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# Large and medium sized mammal species association with habitat type in Southeast Cameroon

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**Abstract:** The present study compares the association of large- and medium-sized mammals to habitats in two Community Hunting Zones managed as one entity, located in the northern periphery of Boumba-Bek National Park (BBNP), southeastern Cameroon. The wildlife survey was conducted along 126 2-km transects and 101 recce walkways between transects, for a total effort of 398 km. A total of 31 species, or groups of species, of large- and medium-sized mammals were observed in the primary forest (PF), secondary forest (SF), swamp (SW), plantation (PL) and fallow (FA) habitats. Species richness and abundance were significantly higher in PF and SF, than in SW, FA and PL. Accordingly, three sites located in PF and SF enclosing patches of SW, FA and PL were selected and proposed to establish eighteen permanent biomonitoring transects. These will provide data for developing an effective wildlife management model in the area.

**Key words:** Boumba-bek National Park, community hunting zone, habitat types, large- and medium-sized mammals, recce-transect, species response.

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## Introduction

Wildlife is a primary source of protein for many rural inhabitants in poor countries, particularly for people living in or near tropical forests (Bakarr *et al.* 2001; Eves & Ruggiero 2000; Fa *et al.* 2002). Due to the increase in human population, bushmeat trade has increased dramatically in the last three decades in these areas (Milner-Gulland & Bennett 2003). Unsustainable hunting of bushmeat has resulted in dramatic declines of local wild animal populations (Bennet *et al.* 2007; Milner-Gulland & Bennett 2003). Conservation of wildlife in the Congo basin has reached a crisis as judged by ecologists (Fa *et al.* 2002, 2003) and local communities (Akumsi 2003).

Habitat conversion is equally reported as a driving factor for species declines (IUCN 2010). Habitat conversion is common in most forest areas of Cameroon, where increased human population densities are driving wildlife species to extinction (Barnes & Lahm 1997; Robinson & Bennett 2000). In addition, logging companies are opening roads and bringing hunters into forests that were previously undisturbed (Oates 1999). Farmers are also moving into the forest zone to grow crops

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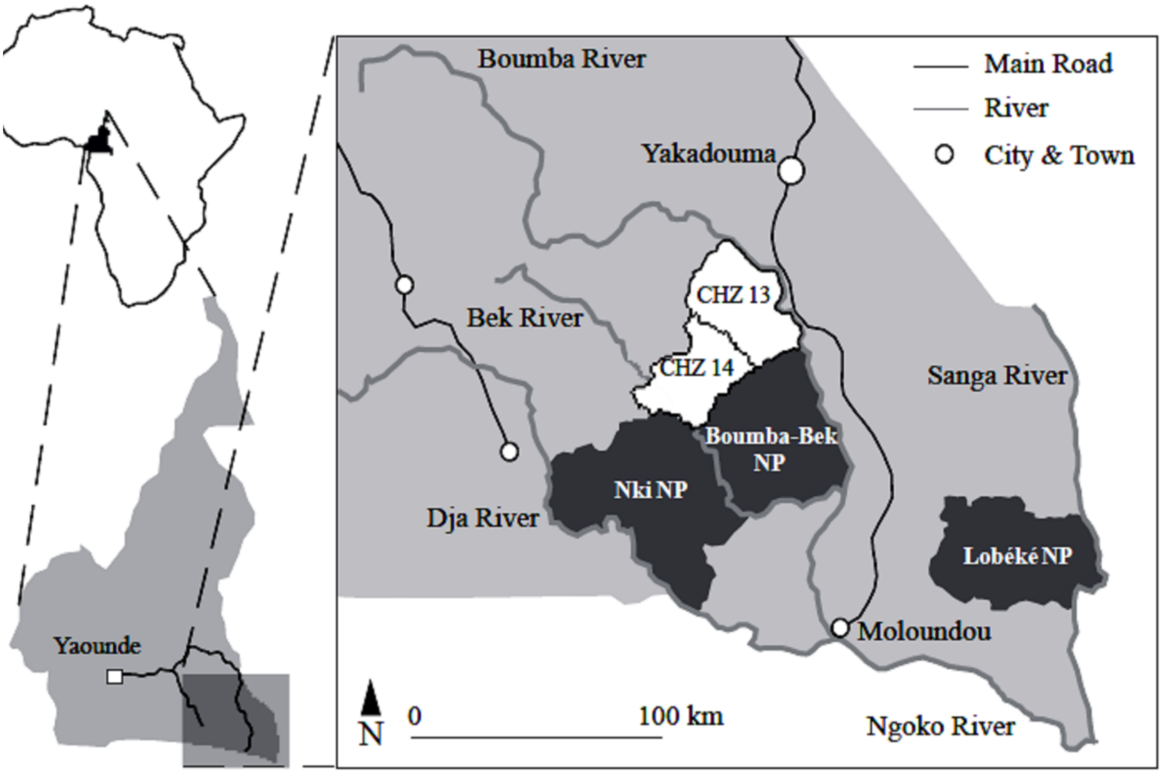


**Fig. 1.** Location of CHZs 13 and 14 (Bobo et al. 2014a).

(Oates 1999) leading to forest fragmentation into isolated patches (Parren & de Graaf 1995). Despite the fact that Southeast Cameroon has high species richness (Bobo *et al.* 2006a, b; Bobo *et al.* 2009; Ekobo 1998), the area is seriously impacted by anthropogenic activities which negatively affect large- and medium-sized mammal species (Bobo *et al.* 2014a). It is clear that sustainable wildlife management is necessary to preventing local species extirpation and extinction (Fa *et al.* 2014).

One response by Cameroon's government has been the development of participative management policies. These policies offer the chance to reconcile the well-being of local communities and biodiversity conservation (Endamana & Etoga 2007). The outcome of such a policy was the creation of Community Hunting Zones (CHZ) around protected areas (Djeukam 2007). CHZs 13 and 14 located at the peripheral zone of Boumba-Bek and Nki National Parks, Southeast Cameroon are key examples. However, these CHZs seem to be a failure because, not all stakeholders are fully invested in the management. In addition, management scenarios are not sufficiently supported by scientific research. Therefore, to assure long term success of CHZs 13 and 14, sustainable wildlife harvesting models must be created and tested in the area (Davies & Brown 2007). These models can only be developed if data to construct the model is available and if the local population is fully engaged in the construction and testing of the model. These data can be obtained by monitoring of mammal populations and the intensity of human activities (Halford *et al.* 2003). The present paper contributes to this long term objective by comparing the habitat associations or response of large- and medium-sized mammals, and identifying potential sites for the establishment of a long-term wildlife and hunting monitoring programme that will provide biological data necessary for building a management model for the area.

## Materials and Methods

### *Study area*

The study was conducted in CHZs 13 and 14, located at the northern periphery of Boumba-Bek National Park (BBNP) in the East region of Cameroon. They lie between latitude 2°09′ to 2°20′N and longitude 15°35′ to 15°50′E (Fig. 1). Because of the CHZs geographical proximity, both

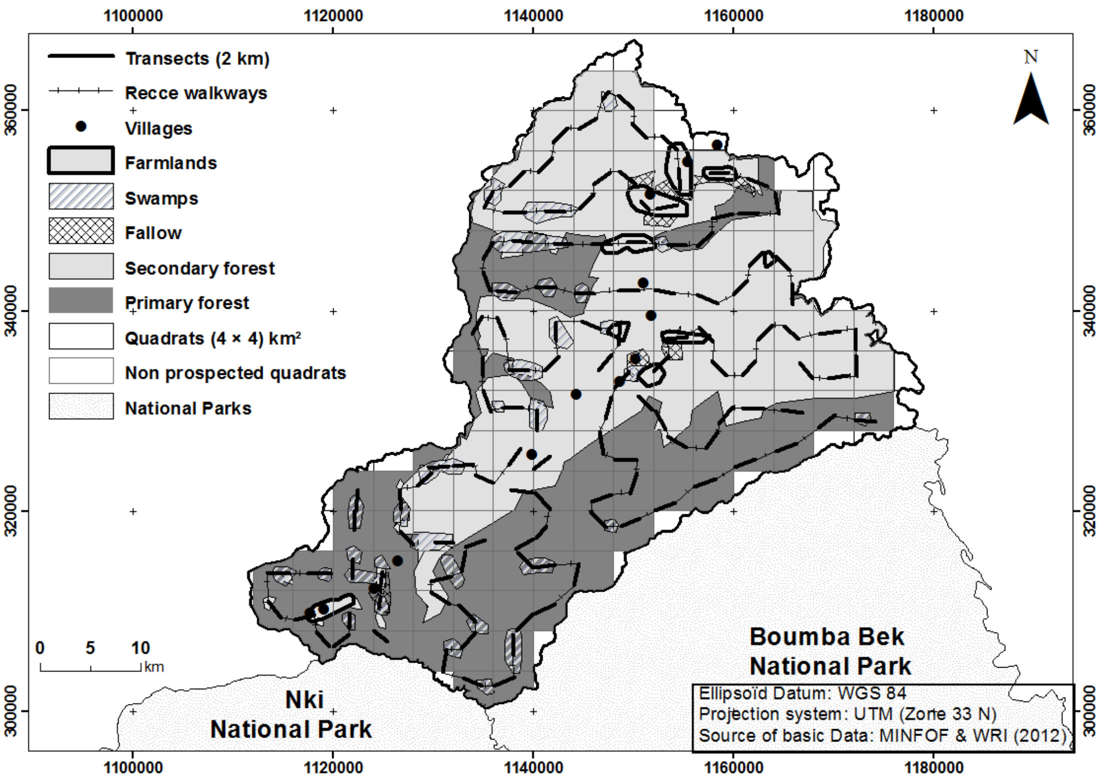


**Fig. 2.** Sampling design and distribution of habitats in the survey area.

are managed as one entity. The area is characterized by a bimodal equatorial forest climate. Average annual rainfall is about 1500 mm yr$^{-1}$, mean temperature is 24 °C and relative humidity lies between 60% and 90% (Ekobo 1995). The vegetation is primarily a mixture of evergreen and semi-deciduous forest (Letouzey 1985). Previous surveys of mammals have confirmed the presence of 34 species, including 11 primates, 12 ungulates, and four carnivores (Ekobo 1998; Makazi *et al.* 1998). The inhabitants of the area are the semi-nomad pygmies known as the Baka, and the local peasants known as the Bantou. The villages in CHZ 13 contain a total of about 4,500 people, whereas CHZ 14 harbors only about 800 people. The Baka Pygmies, the Konabembe, and other Bantu-speaking people inhabit the two CHZs (Fogue & Defo 2006; Halle 2000; Toda 2014). For food resources, local people produce crops (banana, cassava and cocoa), gather forest resources, and hunt wildlife.

## *Methods*

The survey was conducted using a combination of line transect and recce (reconnaissance) walk surveys (White & Edwards 2000) in accordance with the national norms for wildlife surveys in Cameroon forests (MINFOF 2006). CHZs 13 and 14 were divided into 131 quadrats of 4 × 4 km$^2$ each. In each quadrat, one 2-km-long transect was established. Two consecutive transects were joined by a recce walkway. Quadrats on the border of the CHZ were surveyed if at least 50% of its area was within the CHZ (MINFOF 2006). We surveyed 126 quadrats using 126 transects (71 transects in CHZ 13 and 55 transects in CHZ 14) and 101 recce walkways (56 in CHZ 13 and 45 in CHZ 14), giving a total survey effort of 398 km (Fig. 2). Due to logistical constraints, we were not able to prospect one quadrat in CHZ 13.

On both transects and recce walkways, direct observations of animals and indirect signs such as tracks/footprints, dung, feeding, shouts, beddings, and carcasses were recorded. Due to difficulties inherent to distinguishing their dung, footprints, and tracks on the forest ground, Peter's duiker (*Cephalophus callipygus*), bay duiker (*C. dorsalis*), black-fronted duiker (*C. nigrifons*) and white-bellied duiker (*C. leucogaster*) were grouped as red duikers (Bobo *et al.* 2014a; van Vliet *et al.* 2007). As in White & Edwards (2000), the age of each indirect sign observed was classified as: Fresh (0–5

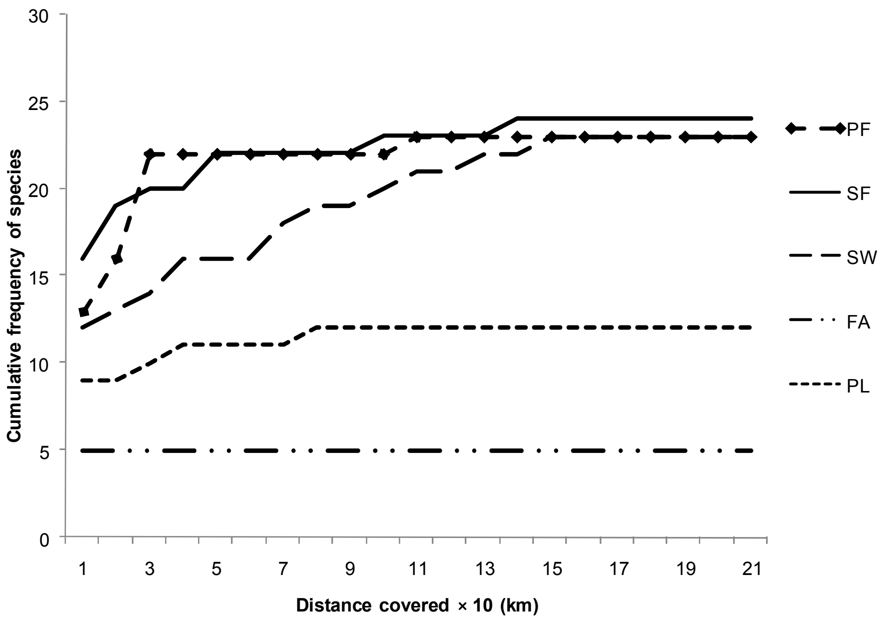


**Fig. 3.** Mammals species richness per habitat type and survey effort (PF = Primary forest, SF = Secondary forest, SW = Swamp, FA = Fallow, PL = Plantation).

days old for nests and 0–2 days old for all other signs, clearly visible, intact, moist, sparkling green coloured for nests and perceptible odour for dung), Recent (6–14 days old for nests and 3–5 days old for all other signs, visible, intact, dry, dull green coloured for nests and no odour for dung), Old (14–28 days old for nests and 6–14 days old for all other signs, visible, scattered, very dry, brown coloured for nests and partly disintegrated but recognisable dung), Very old (more than 28 days for nests and 14 days for other signs, fairly identifiable, completely disintegrated dung or nest on which plants have germinated, and difficult to predict the corresponding species). We assumed that all fresh or recent signs were observed equally across habitats.

Prior to the survey, suspected habitats were classified as: Primary forest (with very little or no anthropogenic activities and a forest canopy height ranging between 35–45 m, a canopy cover of 75–95% and sparse undergrowth), Secondary forest (with very high anthropogenic impacts, a canopy cover of less than 50%, degraded forest along roads, average canopy cover of 40–60%, average canopy height of 25–30 m and dense undergrowth), Plantation (land that has been used for subsistence crop production with very few natural trees left) fallow (previously cultivated land which has been left uncultivated to permit for restoration of soil fertility) and Swamp (land characterised by trees and herbaceous plants growing on muddy organic soils, usually found in flooded plains of rivers and poorly drained water basins). For each observation, the corresponding habitat was equally recorded.

### *Data Analysis*

Maps of the sampling design, habitat categories identified and the future biomonitoring plan were produced with Arc GIS 10.0 software. Relative abundances for species were estimated by computing encounter rates (ER), where: ER= Number of signs / Distance walked in km (Henshell & Ray 2003; Kühl et al. 2008; MINFOF 2006). A combination of all signs recorded was used in calculating the ER. Prior to the calculation, only fresh and recent signs of mammals were selected. Older signs were discarded to avoid bias because they may disappear at a different rate across habitats. Mean ER per species, per transect and per habitat type were computed. Test for significant differences between mean responses of species per habitat type was done using one way ANOVA at a probability threshold of 95%. In the case of significant differences between species response per habitat, Tukey's HSD test was used to compare pairs of mean species response per habitat. All statistical analyses were conducted in Statistica 8.0 software.

## Results

### *Habitat types*

A total of five habitats were encountered in the survey area (Fig. 2). These are: Primary forest (PF), secondary forest (SF), swamp (SW), fallow (FA) and plantation (PL). The survey area was primarily covered by SF and PF habitats. The secondary and primary forest habitats covered an evaluated land cover area of 1084.7 km² (53.8%) and 721.4 km² (35.7%) respectively. Swamps, farmlands and fallow habitats covered 117.7 km² (5.8%), 49.8 km² (2.5%) and 45.5 km² (2.1%) respectively. More than 50% of CHZ 13 is converted to SF, farmlands and fallow land meanwhile CHZ 14 is covered by PF and less modified.

### *Mammalian species richness per habitat type*

We recorded a total of 31 large- and medium-sized mammal species, or groups of species, and 9,922 signs in the survey area. From the cumulative frequency plot of species encountered per distance covered on transects and per habitat (Fig. 3), SF and PF habitats presented the greatest species richness with 24 and 23 mammal species or groups of species respectively. Similarly, we recorded 22 mammal species in SW, 11 in PL, and five mammal species or groups of species FA. As survey effort increased, the number of species encountered per habitat increased (except in FA) until a climax (145 km) where an increase in survey effort showed no change in species richness.

### *Mammalian abundance per habitat*

In the study area, we recorded a total of 9,922 observations corresponding to an encounter rate (ER) of 24.9 signs/ km for the 31 species identified. Accordingly, we recorded 5,247 observations of large- and medium-sized mammals in SF, 3767 in PF, 742 in SW, 89 in PL and 77 in FA.

Highest ERs in different habitats were observed for blue duiker (*Cephalophus monticola*), red duikers (*Cephalophus callipygus,* C. *dorsalis, C. nigrifons* and *C. leucogaster*), porcupines (*Atherurus africanus*), elephant (*Loxodonta africana cyclotis*), red river hog (*Potamochoerus porcus*), tree pangolin (*Phataginus tricuspis*) and putty nosed monkey (*Cercopithecus nictitans*) (Table 1).

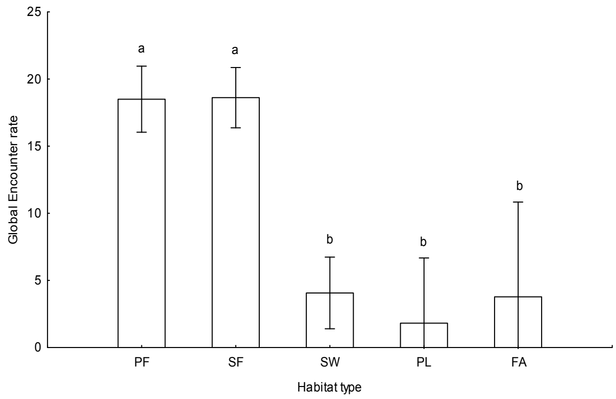


**Fig. 4.** Comparison of mammals species abundance per habitat type (PF = Primary forest, SF = Secondary forest, SW = Swamp, FA = Fallow, PL = Plantation).

### *Comparisons of mammal species abundance per habitat*

Habitat modification significantly affected the abundance of mammals species ($F_{1,4}$ = 28.543; $P$ = 0.000) (Fig. 4). Species response in PF was not significally higher than in SF habitat ($P$ = 0.999) but was significantly higher than in SW ($P$ < 0.001), PL ($P$ < 0.001) and FA ($P$ = 0.030) habitats. Similarly, species response in SF was significantly higher than in SW ($P$ < 0.001), PL ($P$ < 0.001) and FA ($P$ = 0.028) habitats. Species response to habitat modification was not significantly different between SW, PL and FA habitats ($P$ > 0.05).

### *Biomonitoring programme*

We identified three sites for the installation of biomonitoring transects. The first two sites (one in CHZ 13 and one in CHZ 14) are located in PF and SF, and enclosing patches of SW, FA and PL for the installation of biomonitoring transects. The third site was proposed in BBNP (where human activity is expected to be the lowest) to evaluate the differential impact of hunting (Fig. 5). The first two sites are located south-east of each CHZs. The third pool of biomonitoring transects are located in the Northern periphery of BBNP. In these sites, eighteen 2-km transects will be established. Transects will be separated by at least 1 km from each other. Direct and indirect observations regarding mammal and anthropogenic activities will be recorded once every three months as to cover each season of the year. Camera trapping observations using infra-red cameras will also be recorded and, net hunting exercises on 100 m x

**Table 1.** Large- and medium-sized mammal species abundance per habitat.

| Species | Abundance (n/L) | | | | |
|---|---|---|---|---|---|
| | PF | SF | SW | PL | FA |
| *Cephalophus* spp.* | 8.64 | 17.12 | 12.17 | 1.43 | 2.67 |
| *Cephalophus monticola* | 5.37 | 7.75 | 4.87 | 1.86 | 5.00 |
| *Atherurus africanus* | 4.53 | 8.98 | 3.61 | 1.79 | 4.00 |
| *Loxodonta africana cyclotis* | 1.34 | 2.85 | 2.61 | 0.00 | 0.00 |
| *Potamochoerus porcus* | 1.01 | 1.39 | 3.87 | 0.00 | 0.00 |
| *Phataginus tricuspis* | 0.42 | 1.90 | 0.22 | 0.21 | 0.67 |
| *Cephalophus silvicultor* | 0.44 | 0.80 | 0.39 | 0.00 | 0.00 |
| *Gorilla g. gorilla* | 0.56 | 0.98 | 0.52 | 0.00 | 0.00 |
| *Hyemoschus aquaticus* | 0.25 | 0.74 | 1.39 | 0.07 | 0.00 |
| *Cercopithecus nictitans* | 0.37 | 0.73 | 0.35 | 0.36 | 0.00 |
| *Pan troglodytes* | 0.23 | 0.22 | 0.09 | 0.00 | 0.00 |
| *Tragelaphus spekei* | 0.08 | 0.12 | 1.26 | 0.00 | 0.00 |
| *Smutsia gigantea* | 0.13 | 0.22 | 0.13 | 0.00 | 0.00 |
| *Neotragus batesi* | 0.12 | 0.08 | 0.09 | 0.21 | 0.00 |
| *Cercopithecus pogonias* | 0.08 | 0.11 | 0.00 | 0.00 | 0.00 |
| *Lophocebus albigina* | 0.06 | 0.11 | 0.04 | 0.00 | 0.00 |
| *Cercopithecus neglectus* | 0.06 | 0.09 | 0.04 | 0.00 | 0.00 |
| *Tragelaphus euryceros* | 0.06 | 0.01 | 0.04 | 0.00 | 0.00 |
| *Cercocebus agilis* | 0.03 | 0.05 | 0.09 | 0.07 | 0.00 |
| *Atelerix albiventris* | 0.02 | 0.04 | 0.00 | 0.21 | 0.00 |
| *Thryonomys swinderianus* | 0.00 | 0.01 | 0.04 | 0.07 | 0.50 |
| *Civettictis civetta* | 0.01 | 0.04 | 0.04 | 0.14 | 0.00 |
| *Herpestes naso* | 0.00 | 0.07 | 0.00 | 0.00 | 0.00 |
| *Syncerus cafer nanus* | 0.01 | 0.02 | 0.00 | 0.00 | 0.00 |
| *Panthera pardus* | 0.01 | 0.00 | 0.22 | 0.00 | 0.00 |
| *Dendrohyrax arboreus* | 0.00 | 0.00 | 0.09 | 0.00 | 0.00 |

*are red duikers: Peter's duiker (*Cephalophus callipygus*), bay duiker (*C. dorsalis*), black-fronted duiker (*C. nigrifons*) and white-bellied duiker (*C. leucogaster*).

100 m plots installed on randomly chosen points along the transect lines will be performed.

## Discussion

We recorded 31 large- and medium-sized mammal species (or species groups) in five habitat types. We surveyed each habitat until no new species were discovered in subsequent surveys, implying that the 31 species encountered and 145 km effort represented the maximum number of large- and medium- sized mammal species in the survey area and the corresponding survey effort to encounter all mammal species in the area (as in Bobo & Nyansi 2009; Bobo *et al.* 2009; Ekobo 1998; Nzooh *et al.* 2002). The highest species richness was recorded in SF and PF habitats which covered altogether about 90% of the total surface area of the surveyed CHZ. They equally seem to offer the best habitat for mammals that are dependent on undisturbed habitats (e.g. Gorilla and most primates) and logged disturbed habitats (e.g. forest duikers and rodents) (see also Bobo *et al.* 2014b; Waltert *et al.* 2002). In terms of abundance, encounter rates of large- and medium-sized mammals decreased along a gradient from PF to SF, SW, FA and PL respectively. In the study area, increasing levels of anthropogenic disturbance affected species richness and abundance. In both CHZ, Bobo *et al.* (2014a) reveals that densities of

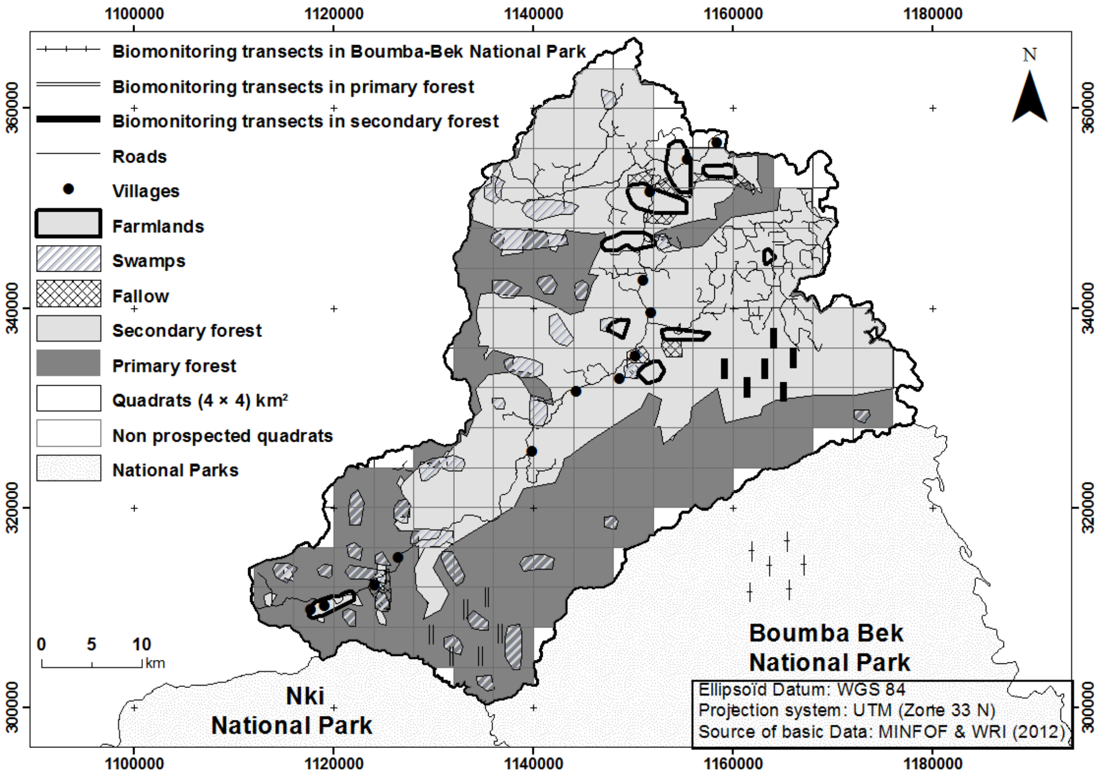


**Fig. 5.** Map of proposed biomonitoring program.

human populations and occurrence of roadways and villages affect negatively the abundance of large- and medium-sized mammals. The high human populations in CHZ 13 may be responsible for the habitat conversion of the area. More than 50% of the CHZ is SF and large farmlands and fallow land can be found around the inhabited villages. Habitat-species associations gives more insights as to how the situation of establishing a wildlife monitoring program to collect biological data necessary for constructing a wildlife management model in the area can be made successful. This process does not neglect the reports that stipulate that habitat modification by human activities are drivers of wildlife declines in neigbouring forest areas South-east of Cameroon (Bobo *et al.* 2006a, b; Bobo *et al.* 2009; Bobo & Nyansi 2009). It favours species displacement to refuge sites especially species that are very sensitive to poaching and habitat modification. Nonetheless, the study area is still rich in terms of species richness and abundance because the area is primarily covered by ancient logged SF and PF habitats (see also Bobo *et al.* 2014a).

Three sites (one in CHZ 13, one in CHZ 14 and one in BBNP) located in PF and SF habitats and enclosing patches of SW, FA and PL were identified for the installation of biomonitoring transects. The site in BBNP will serve as control as it represents nearly the standard situation of wildlife populations in the area. The sites were equally chosen because the spatial distribution of all wildlife species observed and human activity encounter rates ranges are moderate (Bobo *et al.* 2014a). Also, the geographical extent of village hunting territories and data on bushmeat harvest rates are available for the area (Bobo *et al.* 2015) Biomonitoring of wildlife and human activities is a first step of the process for constructing a wildlife management model for the area. The area has a potential in wildlife that is relatively higher than that in other areas of Cameroon (Bobo *et al.* 2014a). Biomonitoring in this area will provide biological data on wildlife abundance and hunting intensity necessary for constructing an Agent-based simulation model. This model will be integrated in an artificial landscape of the area and interactive simulations meetings with locals will be held to raise the awareness of the population about the wildlife situation in their area and to stimulate them to engage in collective discussions about the feasibility of sustainable hunting, based on their aspirations. The trends of wildlife according to hunting activities in the area will be simulated for local communities to understand the potential impact of different hunting techniques in their area and propose possible management measures. The measures will be integrated in the model and the best management scenario will be adopted and implemented in the area.

## Conclusion

The evaluation of large- and medium- sized mammal species richness and abundance, their response to changes in habitat types, completed by species distribution, bushmeat harvest surveys and hunting magnitude in the study area (Bobo *et al.* 2014a), resulted in the identification of three potential sites for biomonitoring. These sites are found in the PF of BBNP and in PF and SF habitats of both CHZ, enclosing patches of SW, FA and PL habitats. They present the best chance to encounter and monitor mammal species dynamics and anthropogenic activities. However, this is just the beginning of a long term process because; biomonitoring will provide information required for the construction and implementation of an effective wildlife management model in the study area. This could be a positive response to the threatened state of wildlife in Southeast Cameroon in particular (as in Ngahane 2015), and the assurance of long term use of wildlife in Central African regions (Fa *et al.* 2014).

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