CAMEROON BIODIVERSITY PROGRAMME

DISTRIBUTION AND CONSERVATION STATUS OF GORILLA POPULATION IN THE FORESTS AROUND BELABO, EASTERN PROVINCE, CAMEROON

Report to:

Cameroon Oil Transportation Company (COTCO)

By

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TABLE OF CONTENTS

TABLES

FIGURES

1 EXECUTIVE SUMMARY

General Background and opportunities

Gorillas are increasingly threatened with extinction. Less that 10% of the western population is currently within protected national park boundaries. Hunting and habitat destruction or fragmentation is likely within a century, to be so devastating that the only surviving gorilla population will be in conservation areas (Doran & Mcneilage 1998). It is unlikely that more than a small percentage of the remaining area of African rain forest can be protected from exploitation and conversion, and many existing primates populations are inevitably going to become extinct.

There is thus an urgent need to formulate plans that will; 1) ensure that no single species or highly distinct form of primate become extinct and 2) ensure the protection of examples of distinct forest communities.

Study Objectives

The chief aim of the survey is to assess the population status, distribution and potential threats to primates (particularly apes (gorilla and chimpanzee) in the area between the Lom-Pangar river system to the north of Deng-Deng area and the river Yong west of Belabo. The ultimate objective is to formulate well-informed recommendations and a strategy for the conservation of viable ape populations in this region that appears to be covered by a large tract of relatively intact suitable habitats for these primates.

Study design and Methodology

The primary method used for the purpose of the present surveys was based on nest counts along pre-cut line transects. A total of 104 km transect were cut within the three forest areas. The number and length of transects varied between the three different study sites according to the size of the area, but also the intactness of natural habitats.

Within the Deng-Deng forest, approximately 24 km of baseline was cut through the centre of the area in an approximate north to south direction. Eighteen, 4km transects were cut perpendicular to the baseline, alternatively eastwards and westwards, and spaced at a distance

of between 2.5 and 3 km apart. Four 4 km transects were cut respectively in the Nanga Eboko forest and the Sanaga-Yong Chimpanzee Sanctuary areas.

A provisional botanical inventory of the Deng-Deng Forest was also undertaken. The team also completed a socio-economic survey of villages in the region, with the aim to assess the hunting pressure or human impact on wildlife in the region.

Results

The vegetation of the region includes a complex of habitats, ranging from farmlands and fallow, through mature savannah, young and old secondary forest, marsh forest to primary or mature forest.

Over the survey period, 46 gorilla nest sites (42 of which were found in the Deng-Deng Forest) and 45 Chimpanzee or tree only nest sites (39 of which were found in the Deng- Deng Forest) were recorded within the three forest areas surveyed on a total of 104 km of transect. The 46 gorilla nest sites include 183 individual nests, while the 45 chimpanzee include only 109 individual nest. The mean gorilla group size was 3.98 (median 2) and the mean chimpanzee group size was 2.42 (median 2).

Comparatively, fewer nest sites were recorded in the area of Nanga Eboko and the Sanaga-Yong Chimpanzee Sanctuary, with 3 gorilla nest site and 2 chimpanzee nest sites encountered at Nanga Eboko, and 1 gorilla nest sites and 4 chimpanzee nest sites at the Sanaga-Yong Chimpanzee Sanctuary. Nest data were too few in both Nanga Eboko and Sanaga-Yong Chimpanzee Sanctuary areas to estimate realistic ape densities.

The data collected in the Deng-Deng Forest provide an estimated density of between 1.5 to 2 weaned gorillas / km^2 and 0.48 to 0.93 weaned chimpanzees / km^2. Therefore it is estimated that a number of 876 to 1168 weaned gorilla individuals, and 175 to 340 weaned chimpanzee individuals, inhabit the Deng-Deng forest.

With reference to gorilla density estimates, our results for the Deng-Deng area were very similar to those observed in the Dja Wildlife Reserve in southern Cameroon, Kahuzi-Biega Lowland sector in Democratic Republic of Congo and the Conkouati National Park in the Republic of Congo. These results suggest that Deng-Deng forest is an important area for gorilla population in central Africa.

These surveys also confirmed the presence of six other primate species including another threatened species, the Black Colobus (*Colobus satanus)*, and 14 other mammal species with important species such as the Bongo (*Tragelaphus euryceros)*, Sitatunga (*Tragelaphus spekii*), Forest Buffalo (*Syncerus caffer nanus*), Hippopotamus (*Hippopotamus amphibius*), swamp Otter (*Aonyx congica*), etc. The Deng-Deng forest where many of these species are found appears to support a very rich and diverse large mammal populations.

Threats to biodiversity conservation in the region are habitat fragmentation caused by road construction by logging companies, pipeline associated development activities, and hunting.

The area of the Deng-Deng forest has been logged in recent years and there are still a number of old logging roads beingn used by hunters. Logging is currently ongoing within the area between Nanga Eboko forest and the Sanaga-Yong Chimpanzee Sanctuary. The Pipeline Construction Company has improved some roads in the area to facilitate its operations. Although the 30m strip of forest opened to lay down the pipe may not have serious long-term effect on gorilla and chimpanzee movements, this open area is likely to limit the movement of smaller primates who may deterred from crossing such open areas.

Overall human pressure was very high in the area around the Sanaga-Yong Chimpanzee Sanctuary, with many more hunter paths and traps seen per km walked than found in either the Deng-Deng forest or the Nanga Eboko forest. Local hunters reported that Gorilla and Chimpanzee are seldom shot. However, it appears from locally conducted interviews that within most of the villages in the area, both Gorilla and Chimpanzee meat is consumed.

Recommendations

1. The conservation status of the Deng-Deng Forest Reserve should be upgraded to make it a Sanctuary for Gorilla and Chimpanzee.

2. Environmental education programs need to be initiated for awareness raising among the population of the region on the importance and need for conserving wildlife.

3. COTCO should develop a regulatory mechanism to reduce or halt the flow of bush meat from concessions or project area and to prevent employees' reliance on bush meat as a source of food and supplementary income.

4. COTCO should consider to assist building the capacity of MINEF personnel in the area along the pipeline route for effective law enforcement to limit the impact of wildlife harvesting.

5. Further surveys , focusing on the ape populations in the Deng-Deng Forest Reserve, shall be initiated at the end of the rainy season, to assess the range and seasonal distribution of apes within the area.

6. Further primate surveys focusing on the ape populations should be undertaken within the Sanaga-Yong Chimpanzee Sanctuary region and the Nanga Eboko forest to clarify distribution and abundance.

7. It is critical to consider additional detailed surveys of important wildlife in other sensible areas along the pipeline route, so as to develop a suite of mechanism that will minimise the impact of the company activities on Biodiversity.

2 INTRODUCTION AND PROBLEM STATEMENT

All the great apes except the Orang Utan live in tropical Africa (Two species of Chimpanzee: Common Chimpanzee and the gracile Chimpanzee and two species of Gorilla: Western Gorilla and Eastern gorilla). All four species of African great apes are found near the equator, primarily inhabiting tropical forest where they are essential components of the rich assemblage of species of the continent. Unfortunately apes are also source of food and cash for many people in west and central Africa. Hunting together with habitat loss has greatly reduced both the distribution and the abundance of all four species.

What are the current threats to populations of apes in Africa? On a continent where food production per person is on decline, where one person in three is malnourished, and where the human population is expected to double by the year 2025, the requirement for food, clothing, fuel wood and shelter will continue to grow rapidly. This coupled with the growing demand for Africa's natural resources by people in Europe, Asia and North America. As a result of this exploitation, the populations of apes are being reduced, fragmented and destroyed, both indirectly through habitat degradation and loss, and directly through unsustainable hunting (Butynski & Ammann 2000).

Throughout their range, populations of great apes are officially protected under both national and international law. Nevertheless, during the last decade the commercial hunting of apes has increased greatly as logging companies open up large tracts of previously inaccessible forest. There are many areas where hunters have completely destroyed populations of apes and greatly reduced many others. As a result, there are large tracts of suitable habitats where populations of apes are either at low densities or no longer present (Ammann & Pearce, 1995; Bowen, 1998).

The increased hunting not only threatens the populations of apes, but it also brings people and apes into closer and more frequent contact than ever, with the consequence that the rate of disease transmission between humans and apes has increased (Butynski & Ammann 2000). Medical researchers now recognise links between the opening up of the tropical forest by logging firms, the increased hunting of great apes and the more frequent transmission of disease between apes and humans.

There is broad consensus among field workers that chimpanzee and gorilla numbers are in sharp decline in the wild, that the rate of decline is rapidly accelerating and that all four species will become extinct in the wild if the causal factors are not sufficiently addressed

(Butynski, 2000). The population estimates for the apes are small in the context of species survival potential, and particularly so in view of extreme fragmentation of their populations and habitats.

Gorillas and chimpanzee are increasingly threatened with extinction. Less that 10% of the western population is currently within protected national park boundaries. Hunting and habitat destruction or fragmentation, are likely within a century, to be so devastating that the only surviving gorilla will be in conservation areas (Doran & Mcneilage 1998). It is unlikely that more than a small percentage of the remaining area of African rain forest can be protected from exploitation and conversion, and many existing primates populations are inevitably going to become extinct.

There is thus an urgent need to formulate plans that will;

1) ensure that no single species or highly distinct form of primate become extinct and 2) ensure the protection of examples of distinct forest communities.

In formulating these plans, we must aim at protecting areas large enough to give populations long term viability, and we must also recognise that local political, social and economic conditions will play a major role in the success of any project and that projects need to be integrated into local development plans

With regards to the potential threat to biodiversity conservation associated with the construction of the Chad Cameroon pipeline and with the aim to minimise its impact, the Cameroon Oil Transportation Company (COTCO), made available resources to allow for large mammal population surveys with focus on apes in the Belabo region, by the Wildlife Conservation Society/ Cameroon Biodiversity Programme (WCS).

Although preliminary faunal surveys were undertaken by T. Smith in 1998, there still exist considerable remote areas that have not been visited by scientists, let alone studied. These surveys, which focused on the Gorilla (*Gorilla gorilla gorilla*) and Chimpanzee (*Pan troglodytes*) populations within the Deng-Deng forest reserve, around the Sanaga-Yong Chimpanzee Sanctuary, and the forest patches located to the north-east of Nanga-Eboko all of which are adjacent to the Chad-Cameroon Pipeline route, were undertaken from December 2001 to February 2002. Biological assessments such as these are essential for both determining the initial impact of human activities and for future management of these biologically important areas as well as providing baseline information required for the design and implementation of a coherent biodiversity-monitoring programme. This report presents data recorded on the large mammal populations within three forest sites over a period of three months.

3 STUDY OBJECTIVES

The chief aim of the survey is to assess the population status, distribution and potential threats to primates (particularly apes: Gorilla and Chimpanzee) in the area between the Lom-Pangar river system to the north of Deng-Deng area and the river Yong, west of Belabo. The ultimate objective is to formulate well-informed recommendations and a strategy for the conservation of viable populations in this region that appears to be covered in large tract of relatively intact suitable habitats for these primates.

The specific objectives are:

- To collect baseline data on the large mammals, focusing on the ape populations at three different locations in the Belabo region: the Deng-Deng forest reserve, the area around the Sanaga-Yong Chimpanzee Sanctuary, and a small patch of forest situated to the north-east of Nanga Eboko (referred to in this report as the Nanga Eboko forest).
- To calculate the following variable: abundance index, and/or (where possible), estimate group size, population density and distribution.
- To assess the major threats and pressures on the gorilla and chimpanzee populations and the potential for their future conservation, including an assessment of forest utilisation by local communities, hunting pressures and the importance of bush meat trade in the region.

4 STUDY SITE

4.1. Location and access

The Deng-Deng forest covers an area of approximately 584 km² and is located north east of Belabo (05° 05-25 N, 13° 23-34 E). Motorable roads and rivers mainly determine the forest boundaries. There are eight main villages surrounding the area with several small hamlets located between these settlements. Access to the area is by road, which runs from Belabo to LomPangar village at the northern tip of the Deng Deng forest. Additionally, the area has been logged in recent years, and therefore a number of timber extraction road or track are still visible across the area, and are being used by local population or hunters to access the most remote part of the forest.

The Nanga Eboko forest is situated north east of Nanga Eboko (4° 40-50 N, 12° 27-38 E) and covers approximately 234 km². The area is partially surrounded by secondary roads with the western boundary determined by the main Belabo to Nanga Eboko road.

Finally, the Sanaga-Yong Chimpanzee Sanctuary area lies approximately 15 km south west of Belabo (4° 47-54 N, 13° 03-10 E). Although the sanctuary covers only a small area of forest, the area as a whole covers roughly 205 km².

All three-forest areas are accessible by existing roads and often poorly maintained, some of which have recently been improved by COTCO to facilitate its operation in the region. However, due to the construction of the pipeline, large strips of forest have now been opened up within or alongside these areas, which in turn has created easier access to local people.

4.2. Relief and altitude

Deng-Deng: Most of the lowland forest lies between 100-400 m a.s.l. The terrain is rolling in the lowlands with small hills rising up to 738 m a.s.l. in the western section of the forest.
Nanga Eboko: The north-western part is a lowland forest between altitudes of 300-600 m a. s. l., meanwhile, the south-eastern forest support highlands rising up to 870 m a.s.l.
Sanaga Yong: Most of the forest is comprised of small hills rising between 680-728 m a.s.l.

4.3. Hydrology

Deng Deng Forest Reserve

There are a series of small streams running through the Deng Deng forest, many of which are seasonal. The main rivers within the area are the Sanaga River, which runs from north to south along the western boundary of the forest and the Lom River, which forms the northern boundary.

Nanga Eboko Forest

The River Sanaga on the western border limits the Nanga Eboko forest and River Avéa on the north, which is the major drainage network in the area. There are a number of seasonal streams, which where not running during this survey.

Sanaga-yong Chimpazee Sanctuary

The major river drainage is from River Sanaga on the northern border of the Sanaga-Yong Chimpanzee Sanctuary forest. The forest also has River Bea running all year and some seasonal streams.

4.4. Climate

The climate of the area is typically equatorial with four unequal seasons:
a long dry season from November to March;
a short wet season from April to June;
a short dry season from July to mid August; and,
a long wet season from mid August to November.
Rainfall and temperature average 2817 mm per year and 26.8 °C, respectively (Gartlan, 1989).

4.5. Vegetation

The area considered for the present surveys, basically falls under the classification of “semi-deciduous forest” which is an extensive forest formation over much of eastern Cameroon, particularly close to the peri-forested savannah (Letouzey 1985). This forest is dominated by the commercially valuable *Triplochiton scleroxylon* (Sterculiaceae), which has been heavily exploited throughout its range. In essence this forest formation is very similar to evergreen forest, aside from the fact that many species are somewhat deciduous for at least some time during the year, particularly during the dry season. Because of this, the herbaceous layer is

particularly well developed, as is the liana flora. However, the drier nature of this forest means that epiphytes are relatively uncommon.

4.6. Legal status

The Deng-Deng forest at present is a forest reserve, however there is no effective protection of this forest, hence it may in future be allocated for logging. The other patches of forest surveyed have no formal legal status.

4.7. Human population

In general population density in the region is very low, with a total population of about 1300 inhabitants for the 16 villages surveyed around the Deng-Deng forest reserve (Table 4.1.). The majority of these people are found in three relatively big villages, situated on main road (Deng-Deng with 210 inhabitant) or near the railroad (Goyoum 400 inhabitants, Mbaki II 350 inhabitants). Also there is a number of recently abandoned villages (Déolé, Muyal, Lom-bord) or almost abandoned with very few people remaining (Mbambo, Haman, Sakudi, Mbaki village), suggesting important movement of population. From interviews with local people in the region, it appears that the economic factor is the primary cause of these population movements, with people moving away from their village to look for better opportunities in bigger villages or cities. In some other cases the reason for abandoning villages is enclavement and lack of school or medical facilities. The indigenous population in the region is composed of four major tribes: the Kepere, Bodomo, Pôle, who have been long established in the region and the Gbaya who just recently migrated into the region but who now appears to be the dominant tribe group in the region.

Table 4.1. Village location, population size and present status

Village	GPS Location	Population	Status	Canton
Deng-Deng	N:05°14.587 E: 013°34.191	210 hbts.		Képéré- Deng-Deng
Déolé	No data	02 hbts	Abandon	----II----
Hona	N: 05°09.223 E: 013°31.565	30 hbts		Képéré-Pôle
Haman	N: 05°14.347 E: 013°34.005	15 hbts		Képéré-Deng-Deng
Goyoum	N: 05°12.266 E: 013°23.025	400 hbts		Képéré-Vouchaba
Kambakassi	N: 05°10.129 E: 013°31.107	60 hbts		----II----
Mbambo	N: 05°03.447 E: 013°21.696	15 hbts		----II----
Mbaki village	N: 05°04.942 E: 013°23.750	20 hbts		----II----
Mbaki I	N: 05°05.030 E: 013°28.036	30 hbts		----II----
Mbaki II	N: 05°07.187 E: 013°23.835	350 hbts		----II----
Mouyal	No data	0 hbt	Abandon	Képéré Deng-Deng
Satando	N: 05°05.049 E: 013°23.897	50 hbts		----II----
Sakudi	N: 05°03.890 E: 013°22.278	10 hbts		----II----
Lom-Bord	N: 05°15.622 E: 013°34.325	3 hbts	Abandon	----II----
Lom I	No data	42 hbts	Between Goyoum & Lom bridge	----II----
Lom Pangar	No data	20 hbts	Fishing camp	
Ouami	N: 05°14.587 E: 013°34.191	29 hbts		----II----

4.8. Agricultural activities

As is often the case in rural area, the main activity here is subsistence farming, to produce cocoyam, plantain, cassava, maize, peanut and cucumber seed. There are a number of coffee farms, but they are often neglected, certainly due to the poor prices.

4.9. Hunting and human forest use

4.9.1. Hunting and bushmeat

Although farming is the primary activity in the region because of the number of people who are involved, hunting and poaching constitute the main source of income for the local human population. Target species are among the ungulates (duiker, bongo, sitatunga, buffalo, bush pig…), primates including gorilla and chimpanzee, and rodents. Hundreds of African grey Parrots are also captured for the pet trade. Important bushmeat markets in the region are: Goyoum, Deng-Deng, with middlemen coming from as far as Bertoua, Yaounde or Douala. The people generally involved in illegal activities such as hunting and poaching are often very aggressive, making it almost impossible for the very small number and poorly equipped MINEF personnel posted in the region to be effective for any law enforcement initiative. The most notorious hunters or poachers are found among the Gbaya tribe men. Cartridges and wire snares are freely available on the village market

4.9.1.1. Local traditions

Traditionally, some species were protected by taboo and therefore not hunted. Some indigenous tribes do not eat primates including gorilla and chimpanzee due to their belief that these primates may be related to their ancestors and in past times, helped the community to get out of difficult situations. Additionally the killing of a Bongo is said to bring bad-luck to the community. The royal antelope is believed to transmit diseases such as epilepsy if consumed. Pregnant women are not allowed to consume the Yellow-backed duiker. There are many such stories, emanating from various ethnic groups in the region. However, because of the high demand for bushmeat and the associated financial incentives, but also the influx of immigrant population from other region, these taboos often are no longer respected.

4.9.2. Fishing

Fishing is another important income generating activity for the people in the region, andd is undertaken along the River Lom by the use of fishing nets and pirogue. The fish is smoked and sold on Fridays (market day) in LomPangar. Just like in the case of bushmeat, buyers travel from Belabo, Bertoua, and Yaounde.

4.9.3. Mining

Presently, small scale gold mining is taking place in the north-eastern part of the region with miners coming from as far away as Betare Oya. A relatively large number of people are involved and, subsequently contributing to additional pressure on wildlife populations through habitat destruction, hunting and providing a lucrative bushmeat market.

4.9.4. Logging activities

There have been no active commercial logging companies operating in and around the Deng-Deng forest reserve since SOFIBEL who completed their activities the region in the early nineties. However illegal logging by poorly organised local groups is very intense. Timber trees extracted from the region include; Sapelli, Ayous, Bete, and Sipo.

5 METHODS

5.1. Line transect sampling

The line transect method is used widely in animal density census (Burnham *et al.* 1980) as refined by Buckland *et al.* (1993). The computer software program DISTANCE is usually used for data analysis although requires a minimum of 40 observations per species. Line transect census is based on distance sampling of data collected along line transects, where all objects (nests, animal dung, cartridges etc.) or live animals that are seen, are recorded from the transect (Buckland *et al.*, 1993). The perpendicular distance from the transect to the detected object/ animal is measured (or estimated as accurately as possible). This method allows for the non-detection of some objects, especially those that are situated at increasing distances from the transect.

Densities or relative abundance of mammals e.g. duikers, elephants, and apes can be estimated by estimating the density of their signs such as dung or nests, and converting the results by known factors such as the rate of dung deposition and decay, or rate of nest production and decay. The signs used are those that are produced at known rates (or rates that are known to be regular over time). For example, each weaned gorilla in a group builds one new nest each night; so one nest represents one gorilla-night. When the rate of decay of the signs is known, for example, a gorilla nest lasts on average 78 days in Lope, Gabon, (Tutin *et al*., 1995) the density of the individual animals of each species can be calculated.

5.1.1. Encounter rates

The density of animals that are naturally rare such as carnivores (leopard) or animals that have been intensively hunted cannot be reliably estimated using line transects. In addition, density estimates cannot be made for animals that do not produce signs regularly over time. Therefore, only encounter rates or presence/absence of these species was recorded.

An estimation of the relative degree of human disturbance (especially hunting) was made by recording all human signs along transects such as hunter paths, cartridge cases, traps or bush houses, etc. These signs can then be expressed as an encounter rate as it is usually very difficult to obtain a sufficiently large sample (number of signs/kilometre of transect) that could be compared to animal densities within each area sampled.

5.1.2. Using nest sites to estimate ape density

The following formula, developed by Tutin & Fernandez (1984) was used to estimate ape density:

(1) $[(N/A)/V][M] = D$

where N= No. sleeping sites

A= area sampled in km^2

V= mean no. days nest remains visible

M= median nest group size

D= no. weaned individuals km^2.

Gorilla nests remained visible for an average of 78 days in lowland forest within Lopé, Gabon (Tutin *et al.*, 1995). Mean chimpanzee nest duration was 113.6 days in Gabon (Tutin & Fernandez, 1984). Since there is no comparable nest duration data available for the Eastern Province, Cameroon, this study used the same data as V. It is possible that by using average nest duration for Gabon for this study, considerable errors may be incurred.

Subsequent work in Lopé, Gabon by Tutin *et al*. (1995) showed that around 26% gorilla nest groups 'convert' to chimpanzee nests as they age. This 'conversion' is due to the fact that ground nests (which are only constructed by gorillas) age faster than tree nests and thus vanish faster than tree nests of the same nest group, where present. Thus, if a gorilla group have made nests in trees and on the ground, only the tree nests will be visible after a given time, and the nest group may be erroneously assigned to chimps. Therefore, when the densities of chimps and gorillas at a site have been calculated from formula 1, the missing 26% of the gorilla nest groups must be calculated from the "chimpanzee" density and reassigned to gorillas.

Estimates of gorilla and chimpanzee density can be calculated from these formulae if data are not sufficient for the DISTANCE programme. Obviously the fewer the data the less precise the calculation can be. However, it does provide an estimate of ape density that can be used in comparison with density estimates for other sites and as a guide to where future work should lead.

5.2. Study sites

Within the Deng-Deng forest, approximately 24km of baseline were cut through the centre of the area in an approximate north to south direction. In the northern and central areas of Deng-Deng, six transects were cut perpendicular to the baseline, eastwards and six transects were cut westwards and spaced at a distance of 2.5 km apart. In the lower section of the forest three transects were cut perpendicular to the baseline eastwards and three westwards and spaced at a distance of 3 km apart. This enabled a wider area to sampled and for the eastern and the western sections of the forest to be compared for differences in mammal density and hunting pressure; the western transects being near to the pipeline activities and the eastern transects closer to the Deng-Deng to LomPangar road. Each transect was 4km long.

Four transects were cut in the Nanga Eboko forest and four transects were cut in the forests around the Sanaga-Yong Chimpanzee Sanctuary. During the Nanga Eboko field activities the road was used as the start point for each transect. Transects were spaced 8kms apart. In the Sanaga-Yong Sanctuary 2km of baseline was cut south of the pipeline and 2km north of the pipeline. Four transects were cut perpendicular to the baseline. Again, all transects were 4 km in length.

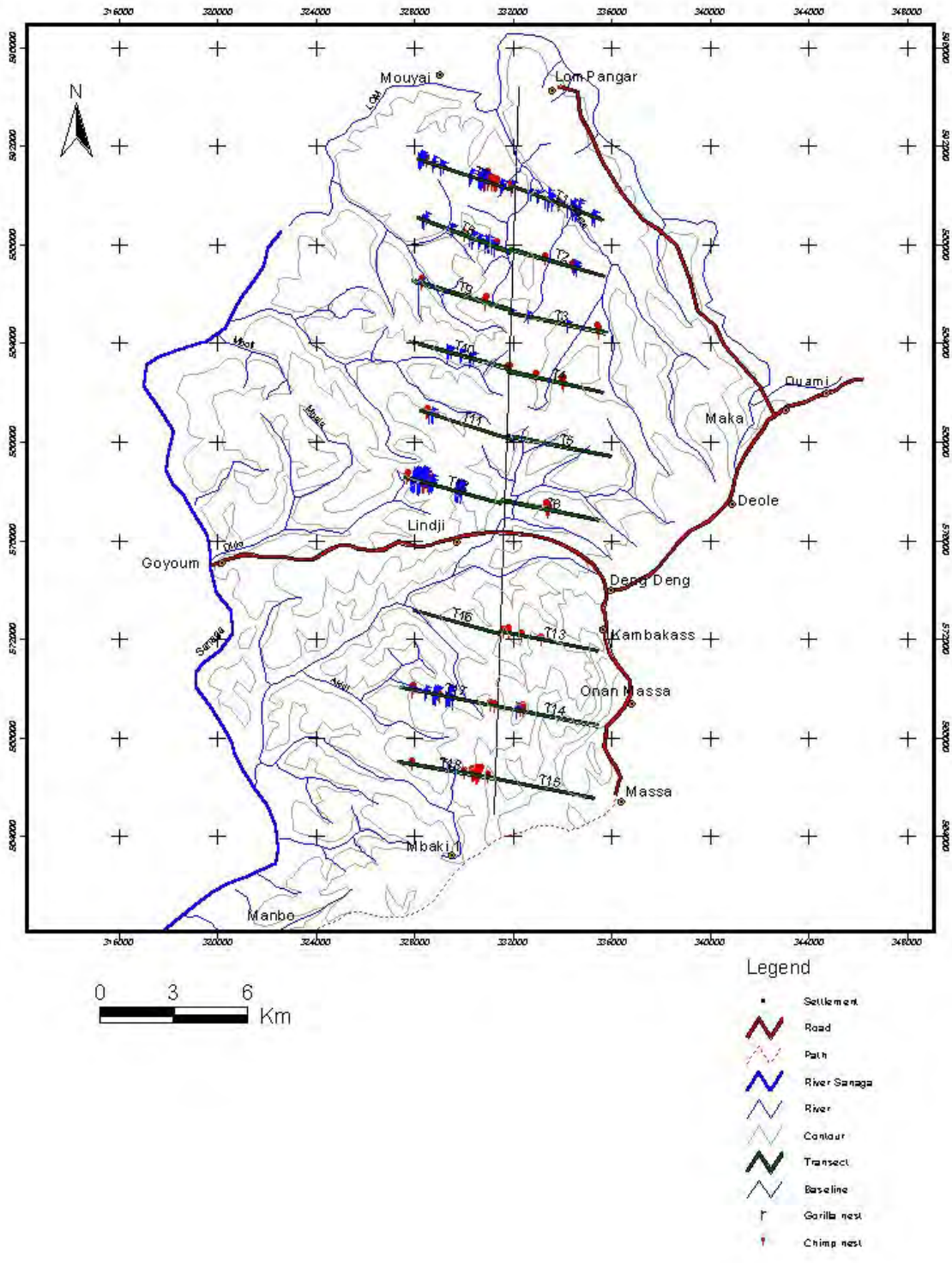
5.3. Timing of surveys

All transects were walked in the dry season (Table 5.1.). Timing did not allow for repeat sampling in the wet season. A summary of dates when transects were walked are presented in Appendix. I.

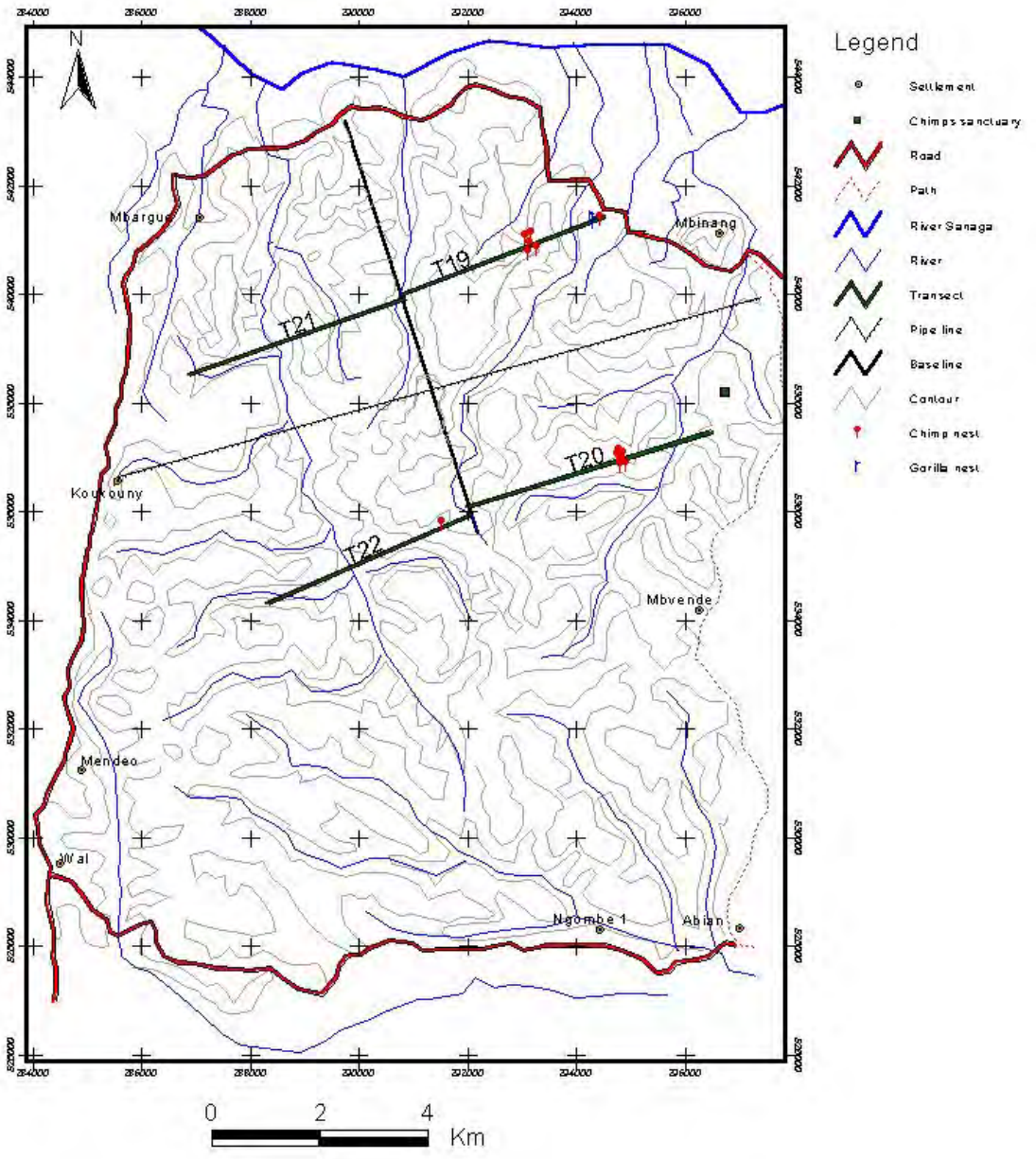
Table 5.1. Summary of forest area and months transects sampled

Dry season (month/yr)	Site	Total length of transects
December 2001 – January 2002	Area.1. Upper Deng Deng	48km
January 2001	Area 2. Lower Deng Deng	24km
February 2001	Area 3. Nango Eboko	16km
February 2001	Area 4. Sanaga-Yong Sanctuary	16km

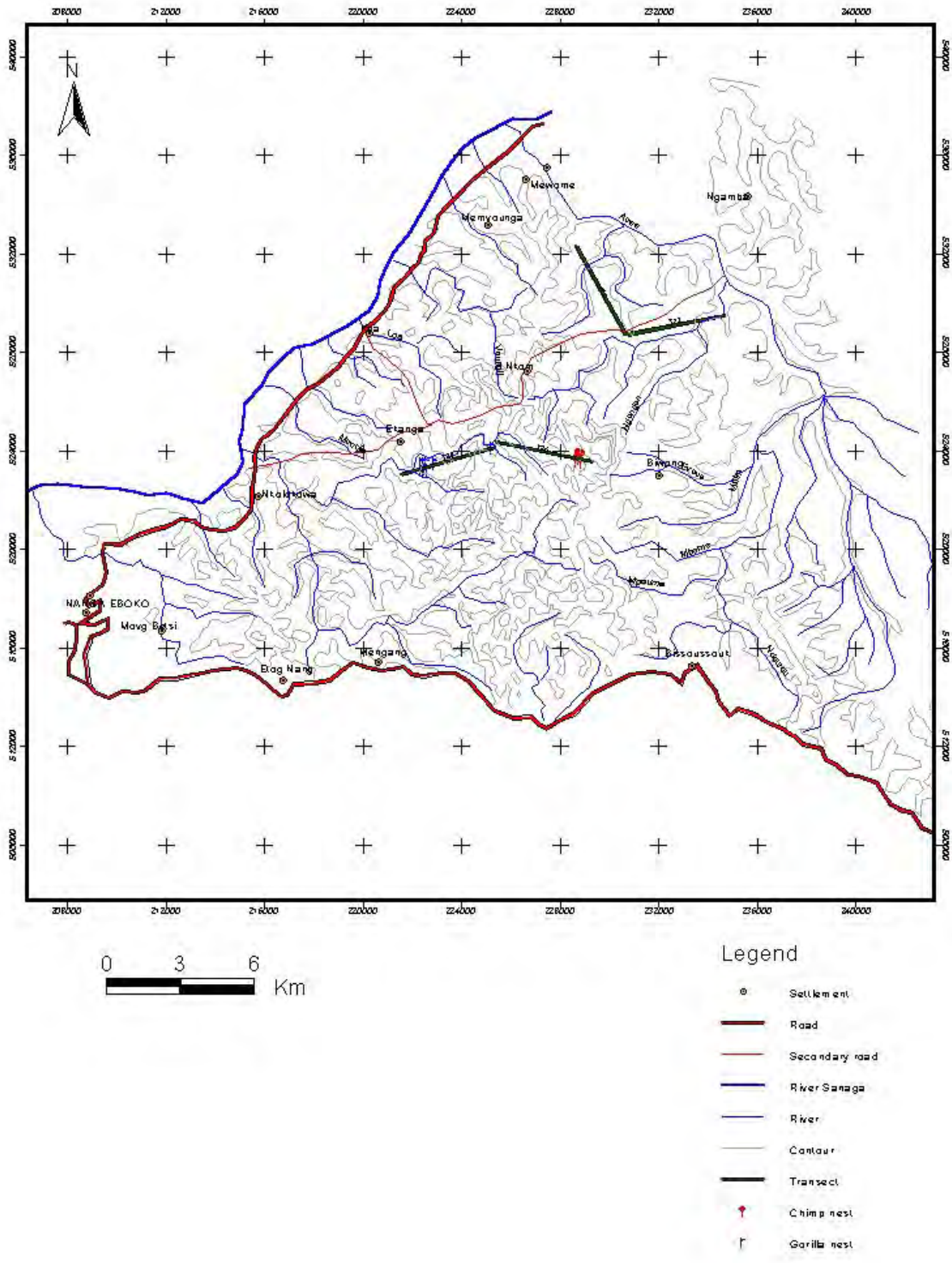
Location of Survey Transects
in the Deng Deng Forest



Location of Survey Transects in the
Sanaga-Yong Chimpanzee Sanctuary Forest



Location of Survey Transects
in the Nanga Eboko Forest



5.4. Data collection on transects

Five people walked and collected data on each transect to keep the sampling effort uniform between transects. Four of these people were recruited locally, ensuring beforehand that they had a good knowledge of the area and of mammal signs and vocalisations. During training it was made clear to every individual that every sign should be recorded. Unfortunately time did not allow for all transects to be pre-cut hence the disturbance level on transects was, at times higher in some areas. Each walk began as soon after daybreak as feasible

5.4.1. Vegetation and topography

A continuous record of topography and vegetation was completed for each transect including position of watercourses, forest type, understorey type and tree fall sites.

The vegetation codes were broad and were as follows:

Type of forest

P Primary Forest
MF: Marsh Forest
MS: Matured Savannah
AS: Adult Secondary Forest
YS: Young Secondary Forest and Cultivation
CL: Clearing (mud, grass, water)
FL: Farm Land

Understorey

-OU: open understorey, easily penetrated using a machete, may comprise of small shrubs, saplings and/or Marantaceae and Zingberaceae.
-MC: dense understorey of Marantaceae difficult to penetrate even using a machete
-L: presence of lianas &/or herbaceous vines
-F: farm land / plantations

Substrate

-H: Hard
-S: Soft
-M: Moderate
-ST: Stream

Rapid botanical inventory in the Deng-Deng Forest

A rapid botanical inventory was conducted along the pre-cut transects that was established by the zoological team. The aim of the inventory was to obtain a better understanding of the vegetation structure and composition of the various habitats forming the Deng-Deng forest ecosystem. For the purpose of this inventory, the botanist walked along the pre-cut transects, recording the most common or characteristic species as well as typical habitats (distinctive vegetation association is often characterised by given species or group of species). Whenever possible, botanical specimens were collected for future identification and storage at the National Herbaria in Yaounde. The survey also allowed for the definition of stratification or vegetation gradient in the region. Because of the fragmented nature but also the small size of the other forest patches (Nanga Eboko area and the area around the Chimpanzee sanctuary), and time constraints this botanical assessment was conducted only within the Deng-Deng forest.

5.4.2. Large mammals

Data on all large mammal sightings, vocalisations and signs (dung, tracks etc.) were recorded and perpendicular distances measured. Although tracks cannot be used to estimate absolute animal density, as one cannot estimate the times per day an animal would cross the transect, they can be used to calculate relative encounter rates and therefore abundance between sites. All gorilla and chimpanzee nest sites encountered were marked with flagging tape detailing the date and individual nest number.

5.4.3. Human sign

All human sign or direct encounters were recorded including spent cartridges, traps/ snares, and carbide ash from night hunting lights, footprints, bush houses, hunter paths and audible gunshots.

5.4.4. Ape nests

All ape nest sites located were recorded and perpendicular distances from the transects measured. Additional information was recorded including nest and tree height. The age of

the nest was estimated and construction of nest documented using techniques from Tutin *et al.* (1995) and as follows:

Nest age

A = Fresh – vegetation green or not wilted
B = Recent – vegetation dry and changing colour
C = Old – vegetation dead but nest still intact
D = Rotting – nest beginning to disintegrate

Type of Nest

Zero = No nest structure exists and the gorilla has slept on the ground. The sleeping side appears as a flattened patch usually with scattered leaves or small flattened plants. The presence of faeces or hair and, sometimes the smell of gorilla aids in identification of the site.
Minimum = Nest consists of between 3 or more stems of herbaceous plants that have been bent (sometimes several times) to form a rudimentary pad where the gorilla has slept.
Herbaceous = A nest that consists of between 3 or more stems of herbaceous plants that have been bent, and sometimes interwoven, to form a substantial platform with a roughly circular depression where the gorilla has slept.
Mixed = Similar to herbaceous nests but woody vegetation (lianas, shrubs, saplings or small-detached branches) has been incorporated into the nest.
Tree = Nests built in trees constructed by bending/breaking branches to form a platform.
Woody = Nests built on the ground entirely of woody vegetation from bent lianas, shrubs or saplings.
Detached Woody = These are similar to woody nests but built entirely from detached leafy branches that have been carried to the site and assembled into a nest.

If additional nest groups were located after leaving the transect (either to examine nests seen from the transect or during random searches) identical information was still recorded but it was noted that they had not been seen from transects. GPS co-ordinates were taken at each nest site where possible.

5.4.5. Diet

Data on plants consumed by gorillas were recorded at gorilla feeding sites encountered. Voucher specimens were collected and taken to Limbe Botanic Garden for future identification.

5.5. Gorilla taxonomic material

5.8.1. Hair samples

Each fresh ground nest encountered was searched for shed hairs, which were sent to Richard Bergl working under the supervision of Todd Distol at New York University for mitochondrial DNA analysis. This type of analysis is currently being used to examine taxonomic differences between populations of gorillas in West and Central Africa. Hairs were collected using plastic surgical gloves, placed in separate envelopes and stored in silica gel.

6 RESULTS

6.1. Habitat descriptions

Broad vegetation descriptions were recorded along each transect at every 100 metre point and the percentage of the different habitats within each site surveyed were calculated (Table 6.1).

Table 6.1. Summary of habitats surveyed using line transects

Substrate	**Deng-Deng %**	**Nanga Eboko %**	**Sanaga-Yong %**
Hard	93.47	99.06	90.94
Moderate	4.72	0.31	9.06
Moderate & steam	0.76	0.63	0
Stream	1.04	0	0
Forest type			
Primary (P)	63.40	25.63	76.56
Marsh forest (MF)	6.6	0	9.06
Matured Savannah (MS)	0.97	23.13	14.38
Adult Secondary forest (AS)	24.44	49.38	0
Young Secondary forest (YS)	3.54	0	0
Clearing (mud, grass, water)	0.07	0	0
Farm Land	0.97	1.88	0
Understorey			
Open understorey (shrubs, saplings) (OU)	0.83	0	29.06
Dense Marantaceae difficult to penetrate (MC)	43.33	36.25	18.13
Presence of lianas & or herbaceous vines (L)	18.26	0	0
Farm land / plantations (F)	0	0	0
Grassland (GL)	0	24.69	0
Mixed: open understorey with presence of marantacea (OU/MC)	10.07	39.06	50.31
Mixed: open understorey with presence of lianas (OU/L)	3.96	0	2.5
Mixed: Dense marantaceae with presence of lianas (MC/L)	1.19	0	0
Mixed: Dense marantaceae mixed with farm bush (MC/F)	22.01	0	0
no data	0.07	0	0

Habitat description in the Deng-Deng forest

A total of 125 plant species (tree with dbh > 10cm), belonging to 37 families, were recorded along the 72 km of transect established by the zoological team in the Deng Deng Forest Reserve. Fourteen of these species appear to be regularly distributed along all transects visited. These species are listed in Table 6.2 below, with the value in various column indicating the number of time each of them was recorded on each of the transects (it is important to note that the survey was not exhaustive). In the last column of the table we are presenting the encounter rate of the various species as a

percentage of all the observation. The completed list of species recorded is presented in Appendix II.

Table 6.2. List of common species within the various sectors visited during the surveys. (P correspond to a sector or group of transects)

Species	P1	P2	P3	P4	P5	P6	P7	Total	Encounter rates
Sterculia rhinopetala	2	1	1	2	6	2	1	15	4,05
Terminalia superba	1	1	1	2	3	5	1	14	3,78
Erythrophleum suaveolens	2	1	2	2	1	4	1	13	3,51
Ricinodendron heudelotii	6	1	1	1	3	1		13	3,51
Entandrophragma spp		2	4	2	1	2	1	12	3,24
Mansonia altissima	3		3		2	2	1	11	2,97
Celtis tessmannii	3	2	2		1	1	1	10	2,70
Greenwayodendron suaveolens	3	1	1	2		2	1	10	2,70
Piptadeniastrum africanum	1	1	3		2	3		10	2,70
Discoglypremna caloneura	3	2			3	1		9	2,43
Hylodendron gabunense			1	2	2	2	2	9	2,43
Petersianthus macrocarpus	2	1	1		2	3		9	2,43
Xylopia aethiopica	6	2	1					9	2,43
Triplochiton scleroxylon			1	2	3	2		8	2,16

Fourteen of the thirty-seven families appear to be largely dominant as they represent about 69,45% of all the observations. The dominant families are the following, with their encounter rate: Sterculiaceae (13,24 %), Annonaceae (12,16 %), Euphorbiaceae (10,54 %), Meliaceae (7 %), Combretaceae (4,32 %), Apocynaceae, Rubiaceae (3,51 %), Ulmaceae (3,24 %), Irvingiaceae (2,7 %), Lecythidaceae (2,4 %), Moraceae (2,43 %), Bignoniaceae, Burseraceae, (2,16 %). The Leguminosae (16,48 %) are not considered in this ranking as this family is made up of three sub-families (Caesalpiniaceae, Fabaceae, Mimosaceae)

Vegetation association and Habitats description

Major vegetation association or habitats recorded are very similar to those described by Letouzey (1985) for this biome ("semi-deciduous forest"). The above-mentioned families largely dominate the vegetation in the region. But because the Sterculiaceae and Ulmaceae rank very high among the dominant families, the forest of the region is generally refered to as « forêt à Sterculiaceae et Ulmaceae », according to the Letouzey definition. Another reason for this denomination is the absence or poor representation of such families like the Caesalpiniaceae.
Representatives of the Ulmaceae often recorded along the transect are: *Celtis tessmannii* and *Celtis zenkeri.*

Among the representatives of the Sterculiaceae, *Cola lateritia*, *Chlamydocola chlamydantha* appear to be relatively common. These two species are widely known to be typical of the evergreen forest in southern Cameroon. The other common species

of the family characteristic of the semi-deciduous forest are: *Sterculia bequeartii, Sterculia rhinopetala, Mansonia altissima, Nesogordenia papavifera.*

The various habitat types, recorded in the Deng-Deng forest are listed below:
Dry forest with under-storey dominated by *Costus englerianus* (Costaceae)

This habitat was observed many times along the baseline transect. Rinorea sp. appear to be very common among the trees of the mid-storey, while emerging trees in general are representatives of the Sterculiaceae and Ulmaceae, characteristic of the forest of the region. Figure 1 below provides a good illustration of the forest under-storey, while figure 2 gives the image of the forest structure for this typical habitat.

Figure 6.9. A view of the forest under-storey dominated by *Costus englerianus* (Costaceae)

Figure 6.10. A view of the forest with *Costus englerianus*.

- **Dry forest dominated or characterised by *Strebleus kamerunensis* (Moraceae*)***

Individuals of the species dominate the forest under-storey. Other characteristic species of these habitats, well represented in the area are: *Cavacoa quintasii, Meiocarpidium lepidotum*. Individuals of the following species were recorded among the big tall trees: *Anopyxis klaineana, Celtis tessmannii, Entandrophragma spp, Erythrophleum suaveolens, Gambeya lacourtiana, Greenwayodendron suaveolens, Hylodendron gabunense, Lovoa trichilioides, Mansonia altissima, Nesogordonia papavifera, Pterocarpus soyauxii, Pterygota bequaertii, Sterculia rhinopetala, Strombosia pustulata, Swartzia fistuloides, Terminalia superba, Treculia africana*.

Figure 6.11. A view of the forest with *Strebleus kamerunensis*

- **Marantaceae forest with sparced under-storey**

These are young semi-deciduous forests with open under-storey dominated by small trees. The lower strata of the forest is dominated by species of the Marantaceae family such as *Ataenidia conferta*, *Haumania danckelmaniana*, some of which can be 2-3m high. The forest floor is made of clay soil which seems to be typical of this type of habitats.

Figure 6.12. Forest under-storey with *Ataenidia conferta* (Marantaceae)

Figure 6.13. A view of the forest with *Haumania danckelmaniana* (Marantaceae)

Inselberg and other vegetation on rock substrate;
This category includes bare rock outcrop, vegetation on tin soil on rocky basement. In general these areas consist of small hill with rocky basement often referred to as inselberg. But in some cases these habitats type correspond to a relatively extensive rocky platform dominated by *Xylopia aethiopica*, *Polyscia fulva*, *Tricalysia pallens*, *Greenwaydendron suaveolens*, *Markhamia tomemtosa*, *Xylopia hylampra.*

Swamp forests; These habitats in general are characterised by the abundance of *Uapaca spp* (Euphorbiaceae), *Pterocarpus soyauxii* (Fabaceae), *Alstonia boonei* (Euphorbiaceae), *Lasiodiscus mannii* (Rhamnaceae). Another species often recorded in these habitats is *Mitrgyna stipulosa*. This species known to be locally abundant was recorded in almost all the swampy forests that were visited.

Swamp forests with *Cyathea manniana*; This habitat is dominated by *Cyathea manniana,* in association with other species such as *Uapaca vanhoutei* (Euphorbiaceae), *Lasiodiscus mannii* (Rhamnaceae).

Figure 6.14. Swamp forest with *Cyathea manniana*.

- **Woodland savannah with *Terminalia glaucescens* (peri-forested savannah);**

Tree density was relatively low compared with the forest. Also the tallest trees in this habitat were no more than 10 m high. The dominant species within this habitat is *Terminalia glaucescens*. It appears from the present surveys that, young trees of the species are very rare, and we suspect this to be a direct consequence of frequent burning. Other species well represented in this habitat are: *Albizia glaberrima* (Mimosaceae), *Annona senegalensis* (Annonaceae), *Bridelia ferruginea* (Euphorbiaceae), *Crossopteryx febrifuga* (Rubiaceae), *Piliostigma thonningii* (Fabaceae), *Markhamia tomentosa* (Bignoniaceae). Figure 7. below provides a good illustration of these habitats with this sector mainly dominated by *Cyclosorus sp*. (Thelypteridaceae). Figure 8 provides the aspect of the same habitats just after a bush-fire.

Figure 6.15. Peri-forested savannah with *Terminalia glaucescens* and *Cyclosorus sp.*

Figure 6.16. Peri-forested savannah with *Terminalia glaucescens* and *Cyclosorus sp.* just after the area has been burned.

6.2. Apes

6.2.2. Summary of nest sites

Over the survey period 46 gorilla nest sites and 45 chimpanzee or tree only nest sites were recorded within the three forest areas surveyed on a total of 104 km of transect. Tree-only nest sites were attributed to chimpanzees, when no other sign (dung or ground nests) were visible to indicate the site was made by gorillas. It is possible that 26% of the tree-only nests sites were actually made by gorillas but due to the faster decay rate and disappearance of ground nests than tree nests, means that the remaining tree nests in an old gorilla nest site are assumed to have been made by chimpanzees. The proportion of gorilla nest sites that 'converted' to chimpanzee nest sites was 26% in the Lopé Reserve, Gabon (Tutin *et al.* 1995) and this percentage has been used to calculate to our results.

6.2.3. Group size

If all data is considered including nests that appear to be from single individuals, mean gorilla group size was 3.98 (median 2) and mean chimpanzee group size was 2.42 (median 2) (Table 6.3.). When considering data recorded in each forest area separately (Deng-Deng, Nanga Eboko and Sanaga-Yong sanctuary), mean gorilla group size for Deng-Deng was 4.07 (median 2), which is similar to our overall mean group size and mean chimpanzee group size was 2.36. Data recorded in Nanga Eboko and Sanaga-Yong due were too few to offer a representative group size for these areas and the results below should be treated cautiously (Table 6.4).

Table 6.3. Ape nests: summary of all data all sites

Species	Mean group size	Median group size	No. of nest groups seen from transects, all forest areas combined (L=104km)	**Encounter rate of nest groups seen on transects (n/L)**
Gorilla gorilla	3.98	2	46	**0.442**
Pan troglodytes	2.42	2	45	**0.433**

Table 6.4. Ape nests: summary of all data each forest area separately
DD = Deng-Deng Forest; NE = Nanga Eboko Forest; SYCS = Sanaga-Yong Chimpanzee Sanctuary

Area	Species	Mean group size	Median group size	No. of nest groups seen from transects, all strata combined (L=72km DD; L=16km NE; L=16km SYS)	**Encounter rate of nest groups seen on transects (n/L)**
DD	*Gorilla gorilla*	4.07	2	42	**0.583**
	Pan troglodytes	2.36	2	39	**0.542**
NE	*Gorilla gorilla*	3.33	1	3	**0.188**
	Pan troglodytes	2.5	2.5	2	**0.125**
SYCS	*Gorilla gorilla*	-	-	1	**0.063**
	Pan troglodytes	2.5	3	4	**0.25**

6.2.4. Density estimates

Within the Deng-Deng forest, 42 gorilla nest sites and 39 chimpanzee or tree only nests sites were recorded along 72km of transect (Table 6.5, 6.6. Fig 6.8, 6.9). Comparatively fewer nest sites were recorded in the areas of Nanga Eboko and the Sanaga-Yong Chimpanzee Sanctuary with 3 gorilla sites and 2 chimpanzee nest sites encountered at Nanga Eboko and 1 gorilla site and 4 chimpanzee nest sites recorded at the Sanaga-Yong Sanctuary. Only 16 km of transect were cut in each of these forest areas. Gorilla nests were most frequently detected at a perpendicular distance of between 0-5m from the transect (76.09%) (Table 7). Chimpanzee or tree only nests were most frequently detected at between 5.1-10m. Meaning that the area sampled for gorillas in the Deng-Deng forest was 72km multiplied by the detective distance either side of the transect 10m or 720,000m². For chimpanzees the area sampled was 72km multiplied by the detective distance of between 10.2-20m or 734,400m²–1,440,000m². In both Nanga Eboko and the Sanaga-Yong Sanctuary the area sampled for gorillas was 16 km multiplied by 10m or 160,000m² and for chimpanzees between 163,200 and 320,000m².

Table 6.5. Encounter rate by site: gorillas

Forest area	**Nest groups**	**Individual nests**	**Survey distance (km)**	**n/L groups/ transect**	**n/L indivs / transect**
Deng Deng	42	171	72	0.583	2.375
Nanga Eboko	3	10	16	0.188	0.625
Sanaga-Yong Sanctuary	1	2	16	0.063	0.125
Total	**46**	**183**	**104**		

Table 6.6. Encounter rate by site: chimpanzees

Forest area	Nest groups	Individual nests	Survey distance (km)	n/L groups/ transect	n/L indivs / transect
Deng Deng	39	92	72	0.542	1.278
Nanga Eboko	2	5	16	0.125	0.313
Sanaga-Yong Sanctuary	4	12	16	0.25	0.75
Total	**45**	**109**	**104**		

Fig 6.9. Encounter rates per kilometre (n/L) for nest groups and individual nests of gorillas in each of the different sites surveyed.

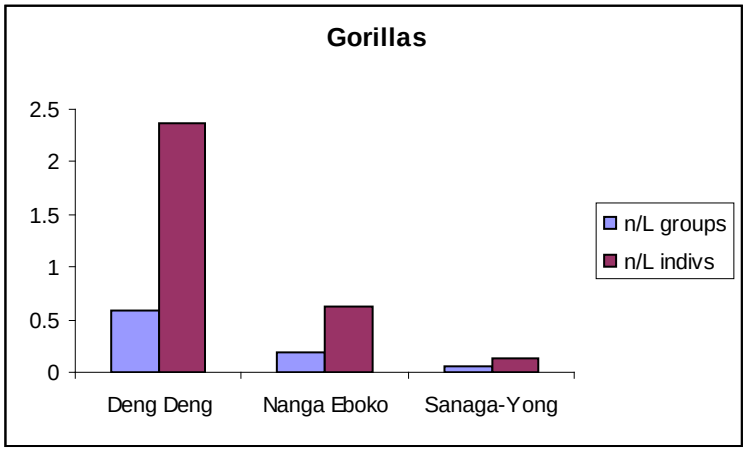


Fig 6.10. Encounter rates per kilometre (n/L) for nest groups and individual nests of chimpanzees in each of the different sites surveyed.

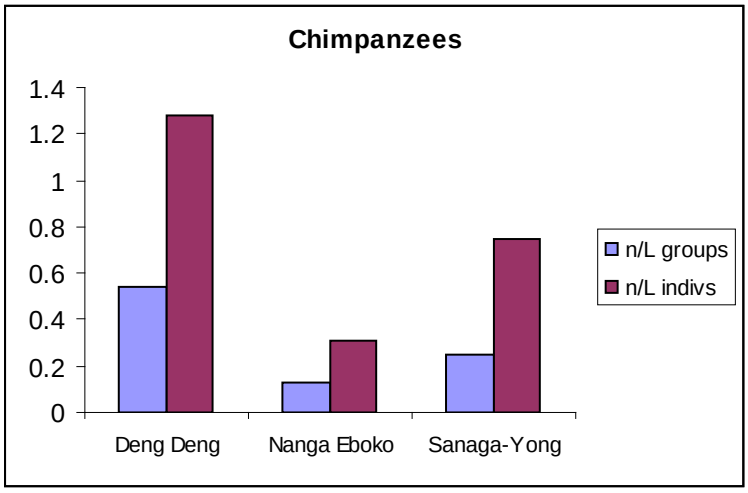


Table 6.7. Visibility (detective distance) of gorilla and chimpanzee nest sites

Visibility (metres)	Gorilla (183 nests)	Chimpanzee (109 nests)
0-5 metres	76.09%	37.78%
5.1 – 10 metres	21.74%	48.89%
10.1 – 15 metres	2.17%	11.11%
15.1 – 20 metres	0.00%	0.00%
20.1 – 25 metres	0.00%	2.22%

Following Tutin & Fernandez (1984) a rough estimate of ape density can be made based on a small sample sizes using the formula:

([Number of nest sites/no. km² surveyed]/no. days a nest is visible)(median nest group size)=No. weaned gorillas/km². Applied to our data, this formula gives the following results**:**

Deng-Deng Forest

Gorillas: ([42/0.72]/78(2.0) = **1.5 weaned gorilla individuals km².**

Chimps: ([39/0.7344 or 1.44]/113.6(2.0) = **0.48 – 0.93 weaned chimpanzee individuals km².**

By removing 26% of the estimated chimp density and reassigning it to gorillas provides the adjusted densities of between 1.5 - 2 gorillas/ km² and between 0.3 - 0.58 chimps/ km².

Nest data were too few in both Nanga Eboko and the Sanaga-Yong Chimpanzee Sanctuary to calculate actual ape densities using this formula.

To summarise, the Deng-Deng forest covers an area of 584 km². If calculating gorilla density based on 2-gorillas/ km² results would indicated that there are possibly around 1160 weaned individuals existing today within and surrounding the Deng-Deng forest and 175 - 340 chimpanzees (0.3 – 0.58 chimps/ km²).

In Nanga Eboko and the Sanaga-Yong Chimpanzee Sanctuary, nest encounters were too few to estimate realistic ape densities. This may be because either not enough area was sampled or that ape populations are very low indeed. However, it should be taken into consideration that during an earlier reconnaissance survey (O'Connor, 2001), 84 individuals nests were found in the Sanaga-Yong Sanctuary region over a one-week period, of which 79 were attributed to gorillas. Therefore, to obtain a more accurate estimate of density it is recommended that further intensive surveys be undertaken within these areas.

6.2.5. Comparison of gorilla encounter rates and density estimates with other sites

The majority of gorilla studies have been carried out on populations where there are sufficient observations to obtain gorilla density. Encounter rates are less often quoted thus we are only been able to find a relatively small number of studies with which we can compare the data from our study (Table 6.8). Gorilla encounter rates in the Deng -Deng Forest fall within the same order of magnitude as those recorded in the highlands of the Takamanda Forest Reserve (Groves, 2002) and also in a highly hunted area of the Conkouati Reserve in the Congo (Maisels & Cruickshank, 1996). Gorilla encounter rates recorded in Nanga Eboko are similar to those recorded in Kahuzi-Biega, DRC (Hall *et al*, 1998) whilst encounter rates recorded within the Sanaga-Yong Chimpanzee Sanctuary are very low indeed.

Table 6.8. Encounter rates for gorilla populations at other sites

Site	Encounter rate of nest groups/ km	Indiv nests	Source
Dja Reserve, Cameroon	1.16		Williamson & Usongo 1995
Dja Reserve, Cameroon	0.801		Wal & Nku 1999
Conkouati: unhunted	2.0		Maisels & Cruickshank 1996
Conkouati: medium hunting pressure	1.56		Maisels & Cruickshank 1996
Mbulu Forest (highlands), Cameroon	1.111		Groves 2002
Kahuzi-Biega, Eastern Zaire, DRC	0.11-0.96		Hall *et al* 1998
Conkouati, Rep. of Congo: high hunting pressure	0.71		Maisels & Cruickshank 1996
Takamanda Forest Reserve highlands, Cameroon	0.642		Groves 2002
Mone Forest Reserve highlands, Cameroon	0.444		Groves 2002
Takamanda lowland (Makone East), Cameroon	0.025	0.125	Groves & Maisels 1999
Deng Deng forest	**0.583**	**2.375**	**This study**
Nanga Eboko forest	**0.188**	**0.625**	**This study**
Sanaga-Yong Chimpanzee Sanctuary	**0.063**	**0.125**	**This study**

With reference to gorilla density estimates, Table 6.9. presents data recorded from different sites in West and Central Africa. Our results for the Deng Deng forest fall in the same order of magnitude as those recorded in the Dja Reserve, Cameroon (Williamson *et al*, 1995 and Wal *et al*, 1999), the Kahuzi-Beiga lowland sector in DRC (Hall *et al* 1989) and again, with an area in Conkouati, Congo which is subject to high hunting pressure (Maisels & Cruikshank, 1996).

Table 6.9. Gorilla densities at different sites and in different habitats (adapted from Groves & Maisels, 1999).

Country	Site or forest type	Density (N°/ km2)	Year	Source
RCA	Secondary forest	10.9	1986	Carroll 1986
Republic of Congo	Odzala (Marantaceae forest)	10.5	1994	Bermejo 1995
Cameroun	Dja (*Raphia* swamp)	7.88	1994	Williamson & Usongo 1995
Republic of Congo	Likouala (Raphiales)	5.8	1994	Blake *et al.* 1995
RCA	Light gaps	5.6	1986	Carroll 1986
Cameroun	Lac Lobeke swamp forest	5.28	1990	Stromayer & Ekabo 1991
Guinea Equatoriale	Monte Alen (secondary forest)	4.53	1994	Juste 1995
Republic of Congo	Odzala (Marsh forest)	3.9	1994	Bermejo 1995
Republic of Congo	Conkouati medium hunting pressure	3.9	1996	Maisels & Cruikshank (1996)
Cameroun	Lac Lobeke primary forest	3.27	1990	Stromayer & Ekabo 1991
Gabon	Secondary forest	3.2	1983	Tutin & Fernandez 1984
Republic of Congo	Likouala (*Raphia* and *Uapaca*)	2.88	1994	Blake *et al.* 1995
Cameroon	Takamanda forest: highlands	2.84	2001	Groves 2002
Republic of Congo	Likouala swamp	2.6	1989	Fay *et al.* 1989
Cameroun	Lac Lobeke overall	2.5	1990	Stromayer & Ekabo 1991
Republic of Congo	Northern Congo (Marsh forest)	2.4	1992	Fay & Agnagna 1992
Cameroon	**Deng Deng forest**	**2**	**2002**	**This study**
Cameroon	Dja (closed forest)	1.9 (1.3-2.7)	1999	Wal *et al* 1999
Cameroon	Dja (closed forest)	1.71 (1.02-2.86)	1994	Williamson *et al* 1995
Dem. Rep. of Congo	Kahuzi-Biega, lowland sector	0.75-3.21	1996	Hall *et al.* (1998)
Republic of Congo	Conkouati: high hunting pressure	1.62	1996	Maisels & Cruikshank (1996)
RCA	Closed forest	1.6	1989	Fay 1989
Nigeria	Mbe and Afi forests	1.4-1.79	1987	Harcourt *et al* 1988
Republic of Congo	Northern Congo (Closed forest)	1.2	1992	Fay & Agnagna 1992
Republic of Congo	Odzala (Closed canopy forest)	1.1	1994	Bermejo 1995
RCA	Closed forest	0.89-1.45	1986	Carroll 1986
Gabon	Lopé (Marantaceae forest)	0.7-1.0	1989-1991	White 1994
Republic of Congo	Northeast Congo (Marsh forest)	0.6	1992	Fay & Agnagna 1992
Guinea Equatoriale	Monte Alen (primary forest)	0.28-0.91	1994	Juste 1995
Nigeria	Mbe forest	0.5	1990	Oates *et al* 1990
Dem. Rep. of Congo	Kasese	0.4	1996	Hall *et al.* (1998)
Gabon	Lopé (closed forest)	0.3-0.5	1989-1991	White 1994
Gabon	Primary forest (unlogged)	0-0.23	1983	Tutin & Fernandez 1984
Gabon	Whole country	0.18 (0.008-0.44)	1983	Tutin & Fernandez 1984
Cameroon	Takamanda forest: lowlands	0.04-0.07	1998	Groves & Maisels 1999

6.3. Large mammals

Medium to large mammal species seen, heard or recorded during the surveys is listed by site in Table 6.10. This includes observations recorded whilst walking transects and during reconnaissance surveys (Large mammal vernacular names are presented in appendix III).

6.3.1 Direct observations on transects

Direct observations were generally low and this may be because; data were recorded during transect cutting attributing to a higher level of disturbance and surveys were undertaken during the dry season when the leaf litter is very noisy to walk on. Sightings were recorded in all study areas but more frequently within the Deng-Deng forest than in the Sanaga-Yong Sanctuary or the Nanga Eboko area. Sighting encounter rates per kilometre of large mammals are presented in Table 6.11 and Fig. 6.11.

6.3.1.1. Gorillas *(Gorilla gorilla)*

Gorillas were seen on two occasions in the Deng-Deng forest but not whilst walking transects. On the second occasion, a young male was observed in a tree for approximately 1hour and 30mins (Plate 1.)

Table 6.10. Large mammal presence or absence recorded in all sites surveyed.
T = track; V = vocalisation; D = dung; S = seen; F = feeding site; N = nest

Latin name	English name	Deng Deng	Nanga Eboko	Sanaga-Yong
Loxodonta africana	Elephant	No data	No data	No data
Gorilla gorilla gorilla	Gorilla	N, D, V, S, T,F	N, F	N, F
Pan troglodytes	Chimpanzee	N, D, T	N	N, T
Colobus satanus	Black colobus	S, V	-	-
Colobus guereza occidentalis	Guereza colobus	S, V	-	-
Cercopithecus neglectus	De Brazza's Money	V	-	-
Cercopithecus nictitans	Putty nosed monkey	S, V	V	V
Cercopithecus pogonias	Crowned monkey	-	V	-
Papio anibus	Baboon	V, D	-	-
Potamochoerus porcus	Red river hog	T, F	T,F	T
Cephalophus silvicultor	Yellow-backed duiker	-	-	D
Cephalophus callipygus	Peter's duiker	-	-	D, T
Cephalophus dorsalis	Bay duiker	S, D, T	D,T	D, T
Cephalophus monticola	Blue duiker	S, D, T	-	D, T
Neotragus pygmaeus	Royal antelope	-	-	D
Orycteropus afer	Aardvark	T	-	-
Smutsia gigantea	Giant pangolin	T	-	T
Hippopotamus amphibius	Hippopotamus	V	-	-
Tragelaphus spekei	Sitatunga	-	-	T
Syncerus caffer	Buffalo	-	-	T

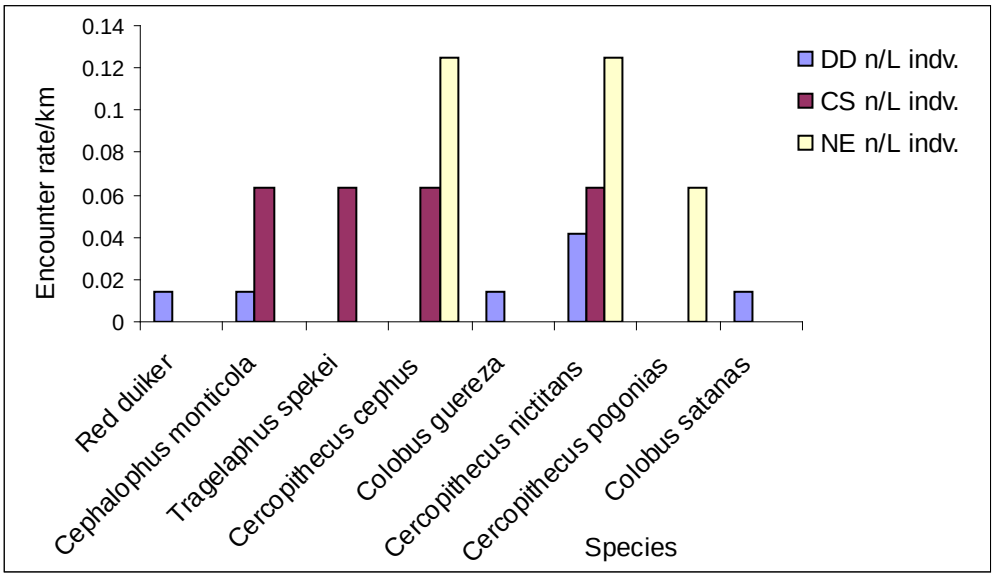
6.3.1.2. Chimpanzees *(Pan troglodytes)*

There were no direct observations of chimpanzees throughout the study period.

Table 6.11. Encounter rates of large mammal sightings per kilometre walked – each site separately. DD=Deng-Deng, CS=Chimpanzee Sanctuary, NE=Nanga Eboko.

Species	DD n/L indv.	CS n/L indv.	NE n/L indv.
Red duiker	0.014	0	0
Cephalophus monticola	0.014	0.063	0
Tragelaphus spekei	0	0.063	0
Cercopithecus cephus	0	0.063	0.125
Cercopithecus nictitans	0.042	0.063	0.125
Cercopithecus pogonias	0	0	0.063
Colobus guereza	0.014	0	0
Colobus satanas	0.014	0	0

Fig 6.11. Sightings of large mammals, each site separately. Encounter rate per kilometre walked. DD=Deng Deng, CS=Chimpanzee Sanctuary, NE=Nanga Eboko.



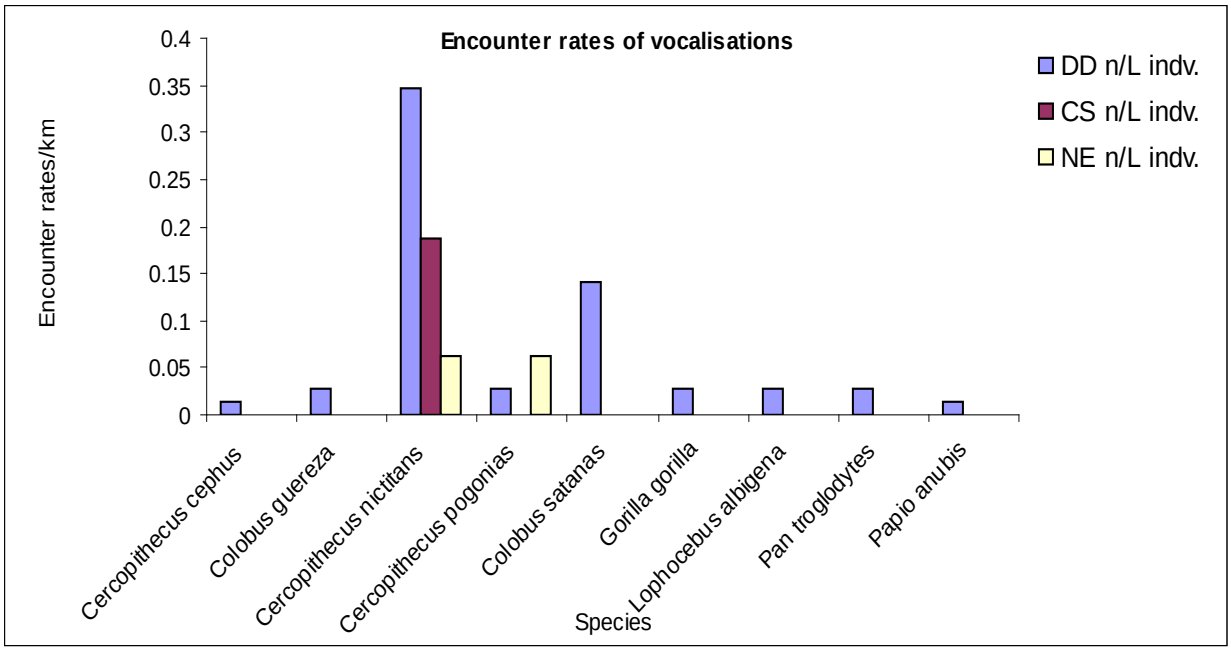
6.3.2 Vocalisations

The majority of vocalisations recorded were from different primate species and most often heard during the morning and late afternoon periods. The number of primate vocalisations heard per kilometre of transect walked (Table 6.12, Fig 6.12) was highest in the Deng Deng forest. *C. nictitans* was heard more than any other species. Within the Sanaga-Yong Sanctuary area, only *C. nictitans* were heard. In the Nanga Eboko area, *C. nictitans* and *C. pogonias* were heard only on one occasion. Due to time constraints, data was collected during transect cutting, which may result in a bias in the encounter rates of vocalisations.

Table 6.12. Encounter rates of vocalisations heard per kilometre walked. DD=Deng Deng, CS=Chimpanzee Sanctuary, NE=Nanga Eboko.

Species	DD n/L indv.	CS n/L indv.	NE n/L indv.
Cercopithecus cephus	0.014	0	0
Cercopithecus nictitans	0.347	0.188	0.063
Cercopithecus pogonias	0.028	0	0.063
Colobus guereza	0.028	0	0
Colobus satanus	0.14	0	0
Gorilla gorilla	0.028	0	0
Pan troglodytes	0.028	0	0
Lophocebus albigena	0.028	0	0
Papio anubis	0.014	0	0

Fig. 6.12. Vocalisations of large mammals each site separately. Encounter rate per kilometre walked. DD=Deng Deng, CS=Chimpanzee Sanctuary, NE=Nanga Eboko.



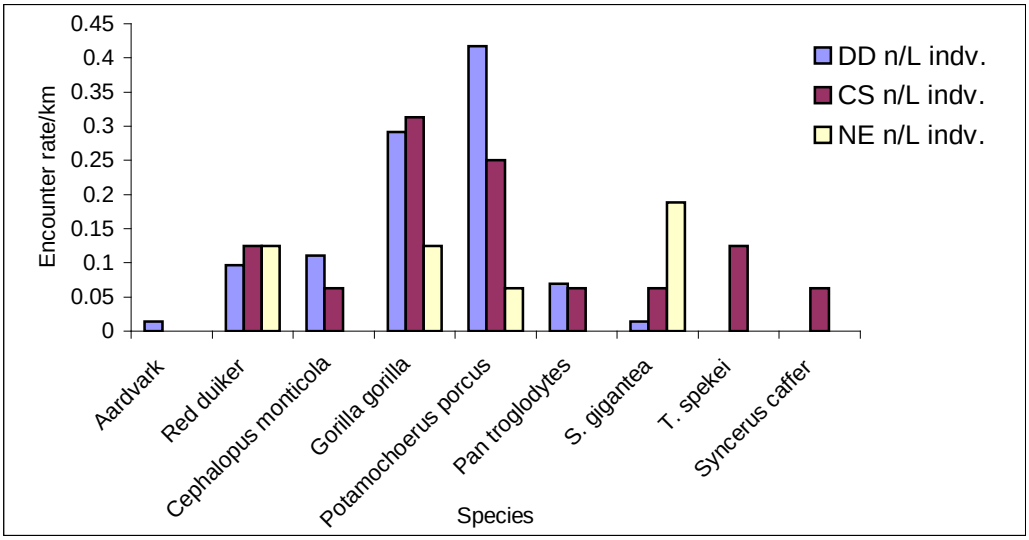
6.3.3 Tracks

The majority of tracks recorded along transects were made by ungulates, and of these, *Potamochoerus porcus* prints were recorded more frequently than any other species (Table 6.13, Fig. 6.13). Due to the dry season when surveys were undertaken, most tracks and other signs (e.g. feeding sites) of *Gorilla gorilla*, medium-sized ('red') duikers and *Cephalophus monticola* were found in moderate substrate swamps or close to streams and riverbanks. Results from track data is not quantifiable as in the dry season dense leaf litter covers the ground making tracks different to see and during the wet season, tracks are quickly washed away. Therefore the results of this section are not clear.

Table 6.13. Encounter rate of tracks recorded per kilometre of transect walked.
DD=Deng Deng, CS=Chimpanzee Sanctuary, NE=Nanga Eboko

Species	DD n/L indv.	CS n/L indv.	NE n/L indv.
Orycteropus afer	0.014	0	0
Red duiker	0.097	0.125	0.125
Cephalophus monticola	0.111	0.063	0
Gorilla gorilla	0.292	0.313	0.125
Potamochoerus porcus	0.417	0.25	0.063
Pan troglodytes	0.069	0.063	0
Smutsia gigantea	0.014	0.063	0.188
Tragelaphus spekei	0	0.125	0
Syncerus caffer	0	0.063	0

Fig. 6.13 Tracks of large mammals, each site separately. Encounter rate per kilometre walked. DD=Deng Deng, CS=Chimpanzee Sanctuary, NE=Nanga Eboko.



6.3.3.1 Apes

Tracks (feeding sites) of *Gorilla gorilla* were recorded in all areas but for *Pan troglodytes*, mostly footprints were found in marsh forest or close to streams.

6.3.3.2 Other large mammals

Tracks of *Smutsia gigantea* were recorded in all areas, meanwhile tracks of *Tragelaphus spekei* and *Syncerus caffer* were recorded only in the Sanaga-Yong Chimpanzee Sanctuary area.

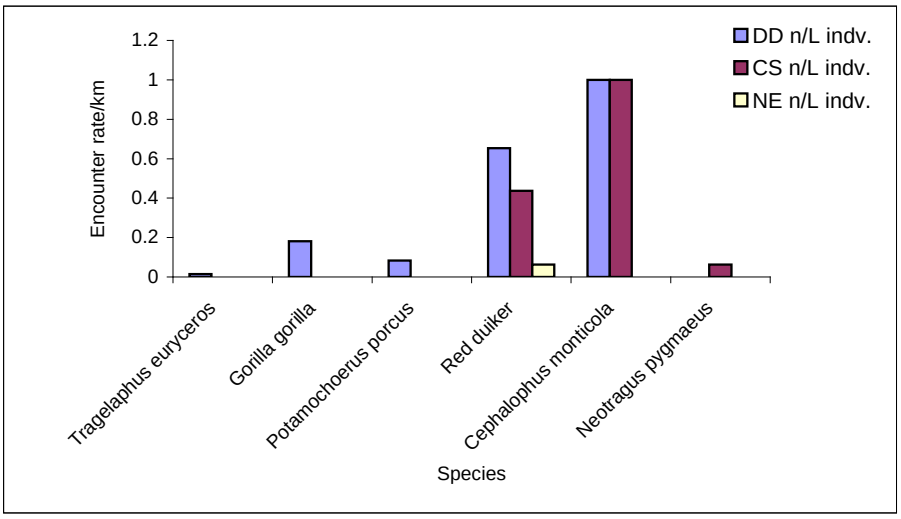
6.3.3.3 Dung

Dung sampling for medium-sized duikers i.e. *Cephalophus callipygus*, *Cephalophus dorsalis* and *Cephalophus silvicultor* were grouped as "Red duiker", meanwhile blue duikers (*Cephalophus monticola*) and the royal antelope (*Neotragus pygmaeus*) were sampled as individuals. Encounter rates per site are presented in Table 6.14, Fig 6.14.)

Table 6.14. Encounter rate of dung per kilometre of transects walked
DD=Deng Deng, CS=Chimpanzee Sanctuary, NE=Nanga Eboko.

Species	DD n/L indv.	CS n/L indv.	NE n/L indv.
Tragelaphus euryceros	0.014	0	0
Gorilla gorilla	0.181	0	0
Potamochoerus porcus	0.083	0	0
Red duiker	0.653	0.437	0.063
Cephalophus monticola	1	1	0
Neotragus pygmaeus	0	0.063	0

Fig. 6.14. Encounter rate of dung recorded per kilometre of transects walked in all areas. DD=Deng Deng, CS=Chimpanzee Sanctuary, NE=Nanga Eboko.



6.4. Human pressure

6.4.1 Comparison of human pressure between sites

During the study period all signs of human activities (traps, paths, logging etc.) were recorded on transect surveys (Fig 6.15.). Only one bush house was encountered during the surveys and this was located in the Deng-Deng forest. Overall human pressure was very high in the Sanaga-Yong Sanctuary region (Fig 6.16.) with many more hunter paths and traps seen per km walked than found in either Deng-Deng or Nanga Eboko. Within both Deng-Deng and Nanga Eboko abandoned logging roads were encountered fairly frequently. New logging activities were recorded in Nanga Eboko.

Fig. 6.15. Encounter rates of human sign recorded per kilometre of transects walked in each area.

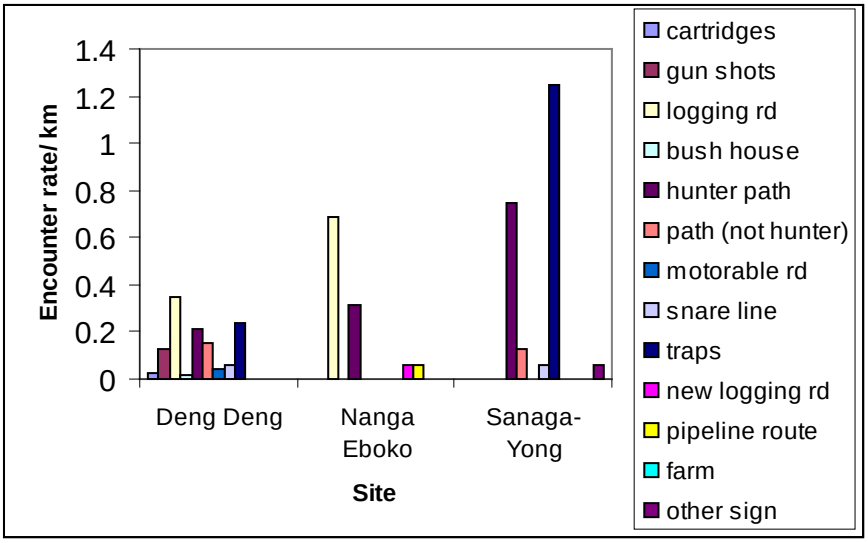
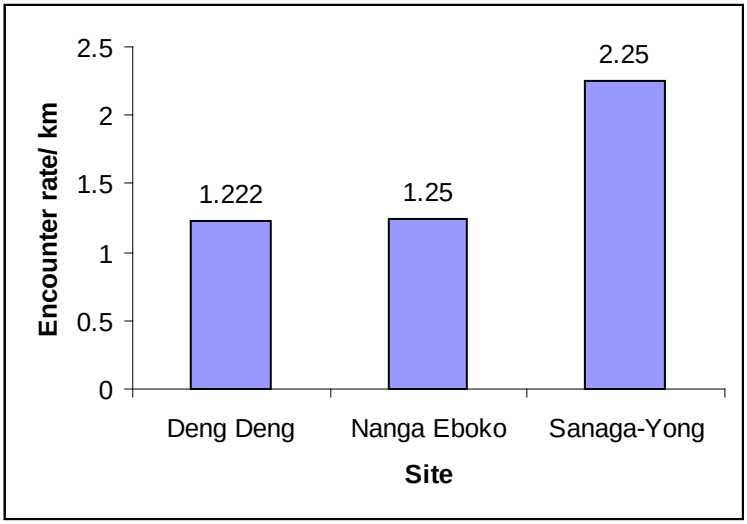


Fig. 6.16. Overall encounter rate of human sign within each area.



6.4.2. Ape hunting

There were no reports of ape shootings during the survey period. Local hunters reported that gorillas and chimps were seldom shot and it seems that the majority of people are aware of the wildlife laws banning the killing of gorillas, chimps etc. These however, are not always adhered to. Only one ape skull was seen in a village, which was from a young male gorilla in the village of LomPangar.

It appears that within most villages in all areas, both gorilla and chimpanzee meat is consumed locally. The only village that reported that they do not eat apes was the village of Bilol I (Sanaga-Yong Sanctuary region). According to O'Connnor, 2001 ancient traditions prevent them from consuming this type of bush meat.

6.5. Taxonomic material – gorillas

Shed hairs collected from gorilla nests were forwarded to Richard Bergl at New York University for mitochondrial DNA analysis, currently used to examine taxonomic differences between populations of gorillas in West and Central Africa. Results are anticipated by the end of August 2002.

DISCUSSION

Over the survey period, forty-two gorilla nest sites and thirty-nine chimpanzee nest sites were recorded in the Deng Deng Forest Reserve. Comparatively fewer nest sites were recorded in the area of Nanga Eboko and the Sanaga-Yong Chimpanzee Sanctuary, with three gorilla nest sites and two chimpanzee nest sites encountered at Nanga Eboko and only one gorilla nest site and four chimpanzee nest sites encountered at the Sanaga-Yong CS. In the first instance is may appear that these figures are a direct consequence of the difference in sampling effort, with 72km of transect sampled in the Deng Deng Forest Reserve and only 16km sampled in each of the other two sites (Nanga Eboko and the Sanaga-Yong CS). However, these differences may be explained by other important factors one of which being the relative intactness of each forest area. For instance the Deng Deng Forest Reserve covers an area of approximately 584km², and was found to support less disturbed habitats than in either the Nanga Eboko area (234km²) or the Sanaga-Yong CS (205km²). These two latter areas were highly fragmented and degraded. Additionally, overall human pressure was found to be very high within the area surrounding the Sanaga-Yong CS, with more traps and hunter paths seen per km walked than found in either the Deng Deng area or Nanga Eboko. Within both Deng Deng and Nanga Eboko, abandoned logging roads were encountered fairly frequently with the addition of recent logging activities being recorded in the Nanga Eboko area.

In view of these results, we believe that the differences in ape population densities between the three forest areas are due to the level of habitat fragmentation and degradation and human disturbances within each site surveyed. It seems clear from these tentative surveys that ape populations appear to be lower in both the Sanaga-Yong CS and Nanga Eboko than within Deng Deng. However, if should be taken into consideration that during an earlier reconnaissance survey by an independent researcher in 2001, 84 individual nests were located in the Sanaga-Yong CS region, over a period of one week, of which 79 were attributed to gorillas. Therefore, in order to obtain more accurate density estimates on ape populations, it is recommended that further surveys be undertaken within both the Sanaga-Yong CS and the Nanga Eboko forest.

Nest data recorded were too few in the areas of both Nanga Eboko and the Sanaga-Yong CS to calculate ape densities, therefore density estimates were only calculated for the Deng Deng Forest Reserve. Using all nest data recorded there were between 1.5 to 2 weaned gorillas/ km² and 0.48 to 0.93 weaned chimpanzees/ km². Meaning that between 880 to 1170 weaned gorilla individuals and 175 to 340 weaned chimpanzees are possibly existing in the Deng Deng Forest Reserve and surrounding area.

Our results for Deng Deng are very similar to those observed in the Dja Wildlife Reserve in southern Cameroon, Kahuzi-Biega lowland sector in the Democratic Republic of Congo and the Conkouati National Park in Congo Brazzaville. These results suggest that Deng Deng is an important area for gorillas in central Africa. It should also be noted, that in the comparative studies mentioned here, researchers were targeting protected areas most suitable for gorillas whilst this report presents the global finding for the Deng Deng Forest Reserve.

The differences observed between gorilla population size and chimpanzee populations could be attributed to earlier logging activities. The company SOFIBEL terminated their operation in the area in the early nineties although many logging tracks still remain visible. Studies in both west and east Africa has shown that chimpanzee densities decline following logging (Tutin and Fernandez, 1984; Skorupa, 1986), while gorillas seem to be less affected (Tutin and Fernandez, 1984).

As reported by White and Tutin (2001) gorillas were originally classified as folivores (Schaller, 1963; Fossey and Harcourt, 1977). However more recent studies within the lowland forests of West Africa, have shown that gorillas seasonally consume large quantities of fruit. For example in Lopé, Gabon the diets of gorillas and chimpanzees were found to be similar with 80% of the same species consumed by both species in certain seasons (Tutin *et al*, 1991, Tutin and Fernandez, 1993). Their study also revealed that during times when fruit availability was scarce, gorillas subsisted almost entirely on vegetative foods, while chimpanzees maintained some of the fruit component of the diet but showed differences in their social behaviour by either foraging alone or in smaller groups. This adjustment alleviated competition between chimpanzee group members caused by the low abundance of fruit foods (White and Tutin, 2001).

The seasonal feeding patterns of these two species obviously effect their behaviour and this information is supported by the fact that gorillas are adaptable enough to thrive in old secondary vegetation whilst chimpanzee densities either remain low or decline. It is hence possible that gorilla adaptability and chimpanzee dependence on fruit is the reason for their different response to logging. Logging obviously results in decreasing densities of trees, which provide the majority of fruits consumed by chimpanzees and gorillas (Williamson *et al*, 1990; Tutin & Fernandez, 1993) and hence decrease food availability. Where as gorillas may benefit from secondary vegetative growth in logged forest (White and Tutin, 2001).

In view of this information, while selective *per se* logging may not have a lasting negative impact on gorilla populations, such activities undoubtedly open up forest areas, which were previously less accessible to humans. With the increase of human pressure comes the demand for meat and hunting for commercial purposes poses a new and potentially more serious threat to both gorilla and chimpanzee populations. Certainly this is the case in some areas of southeastern Cameroon and northern Congo (Pearce, 1995; Wilkie *et al*. 1992). Hunting therefore remains the major threat currently facing western lowland gorillas, and whereas no quantitative data exist, there are reasons to believe that gorillas are particularly vulnerable to hunting.

The habitat requirements of gorillas are substantial, and thus population densities are generally low. Population densities vary between 0.2 to 10 individuals per km^2 depending on habitats and human activities (hunting, agriculture, selective logging and road construction). Gorilla groups show nomadic movements within their large home ranges in response to seasonal shift in food availability. The present survey was undertaken at a time corresponding to the long dry season in the region, therefore it would be critical to resample the area during the wet season to allow for a more accurate population estimate of the ape population.

1 CONCLUSION

It appears from the results of the present survey that of the three forest patches sampled, the Deng Deng Forest Reserve is comparatively more intact with a complex of relatively stable habitats than either of the other two sites surveyed.

Asides from the ape populations the survey team confirmed the presence of six other primate species including the black colobus (*Colobus satanus*) listed as threatened (IUCN, 2000). Fourteen additional large mammal species were confirmed as existing in the area including, bongo (*Tragelaphus euryceros*), sitatunga (*Tragelaphus spekii*), forest buffalo (*Syncerus caffer nanus*), hippopotamus (*Hippopotamus amphibius)* and swamp otter *(Aonyx congica).* Many of these species were recorded in the Deng Deng Forest indicating a high species richness and diversity.

Where as the size of home range varies, the minimum habitat required for a small but potentially viable population of gorillas (for example those existing in the Virunga's or the forests of Bwindi) is in the order of 400 km². Such an area is sufficient to maintain viable populations of sympatric forest fauna, which reinforce the value of gorillas as an umbrella species. The Deng Deng Forest Reserve covers an area of 584km and we therefore strongly recommend that the status of the reserve be upgraded to that of a wildlife sanctuary, protecting important and endangered or threatened species such as gorillas and chimpanzees.

Threats to biodiversity conservation in the region are specifically habitat fragmentation, caused by road construction by logging companies and the pipeline associated development activities. Both of these have led to increased and unsustainable hunting activities. Gorillas are a large primate quite capable of attacking humans if threatened, hence they are often perceived as dangerous by most humans with whom they share the area. This image is not helped by the reported gorilla tendency to raid food crops or plantations in some areas. Obviously these reports and local perception of gorillas *per se* needs to be investigated and steps taken to ensure the future protection of this species.

Only a minority of wild western lowland gorillas live within protected areas, and although they are generally better off than those in habitats without protected status, their future is not assured. In developing countries, other large mammals such as bears and wolves survive only within strictly demarcated parks and reserves. This is clearly the case in Rwanda, Uganda and the Democratic Republic of Congo with regards to the conservation of the Mountain gorillas. The plight of the Cross River gorillas located in the SouthWest Province of Cameroon face certain extinction if measures are not taken to secure their already depleting habitat. Despite further human development in the area such as the pipeline-associated activities and increased commercial hunting, the Deng Deng Forest Reserve still supports a wide range of biodiversity. If effective conservation measures are initiated now, the rich biodiversity of Deng Deng including the ape populations can be preserved. The recommendations within this report will facilitate the effective conservation of this area for future generations.

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10 PHOTO MATERIAL PLATES 1-5

11 ACKNOWLEDGEMENTS

APPENDICES

Appendix I. Timing of transect sampling in each site.

DD=Deng Deng, CS=Chimpanzee Sanctuary, NE=Nanga Eboko

Area/ transect #	Date	Length (m)
DD / T1	11-12/12/01	4000
DD / T2	13-14/12/01	4000
DD / T3	15-16/12/01	4000
DD / T4	12/01/02	4000
DD / T5	10/01/02	4000
DD / T6	09/01/02	4000
DD / T7	11-12/12/01	4000
DD / T8	13-14/12/01	4000
DD / T9	15-16/12/01	4000
DD / T10	12/01/02	4000
DD / T11	11/01/02	4000
DD / T12	09-10/01/02	4000
DD / T13	15/01/02	4000
DD / T14	16/01/02	4000
DD / T15	17/01/02	4000
DD / T16	15/01/02	4000
DD / T17	16/01/02	4000
DD / T18	17/01/02	4000
CS / T19	15/02/02	4000
CS / T20	14/02/02	4000
CS / T21	16/02/02	4000
CS / T22	13/02/02	4000
NE / T23	16/02/02	4000
NE / T24	13/02/02	4000
NE / T25	15/02/02	4000
NE / T26	14/02/02	4000

Appendix II. List of all recorded species during the botanical survey in the Deng-Deng forest.

Species	P1	P2	P3	P4	P5	P6	P7	Total	Encounter rates
Sterculia rhinopetala	2	1	1	2	6	2	1	15	4,05
Terminalia superba	1	1	1	2	3	5	1	14	3,78
Erythrophleum suaveolens	2	1	2	2	1	4	1	13	3,51
Ricinodendron heudelotii	6	1	1	1	3	1		13	3,51
Entandrophragma spp		2	4	2	1	2	1	12	3,24
Mansonia altissima	3		3		2	2	1	11	2,97
Celtis tessmannii	3	2	2		1	1	1	10	2,70
Greenwayodendron suaveolens	3	1	1	2		2	1	10	2,70
Piptadeniastrum africanum	1	1	3		2	3		10	2,70
Discoglypremna caloneura	3	2			3	1		9	2,43
Hylodendron gabunense			1	2	2	2	2	9	2,43
Petersianthus macrocarpus	2	1	1		2	3		9	2,43
Xylopia aethiopica	6	2	1					9	2,43
Triplochiton scleroxylon			1	2	3	2		8	2,16
Fernandoa adolphi-friderici	1	1	3			2		7	1,89
Xylopia hypolampra	1	4	2					7	1,89
Cleistopholis patens	1		2	1		2		6	1,62
Cola lateritia	2	1	2		1			6	1,62
Klainedoxa gabonensis	1		1		1	3		6	1,62
Margaritaria discoidea	2		1			3		6	1,62
Pterocarpus soyauxii		1	2		1	1	1	6	1,62
Funtumia elastica	1			1	1	2		5	1,35
Milicia excelsa	1	1	1	1		1		5	1,35
Samanea leptophylla			1	1	1	2		5	1,35
Alstonia boonei		1	1		1	1		4	1,08
Guarea cedrata			1	1	1	1		4	1,08
Pycnanthus angolensis		1	1	2				4	1,08
Santiria trimera				1		3		4	1,08
Afzelia bipindensis	1		1	1				3	0,81
Anonidium mannii	1			1	1			3	0,81
Dacryodes edulis		1		1		1		3	0,81
Duboscia macrocarpa						3		3	0,81
Gambeya lacourtiana	1		1				1	3	0,81
Guarea thompsonii	1	1				1		3	0,81
Lovoa trichilioides		1			1		1	3	0,81
Ongokea gore	1	1	1					3	0,81
Pachypodanthium staudtii	2		1					3	0,81
Staudtia kamerunensis				1		2		3	0,81
Tabernaemontana crassa	1	1	1					3	0,81
Xylopia parviflora	1					2		3	0,81
Anopyxis klaineana						1	1	2	0,54
Bombax brevicuspe		1	1					2	0,54
Bombax buonopozense			2					2	0,54
Cavacoa quintasii					2			2	0,54
Celtis zenkeri					2			2	0,54
Cylicodiscus gabunensis					1	1		2	0,54
Dictyandra arborescens	1		1					2	0,54
Hallea stipulosa			1	1				2	0,54
Haumania danckelmaniana			1			1		2	0,54
Irvingia grandifolia		1				1		2	0,54

Khaya ivorensis			1			1		2	0,54
Lepidobotrys staudtii					1	1		2	0,54
Macaranga spinosa	1		1					2	0,54
Nesogordenia papavifera						2		2	0,54
Pachyelasma tessmannii			1		1			2	0,54
Sterculia oblonga		1				1		2	0,54
Sterculia tragacantha					1	1		2	0,54
Streblus kamerunensis					1		1	2	0,54
Strombosia pustulata					1		1	2	0,54
Tessmannia africana			1			1		2	0,54
Tetrapleura tetraptera	1					1		2	0,54
Tricalysia pallens		1	1					2	0,54
Uapaca vanhouttei	1	1						2	0,54
Albizia						1		1	0,27
Albizia zygia	1							1	0,27
Amphimas pterocarpoides						1		1	0,27
Anthocleista vogelii					1			1	0,27
Antrocaryon micaster						1		1	0,27
Aoranthe cladantha						1		1	0,27
Bertiera lujae		1						1	0,27
Bridelia grandis	1							1	0,27
Canarium schweinfurthii					1			1	0,27
Ceiba pentandra						1		1	0,27
Cola verticillata			1					1	0,27
Corynanthe pachyceras		1						1	0,27
Costus englerianus			1					1	0,27
Croton oligandrus			1					1	0,27
Cyathea manniana						1		1	0,27
Desbordesia glaucescens						1		1	0,27
Detarium macrocarpum					1			1	0,27
Diospyros						1		1	0,27
Diospyros crassiflora					1			1	0,27
Donella ubanguiensis						1		1	0,27
Drypetes staudtii						1		1	0,27
Funtumia africana						1		1	0,27
Hyparrhenia sp.			1					1	0,27
Irvingia gabonensis		1						1	0,27
Khaya grandifolia						1		1	0,27
Lannea welwitschii						1		1	0,27
Lasiodiscus mannii			1					1	0,27
Leptactina involucrata			1					1	0,27
Leptactina laurentiana	1							1	0,27
Maesopsis eminii					1			1	0,27
Maranthes glabra			1					1	0,27
Markhamia tomemtosa			1					1	0,27
Meiocarpidium lepidotum							1	1	0,27
Microdesmis puberula	1							1	0,27
Monodora myristica						1		1	0,27
Musanga cecropioides			1					1	0,27
Nauclea diderrichii		1						1	0,27
Nesogordonia papavifera							1	1	0,27
Oxyanthus speciosus	1							1	0,27
Pentaclethra macrophylla			1					1	0,27

Piliostigma thonningii			1					1	0,27
Poga oleosa					1			1	0,27
Polyscias fulva		1						1	0,27
Pteleopsis hylodendron	1							1	0,27
Pterygota bequaertii							1	1	0,27
Rinorea				1				1	0,27
Sorindeia grandifolia	1							1	0,27
Swartzia fistuloides							1	1	0,27
Synsepalum brevipes						1		1	0,27
Synsepalum longicuneatum				1				1	0,27
Syzygium rowlandii	1							1	0,27
Terminalia glaucescens			1					1	0,27
Treculia africana							1	1	0,27
Trichilia							1	1	0,27
Trichoscypha acuminata		1						1	0,27
Tridesmostemon omphalocarpoides			1					1	0,27
Trilepisium madagascariense						1		1	0,27
Uapaca guineensis			1					1	0,27
Uapaca paludosa				1				1	0,27
Xylopia							1	1	0,27
Xylopia quintasii		1						1	0,27

Appendix III Partial list of large mammals in the Deng-Deng area, Eastern Province, Cameroon (Vernacular names.

Scientific name	English name	French name	Kepere name
Colobus guereza	Black and white colobus	Colobe de guereza	Mbanlan
Colobus satanus	Black colobus	Colobe noir	Borndi
Cercopithecus nictitans	Putty-nosed guenon	Cercopitheque nez blanc	Douapirki
Cercopithecus pogonias	Crowned monkey(mona)	Cercopitheque pogonias	Tadi
Cercopithecus cephus	Moustached guenon	Moustac	Yere
Cercopithecus negletus	De Brazza's monkey	Cercopitheque de Brazza	Douambi
Gorilla g. gorilla	Western lowland gorilla	Gorille	Ngie
Pan troglodytes	Chimpanzee	Chimpanzé	Waa
Aonyx congica	Swamp otter	Loutre á joues blanches	Tirinmbi
Atilax paludinosus	Marsh mongoose	Mangouste des marais	Tindjon ndjara
Bdeogale jacksoni	Jackson's mongoose	Mangouste de jackson	Mbanlan njal
Potamochoerus porcus	Red river hog	Potamochere	Ngoya
Hippopotamus amphibius	Hippopotamus	Hippopotame	Mgbeme
Hyemoschus aquaticus	Water chevrotain	Chevrotain aquatique	Nkpoundoun
Syncerus caffer (nanus)	African forest buffalo	Buffle nain	Nkpere
Tragelaphus euryceros	Bongo	Bongo	Mbongo
Tragelaphus spekii	Sitatunga	Sitatunga	Touku
Cephalophus monticola	Blue duiker	Lievre (locale)	Ndouri
Cephalophus dorsalis	Bay duiker	Céphalophe bai	Mbgere hol
Cephalophus callipygus	Peter's duiker	Céphalophe de peters	Mbindi
Cephalophus sylvicultor	Yellow-backed duiker	Céphalophe á dos jaune	Mboka
Neotragus pygmaeus	Royal antelope	Antelope royale	Kubi
Orycteropus afer	Aardvark	Orycterope	
Smutsia gigantea	Giant pangolin	Pangolin geant	