

Assessing Bat Diversity and Human-Bat Interactions in Rural Communities of Menoua Division, West Region of Cameroon

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Abstract

The development of successful conservation plans for bat species depends on accurate knowledge of bat diversity and interactions with humans. In this study, we aimed to investigate the diversity and ethnozoology of bats in four rural communities of the western region of Cameroon. We mist-netted bats for twenty non-consecutive nights and administered 150 open- and closed-ended survey questionnaires to the inhabitants of Bafou, Foto, Fongo-Tongo, and Fongong Ellelem communities in the Menoua division of the west region of Cameroon. During the 20 nights of capture, 61 bats were captured, representing six species, five genera, and three families. *Myonycteris angolensis* had the highest abundance in the area (42.62%; $n = 26$), followed by *Rousettus aegyptiacus* (18.03%; $n = 11$) and *Rhinolophus landeri* (18.03%; $n = 11$). Nearly 87% of the respondents acknowledge the presence of bats in their village and that the sightings of bats have decreased over time. According to the respondents, the main motivations for hunting bats were food (73.4%), trade (16.2%), and health (10.4%), including the use of particular body parts as aphrodisiacs and to treat baldness. The study also provided that 58.67% of the respondents disapproved of the preservation of bats' roosts close to their homes because they thought they were a sign of bad luck. Our study highlights how bats are perceived by the rural population, as well as the persistence of beliefs that impede the implementation of effective conservation measures for bats in the area. We recommend the establishment of education programs that emphasize the importance of bat ecological services and the necessity for effective bat conservation.

Keywords

Conservation, Bats, Diversity, Human-Bat Relations, Hunting

1. Introduction

Cultural misconceptions about wildlife, which lead to human-wildlife conflicts, are one of the causes of human-induced global biodiversity loss (Chapin III et al., 2000; Haberl et al., 2006). Furthermore, false perceptions about some species, such as those linked with bats, limit their sustainable management and may contribute to the extinction of some species. Misconceptions and disinformation regarding wildlife species are frequently linked to human-wildlife conflict. One of the negative consequences of these conflicts for conservation and protected area management is that they develop unfavorable human attitudes toward wildlife, including habitat damage.

Bat-related superstitions and myths have been documented throughout history (Gomes & Neto, 2016). Bats are typically viewed as unpleasant inhabitants of the environments in which they inhabit. People frequently associate bats with misfortune, death, and evil spirits as a result of their striking characteristics, such as their upside-down sleeping position, nocturnal habits, and the blood-sucking habit of a few species (Prokop & Tunnicliffe, 2008; Gomes et al., 2017; Silva et al., 2022). According to several studies (Prokop et al., 2009; Navarro Noriega, 2015; Musila et al., 2018), how people perceive bats is significantly influenced by the perceptions about them that have been passed down through the generations. For example, some groups in southern Cameroon see bats as witchcraft agents when they enter the house in the nighttime to hunt insects and are predisposed to kill them, whilst other communities regard the same event as good fortune. In recent years, negative perceptions of bats have been exacerbated by their connection to emerging zoonotic illnesses (Calisher et al., 2006; Brook & Dobson, 2015), leading to the destruction of bat roosts and the eradication of bats in some areas (Phelps et al., 2019).

Also, the increase in human population and the modification of the forest habitat through agriculture expansion and various developmental projects are negatively influencing bats' species and their habitat. Indeed, bat species richness, abundance and distribution may be affected by roost site losses and disturbances that have been identified as major threats to bats worldwide (Frick et al., 2020).

Bats are one of the most species-rich groups of mammals, with over 1400 species classified into frugivores and insectivorous bats (Kunz et al., 2011). Cameroon has over 120 bat species, divided into 26 taxa and 8 families (Mongombe et al., 2020). They eat enormous quantities of insects and fruits each night and disperse a large number of seeds in their feces (Bakwo Fils et al., 2010; Manfothang et al., 2023). The dispersal of seeds constitutes one of the primordial elements permitting the maintenance and regeneration of the tropical forest ecosystem (Picot, 2005; Picot et al.,

2007). Furthermore, bats are important seed dispersal agents (Reis & Guillaumet, 1983) and pollinate many important plants because of their great mobility (Rodriguez et al., 2006; Kunz et al., 2011). Considering this importance, there is a good reason to believe that the eradication of bats would have a catastrophic impact on tropical forests: for many trees, reproduction, seed dispersal would cease and regulation of insect populations (Bakwo Fils et al., 2010).

Although knowledge of bat fauna in the Menoua division of the west region of Cameroon is still sparse, the partial information available for this group suggests an existence of a colony of *Eidolon helvum* in Dschang (Tamungang et al., 2008). Ethnozoological knowledge is scarcer, and information from this discipline will be required for a comprehensive understanding of cultural biases that harm bat conservation in the area. It would be critical for managing elements that influence the local evolution of bat populations. Identifying social and cultural elements linked with human-bat coexistence in this area is becoming increasingly essential. Understanding local bat knowledge in this zone is critical for developing successful and culturally relevant conservation policies that benefit both humans and bats.

We aim to understand the diverse patterns of bat species and human-bat interactions in the Menoua division. The survival of wild species like bats depends not only on environmental issues but also on social and cultural perspectives (Enriquez-Rocha & Mikkola, 1997). Our assessment of knowledge includes the uses of bats, attitudes towards bats, and the existence of local taboos on bats.

2. Methods

2.1. Study Area

The study was undertaken in the Menoua division, west region of Cameroon, between latitude 5° 25' and 5° 30' North and longitude 10° and 10° 5' East (Figure 1). With a surface area of 1255 km², the vegetation is constituted of herbaceous savannah that is progressively being converted to agricultural land and relatively dense human dwellings. The climate is characterized by two major seasons: the rainy season starts from mid-March to October/November with peak precipitation in August while the dry season runs from December to mid-March. Data collected from the Agricultural Research Institute for Development (IRAD) indicated that mean annual temperature ranges from 21.3°C in August to 29°C in March, and Relative Humidity (RH) ranges between 75% - 80% within the study area (Matsaguim et al., 2019).

2.2. Data Collection

2.2.1. Bat Sampling

Bats were captured from December 2012 to April 2013 with monofilament nylon mist nets in each village with two mist nets of 12.0 × 2.6 m, based on prior knowledge of bats activities (small streams, dip ponds, cultivated farms, cave openings) in four villages of the Menoua (Fongo-tongo, Fossong Elellem, Bafou, and Foto) (Figure 2). Mist nets were deployed at ground level in each village from 6:00 pm to

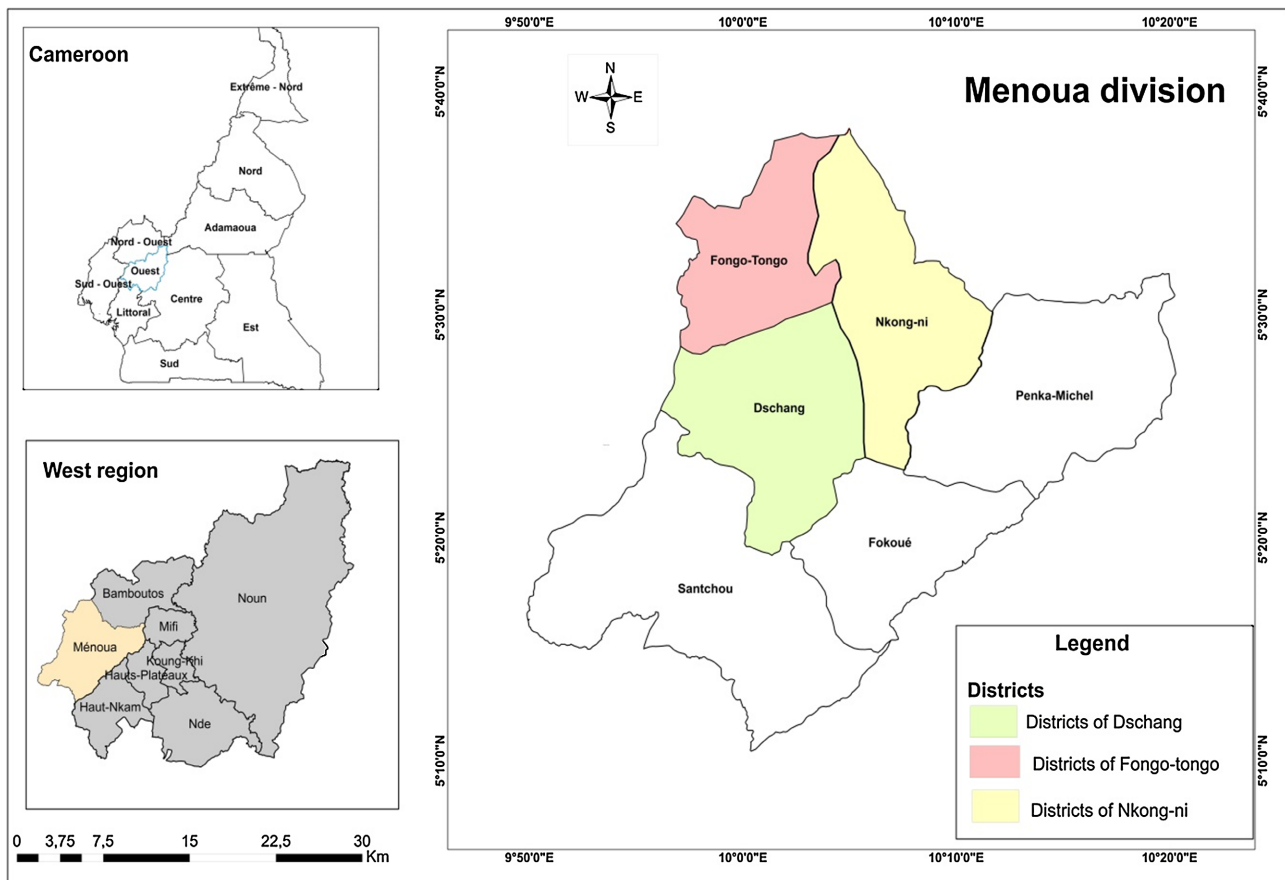


Figure 1. Map of Cameroon showing the Menoua division in west region.

12:00 am to maintain uniform sampling efforts across village. The nets were checked regularly at intervals of 15 minutes to remove captured bats. Across each village, a sampling effort of $1872 \text{ m}^{-2} \cdot \text{h}^{-1}$ (square metre hours) corresponding of a frequency of five consecutive days was carried out in each village. Age, sex, forearm length, weight, and species name were recorded for all bats captured. Morphometric measurements were taken using a Vernier caliper, weight was recorded using a Pesola spring balance. The geographical positions of each site sampled were recorded using a hand-held GPS (Garmin eTrex) (**Figure 2**). Morphometric measurements from each captured bat were used for the identification of each species using the keys of [Rosevear \(1965\)](#), [Hayman and Hill \(1971\)](#), and [Patterson and Webala \(2012\)](#). After external measurements were recorded, the bats were released.

2.2.2. Ethnozoological Knowledge

During four months from December 2012 to March 2013 in the four villages (Bafou, Foto, Fongo-Tongo, Fossong Elellem), a number of research methods were deployed and involved socio-economic surveys that included interviews, focus group discussions, and guided questionnaires. The target population was stratified according to the sex, age groups, occupations, social status. A total of 150 questionnaires: Fongo-tongo ($n = 36$), Fossong Elellem ($n = 27$), Foto ($n = 49$) and Bafou ($n = 38$)

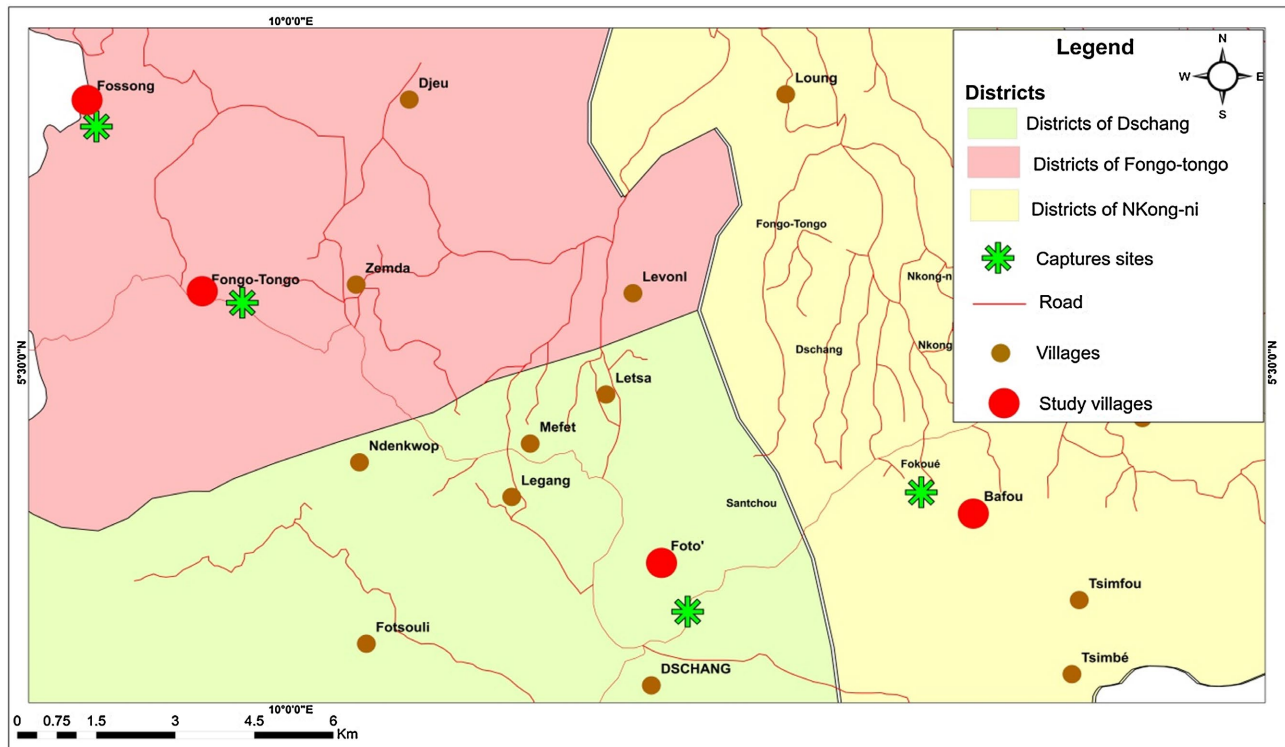


Figure 2. Map of Menoua division with sites sampled for bats.

accompanied by interviews and focus group discussions were administered to adults' persons of both sexes (18 years or older). All the respondents were associated with a colony or roost of bat around human settlements. Questionnaires were divided into four sections:

- Socio-demographic profile, which included questions on age group, sex, religion and activity;
- Observation, frequency and evolution of abundance of bats in the area;
- Attitude towards conservation, including questions on whether they think it is important to conserve bat, if there were any taboos or customs in their habitat related of bat;
- Use of the animal and its habitat with misconception about bats (bat killing, bats used as cure for diseases, bat are symbol of bad omen).

2.3. Data Analyses

The sampling efforts and capture success were calculated according to [Straube and Bianconi \(2002\)](#):

Sampling effort = net area × number of nets deployed each night × total number of hours

$$\text{Capture success} = \frac{\text{number of individuals captured per village}}{\text{sampling effort}}$$

To test for sampling completeness in the area, we generated randomised (100 randomisations) sample-based on Sobs (Mao Tau) species accumulation curves with

95% Confidence Intervals (CI) in Estimate S 9.1.0 (Colwell, 2009).

Shannon diversity (H') and Pielou's index (J') were used and calculated using formula for species diversity:

$$\text{Shannon index } (H'): H' = -\sum P_i \log P_i$$

$$\text{Pielou's index } (J'): J' = H'/H'_{\max}; H'_{\max} = \log S$$

where

S = species richness;

P_i = relative abundance of species i ;

\log = natural logarithm (\log_2).

The data resulting from questionnaires were arranged in different folders, keyed into excel 2013 spreadsheet. We used ANOVA Chi-squared statistic (χ^2) to compare the occurrence of knowledge and attitude score in each village according to sex, age groups, occupations, social status and local perceptions about bats. Basic frequencies were calculated for all categorical data and appropriate charts produced using SPSS 11.0 software. All statistical tests were set at 5% significant level.

3. Results

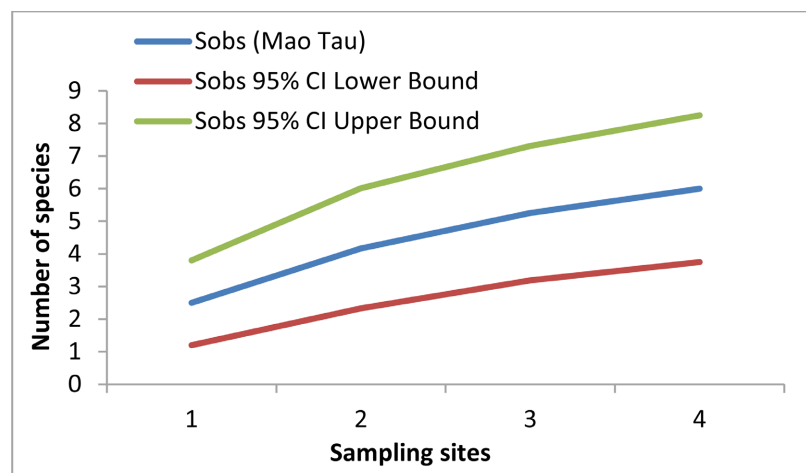
3.1. Species Diversity

During 20 sampling nights, we recorded a total of 61 bats, comprising 6 species, 5 genera and three families. The family Pteropodidae had 4 species, and the Vespertilionidae and Rhinolophidae one species each (Table 1). The species with the highest capture frequency in the area was *Myonycteris angolensis* (42.62%; $n = 26$), followed by followed *Rousettus aegyptiacus* (18.03%; $n = 11$) and *Rhinolophus landeri* (18.03%; $n = 11$). *Epomophorus pusillus* and *Eidolon helvum* have respectively 7 and 5 individuals. The least common species of bat was *Pipistrellus nanulus* (1.63%; $n = 1$). The capture success of 0.0081 individual $\text{m}^{-2}\cdot\text{h}^{-1}$ corresponding to a sampling effort of 7488 $\text{m}^{-2}\cdot\text{h}^{-1}$ (square metre hours) (Table 1) was realised. The species accumulation curve Sobs means (Mao Tau) in the study area was ascending and did not reach an asymptote (Figure 3), indicating that our sampling was incomplete or indicates that more species can still be recorded with increased survey effort.

The Shannon diversity (H') and Pielou's index (J') revealed that the species diversity was highest in Bafou ($H' = 1.64$; $J' = 0.82$) (4 species) and its bat fauna was represented by Pteropodidae, Vespertilionidae, and Rhinolophidae (Table 1). *Rhinolophus landeri* ($n = 10$), was the most abundant species captured at this village, followed by *Epomophorus pusillus* ($n = 7$) and *Myonycteris angolensis* ($n = 3$). In village Fossong Elellem ($H' = 1.13$; $J' = 0.71$), we recorded a total of 3 species, represented by Pteropodidae and Rhinolophidae. *Myonycteris angolensis* was the most abundant ($n = 17$), followed by *Rousettus aegyptiacus* ($n = 10$) and one individual for *Rhinolophus landeri*. At the village Fongo-Tongo ($H' = 0.57$; $J' = 0.57$), we recorded two species belonging to the family of Pteropodidae. *Myonycteris*

Table 1. Number of individuals, species richness, sampling effort, capture success and UICN statut of bats captured in four villages of the Menoua division, western region of Cameroon.

Taxon	UICN statut	Fongo-Tongo	Fossong Elellem	Foto	Bafou	Total
Yinpterochiroptera						
Pteropodidae						
<i>Eidolon helvum</i>	NT	0	0	5	0	5
<i>Rousetus aegyptiacus</i>	LC	1	10		0	11
<i>Myonycteris angolensis</i>	LC	6	17	0	3	26
<i>Epomophorus pusillus</i>	LC	0	0	0	7	7
Rhinolophidae						
<i>Rhinolophus landeri</i>	LC	0	1	0	10	11
Yangochiroptera						
Vespertilionidae						
<i>Pipistrellus nanulus</i>	LC				1	1
Species abundance		7	28	5	21	61
Species diversity		2	3	1	4	6
Shannon diversity (H')		0.57	1.13	0	1.64	3.34
Pielou's index (J')		0.57	0.71	0	0.82	2.1
Sampling effort ($m^{-2}\cdot h^{-1}$)		1872	1872	1872	1872	7488
Capture success ($individuals\cdot m^{-2}\cdot h^{-1}$)		0.0037	0.014	0.0026	0.011	0.0081

**Figure 3.** Accumulation curve of bats species in Menoua division.

angolensis was the frequently captured bat ($n = 6$), followed by *Rousetus aegyptiacus* ($n = 1$). Village Foto was the least diverse ($H' = 0.0$; $J' = 0.0$), with one species of *Eidolon helvum* ($n = 5$) belonging to the family Pteropodidae. We also noted that there was considerable difference in species diversity and abundance of frugivorous bats (Pteropodidae) across the different villages.

3.2. Ethnozoology

Characteristics of the respondents

A total of 150 participants responded to the questionnaires, including 40.93% of the age group 20 - 40 years old, 34.22% of the age group 41 - 60 years old, 17.44% of the age group fewer than the age group 20 years old (>20 years old) and 7% of the age group upper than 60 years old (<60 years old) (Figure 4). Concerning respondents' activities, farmers were the most represented (37.9%), followed by students (23.1%), poachers and healer 13% each. Only about 7% of the respondents were in the logging (timber operator) and 6% other activities. Most participants especially men combined farming and poaching, or poaching and logging, and their orientation in each of these activities depended on the seasons and village.

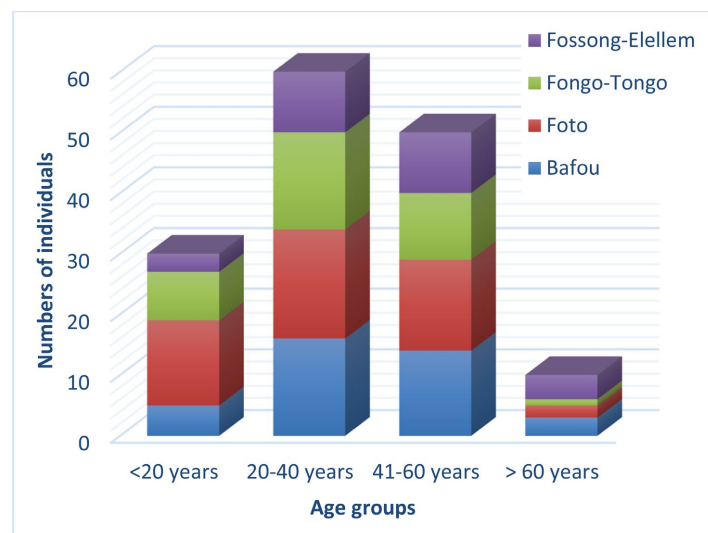


Figure 4. Demography survey of respondents.

Existence and local perceptions about bats

Most respondents (86.6%) were aware of the existence of bats in their village or its surroundings and mentioned either one month (37.4%), 2 - 6 months (38%), or more than one year old (24.6%) regarding the observation frequency of bats. The observation of bats did not differ statistically significantly at $P < 0.05$ ($\chi^2 = 5.88$, $df = 3$, $P = 0.11$) in the four villages. There was also no statistically significant difference in species abundance between season ($\chi^2 = 8.3$, $df = 6$, $P = 0.21$) with 50.76% of the respondents in the dry season, 33.07% in the rainy season and 16.15% in both. A total of 53.8% of the respondents believe that the number of bats has decreased over time, 28% has stable and 18.2% has increased in the area ($\chi^2 = 2.23$, $df = 6$, $P = 0.89$). Figure 5 shows three anthropogenic activities potentially harmful to bats in the study area with a statistically significant difference between villages ($\chi^2 = 30.6$, $df = 9$, $P < 0.000$). Hunting was the most practised human activity while we collapsed the other activities together. We observed a very strong presence of human activities (hunting) in the Foto village. In Manoua Division, bats are impacted by hunting activities, agriculture and logging. Of the

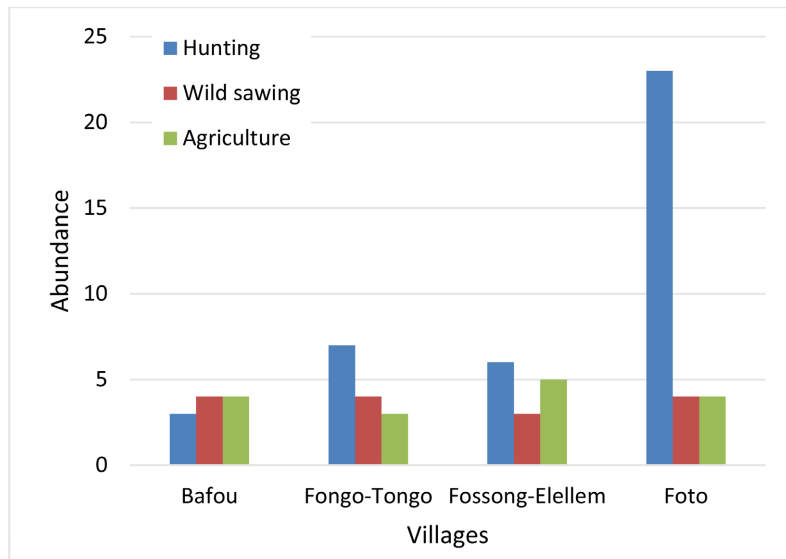


Figure 5. Human activities per village.

target communities mainly go hunting in different villages, the main purpose being to eat (73.4%), 16.2% to sell, against 10.4% of respondent who declared for curing diseases like baldness and aphrodisiacs.

58.67% of the population in the area believed that bats were symbol of bad omen, against 18.67% who declared no and 23% don't know. All the respondents (100%) denounced the conservation of bats roost near their houses.

4. Discussion

4.1. Species Richness and Abundance of Bats

Here is an initial documentation from surveys carried out in four villages of the Menoua division. The species accumulation curves were ascending and did not reach an asymptote in the study area. The capture success of 0.0081 individual $m^{-2} \cdot h^{-1}$ seems to confirm that additional surveys using different capture methods (Colwell, 2013) might significantly improve our chances of recording new species for longer periods of sampling (Fahr et al., 2003; Chao et al., 2005). A total of 61 individuals belonging to six species of bats captured within the different villages represent a highly impoverished assemblage in comparison to the 272 bats comprising 29 species, 16 genera and 8 families captured in the Dja Biosphere Reserve of Cameroon by Bakwo Fils (2009) for 68 sampling nights using six mist nets per night. Also, this highly impoverishment in bats diversity in the Menoua division, which is unprotected areas than the Protected areas of Dja Biosphere Reserve of Cameroon could be linked to a strong human impact on natural forests. According to Laurance et al. (2012), protected areas harbor higher species diversity than unprotected areas resulting from the reduction in human-induced land-use changes such as poaching, wildfires, and deforestation. Mammalian species show higher abundance and species richness where anthropogenic activities are limited (Terborgh, 1992). Of the 61 bats recorded, *Myonycteris angolensis* species was the most abun-

dant in the area. This species inhabits forest common in Cameroon, and is widespread in the country and was previously recorded by Matschie (1891) in Buea; Sjöstedt (1897) in Bibundi, Bonge, Ndiang; Eisentraut (1941) in Bimbria, Tombel; Haiduk et al. (1981) in Eseka; Müller et al. (1981) in Ngaoundere; and Bakwo Fils (2009) in Dja Biosphere Reserve. Also, the abundance of this species in an area may be due to the existence of fruiting trees and roost like numerous natural and manmade structures present (Happold, 2013, as *Lissonycteris angolensis*). Only two species of insectivorous bats were recorded. It is *Rhinolophus landeri* and *Pipistrellus nanulus* with respectively 11 and one individual. This few numbers of insectivorous bats could be due to the only used of mist nets for recorded bats in this study. According to Reis and Guillaumet (1983), sampling using mist nets does not offer the same chance of capture to all of the bat's fauna in a particular area, because only species flying at low altitudes can be caught and partially avoided by bats flying higher. To obtain more complete inventories of the species richness and abundance of bats in an area, complementary methods like ultrasonic monitoring, harp traps, and canopy netting are necessary (Colwell, 2013).

4.2. Ethnobiological Knowledge

In this study, we also have investigated knowledge of and attitudes towards bats in four different villages of the Menoua division. Our results revealed numerous human-bat relations and most respondents (86.6%) were aware of the existence of bats in their villages and/or in their surroundings. However, the number of this species in the area has decreased over time, due to three anthropogenic activities (hunting, agriculture and logging) that potentially harmful bats. In everywhere in the world, the major obstacles to wildlife fauna conservation have been poaching, habitat destruction, infectious diseases and logging (Kormos et al., 2002). Bat meat, particularly of frugivorous species, have long time been hunted by humans and is widely consumed across many countries (Goodman et al., 2008; Jenkins & Racey, 2008; Kamins et al., 2011). Hunting by humans for meat, is one of the primary threats to wildlife in many African forests (Bennett & Robinson, 2000; Koulagna, 2001). Anthropogenic pressures, particularly over-hunting, wild sawing are driving wildlife species toward extinction in African forests (Fa & Brown, 2009). 10.4% of respondent declared the use of bats for medicinal purposes, especially for curing diseases like baldness and aphrodisiacs. Our result is consistent with the findings of Jenkins and Racey (2008) in Madagasca and Tuladhar-Douglas (2008) in multiple Asian countries who previously providing evidence of this practice. Another threat and not the least has been identified in many countries, it is a taboos and Folklore associated with bats. 58.67% of the population in the area believed that bats were symbol of bad omen, and denounced the conservation of bats roost near human houses. According to Mahmood-ul-Hassan et al. (2011), this attitude toward bat may due to the fact that, bats are small nocturnal animals which are unfamiliar to humans. Their behaviour, physical appearance and aesthetic value don't evoke any biophilic response (Kellert, 1996). These attitudes towards bats are similar as vast majority of people in Pakistan, Americas and Europe. They also believed that bats are

hematophagous (vampires), symbols of bad omen and detested to have bat roost close to their house (Mahmood-ul-Hassan et al., 2011). This aversive attitude (blind rats with wings carrying rabies, causing blindness, vampires and flying into people's hair) against bats push human to killed bats.

4.3. Implication for Conservation

Assessing diversity and Ethnobiological Knowledge towards bats in Menoua division is crucial in the elaboration of conservation strategies in this important zone on the Chiroptera fauna. The result of this study was provided with an updated account on the diversity and distribution of bats on Menoua, shown the structure of their communities, and to assess the level of anthropic pressure in the area about bats. The diversity of bats has been studied in the four different villages in the study area. Hunting was the most practised human activity while we collapsed the other activities together. We observed a very strong presence of human activities (hunting) in the Foto village. In Manoua Division, bats are impacted by hunting activities, agriculture and logging. The negative relationship between human activities and in the study area is sufficient evidence of the many pressures that wildlife is subject to in this part of the country. In this area, the continued population growth and improved dietary patterns are associated with the unsustainable exploitation of natural resources, even more when you are in an unprotected area. Hence, with the farming activity high like collection of fire wood, cutting grass and other activities which affecting the study area which in turn affects wildlife in the area. Human actions on mammalian fauna in the Congo Basin forests are so great that many species are threatened.

The results of the work will be used to establish a long-term monitoring system in order to control and reduce the pressure of local population's activities such as deforestation, hunting, forest fragmentation and intensive agriculture that highly contribute to destroying forest landscape. The results will also be used by local authorities in charge of protection of forest resource in Menoua division to initiate and sensitize local populations about the beneficial effect of conservation of natural ecosystems and promote the establishment of education programs that emphasize the importance of bat ecological. Also, roost sites such as caves and buildings have been mapped out using a GPS. Knowledge of these sites can enable authorities to better protect them against human destruction.

5. Conclusion

This study, carried out in the Menoua division, west region of Cameroon, helped to identify six species of bats belonging to 5 genera and 3 families. The capture success of 0.0081 individual $m^{-2}\cdot h^{-1}$ corresponding to a sampling effort of 7488 $m^{-2}\cdot h^{-1}$, and the species accumulation curve, which did not reach an asymptote, confirmed that the surveyed villages are favorable for bats' biodiversity conservation. However, additional surveys using different capture methods for longer periods of capture might significantly improve the chances of recording new species in the area.

Our results also show that these species are potentially threatened not only by anthropogenic activities, but also by aversive attitudes about bats while denouncing the conservation of bats' roost near their houses. Only the establishment of education programs emphasize the importance of bat ecological services and the necessity for effective bat conservation.

Acknowledgments

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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