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# Status of Medium-sized Mammals in Mbi Crater Game Reserve, North West Region, Cameroon Case Study of: Blue Duiker (*Cephalophus monticola*) and Bushbuck (*Tragelaphus scriptus*)

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### *Authors' contributions*

*This work was carried out in collaboration between all authors. Authors TEA and FC designed the study, wrote the protocol and interpreted the data. Authors FC and BSF anchored the field study, gathered the initial data and performed preliminary data analysis. While authors TEA and FC managed the literature searches and produced the initial draft. All authors read and approved the final manuscript.*

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## ABSTRACT

This study was carried out in the dry season between the months of November 2013 and February 2014. The goal was to contribute to the conservation of mammals through the establishment of base line information on mammal population in Mbi Crater Game Reserve (MCGR). The recce-transect method was used during the inventory. Seven (7) recce of 0.5 km each and fourteen (14) line transects of 0.5 km long were surveyed within the reserve making a total effort of 11 km. One hundred and twenty eight (128) questionnaires were administered to the local population, twenty four (24) semi-structured interviews to households and eight (8) focus group discussions with local

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chiefs and notables to get local people’s perceptions about wildlife conservation in MCGR. Nine (9) species of medium sized mammals were recorded within the reserve. The family Bovidae was well represented. Bushbuck and blue duiker were the most abundant mammal species with an encounter rate of 1.09 and 0.73 signs/km respectively. Mammals had higher densities in the west and southwest section of the reserve because of low intensity of anthropogenic activities. Hunting was the most frequent anthropogenic activity recorded in the study area. Only 37.5% variation in the encounter rate of medium mammals was provoked by anthropogenic activities. A majority of respondents acknowledged the reserve was important because they depended on it for bush meat, medicinal plants, and water. Other respondents considered the reserve as a liability and complained of restricted access and constant raiding of their farms by monkeys from the reserve. A greater fraction of respondents declared the community was not involved in managing the reserve. We can generally recommend that the government adopts a participatory management approach, establishing a joint anti-poaching team and provide alternative sources of protein to local people to reduce unsustainable hunting in the reserve. The government should also establish a compensation mechanism for those whose crops are constantly raided by animals from the reserve and organize mass sensitization programs for local communities on the importance of wildlife conservation.

*Keywords: Anthropogenic activities; blue duiker; bushbuck; conservation; encounter rate; Mbi crater game reserve; medium-sized mammals; status; perception.*

## 1. INTRODUCTION

Cameroon encompasses a large variety of ecosystems, habitats and species [1]. About 409 species of mammals in Cameroon of which 14 are endemic, 165 reptile species; 916 species of birds, of which 8 are endemic while some 150 are migratory, 9000 plant species, of which 156 are endemic, 200 amphibian species, of which 63 are endemic and about 1500 Butterfly species [2]. The diversity of ecosystems and habitats make here generally termed Africa in miniature [3]. About 70% of Cameroon’s population depends on these natural resources for their livelihoods (source of income and daily protein intake), with bush meat contributing about 90% of animal protein consumed in some rural areas [4,5].

Most of these species are either threatened, endangered or at the brink of extinction due to habitat loss through unsustainable agriculture, hunting and logging activities. Blue duikers are among the major hunted species in the East Region of Cameroon [6]. Following the Earth Summit of Rio de Janeiro in Brazil in 1992, and the recommendation to its parties for tracking progress towards the 2010 target to halt biodiversity loss, the number of protected areas in Cameroon increased substantially [7]. Cameroon has developed a network of protected areas which covers a surface area of about 8138800 hectares and 17 National Parks, all of which covers about 19.2% of the national territory to reduce habitat loss and wildlife poaching [8]. Mbi crater game reserve is found in the Bamenda Highlands which is the most diverse and important area in Western Cameroon after Mt. Cameroon and Mt. Kupé [9]. It is the only site in the world harboring *Kniphofia reflexa*, a ‘Red Data’ list species being officially accepted by IUCN as being Endangered [10] with two endemic bird species (*Tauraco bannermani* and *Platysteira laticincta*) which are restricted to the Bamenda montane forests [11]. Several species of primates, including Nigeria-Cameroon chimpanzees (*Pan troglosytes ellioti*) and Preuss’s guenons (*Cercopithecus preussi*), both considered as Endangered by the International Union for the Conservation of Nature [12], still live in the remaining patches of submontane and afromontane forests of the Bamenda Highlands [13]. Despite the importance of this reserve and the immense wildlife species that it harbors, the main problem that calls the attention of this research is the decrease in the population of blue duiker and bushbucks [14]. This decrease is driven by habitat loss caused by encroachment by the Elba Cattle Ranch Company and Ndawara Tea estate [15] and poaching for subsistence and commercial purposes in the reserve driven by a high demand for bush meat by the local population [14]. In spite of these problems, mammals have not received any conservation attention in Mbi Crater Game Reserve and very little or no efforts have been made to determine their abundance, distribution and threats to their population.

Therefore, the main objective of this research was to contribute to the conservation of medium-sized mammals through establishing base line information on mammal population in Mbi Crater Game Reserve.

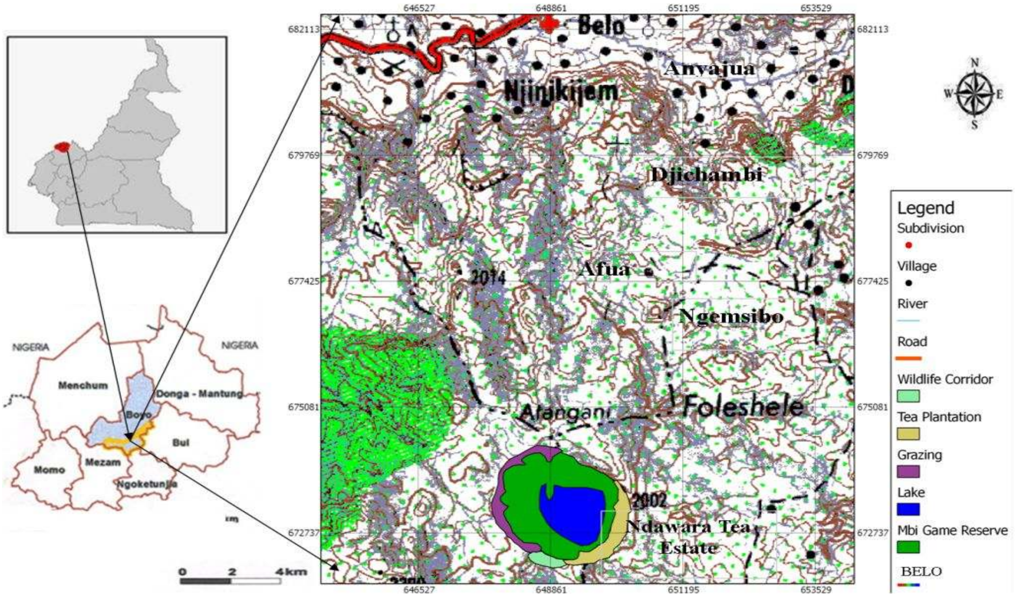
More specifically to;

1. Investigate the relative abundance of medium-sized mammals in MCGR.
2. Determine the spatial distribution of Blue duiker and bushbuck mammals in MCGR.
3. Evaluate the effects of anthropogenic activities on the distribution of medium-sized mammals in MCGR.
4. Assess the perceptions of the local people towards wildlife conservation in MCGR.
5. Propose better management strategies for medium-sized mammal in MCGR.

## 2. MATERIALS AND METHODS

### 2.1 Study Area

Mbi Crater Game Reserve is found in Belo sub division in the Boyo division of the North West region of Cameroon. It is located between latitude 6° 7' 00’’ North and longitude 10° 20' 00’ ’ East with a surface area of 400 ha. The climate of this area is cold tropical characterized by two distinct seasons; a dry season which spans from November to February and the rainy season which starts from March to late October. Rainfall is generally heavy, ranging from 1800 to 32000 mm per annum. During the dry season mean annual temperatures range 14℃ to 28℃. It lies at an altitude of 2,060 m. The slopes range 40-70% with undulating hills and deep valleys made up of ferrallitic and lateritic soils. The reserve is important water shed with many flow streams which take different names along their courses and jointly form river Mughom the main river which flows across Belo. Mbi Crater consists mostly of grassland, probably seasonally flooded, and there is also a smaller permanent swamp. The rims are covered with a mosaic of montane forest, *Gnidia* woodland and montane which support high diversity of plants and animals such as Pygeum (*Prunus africana*), *Kniphofia* (*Kniphofia reflexa*), Mahogany, (*Khaya ivorensis)* Sapele (*Entandrophragma cylindricum*), Iroko (*Milicia excelsa*), Obeche (*Triplochiton scleroxylon*), with two endemic bird species Bannerman’s tauraco (*Tauraco bannermani)* and Banded wattle-eye (*Platysteira laticincta*) which are restricted to the Bamenda montane forests in the mountainous stretch of the western highlands regions of Cameroon [11]. Apart from these endemic birds and plant species, this Game reserve also harbors some species of medium mammals like Bushbuck (*Tragelaphus scriptus*), Blue duiker (*Cephalophus monticola*,) Sitatunga (*Tragelaphus spekei*) and Chimpanzee (*Pan troglodytes*) just to name a few.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Wildlife Corridor
Tea Plantation
Grazing
Lake
Mbi Game Reserve
BELO

**Fig. 1. Map of Cameroon showing location of the MCGR in Boyo Division in the North West Region of Cameroon**

*Source: Adapted from the Belo council maps (2011)*

## 2.2 Methods

Data was collected using two approaches: the recce- transect for mammals surveys and questionnaires for socio-economic data from the local population.

### 2.2.1 Mammal survey

Data collection was carried out from November $8^{th}$ 2013 to February $25^{th}$ 2014. The recce-transect [16] was used for animal inventory. The zone was subdivided into quadrates of 0.5 km x 0.5 km. Transects of 500m were randomly oriented in all sampled quadrates. The starting point of each transect was randomly generated using a random number table. Their exact positions in the field were determined by using the 'GO TO function' of GPS GARMIN 62CSx. Transects were oriented to cross major drainages (rivers, streams) and features in order to sample a representative proportion of all vegetation types (Gnidia forest, gallery forest and tea plantation). A total of 11 km recce- transects were walked within the reserve including (14) line transects of 0.5 km long using geographical information map (GIS) of MCGR (Fig. 2). The field team was made up of five individuals: one leader, one observer, two field assistants and one laborer. The leader was responsible for reading the bearing and recording data, the observer was searching for animal signs, the two field assistants were measuring distances to the nearest centimeter, while the laborer was responsible for opening the bush ahead along the compass bearing. Data on direct sightings, sings of mammals (dung, foot prints, carcasses, nests, tracks and food remains, and vocalization) and the signs of anthropogenic activities such as farms (active or abandoned), machete cuts, regularly used human trails, snares, shotgun shells, honey extraction sites and hunting camps (active or abandoned) were search for and those found were recorded on a data collecting sheet.

### 2.2.2 Socio-economic survey

A survey was conducted to get local people's perception about conservation of mammals in MCGR in eight out of 29 villages (Njinikejem, Belo, Kitchu, Djichami, Anyajua, Afua Ngemsibo and Mujung) with a population of 18000 purposively selected based on their closeness to the reserve. One focus group discussion was conducted per village after consultation with the chiefs. Each focus group had 8 participants (2 notables, 2 men, 2 women and 2 youths). Semi-structured interviews were conducted with 3 households per village with the help of an interview guide giving a total number of 24 households sampled. One hundred and twenty eight (128) closed ended questionnaires were administered to 8 hunters, 64 farmers, 24 students, 16 teachers, 8 traders and 8 traditional healers. These informants were identified at village meetings with the Chiefs. A total number of 216 individuals out of a population of 18000 were sampled giving a sampling rate 1.2%.

## 2.3 Data Analysis

Field data sheets were decoded and information entered into Microsoft excel. The observations were grouped according to the different mammal species and type of anthropogenic activity. Densities were calculated manually since the number of times indices encountered did not attain 60 for all species to use the program DISTANCE 6.0. The encounter rate for all mammals was calculated using the formula: Encounter rate (ER) = Total number of objects or signs observed divided by the length (L) of transect (in kilometer). **ER= N /L**.

Where:

N = Number of objects observed,
Lt = Length of transect (Km)

This permitted us to estimate the relative abundance of animal population and signs of anthropogenic activities. The encounter rate per quadrate for blue duikers and bushbucks were also calculated.

The GPS points of all animal species and signs of human activities recorded per quadrant were exported to Arc View computer program 3.3 and geo-referenced to produce different spatial distribution maps. The classes of encounter rate were then defined in order to group similar quadrates and represent zones of different densities. Different color bands and corresponding color intensities were used to represent different encounter rates on the distribution maps. This permitted the definition of important zones for mammal species like (chimpanzee, Sitatunga, buffalo and bushbuck) in order to determine management strategies for their conservation.

Regression analyses were carried out to test the relationship between the encounter rate of medium mammals and signs of anthropogenic

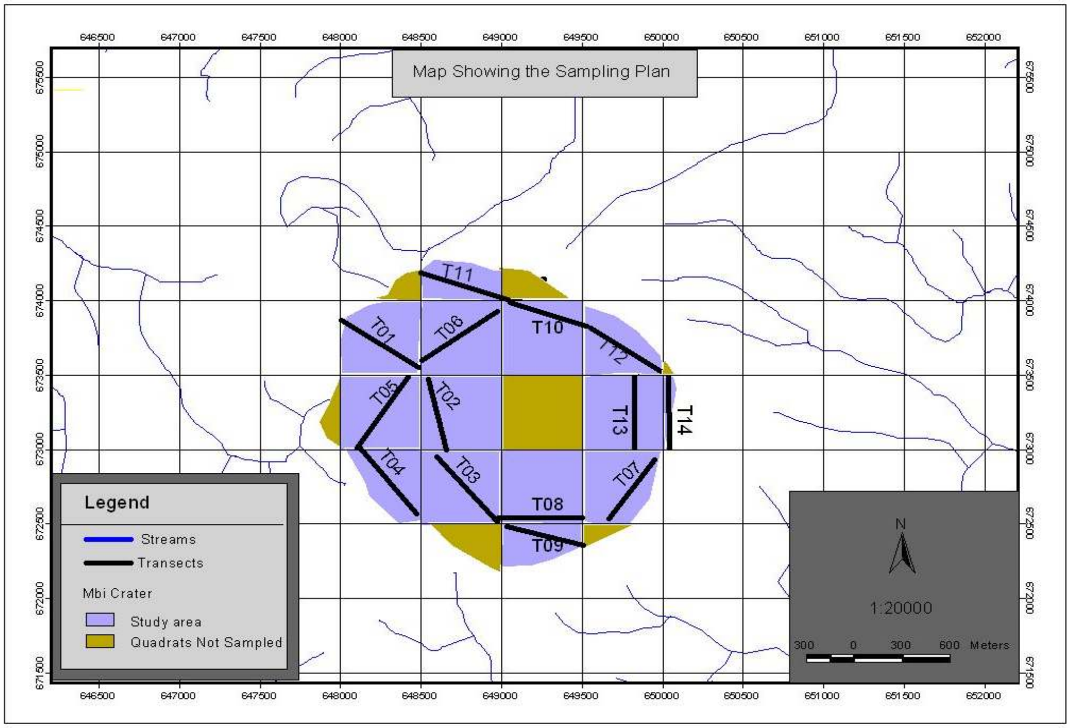
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**Fig. 2. GIS Map showing representation of transects for animal inventory in MCGR**

activities. Encounter rates of these two variables were exported to SPSS to produce a fitted regression line. Quantitative data analysis began with coding the answers given by the respondents from questionnaires. The coded answers were entered into Microsoft Excel and SPSS (vs. 17 computer software and analyzed in line with the objectives. Descriptive analysis was also used to analyze qualitative data (information collected from informal interviews and information captured through observation and group discussions). Results were presented in the form of frequencies, percentages and other statistical diagrams such as histograms, pie charts, graphs and tables.

## 3. RESULTS

### 3.1 Relative Abundance of Medium Mammals in MCGR

A total of nine (9) species of medium mammals belonging to three families namely, *Bovidea, Cercopithecinae* and *Pongidae* were recorded in MCGR*.* The family *Bovidae* was the most abundant as far as species richness is concerned, with five (5) species recorded, the *Cercopithecinae* family followed with three (3) species and *Pongidae* with only (1) one species. Mammals were identified by direct and indirect indices (Dung, nests, and vocalizations). One groups of *Cercopithecus nictations* (6 individuals) andone group of *Chlorocebus aethiops* (*5* individuals) was seen during inventory. Only one Chimpanzee nesting site with a single old nest of *Pan troglodytes ellioti* was found during the survey. Vocalizations were recoded only for *Papio anubis* during the survey. No species in the family bovidae was seen directly. The most frequent biological indices were dung of bushbuck and blue duiker. Bushbucks (*Tragelaphus scriptus*) were the most abundant mammal in the MCGR with an encounter rate of 1.09 signs/km followed by blue duikers with an encounter rate of 0.73 signs/km. Table 1 show all species of medium mammals seen, heard and signs recorded in MCGR, classified by family and encounter rate.

### 3.2 Spatial Distribution of Medium Mammals in MCGR

Generally, the relative densities of medium mammals were high on the the west and south west and low on the east and north east sections of the reserve.

**Table 1. Classification of medium mammals recorded in the MCGR by family and encounter rate**

| Family | Common name | Scientific name | D | V | S | N | Dt (km) | ER |
|---|---|---|---|---|---|---|---|---|
| Bovidae | Blue duiker | *Cephalophus monticola* | 8 | 0 | 0 | 0 | 11 | 0.73 |
| | Bushbuck | *Tragelaphus scriptus* | 12 | 0 | 0 | 0 | 11 | 1.09 |
| | Red duikers | *Cephalophus dorsalis* | 7 | 0 | 0 | 0 | 11 | 0.64 |
| | Sitatunga | *Tragelaphus spekei* | 7 | 0 | 0 | 0 | 11 | 0.64 |
| | Buffalo | *Syncerus caffer* | 2 | 0 | | 0 | 11 | 0.18 |
| Cercopithecinae | Putty-nose monkey | *Cercopithecus nictitans* | 0 | | 6 | | 11 | 0,54 |
| | Vevet monkey | *Chlorocebus aethiops* | 0 | 0 | 5 | 0 | 11 | 0.45 |
| | Yellow baboon | *Papio anubis* | 0 | 2 | 0 | 0 | 11 | 0.18 |
| Pongidae | Chimpanzee | *Pan troglodytes* | 0 | 0 | 0 | 1 | 11 | 0.09 |
| Mean ER | | | | | | | | 0.50 |

*Key: ER= Encounter rate, D= Dung, Dt= Distance, S=Seen, N= Nest, 0= No observation, V= Vocalization*

#### 3.2.1 Spatial distribution of Blue duiker and Bushbuck in MCGR

Figs. 3 and 4 show the spatial distribution of Blue duiker and Bushbuck in MCGR. The relative density of Blue duiker was high (0.2 < ER< 0.29) in the north west and south west and low (0 < ER< 0.09) in the north east and east sections of MCGR (Fig. 3), While the relative density of bushbuck was high in west (0.9 < ER< 1.19) and southwest (0.6 < ER< 0.89) and low (0 < ER< 0.09) in the North West and east sections of the reserve (Fig. 4).

### 3.3 Anthropogenic Activities in MCGR

All signs of anthropogenic activities recorded in the MCGR were grouped in a decreasing order; Hunting (60.71%) having a mean encounter rate of 2.24 signs/km, agriculture (17.34%) with 0.64 signs/km, and grazing (21.95%) with a mean encounter rate of 0.81 signs/km (Fig. 5). The mean encounter rate for all anthropogenic activities was estimated at 1.44 signs/km (Table 2). Fig. 6 shows a regression line of the encounter of medium-sized mammals and anthropogenic activities in MCGR. The effects of anthropogenic activities on the abundance of medium sized mammal in MCGR is weak ($R^2$=0.375*) F* (d.f. = 1) = 4.199, *P* = 0.08).

**Table 2. Encounter rate of anthropogenic activities in MCGR**

| Anthropogenic activity | Encouter rate (Relative density) |
|---|---|
| Hunting | 2.24 |
| Grazing | 0.81 |
| Agriculture | 0.64 |
| Max | 2.24 |
| Min | 0.64 |
| Mean | 1.44 |

### 3.4 Perception of Local People towards Wildlife Conservation in MCGR

Fig. 7 summarizes respondent's perception towards importance of the MCGR. A majority of respondents (80%) agreed that the MCGR was important while (15%) said that the reserve was not important to them and more of a liability. Table 3 indicates that, majority (75.61%) of respondents considered wildlife conservation as beneficial whereas, a minority (15.62%) of respondents expressed negative views towards wildlife conservation in the reserve. Also, more than half (66.84%) of the community were not involved in managing the MCGR. However, 23.43% of respondents acknowledged that the community was implicated in the management of the MCGR.

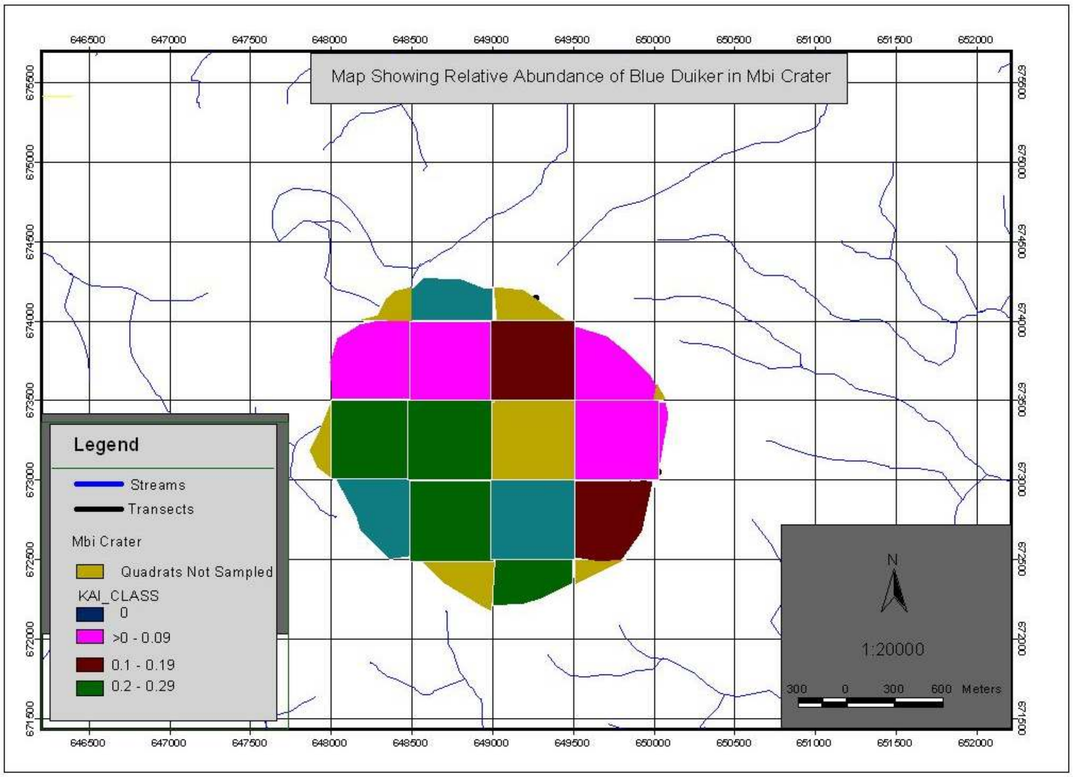
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Fig. 3. GIS map of MCGR showing spatial distribution of Blue duiker

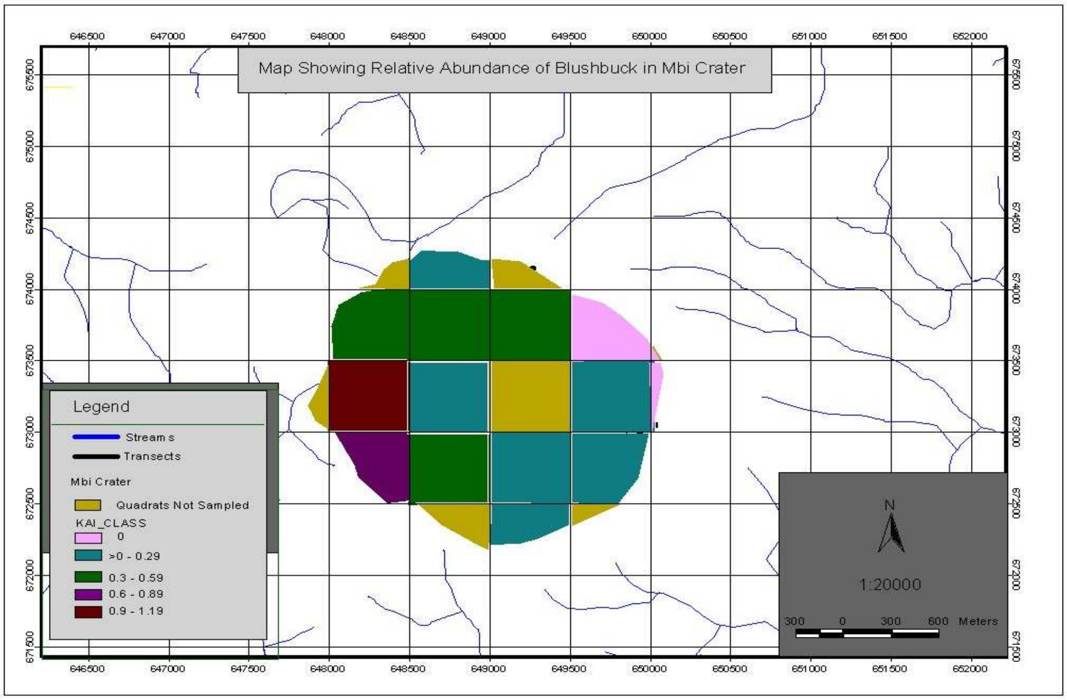
Map Showing Relative Abundance of Blushbuck in Mbi Crater
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Fig. 4. GIS Map of MCGR showing spatial distribution of Bushbuck

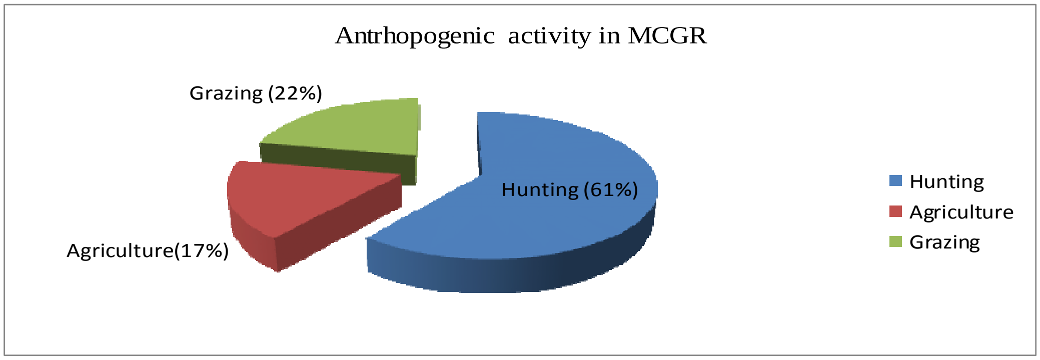

**Fig. 5. Frequency of anthropogenic activities in MCGR**

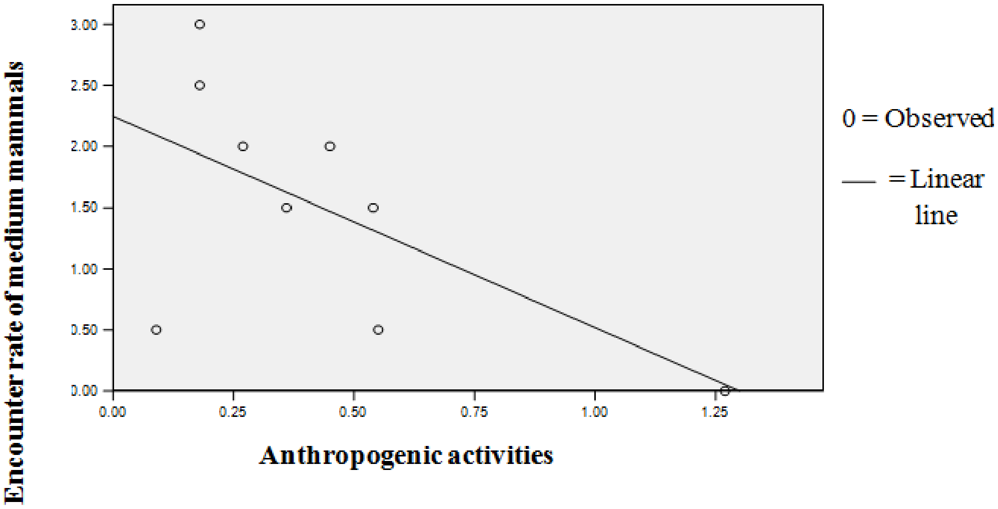

**Fig. 6. Fitted regression line of the encounter of medium mammals and anthropogenic activities in MCGR**

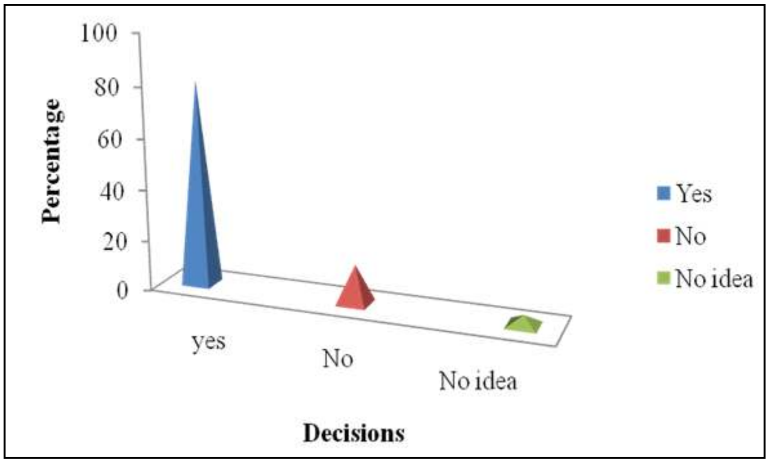

**Fig. 7. Respondent's perception towards importance of the MCGR**

**Table 3. Perception of respondents towards wildlife conservation and community implication in managing the MCGR**

| Villages | Individuals | Perception towards wildlife conservation and community implication in managing the MCGR | | | | | |
|---|---|---|---|---|---|---|---|
| | | Conservation | | | Community implication in management | | |
| | | For | Against | Don't know | Yes | No | No idea |
| Njinikejem | 16 | 13 | 0 | 3 | 0 | 15 | 4 |
| Belo central | 16 | 16 | 0 | 0 | 0 | 13 | 2 |
| Kitchu | 16 | 8 | 3 | 5 | | 14 | 1 |
| Djichami | 16 | 9 | 7 | 0 | 0 | 15 | 0 |
| Anyajua | 16 | 6 | 10 | | | 11 | 4 |
| Afua | 16 | 16 | 0 | 0 | 15 | 0 | |
| Mujung | 16 | 15 | | 1 | 15 | 0 | 0 |
| Ngemsibo | 16 | 15 | | 1 | 0 | 15 | 0 |
| Total | 128 | 98 | 20 | 10 | 30 | 83 | 11 |
| Percentages | | 75.61% | 15.62.% | 7.8% | 23.43% | 64.84% | 8.59% |

## 4. DISCUSSION

Among the nine species of animal recorded in the MCGR, only one species that is *Pan troglodytesellioti* belongs to class A according to Cameroon law. This species is totally protected and it is forbidden to kill it. *Tragelaphus scriptus, Cercopithecus nictations, Tragelaphus spekei, Syncerus caffer* and *Papio anubis* belong to class Bwhich benefit from partial protection and *Cephalophus monticola, Cephalophus dorsalis, Chlorocebus aethiops* are Class C species which are partially protected and which their capture and killing are regulated in order to maintain the dynamics of their population.

The results reveal that one would identify less than one mammal signs for every kilometer walked in the study area (Table 1). The low encounter rate might be due to overhunting by the tea plantation workers. The artiodactyls were more abundant than the primates. This might be caused by noise from trucks working in the tea plantation and or noise produce by the survey team during inventory which scared them away and reduce vocalization and direct sightings. Similar results were obtained by [17] in the lebialemmone forest landscape were the overall density of medium mammals were estimated to be 0.64 signs/km. The result of this study with 1,09 signs/km for bushbuck contrasted those carried out by [18] in the Bakossi landscape area in the Southwest Region of Cameroon where bushbucks registered an encounter rate of 0.15 signs/km and those carried out by [19] in the Nguti Council Forest in the Southwest Region of Cameroon in which blue duiker s recorded an encounter rate of 0.38 signs/km.

Human activities, vegetation type and food availably affected the abundance and distribution of mammals in the reserve. The high abundance of blue duikers in the north west and south west parts of the reserve for example could be attributed to the intact nature of the forest and presence of their preferred foods such as the fruits of wild okra (*Aspillasp)* in this section. Indices of bushbuck were also high in the west and south west probably because of the high degree of forest cover and swampy nature of the forest which favored the growth of their favorite diet *Albizia glaberima*in the west in particular. The presence of two caves with huge deposits of natron (hydrous sodium carbonate) could also be responsible for a high density of indices of their presence in this section. The rims of the north west and south west sections of the reserve are made up of steep escarpment with slopes greater than 42% which rendered this section difficult for agriculture and hunting.

Hunting for bush meat does not only provide an important source of protein but also a major source of income for the local communities surrounding MCGR. Most workers of the tea estate hunted in the reserve because of low income, preference to bush meat and absence of conventional livestock. Grazing among these anthropogenic activities was also common because of the frequent entry of the cattle from the Elba ranch into the reserve during the dry for pasture. Encroachment into the reserve to grow tea is one of the major causes of biodiversity loss in the MCGR. It was observed that there have been encroachments on the MCGR to grow tea. In fact, there has been a 20% (82 ha) decrease of forest cover in the MCGR from 400 ha in 1964 [11] to 317 ha in 2014 (*Pers. Observ.*). Anthropogenic activities only slightly affect the abundance and distribution of mammals when plotted together with the encounter rate of mammals through regression analyses. This shows that anthropogenic activities have not yet reach their peak in the study area but will have a devastating effect on wildlife conservation in the future if not controlled.

Respondents who considered the reserve to be important reported that they depend on it for medicinal plants, firewood, water for irrigation, livestock during the dry season and hunting for subsistence. Those who saw the reserve as a liability argued farming and hunting inside the reserve had been prohibited by the government. They therefore complain of limited land for farming and want such lands to be freed. Some respondents during interviews denied that the reserve has not benefited them since its creation because access to certain plant and animal species which were of great cultural value to them had been denied by the government. These results are in line with those obtained by [20] in Uganda where a majority (83.6%) of respondents did not perceive the importance of the Ajai wildlife Reserve and considered it as a liability to the communities of its environs because of loss of land for cultivation and grazing. The major reason given during focus group discussion in favor of conservation was the value of wildlife for the future generation. Respondents also said Bushbucks and Blue duikers were of great medicinal, cultural and food values to them so should be protected. Respondents against conservation were alleged to be employees of the owner of the tea estate. They preferred the reserve should be cleared down to plant tea because wildlife conservation by the government could not give them the money that they received from harvesting tea from the Ndawara tea estate. In addition, the proprietor of the tea estate constructed schools, hospital, roads and provided portable water that the government had been able to provide since the creation of the reserve. Other respondent were against conservation because their crops were constantly being raided by monkeys from the MCGR especially victims of human wildlife conflict who complained of no compensation from the government up till date. [21] also observed failure in many compensation schemes in the Wazalogone flood plain of North Cameroon where human/elephant conflict was escalating. [22] also reported that 90% of respondents in the Bakossi area, South West Region Cameroon did not consider wildlife conservation as beneficial because of the damages incurred from wild animal raids.

During focus group discussions, respondents considered management as government business and not an affair of the community since access to hunt had been denied by government and their farmlands seized by the proprietor of the Elba ranch company. They therefore considered management as a negotiation between the proprietor of the Elba ranch company, the chiefs and the government and therefore saw no need of protecting something they will not benefit from.

Respondents who accepted community was implicated in management confirmed two villagers one from *Afua* and another from *Mujung* have been employed by the services of Forestry and Wildlife to assist in sensitization campaigns and anti-poaching patrols.

## 5. RISK AND UNCERTAINTY IN AGRICULTURE

MCGR is an inland wetland which renders many ecosystem goods and services to the people of Belo subdivision. Forest conversion to agriculture in Mbi Crater Game Reserve poses the following risks:

### 5.1 Production Risks

Reduction or loss of ecosystem goods produced by the reserve such as: Food (production of fish, bush meat, fruits and grains), fresh water (Storage and retention of water for domestic, industrial and agricultural use), fibre & fuel (fuel wood, fodder), biochemical products (extraction of medicines and other materials from plants and animals), will lead to poverty and eventually cause famine in the locality.

## 5.2 Weather Risks

The loss of ecosystem services such as the regulating services and hydrological regimes: Mbi Crater Game Serves as a sink for greenhouse gases. Deforestation will provoke periodic deficit or excess precipitation and temperature variation which may cause low farm yield, loss of productive assets and farmers income. It will also lead to loss in ground water recharge /discharge capacity of the reserve.

## 5.3 Biological and Environmental Risks

### 5.3.1 Biodiversity loss

Deforestation which is the conversion of land cover from natural vegetation to cultivation causes the loss of native species in natural habitats, destruction of animal habitat, exposing soils to water and wind erosion reducing fertility, reduction in shade on soils, increase in abundance of unpalatable grasses and introduction of new species. The conversion of land cover from natural vegetation to grazing causes loss of tree and shrub cover, loss of habitat for animals, selective reduction of palatable grass species.

### 5.3.2 Pollution and eutrophication

Both the extensive use of water for tea irrigation and excessive nutrient loading associated with the use of nitrogen and phosphorus in fertilizers in tea plantation in Mbi crater will lead to a decline in the ecosystem delivery of services of stream and other water sources. The continuous degradation of water quality will increase the prevalence of crop/livestock pests and diseases and human contamination caused by poor sanitation.

### 5.3.3 Loss of cultural services

Mbi crater is a shrine where the village gods (Mbi) of the people and their ancestors live. Habitat loss will lead to the loss of the spiritual and inspirational value they attach to the reserve, opportunities for recreational activities, and opportunities for research.

# 6. CONCLUSION AND RECOMMENDATIONS

MCGR is therefore poor in medium-sized mammal species richness and abundance with a species diversity of nine (9) and an overall relative abundance of 0.50 signs/km. Blue duikers and bushbuck are the most abundant species in the reserve.

Hunting at the moment has the highest effect on the abundance and distribution of mammals in the reserve. The effect of human activities on the abundance and distribution is not yet severe but may have damaging effects in the long run if not controlled. Encroachment by the Ndawara tea estate might lead to habitat loss of the fauna species of the reserve with only 317 ha of gallery forest left.

The local people acknowledged the importance of conservation but complained of denied access into the reserve, no implication in management and constant raiding of crops by animals from the reserve.

It will therefore be good if the government:

Implement a collaborative approach were the local people are compensated for participating in anti-poaching patrols such as de-cabling of wire traps and the seizure of hunting material from defaulters.

Train local people on alternative source of protein and income generation activities like cane rat domestication, piggery, poultry and fish farming to reduce hunting. Create awareness through sensitization campaigns to inform the local people about laws protecting the hunting of protected species.

Established a benefits sharing mechanism were only trained individual from the local community can get access into the reserve to harvest important forest products under supervision by the authorities of forestry and wildlife.

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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