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Inventory of mammals in the Bomassa Triangle towards its transformation into a community wildlife reserve

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1 SUMMARY

The classification of a zone as an animal reserve or the extension of an area that is protected for tourism purposes, or protection of animals against illegal exploitation requires, as a preliminary, sufficient knowledge of the target area. One of the first stages in such a study is quantitative and qualitative inventory of the components of such an ecosystem. This study was undertaken in the Bomassa Triangle, a zone of approximately 45.000 hectares in the Department of Sangha, at the meeting point of Congo, the Central African Republic (RCA) and Cameroon. For eight (8) months, from February to September 2009, corresponding to the period of the dry seasons, an inventory of the large mammals was carried out by linear transects method in order to determine the abundance and distribution of species. The results showed that the Bomassa Triangle has a rich diversity of animals, including 13 species of large and average sized mammals. The population and the density of the elephant as analyzed by the distance program showed that N = 167, 37 and D = 3, 73 observations/km². The information generated will help decision makers as they classify this zone into a community wildlife reserve.

2 INTRODUCTION

The problem of conservation of wild animals is significant in most developing countries in general and in Congo in particular. From its trophic chain, wild fauna is highly sensitive to modifications that occur in its habitat. The situation is more serious where the indigenous populations exploit wild animals for food, which can exert pressure with generally adverse consequences on the populations.

Presently, increase in population, which is particularly high in Congo (4%), has been associated with increasing pressure on protected zones, e.g. national parks and classified forests. Improved hunting methods, capture or removal and the disappearance of many benefits associated with wild animals led to increased interest to seek acceptable methods of exploitation that accommodate the needs of the population but also fulfils the requirements for conservation. In many situations, the human impact is such that it could lead to total destruction of the animal populations and their habitats, if uncontrolled.

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Conscious of the current and potential role of its biological diversity for present and future generations, Congo directed its efforts of conservation towards the creation of protected zones, in which some controlled hunting is allowed. Furthermore, a rational and durable management is needed for the peripheral ecosystems surrounding the protected zones as these are also vulnerable to exploitation by the surrounding communities for providing animal protein substitutes and alternative economic activities.

The Bomassa Triangle is a rich zone which offers the ideal opportunity to undertake a study towards classification in a community animal reserve. The objective of this study was to obtain information on the biological richness of the Bomassa Triangle in order to decide the legal status to accord the zone.

3 MATERIALS AND METHODS

3.1 Localization and characteristic of the zone of study: The Triangle of Bomassa is a zone of roughly 45.000 hectares in the department of Sangha, located at the meeting point of Congo, the Central African Republic (RCA) and Cameroun (Figure 1). Its part of the forest unit (UFA) of Kabo, currently conceded to the wood harvesting company, (CIB). The Triangle is a corridor of immigration of large mammals coming from the Lobéké National park in Cameroun to the National park of Nouabalé-Ndoki in Congo and vice versa. In addition to its role as an ecological corridor, the large mammals are attracted to this zone by secondary vegetation which provides sources of food.

This triangle forms part of the territory of Bomassa - Boncoin, two peripheral villages with the National park of Nouabalé-Ndoki, which are used as a basis for the execution of conservation activities. This territory abounds in natural resources (fauna and flora) including animal products (game, birds, insects) and plants (mushroom, fruits, sheets, tubers) that the Bantous and semi nomad (pygmies) populations utilise for food.

The communities of Bomassa recognize the current limits of this zone as being to the North by the Djeké River; in the South by the rivers Lombé and Malolé; in the East by the Ndoki River; in the West by the Sangha River and the tailboard bordering Congo - RCA.

3.1.1 The abiotic environment

Climate: The climate of the zone of Bomassa is of the equatorial type. It is subdivided into four (4) seasons with main rain season from August at October, and a short rain season from November to January, a long dry season from February to April and a short dry season from May to July.

Hydrography: The hydrographic network of the Triangle of Bomassa is rich and diversified. In the north of the Triangle, there is the Djeké River and the prolongation of Ndoki. The western side is bordered by the Sangha river, the southern part by the rivers Lombé and Malolé, the Ndoki river on the eastern side, and at the interior of the Triangle, certain rivers, e.g. Wali.

Soils: The soils are mostly ferrallitic on laterite.

3.1.2 The biotic medium

Vegetation: The zone of study is characterized by a secondary and regenerated forest with six subclasses of plants found there. These include the regenerated forest zone (old zones of agricultural activities around the Bomassa villages and Good-Corner); the forest with Marantacées and Zingibéracées; the mixed forest ground cover (e.g. *Entandophragma* spp., *Anonidium manii*, *Chrysophylum africanum*, *Duboscia macrocarpa*, *Symphonia* sp.); the forest monodominate in *Gilbetiodendron dewevrei*; the marshy forest and the clearings or baïs (Wali, Mopo, Mombongo) which is attended by the large mammals such as the *Loxodonta africana cyclotis* , the *Syncerus caffer nanus*, *Tragelaphus euryceros*.

Fauna: The zone of study has diversified fauna, especially important populations of large mammals which are in danger such as the *Loxodonta africana cyclotis*, the *Gorilla gorilla gorilla*, the *Pan troglodytes* and *Tragelaphus euryceros*.

Population: The population bordering the National park of Nouabalé-Ndoki, more precisely that of Bomassa - Boncon present in the Triangle of Bomassa increased considerably in the last decade. In 1999, it was estimated at 195 inhabitants but during the last demographic census carried out in March 2009 (Ekoutouba and Dissondet, 2009...) the population of Bomassa - Boncoin had passed 517 inhabitants, indicating an annual increase rate of 5.08%. This census does not take account of the population lying in other sites of the Triangle such as Mombongo and the campings along Sangha.

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Table 1 shows the evolution of this population since the creation of the park so far. It places at the disposal of the decision maker's information likely to direct them towards the policy to be adopted for the Triangle of Bomassa.

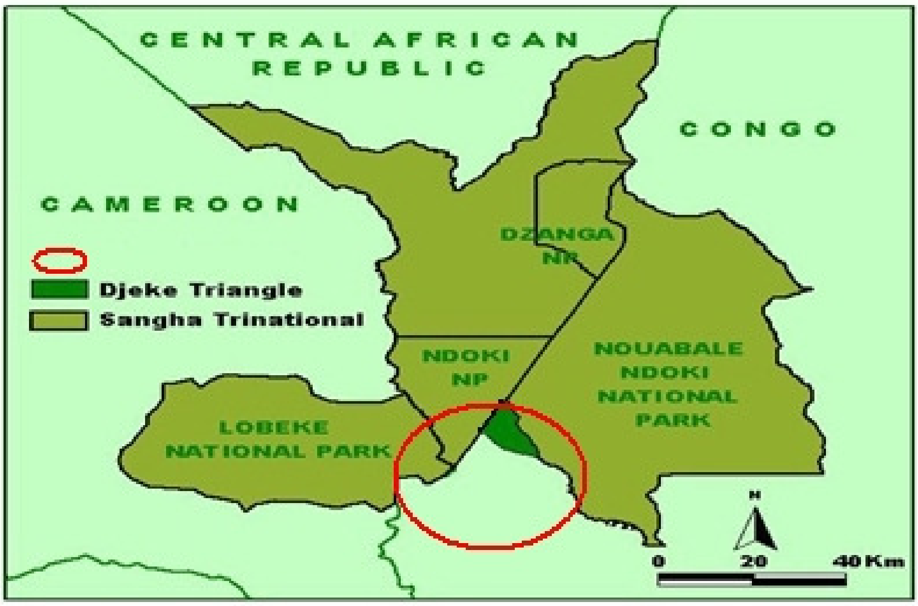

Figure 1: Presentation of the zone of study Triangle of Bomassa

Table 1: Evolution of the population of Bomassa – Bon-Coin, 1992-2009.

Year	Effective Bomassa	Effective Bon-Coin	Total population	TA (%)
1992	214	66	280	
1993	149	43	192	-31.4
1994	188	46	234	21.9
1995	149	43	192	-17.9
1996	156	39	195	1.6
1997	159	34	193	-1
1998	162	33	195	1
1999	157	38	195	0
2000	161	46	207	6.2
2001	199	55	254	23
2002	202	53	255	0
2003	206	65	271	6
2004	209	63	272	0
2005	280	90	370	36.03
2006	284	91	375	1.35
2007	318	95	413	10.12
2008	361	131	492	19.12
2009	**377**	**140**	**517**	**5.08**

3.1.3 Techniques of inventory: Two techniques of inventories of the large mammals in the Triangle of Bomassa were adopted in this study, i.e. (1) investigations from the local population and (2) investigation on the ground using linear transects method (Van Lavierien & Bosch, 1997, quoted by Tsakem, 2000).

To obtain information about the large mammals in the Triangle of Bomassa, interviews were carried out with the hunters and residents of Bomassa – Boncoin villages. After analysis, it was noted that majority of the sampled population are hunters. The former recognize the existence of the large mammals in the Triangle of Bomassa but the latter are unaware of the benefits existing in this zone. Majority think that the resources that have existed since their ancestors cannot in any way disappear, though some note it is increasingly difficult to find game compared to the former years. Although there is appreciation of game reduction by the population of Bomassa-Boncoin, they are repulsive to new proposals on the development of alternative interventions, e.g. breeding, to compensate for the reduced sources of proteins. In their opinion animals resulting from breeding are of inferior quality compared to bush meat.

By the linear transect method, data were recorded along a linear transect, animal species seen or their signs (droppings, tracks, nests, carcasses); the exact hour when the observation was made; the perpendicular distance, measured between the line of walk (transect) and the place where the animal (or signs it) was seen; the type of vegetation where the animal (or signs is); meteorology; and the distance covered by the observer on the transect.

3.1.4 Data recording

Research equipment: These included 2 GPS (Garmin 12XL) for recording the geographical co-ordinates, 2 compasses for directions, 2 binoculars for distant observations, 1 topo wire and a biodegradable wire for the measurement of distances covered; 1 pentameter and a double decametre for measuring perpendicular distances; 2 shears to open the transects; watches for the synchronization of time; coloured ribbons to mark starting point (GPS beginning + course) and of end (final GPS + course) of the transects; materials for camping.

Research team: The team included the principal observer, charged to collect the data on the signs of animals and human activities; 1 assistant observer responsible for detecting the nests of Pongidés, to estimate their height and measure the perpendicular distances from the various observations; 1 research assistant; 1 tracker charged with opening of the transects; 1 boussolier; and 3 carriers for the handling of the material.

Research plan: The inventory started at 07.00 hours and ended at the latest at 16.00 hours if one could make two transects and two recesses on the same day. Once the starting point of the transect was located using GPS (GPS beginning), the boussolier directed the team in the appropriate direction. The members of the team moved in the direction indicated one after the other with the least possible disturbance to the vegetation. The boussolier had the obligation to take care at every moment on the azimuth so that the tracker maintained the same direction of walk until the end of the transect. The team traversed the transect as silently as possible while scanning on both sides of the transect axis to detect any signs present. When a sign was detected, the following information was noted: the species; the perpendicular distance; the hour (to the nearest second) when the observation was made; vegetation; meteorology; and the age of the sign.

Data handling: The data were entered on MS Excel template and after pre-treatment, statistical analyses were carried out using the software OUTDISTANCES version 5.0 for Windows. This program requires a high degree of accuracy in measurement of the distances and sufficiently analyzes data for the species observed with at least 40 observations (Buckland *et al.*, 1999). In the present study, this threshold (40 observations per species) was reached only for the *Loxodonta africana cyclotis*. Thus, our analyses on Distance relates only to this species. For the other mammals, it data were calculated based on the rates of meeting (TR) or kilometric index of abundance (IKA) in the zone.

4 RESULTS

Estimate of the densities: The density is the number of objects (individuals or groups) or of signs observed per unit area in a site. It is expressed according to the general formula:

$$D = \frac{n}{2.L.a}$$

Where;
N = number of observations;
L = traversed total length;

a = estimate of the width prospected of each with dimension of the transect.

Whereas N and L are obtained easily, the difficulty of the estimate of the densities by transects lies in the estimate of the width on which the counting is carried out, which depends on the probability of detecting an object at a given distance. Unknown parameter can be half the real length of the band of the transect and the relation between A and the function of detection are the integral of the curve of detection.

$$a = \int_0^w g(x).dx$$

The function g(x) makes it possible to estimate the probability of detection (pdf) f(x) of the data of transect. It is starting from the function of probability of detection that the program Distance calculates f(0), which is an estimate of the frequency with which the animals or their signs are detected on the line of the transect as well as the confidence interval at 95% (Buckland *et al*., 1999).

In a practical way, the density is calculated by the following mathematical formula:

D = N / (2*l*L)

Where:

N = a number of observations

L = length of (or of) the transect(s) traversed

I = sampled bandwidth

This formula supposes that one counted all the observations on the sampled surface. Moreover, the width is multiplied by two (2) but there is a zone of detection on each side of the transect. However, the data taken in linear transects shows that all the animals or signs of animals are not detected. Intuitively, the animals or the signs of the animals furthest from the transect have less probability of being detected by the observer. Thus, a factor of correction is necessary to correct the unperceived objects. It is about the probability of detection noted (p). Thus, the density is calculated with the function in the following way:

D = N / (2*l*L*p), where p is the probability of detecting an index

The density of the elephants in the sampled zone is thus:

D = 245 Obs / (2 X 4080 km X 20 km X 0, 40157) = 3, 73839 Obs/Km².

D = 3, 73839 Obs/km²

The density of the elephants in the zone of study, calculated manually are thus 3, 7 elephants per km². This implies there is a highly likely chance of meeting 3 elephants in the zone of study within a distance of 20 km. To check the exactitude of this assertion, the software Distance version 5.0 for Windows was used (table 2).

Calculation of the rates of meeting (TR): The species insufficiently observed were subject to an analysis of the rates of meeting (TR) or kilometric index of abundance (IKA). The rate of meeting is defined as the relationship between the total numbers of observation (n) of a species compared to the total traversed distance (L). It is calculated for a species or all the species in a zone. Carried out regularly in the same zone and the same conditions, it is a good indicator of the animal population, for it makes it possible to know if the population increases, decreases or stagnates. Its mathematical expression is:

$$TR = \frac{n}{L}$$

Table 3 shows the rates of meeting of the mammals encountered in the Triangle of Bomassa during the study, except the elephant species. We notice that the gorilla of the plains of the West (*Gorilla gorilla gorilla*) was the species most met in terms of index at 35 observations, followed by *Céphalophus reds* with 23 observations. This group of *Céphalophus* includes all *Céphalophus* except *blue Céphalophus* (*Cephalophus monticola*) and *Céphalophus* with yellow back (*Cephalophus sylvicultor*). This regrouping is due to the fact that it is not easy to make a distinction of the signs of these *Céphalophus*. Due to the the risk of having an illusion, one carries out a regrouping of these animals in the same group during the counting of the signs along the transects. On the other hand droppings of both other *Céphalophes* (*Céphalophe blue* and *Céphalophe with yellow back*) are easily identifiable. Pongidés were observed 11 times. In this group the *Pan troglodytes* are together placed in the same group called Pongidés, since it is often difficult to allot the sign to the *Pan troglodytes* with clear face and the *Pan troglodytes* with black face. The rate of meeting of human signs was of 0.5 observations/km (10 observations in 20km). These observations can be classified by order of importance as follows: 6 tracks of unloading, 2 tailboards forest, 1 heard shot and 1 sign of streamer of the researchers.

The signs of *Céphalophus with yellow back* and *blue Céphalophus* were respectively seen 3 and 2 times. The other mammals observed included *Cercopithecus cephus*, *Cercopithecus pogonias*, the Syncerus caffer nanus and *Colobus guereza* were observed only once. Lastly, Céphalophus bai and Cercocèbe with gray cheeks were not observed during our inventories. However, during former work, these two species were seen in our zone of study.

Table 2: Summary of results after analysis using DISTANCE software for elephants in the forest.

Parameter	Value estimated	Standard error	CV	Confidence interval at 95%	
f(0)	0.68247	11.18	0.49003	0.76022	
p	0.40157	0.44902	11.18	0.3224	0.50017
ESW	1.6384	0.18320	11.18	1.3154	2.0407
n/L	12.235	2.3791	19.45	8.1747	18.311
D	3733.7	837.53	22.43	2379.3	5859.2
N	0.16737	0.37542	22.43	0.10665	0.26264

Effort (traversed total distance) = 20.02500 meters; samples (a number of sampled quadrants) = 20; width (sampled bandwidth) = 4.08 meters; observations = 245.

Component Percentages of Var(D)

Probability of detection: 24.8

Rate of meeting: 75.2

Description of the parameters for the Elephant of forest: - f (0): Ordinate at the origin of the function of density of probability.
Corresponds contrary to the effective bandwidth (ESW) = 1/ESW = 0,610351 - ESW: Bandwidth multiplied by the probability W*p detection = 1, 6384 p is the probability detection (0, 40157), that means that approximately 60 % of animals present in the sampled band (2x m) were not detected.
n/L or TR is the rate of meeting, i.e. the number of animals observed per unit of length.
D: density of the Elephant in the zone (3, 7337 individuals/Km^2) with confidence intervals of [2, 3793 - 5, 8592];
N: population of the Elephants in the zone (0, 16737) with the intervals of [0, 10665 - 0, 26264].

Comparison with previous study: For the period between August to December 2008 and January 2009, corresponding to the rain season, the same study was undertaken in our zone of study using the same traversed transects and recesses. The data collected makes it possible to evaluate the distribution of mammals for two distinct periods, i.e. the rainy and the dry season (table 4). Based on this analysis it is possible to have three principal groups of species:
(i) the animals whose population increased or remained constant. These include the forest elephant, *Céphalophus with yellow back*, *blue Céphalophus, Cercopithecus pogonias* and the Syncerus caffer nanus;
(ii) the species whose population gradually decreased over time, e.g. the Gorilla, Pongidés, *Céphalophus bais* and *Cercocèbe with gray cheeks*;
(iii) the species with no precise tendency or trend, e.g. the *Colobus.*

To check if the differences in abundance between the two phases were significant, the Mann Whitney statistical test was carried out, in which the rates of meeting of all the transects were compared using the software STATISTICA. The results showed no significant difference in abundance between the two seasons, except for the *Gorilla gorilla gorilla.*

Table 3: Rate of meeting of the species insufficiently observed.

Species	Numbers observations	TR (a number of observations / km
Gorilla gorilla gorilla	35	1,75
Cephalophus reds	23	1,15
Pongidés	11	0,55
Signs human	10	0,50
Céphalophus with back yellow	3	0,15
Céphalophus blue	2	0,10
Cercopithecus cephus	1	0,05
Cercopithecus pogonias	1	0,05
Syncerus caffer nanus	1	0,05
Colobus guereza	1	0,05
Céphalophus bai	0	0
Cercocèbe with cheeks gray	0	0

5 DISCUSSION

The methodological approach adopted in this study enabled us to better understand the biological potentialities of the Triangle of Bomassa. This study obtained comprehensive data on the abundance of mammalian species in this the study area, and thus it can be valuable tool which could be used in decision-making regarding the classification of this zone into a community animal reserve.

However, it is worth noting that the linear transects method is far from reality as it is a probabilistic method that requires many inputs. In the case of our study, the inventories carried out did not affect the totality of the Triangle of Bomassa, but were made only on ¼ of the triangle while the analyses carried out using the Distance program took into account the total surface of the Triangle. With this approach one may end up with an over-estimate or undervaluation of the population. Such results could lead to a flawed policy decision on the action to be taken.

With the above in mind, the most effective method would be that of recess, which is currently the preferred methodology of carrying out census on large mammals and human impact (White & Edwards, 2000). This method is less expensive and provides a fast evaluation of the relative abundance of large mammals, human incursions and their impact. This data is particularly useful in management of protected areas. .

Indeed, the creation of a protected area needs to take into consideration all stakeholders interests and should thus be preceded by consultations with the community to be affected. The recognition of the primary role of the populations in biological stock management is one of the major innovations in the process of wildlife conservation. This has been recognised since the 1990s (Assitou Ndinga, 2007). Thus, the transformation of the Triangle of Bomassa into a community animal reserve should not be under the sole control of the ministry in charge of the National Forestry Commission or less still of the non-governmental organisations in conservation. The interests of the resident populations should be taken into account alongside those of the above mentioned actors.

Another challenge that might be encountered and thus to be taken into account is the dependence of the population on hunting to obtain animal protein sources. Our study clearly shows an increase in this population since the establishment of the Nouabalé-Ndoki Project. This increase in the population is associated with a corresponding increase in exploitation and removal of animal resources from the Triangle. Therefore, changes in the legal status of the Triangle needs to ensure measures are in place to support sustainable exploitation to ensure constant renewal of the animal populations.

Table 4: Rate of meeting of mammalian species in Bomassa Triangle during two inventories.

Species	First inventory (rain season)		Second inventory (season dries)	
	A number of observations	TR	A number of observations	TR
Loxodonta africana cyclotis (droppings)	219	10,95	264	13,23
Loxodonta africana cyclotis (tracks)	722	36,1	612	30,6
Gorilla gorilla gorilla	194	9,7	35	1,75
Céphalophus red	41	2,05	23	1,15
Pongidés	33	1,65	11	0,55
Signs human	30	1,5	10	0,50
Céphalophus with back yellow	0	0	3	0,15
Céphalophus blue	0	0	2	0,10
Cercopithecus cephus	2	0,1	1	0,05
Cercopithecus pogonias	0	0	1	0,05
Syncerus caffer nanus	0	0	1	0,05
Colobus guereza	1	0,05	1	0,05
Céphalophus bai	4	0,2	0	0
Cercocèbe with cheeks gray	1	0,05	0	0
	1247 signs	**4,456**	**964 signs**	**3,445**

The decline in the population of some species, e.g. *Gorilla gorilla gorilla*, Pongidés and *Céphalophus bais*, was not significant and this situation could be related to the varying effect of seasons. During the dry season, the food availability reduces for these species in the zone of study and the animals move towards zones where they can find sources of nutriments. The results suggest that human activity in the Triangle of Bomassa is still minimal and thus does not affect the presence of the animals. Lastly, it is important to point out that there were certain species of large mammals that were not observed in the Triangle of Bomassa at the time of the two inventories. These include, for example, the Leopard (*Panthera pardus*) of which signs were observed before starting the inventory in transect 14, and Bongos (*Tragelaphus euryceros*). Other species are nocturnal and arboricoles, whose presence was difficult to detect during the day. Among these is Daman (*Dendrophyrax arboreus*) which can be easily identified using the barking sound that it emits at night around 20.00 hours and very early in the morning.

6 CONCLUSION:

This study on the inventory of fauna in the Triangle of Bomassa is an important scientific step that has provided information on the biological potentialities of this zone in order to enable policy makers to decide on measures for protecting the area as a Community Animal Reserve. The results of the present study show that the Triangle of Bomassa has a rich animal diversity. Some of these animals, e.g. the Elephant and the Gorilla face critical threats worldwide. It is therefore important for zones which shelter these rare species to be accorded detailed attention at the national, sub-regional and international levels. The Triangle of Bomassa will be benefit from legal protection as a wildlife reserve area.

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