the number of protected species exploited with the most captured taxonomic group, the rodents, comprising 37% of the kills or captures and 13% of the total biomass. The artiodactyls followed with 28% of the captures and 68% of the biomass. Proportionately, the much larger-bodied artiodactyls contributed more to biomass off-take than the comparatively smaller primates, reptiles and rodents. The carnivores and birds were the least harvested taxonomic groups of protected species accounting for 9 and 4% of the total protected species off-take, respectively (Figure 2).

The red-eared monkey (*Cercopithecus erythrotis camerunensis*) accounted for 61% of all illegal primates off-take, the bay duiker (Cephalophus dorsalis) constituted 40% of artiodactyls harvest, the African dwarf crocodile (*Osteolaemus tetraspis*) 50% of reptiles, the African civet (*Civettictis civetta*) 41% of carnivores and the African grey parrots (*Psittacus erithacus*) 64% of illegally killed or captured birds.

Off-take distribution by biomass

Our results indicated that though ungulates constituted 28% of total off-take of protected species recorded killed, they constituted the highest percentage of off-take by biomass contributing 68% of the total biomass of threatened

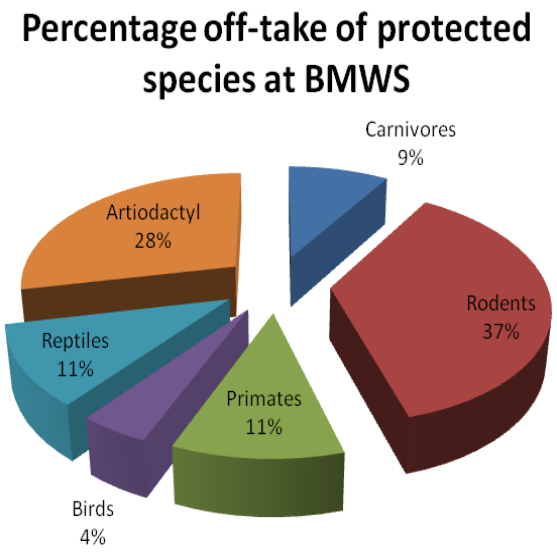

Figure 3. Percentage off-take of protected species at BMWS.

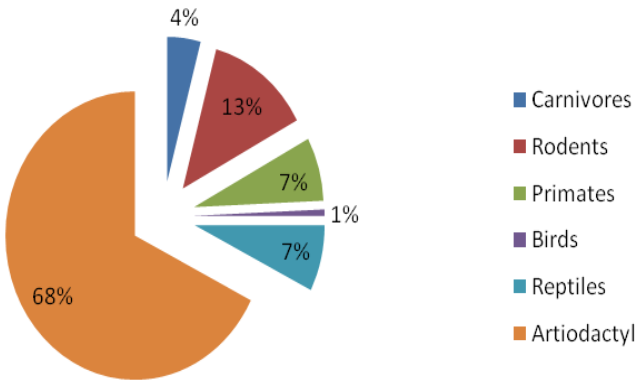

Figure 4. Biomass distribution of hunted protected species at BMWS.

animals killed. This was followed by rodents: constituting 13% of the biomass though had the highest number of off-take of protected species. The least contribution in terms of biomass came from the birds which constituted only 1% of total biomass off-take of protected species (Figure 3). Most of weight for ungulates came from the bay duiker.

Seasonality of off-take of protected species

Hunting occurs as an all-year-round activity although hunting pressures are more intense in the rainy season than the dry season (Figure 5). Peak harvest of most protected species during this study occurred in February and April. Generally, off-take was low in the month of January for all the species. Most hunters revealed that hunting at this time of the year was not very successful because the leaves are dry and animals can see far and are always on alert when they hear any noise. It was gathered from hunters that peak harvest occurs in the months of July to October when rains are heavy. Generally, rodents constituted the most killed or capture protected species in all months of the study followed by artiodactyls whereas birds were the least killed or captured species.

Hunting methods

Generally, the gun and wire snare were weapons of choice for both the Banyangi and Mbo hunters during this study. Firearms (mostly locally fabricated shotguns) accounted for 61% of recorded killed primates and 53% of artiodactyls whereas wire snare accounted for 51% of carnivores kills or captures and 38% of reptile kills or captures. Most of the protected birds (39%) were captured or killed using other methods. Hunters used the two methods against all the major animal groups recorded. Indeed, we recorded no significant difference in the composition of captures by both methods. Adult animals accounted for at least 72% of cable snare captures of the three most hunted species (Figure 6).

Off-take by ethnic group

The Mbo ethnic group killed or captured primates 54%, reptiles 56%, rodents 60% and ungulates 55% in the illegal kills or capture of protected animals whereas the Banyangi hunters accounted for carnivores 59% and birds 55% in the total off-take of protected birds and carnivores (Figure 7). Generally, hunting is more intense in the Mbo section of the sanctuary where most people take hunting as a primary occupation.

Spatial distribution of hunting

The total hunting territory of BMWS was estimated at 15.5 km². However, hunting pressure was only exerted along hunting trails. Therefore, small and medium-sized territorial protected mammals were directly affected only if their territory overlapped one or more hunting trails. At < 10 km from the village, most families used own main and secondary trails however, at > 10 km from the village, trails and camps were used commonly by all hunters. A hunter changed hunting trails according to his or her perception of the decrease in the catch per unit effort and the scarcity of mammal signs. Trails that were located along rivers were only used during the dry season because of difficulty of access. Hunting pressure was not constant throughout the year. In July, August, September and October, > 20% of hunting activities was practiced at > 10 km from the village. During the rest of the year, hunting was mainly practiced close to the village. In February, March and April, at least 50% of hunting activities occurred at < 2 km from the village.

Also, hunting pressure differed among the forest types.

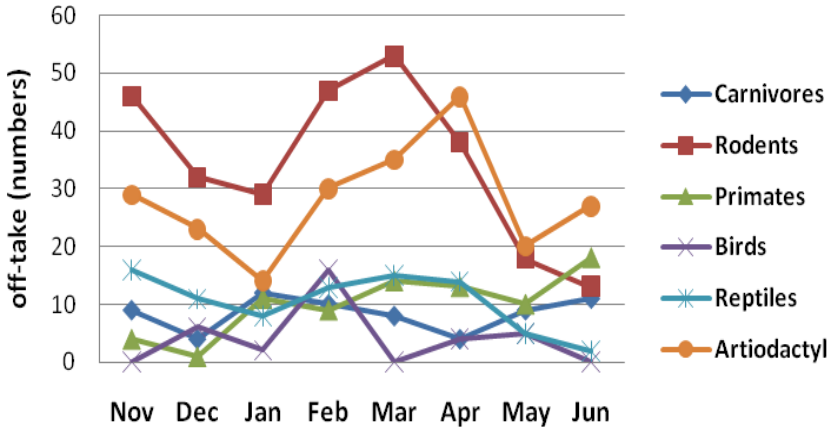

Figure 5. Monthly off-take of species by taxonomic groups in the BMWS and adjacent areas.

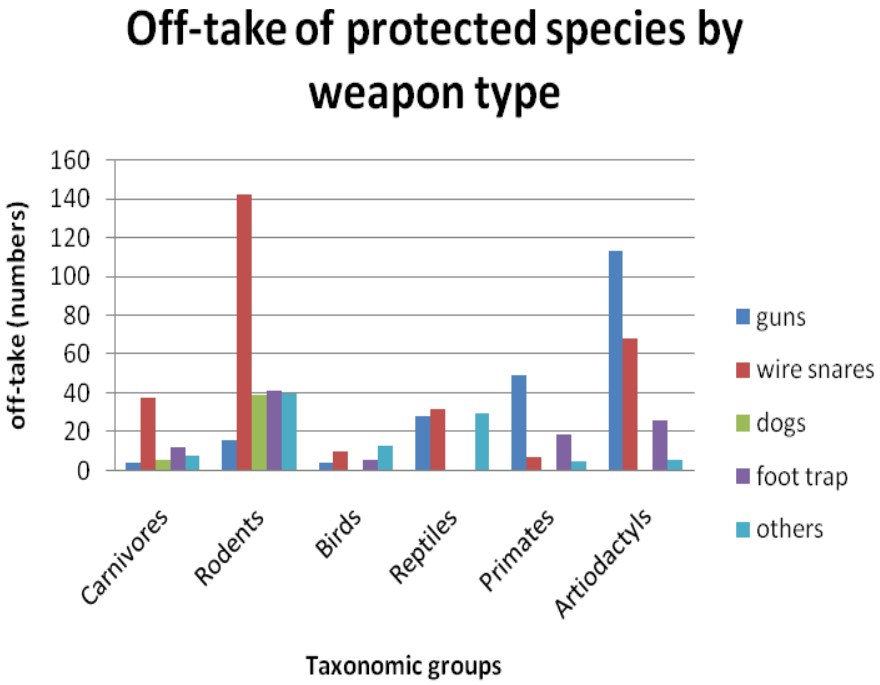

Figure 6. Susceptiblity of taxonomic groups to weapon types.

Off-take records revealed that the primates particularly the red eared guenon (*Cercopithecus erythrotis*) dominated the primates' off-take in all the zones of hunting with most kills at distance more than 10 km. Protected birds, rodents, carnivores and reptiles kills or captures decreased steadily with distance from the village and the number decreased with distance from the village. Kills of ungulates increased with distance from the village. The index of kills (I_d) shows that rodents, carnivores, birds and reptiles were more likely killed at < 2 km and never at > 10 km from the villages (Figure 8). Primates were killed at all distances from the village and ungulates were more likely killed at 5 to 10 km and > 10km from the village.

DISCUSSION

Human responses to a species' perceived to be rare can have wide-ranging impacts on its population dynamics and the benefits arising from increased protection and habitat preservation are well documented. An eight month off-take study was conducted at the BMWS with the aim to understand the current status of protected species in that important area of biodiversity in Cameroon. Off-take reported amounted to a minimum of 1.14 protected animals per km^2 per year, which is much lower than the annual off-take from Monte Mitra, Equatoria Guinea (Fa and Yuste, 2001), Arabuko-Sokoke Forest, Kenya

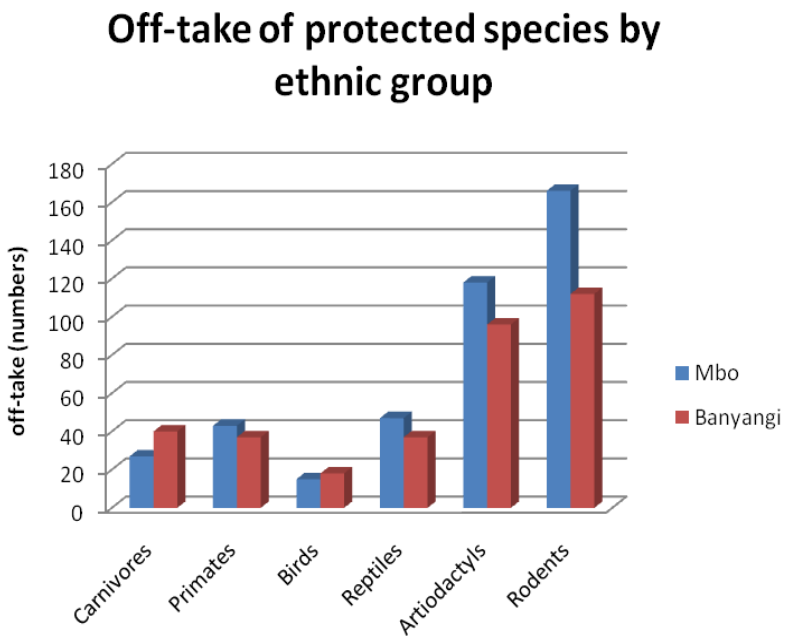

Figure 7. Distribution of animal off-take by ethnic group in BMWS area.

(Fitzgibbon et al., 2000) and the Central African Republic (Noss, 1998). The corresponding minimum biomass is 10 kg of bushmeat per km^2 per year, is consistent with results from the Monte Mitra, Equatoria Guinea, that show an extraction rate of 10 kg of bushmeat per km^2 per year (Fa and Yuste, 2001). With mean annual rainfall in excess of 4000 mm, the BMWS falls under the "wet forest" category of Holdridge (1967) cited in Forboseh et al., (2005) for which Robinson and Bennett (2000b) suggest a mammalian standing biomass of about 3,000 kg/km^2. Assuming that 10% of the standing biomass is available for human harvest as suggested by Robinson and Bennett (2004), it means that BMWS potentially could produce a maximum of 300 kg/km^2/year. The paucity of data on biological productivity precludes formal assessment of the ecological sustainability at the BMWS. Moreover, the extraction rate of 10 kg/km^2/year refers to off-take by 10 villages investigated, and therefore represents the minimum rate. If the nearly 50,000 people adjacent to the sanctuary were to depend exclusively on wildlife for meat it would require about 45000 kg of protected species per year following the US recommended daily amount of protein for a 70 kg man of 0.28 kg of meat per person per day (Robinson and Bennett, 2000b). Clearly, the annual requirement of the adjacent population alone far exceeds the theoretical maximum sustainable off-take of 198,600 kg per year from the 662 km^2 Sanctuary. Our comparison of previous (Forbosoh et al., 2005 unpublished) and current off-take of protected species indicates that the proportion of birds remained stable, whereas the proportions of ungulates, rodents and primates are significantly higher in this study than in 2002 (ungulates: $\chi^2 = 20.116$, $p < 0.0001$; rodents $\chi^2 = 5.624$, $p = 0.009$; primates: $\chi^2 = 6.28$. $p = 0.006$. Off-take of reptiles; $\chi^2 = 6.532$, $p = 0.01$) and carnivores; $\chi^2 = 14.6$, $p < 0.0001$) were significantly lower in this study than in the previous study.

There is growing consensus that even the most productive tropical forests cannot support much more than one person per km^2 where humans depend exclusively on wildlife for meat (Bennett and Robinson, 2000a). Evidently, off-take at the BMWS is highly unlikely to be socio-economically sustainable. These results point to the high degree of threat on the sanctuary wildlife especially protected species and the urgent need for more tangible management strategies required for its conservation. Already, the extraction pattern in and around the sanctuary is already indicative of declines in wildlife populations where the large to medium body-size animals are initially hunted to local extirpation or to such scarcity that small rodents account for most of the remnant animal off-take as is the case reported for the Amazon forest (Carrillo et al., 2000; Alvard et al., 1997; Maisels et al., 2001). Large and medium-sized ungulates, rodents and primates accounted for at least 75% of captures in the BMWS in 1999-2000 (Willcox and Nzouango, 2000). Between 1999 and 2003, blue duikers, the brush-tailed porcupine and red duikers consistently were the most captured species recorded in the area. In particular, duikers made up the majority of the catch in BMWS as in Liberia (Bruner et al., 2001; Buck et al., 2007), Equatorial Guinea (Fa and Yuste 2000; Brooks et al., 2009; Cardillo et al., 2008) and the Lobéké region of Cameroon (Fimbel et al., 2000). Consistent with models of optimal foraging, hunters prefer large-bodied animals that maximize the yield per unit effort. Indeed, large - bodied animals are

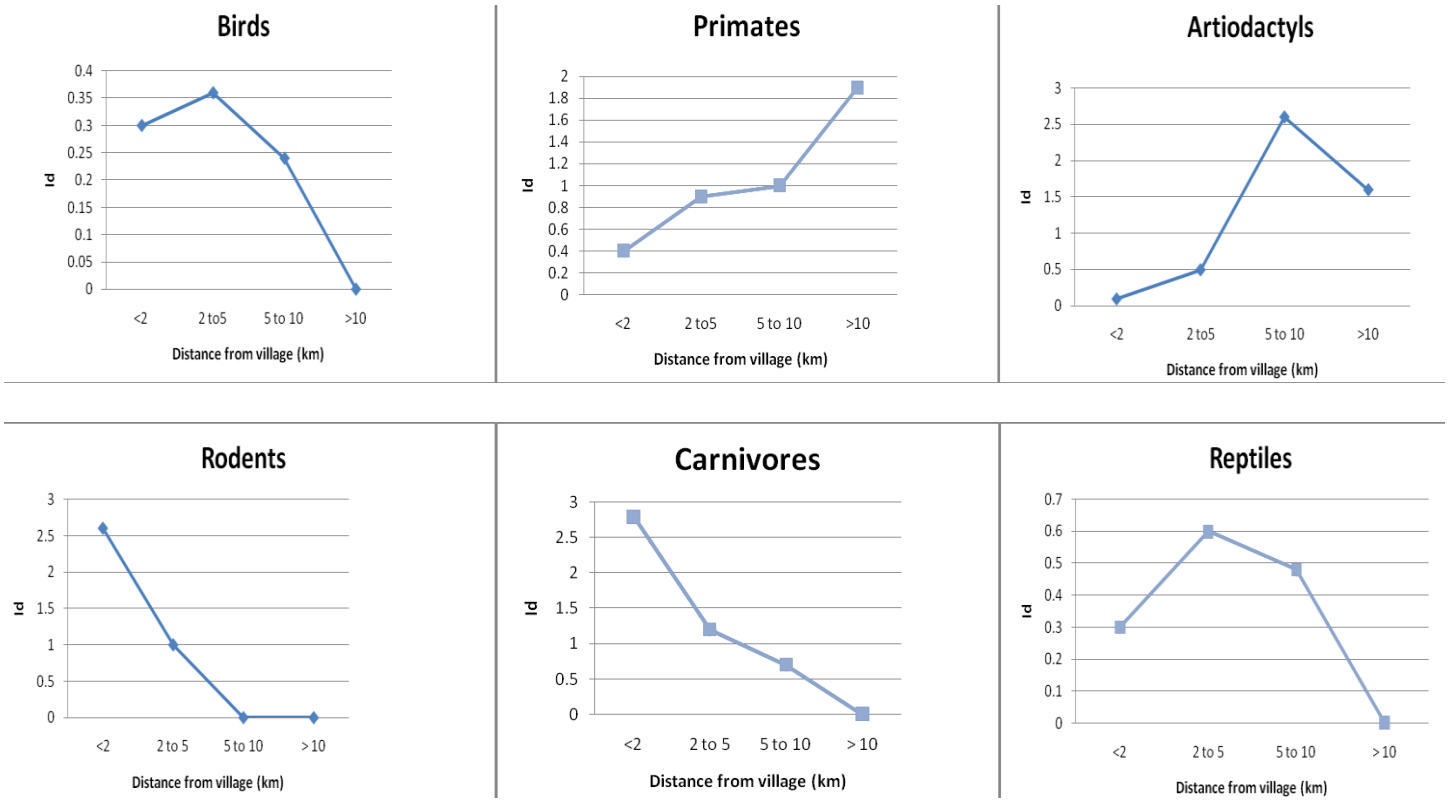

Figure 8. Index of kills (Id) at various classes of distance from a village for six species.

generally more profitable to hunters than smaller animals, though smaller sized species become vulnerable with increasing hunting pressure as found in this study and a similar study by Newing (2001). The preference for large-bodied mammals does not preclude hunting of small animals. Despite this, it is encouraging that the off-take of the most hunted species comprised a high proportion of adult animals, suggesting that the sanctuary still holds large populations of breeding adults. Maintaining a breeding population of adults is critically important for the long-term productivity of the sanctuary's wildlife.

The BMWS data amount to an off-take rate of at least 0.10 water chevrotains per km^2 per year and 0.001 chimpanzees per km^2 per year in this study is low; in a similar study, Forbosoh et al. (2005) reported off-take of 0.05 for water chevrotain and 0.02 for chimpanzee. The chimpanzee off-take rate is similar to that obtained in the Motaba region of north-east Congo (Kano and Asato, 1994), where it represents about 7% of the standing biomass and exceeds the annual population increase (Bowen-Jones and Pendry, 1999). There are no standing biomass figures of the BMWS mammals, but for all the species reported above, off-take is likely to be ecologically unsustainable. There is a general tendency of local hunters to under-report kills of protected species as evidenced by the absence of some threatened species like the elephants in the list of killed animals. Unlike in Monte Mitra, Equatorial Guinea (Fa and Yuste, 2001), only a small proportion of captures in the BMWS enters the market. It seems that hunting for subsistence is more prevalent in the area, and bushmeat is the primary source of dietary protein.

Firearms and cable snares are the most preferred hunting weapons, collectively accounting for 92% of the 2009 recorded animal kills. In Cameroon, firearm owners are required to carry a permit, and a hunting license that clearly specifies species and season, if hunting is the intended use. However, the hunters identified as part of our survey possess neither permits nor licenses and by implication should not hunt. Similarly, the wire snare is outlawed throughout much of Africa, including Cameroon, because it is indiscriminate and wasteful, especially when irregularly inspected (Noss, 1998; Bruner et al., 2001; Robinson and Bennett, 2004). Clearly, our hunters are benefiting from an ambiguous and weak law enforcement regime. Because snare hunting was more common, hunters go hunting every 2 days probably to maximize kills and minimize losses. Similar observations were made by Lahm (1993), however, with the prominence of guns, the rhythm of hunting is very variable, with periods during which hunters go to the forest every day and long periods during which they are occupied by other activities. The widespread adoption of hunting with guns could have a serious implications for the nature of off-take, giving increased opportunities to hunt larger protected animals, mainly red river hog (mean weight: 40 kg) and bay duiker

(mean weight: 35 kg), and arboreal animals such as apes and small diurnal monkeys. In contrast, off-take of rodents such as African brush-tailed porcupine would decrease, most likely with the decrease in snare hunting. Based on our combined approach applied to different sites and contexts, we envision a revision of the Cameroonian forest, wildlife and fisheries law which currently lacks technical and social legitimacy. For example, the current law forbids hunting at night with guns and wire snare hunting. Therefore, 100% of the animals killed in this study are hunted illegally using illegal methods and in banned periods. Giving the dependence of local population on bushmeat as a source of protein and the quasi-technical impossibility to replace wild meat with domestic meat, such law that equate to blanket interdiction have no chance of implementation. The law is also flawed from an ecological and conservation viewpoint because species like brush tail porcupine and some small diurnal monkeys are partially protected, although they are known to be vulnerable and thus need specific hunting regulations for their protection.

Analysis of the seasonal data indicates that hunting is a year-round activity that necessitates a year-round anti-poaching campaign and other legal interventions with emphasis from July to October that stand out as peak hunting months. The protected red-eared monkey, African brush-tail porcupine and water chevrotain are vulnerable throughout the year, while the Cameroon-Nigeria chimpanzee appears most vulnerable between April-June, with the onset of the rains. All class A and B species cannot be hunted or trapped. However, this law is rarely enforced and the absence of organized government involvement has led to the presence of many of such animals in off-take during our survey and those of Wilcox and Zouango (2000), Forbosoh et al. (2005) and Wilcox and Diangha (2007). Bushmeat, including protected species have been reportedly sold openly throughout the country by hunters and middle men, in market stalls, and in restaurants. A law that is not enforced undermines the authority of the government, and a law that can only be enforced at great cost and difficulty might need to be revised. There is much work to be done in order to tackle this issue in most protected areas in Cameroon.

Our results show that hunting in villages adjacent to BMWS is practiced both for local consumption (60%) and for income (40%) to cover basic family expenses. In 2000 and 2007 Wilcox and Zuoango and Wilcox and Diangha made similar observations whereby 70% of the villagers consumed their killed animals, sold 20% and gave out 10% as gifts. There is therefore no clear trend for a shift from subsistence to commercial hunting as has been demonstrated for other regions of Africa (de Merode et al., 2004).

Differences in hunting pressure in different habitat types are explained by hunters' preferences, as well as the spatial distribution of habitats and the ease of access. Despite hunters' preferences for mature forest, disturbed forest had higher hunting pressure because this habitat surrounds the villages, whereas mature forest is only present at > 10 km from villages. Rivers are particularly used during the dry season, when water level is down. Habitat preferences by hunters have also been described for net hunters in Central African Republic (Noss, 1998). Degraded forest such as secondary regrowth supplied 47% of the animals killed and the greatest diversity of species at short distances from the villages. Mature forest supplied species with the greatest commercial value, e.g., red eared monkey, red river hog and bay duikers and is a convenient source of meat for traditional ceremonies. Therefore, the conservation of such undisturbed or lightly disturbed habitat is essential to meet local economic and cultural needs.

Our results indicate that the forests of BMWS are still able to offer large-bodied species to hunters at reasonable distances from villages. Despite off-take being below the MSY, bay duiker and drill were mostly killed at > 5 km from the villages. Van Vliet and Nasi (2007) also found that bay duiker is very vulnerable to hunting. Hunting pressure on small diurnal monkeys and red river hog has increased significantly in the last 20 years, and these species are now mainly found at>10 km from the villages.

Government's policy in conserving wildlife in Cameroon is to ensure that the mortality rate does not exceed the natural rate of increase through setting up conservation areas to safeguard most wildlife species. Law enforcement, though unpopular among the local communities adjacent this protected wildlife area, is one of the most effective means of controlling unsustainable use of wildlife resources. Due to lack of significant conservation and protection measures, many wildlife species including the drill and chimpanzee, still remain strongly threatened by combined effects of several factors such as: poaching, traffic in young animals, deforestation, fragmentation of the habitat and poverty. These Illegal activities are aggravated by ineffective and inadequate protection of BMWS resulting from weak or inexistent management structures and law enforcement. Very little resources have been set aside by government for sanctuary security patrols and wildlife protection. Similar studies by Foguekem et al. (2010) and Omondi et al. (2008) indicate that lack of motivation, infrastructure and equipment further prevents efficiency. If the current trends continue, the long term viability of numerous wildlife species in this protected area may be seriously endangered. Without local effort, this sanctuary is sure to become so degraded that it will no longer require protection and will no longer be listed as a protected area.

A number of protected reptile species found in BMWS are consumed locally. These include the tortoises (*Kinixys erosa* and *Kinixys homeana*), the python (*Python sebae*), the forest cobra (*Naja melanoleuca*), and the green mamba (*Dendroaspis jamesoni*). Despite the efforts of WCS encouraging people not to hunt protected animals, villagers are still heavily exploiting some species.

This is especially the case for tortoises of the genus *Kinixy; K. erosa,* Serrated Hinge-back Tortoise and *K. homeana* Forest Hinge-back Tortoise that are listed as an Appendix I species under the Convention on International Trade in Endangered Species (CITES) and vulnerable (VU A2cd) in the IUCN Red Book, due to a suspected decline in population size caused by habitat loss and over exploitation a similar observation was made at the Waza National Park by (IUCN, 2012). The dependence of these species on primary forest, the late onset of sexual maturity and the low reproduction rate render them especially prone to overexploitation. Of the three species of African crocodiles, the dwarf crocodile, *Osteolaemus tetraspis*, was by far the most heavily hunted, a similar result was obtained at the Waza National Park in northern Cameroon (WCS, 2012). This preference is influenced by its small size and relatively non-aggressive nature, which facilitates easy capture, and further, it, stays alive while being transported to markets. Newing (2001) stated that the African dwarf crocodile is one of the most critically endangered crocodilians in the world. Many officially protected areas, in Cameroon like the BMWS where animals should be safe from depredation by humans, are not actually safe havens for those protected species. There is lack of protection inside and around BMWS and it was found that often more protected species are found per day in bush meat off-take than reported by Wilcox and Zuoango (2000). Conservation should be within the realms of politics, economics, ecology and social problems at a local level.

Currently, no accurate data are available on the status of protected species and habitat for this ecosystem. At present, the Banyang-Mbo Wildlife Sanctuary is seriously compromised, and of uncertain conservation value. However, the lowland sanctuary is still of high biodiversity value. The reptiles reported above are now regarded as rare throughout this ecoregion; however, there is insufficient data to adequately determine the population size of these protected reptiles within BMWS. Further study is clearly warranted to determine population size and threats to those populations. Once this information has been collected, a better picture of the ecological status of these animals can be determined, the effects of hunting and deforestation can be better assessed and with additional data, the implementation of species survival plans for these animals could be improved. The actual population status of most or all the threatened species within the BMWS is unknown, even though hundreds are captured annually (Ajonina, 2009 unpublished). A major institution, actively taking part in the conservation of endangered animals is Convention on International Trade in Endangered Species (CITES). The CITES laws have made the most strict regulations involving the international transport of animals. In the case of the chimpanzee, gorilla, African elephant tusk, African dwarf crocodile, etc, merely the regulation on international transportation is not enough.

Conclusion and recommendation

Cameroon faces major conservation challenges and despite the country's natural riches, several wildlife species are threatened in protected areas within the country. Our results indicate that protected species at Banyang-Mbo Wildlife Sanctuary are further threatened with high population declines due to human population growth, illegal hunting and habitat destruction which have negatively affected the protected species and other wildlife in the Banyang-Mbo wildlife sanctuary.

Despite this findings there is need to further research on status surveys, the identification and protection of important populations and habitat; the enhancement of the conservation and management capacities of national authorities; the development of national management plans for endangered species conservation; captive breeding and restocking programs and the development of economic incentives for protected species conservation through well-regulated sustainable use in protected areas in Cameroon.

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Appendix 1. Questions administered to hunters during study.

1. What really made you to start hunting?
2. How many times per week do you go for hunting?
3. Are you a specialized hunter?
4. Do you hunt for your own consumption or to earn income? If both, which is the most important motivation for hunting?
5. Do you hunt on a year round basis? If no, are there any periods during the year when you particularly hunt? If yes why?
6. Which season is most suitable for hunting and why?
7. Do you go hunting alone or in hunting groups and why?
8. Can a hunter check or remove a dead animal from another hunter's trap if it is getting rotten?
9. Are there periods when hunting is easier? why?
10. How far from the village do you usually go hunting (a) < 2 km, (b) 2 to 5 km, (c) between 5 and 10 km, (d) >10 km any reason for your answer?
11. Which weapon type do you use most for hunting and why?
12. In which forest type do you use your technique? What types of animals are killed most?
13. If snare hunting (a) how many snares do you currently set?
(b) How do you choose where and when to place snares? In what type of forest?
(c) At what time of the day do you set snares? How often do you return to check the snares?
(d) How long does a snare line stay in place? What makes you decide to change the location of your snare line?
(e) How much does a snare cable cost?
(f) Imagine that you set 100 snares. How many would have caught an animal by the first day that you returned to check them?
14. If hunting with a gun (a) was it easy to buy a gun? Where? How much?
(b) Is it easy to find cartridges? Where? How much?
(c) Can you estimate how many missed shots you have on each hunting expedition?
(d) What species are easiest to shoot?
(e) Do you use calls to attract animals? When? Where? What animals?
15. Do you understand the meaning of protected animals?
16. Can you identify a protected animal during hunting in the forest?
17. How many times have you been confronted by a wildlife officer for killing carrying a certain
species of animal?
18. Does the presence of the Ministry of MINFOF in your village have any impact on your hunting activities?