CAMEROUN
Ministère de l'Environnement

Projet ECOFAC - Composante Cameroun

I. SURVEY OF PRIMATE POPULATIONS & LARGE MAMMAL INVENTORY

II. SURVEY OF ELEPHANTS, GORILLAS & CHIMPANZEES

RESERVE DE FAUNE DU DJA CAMEROUN

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SUMMARY

Surveys of elephants, gorillas, chimpanzees and diurnal monkeys by line-transects took place during five months of 1994 and January 1995 in the Réserve de Faune du Dja. The Réserve du Dja covers 5,260 km^2 of semi-deciduous lowland tropical forest and is the focus of activities by Ecofac - Composante Cameroun.

Seventeen transects with a combined length of 94.7 km were surveyed twice at intervals of five to seven months for elephant dung, ape nests, and signs of human activity. All indications of duiker, bush pigs, buffalo and large carnivores were also noted. The program DISTANCE was used to produce density estimates of elephant dung and ape nests. The density of elephant dung piles was estimated to be 705.9 per km2, and a mean dung decay rate of 0.0158 was calculated using rainfall and temperature data. This represents an elephant density of 0.56 /km2 (0.33-0.96 /km2). Two concentrations of elephants were found: one in the M'pep river basin where the vegetation was dominated by *Raphia* swamps, secondary gaps and old secondary forest with *Haumania* and *Ancistrophyllum* thickets. The other near Ndengué coincided with an extensive *Cyperus-Pandanus* marsh. The average density excluding M'pep and Ndengué was 0.22 /km2. It was clear that elephants were not evenly distributed. Although no relationship between elephant densities and human activities was determined, the highest densities recorded were at distances over 25 km from the nearest village. Seasonal effects could not be measured in this short-term study, but we obtained evidence that they occur. An extrapolation from the lowest density stratum suggests a potential elephant population of 1,157 (789-1736) for the Dja Reserve, however, it would be unwise to assume that elephants are present through out the Reserve without further investigation.

The mean group size of chimpanzees was 2.2 $\pm$ 1.9 weaned individuals. The density of nest sites was 41.63 per km2, indicating a population of 0.79 weaned chimpanzees per km2 (0.60-1.04 /km2). Their distribution seemed to be relatively even.

Mean gorilla group size was 3.7 $\pm$ 3.1 weaned individuals and the overall density of nest sites was 36.37 per km2. This translates to 1.71 weaned gorillas/km2 (1.02-2.86 /km2). The average density excluding M'pep and Ndengué was 0.47 /km2, but even this lower limit may not be appropriate for the entire Reserve. Gorilla distribution was uneven, and many transects were devoid of nests. A similar pattern to that of elephants occurred, with concentrations on transects between 15 and 25 kms from villages around the river M'pep and east of Ndengué. High local densities are generally associated with swamp forests (Blake, 1993; Fay *et al,* 1989), and *Raphia* swamp and seasonally inundated forest with abundant *Uapaca* spp. trees covered large areas of the sectors sampled. Most nest sites were found near Ndengué and half of these were in *Raphia* swamp. Swamps, marshes and seasonally inundated forests provide refuge from hunters in northeastern Gabon (Lahm, 1993), and Blake (1993) explained gorillas use of the Likouala swamps in Congo as a modification of the gorillas' behaviour to avoid areas of human impact.

Censuses for primates by direct observation were carried out on the same transects. These add up to 247.8 km (N = 51), and were supplemented by 110 km of census data from Mekas and 105 km from Ekom. Eight species of diurnal primates were seen: *Miopithecus talapoin, Cercopithecus cephus*, *Cercopithecus nictitans*, *Cercopithecus pogonias*, *Cercocebus albigena*, *Cercocebus galeritus, Colobus guereza* and *Pan troglodytes. Cercopithecus neglectus,* was probably seen once only,and *Gorilla gorilla* not at all. *Cercopithecus mona* and *Cercocebus torquatus* are reputed to occur in the Dja Reserve, but the present study found no evidence to support this.

DISTANCE was used to produce density estimates of the four most common species of monkey: *C.cephus, C.pogonias, C.nictitans* and *C.albigena*. The number of observations of all other species was inadequate for density calculations. Monkeys were common throughout the areas sampled, and attained particularly high numbers in the southeast near Alat, where the maximum density for a single species was recorded (*C.nictitans* 3.71 troops/km2) and for four species combined (9.73 troops/kms). Lowest densities were found in the northeast Ndengué (2.22 troops/km2 of four species combined). These estimates are comparable to densities obtained by several other studies in forests with similar primate species composition. It was notable that near Ndengué, where gorillas occurred in their highest numbers, monkeys were relatively rare, and at Alat and Mekas where there were most monkeys, gorillas and elephants densities were quite low. This suggests an inverse relationship between the abundance of monkeys and that of gorillas and elephants, however, no significant trends were identified at the transect level. The frequency with which polyspecific associations were recorded seemed to be low (46.7 to 72.6 % of observations per species), but this may have been a function of the methodology.

In conclusion, the Réserve de Faune du Dja was shown to harbour important populations of elephants, gorillas, chimpanzees and at least four species of diurnal monkeys. Four other diurnal monkey species were confirmed to occur at overall low densities, but their status remains to be determined. These preliminary results should be viewed with extreme caution, and further longer-term studies are needed to confirm our findings.

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Preparation for this mission by the Chef de Composante enabled us to make efficient progress and maximise data collection during the time available. In this context, we also thank Michel Lombardi and François Nkotit for help in the organisation of our sorties. During the surveys, we worked with many guides and porters, but three people in particular deserve mention: Ng Antoine, Bokama Basile and Mekame Moise. Other members of the Ecofac Project personnel at Somalomo provided new perspectives of the challenges in conservation.

Valuable data were contributed to this study by Martin Tchamba, Marc Dethier, Pia Muchaal, Ngandjui Germain, Ngnegueu Paul Robinson, Ken Whitney and Mark Fogiel.

For discussion and companionship during field work, we thank Ken, Mark and the researchers of Projet Calao, Marc, Pauwel De Wachter, Ngandjui, Pia and Bertin Tchikangwa Nkanje. Robinson gets special mention for his ability to maintain team sanity during transect cutting. For advice and moral support during Distance analyses, thanks go to Richard Barnes, Steve Buckland, Atanga Ekobo, Jefferson Hall and Buddy Powell. Lee White gave general advice on methodology. Caroline Tutin and Michel Fernandez of Ecofac Gabon helped towards the standardisation of methods. And for their generous hospitality, we thank the project staff of the Wildlife Conservation Society in Cameroun.

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1. INTRODUCTION

Objectives

Ia. To inventory small diurnal primates (cercopithecines, mangabeys and colobines) and to obtain indices of relative abundance for each species.

Ib. To estimate the densities of diurnal monkeys.

II. To estimate the density of large mammal populations, in particular those of elephants, gorillas and chimpanzees, and to describe their distribution in the Dja Reserve.

Surveys of elephants, gorilla, chimpanzees and diurnal monkeys were carried out as part of the Ecofac-Composante Cameroun programme during the months of May, June, July, August and December 1994 and January 1995. The data in this report were collected by Liz Williamson, Leonard Usongo, Martin Tchamba and Ngnegueu Paul Robinson. Additional data were contributed by Marc Dethier, Pia Muchaal, Ngandjui Germain, Ken Whitney and Mark Fogiel.

Our mission benefited from the experience and knowledge accumulated by other researchers associated with the Ecofac project, and from the contacts they made with thelocal population (Dethier & De Wachter at Ekom-Ndengué; Debroux at Djomedjoh-Alat). In this respect we gained a significant logistical advantage which enabled the team to begin work rapidly. For the most part, we chose to work in sectors of the forest where botanical transects are already in place, one of these (Djolimpoum transect) served as a baseline from which a series of perpendicular transects were cut.

The Réserve de Faune du Dja is poorly known. Gartlan (1989) noted that no systematic inventories had taken place in the Dja Reserve. Gartlan and Struhsaker (1972) presented preliminary information on the primate fauna of the Dja, but quantitative studies of large mammals began only recently with the implantation of the Projet Ecofac (*e.g.* Samba, 1994). At least 10 species of diurnal primates: *Miopithecus talapoin, Cercopithecus cephus*, *Cercopithecus nictitans*, *Cercopithecus pogonias*, *Cercopithecus neglectus, Cercocebus albigena*, *Cercocebus galeritus, Colobus guereza, Pan troglodytes troglodytes* and *Gorilla gorilla gorilla* were already known to occur in the Dja Reserve (Gartlan, 1989).

2. METHODS

In the Terms of Reference for these surveys, the Ecofac Scientific Committee recommends the application of the line-transect census methods developed by Tutin & Fernandez (1983, gorillas and chimpanzees) and Whitesides *et al* (1988, primates). The literature on techniques for sampling the abundance of animal populations using line-transects is ample. Methods for large mammals in tropical forests are described in articles by the authors mentioned above and by Barnes *et al* (1987, 1991, 1993), whilst the theory of line transecting is discussed, critically evaluated, and presented with models and survey designs by Buckland *et al* (1993). To avoid reiteration of these methods, a document prepared by Lee White is included as Annex 1 of this report, which describes the stages of a survey from cutting transects to analysing data.

Nonetheless, certain issues concerning data collection should be stressed here. The first critical point with current census techniques, is that the strip-width is not predetermined: all animals or objects seen should be recorded irrespective of their distance from the centre line of the transect. "Effective strip widths" are estimated *post hoc* by analysing perpendicular distance from the transect to the animal or object sighted, and "detection functions" determined (*i.e.* the probability of detecting an object that is at distance *y* from the random line). This differs from earlier surveys where a strip of a fixed width was searched (*e.g.* Barnes & Jensen, 1987). However, an important assumption of the DISTANCE model is that all objects of interest which lie on or above the centre line are detected with certainty (Buckland *et al*, 1993). Thus the sampling probability at zero perpendicular distance equals one (100%). Violation of this assumption would lead to underestimation of density, and render the model inapplicable. Because of the importance of detection of all objects on the line, and because of the reduced importance of "outliers" at relatively large distances from the transect line, most effort can be put into searching near to the centre line of the transect. Trail on the line should not be missed whilst searching for distant nests or troops of monkeys.

Perpendicular or sighting distances should be recorded accurately. Animals or objects which overlap the centre line should not automatically be recorded as having zero perpendicular distance, but efforts made to locate the centre of the dung pile or nest and to record even a few centimetres. The precision of all measurements, from length of a transect to observer-to-animal distances, is critical if population densities are to be estimated with confidence. For this reason, a hip-chain was used to record all transect lengths (model Topochaix). During our first passage on a transect, distances were marked with forestry ribbon, so that on subsequent passes it was not necessary to use topofil thread. A pedometer is acceptable only for repeat censuses of an already measured route (model used DigiWalker E).

Location of transects

Ideally, transects 5 km long would be placed throughout the reserve, however, due to the large size of the Dja Reserve, 5,260 km^2, and the short duration of our study, the number of transects established was limited. Since extrapolation will be made from a relatively small sample, sampling of the habitat needs to be random, and sampling of animal populations must be random (Buckland *et al*, 1993). Transects were stratified according to distance from the nearest village, as recommended by Barnes and Jensen (1987), and orientated to lie to across the drainage pattern with the intention of sampling a representative proportion of all vegetation types. Transect lines should be straight, and should not follow animal paths in the forest, as this will introduce a major bias in the data.

To locate the start point of a transect, the route walked was measured with Topofil, and direction recorded (using a Silva Ranger Type 15 compass). Topographic features such as rivers and streams were noted, which helped to determine locations on a map. GPS information was collected whenever possible with a Trimble Navigation Ensign XL GPS.

Description of the Vegetation

The Dja Reserve covers 5,260 km^2 of low altitude tropical forest, classified as "forêt semi-décidue congolaise" by Letouzey (1963). As all transects were cut, forest type was noted, and the presence of certain tree species recorded together with the relative abundance of herbs belonging to the Zingiberaceae and Marantaceae families which are known to be important food sources for great apes (*e.g.* Williamson *et al*, 1990; Tutin *et al*, 1991).

I. Primate Censuses

First, it should be stressed that censuses of primates were not carried out on the same day as cutting of a transect, and at least two days lapsed between censuses on the same transect (*c.f.* Whitesides *et al*, 1988). Primates encountered during cutting were recorded, but such data serve only to confirm the presence or absence of monkey species (raw data are to be found in Annex 10). Similarly, records of primates seen from paths provide qualitative but not quantitative information about species presence and distribution (Annex 11).

Direction of travel could not be controlled as with one exception, it was not possible to access the end of the transect and carry out a census in the reverse direction. Although rotation is recommended, analyses of direction of travel by Whitesides *et al* (1988) and White (1992) have not revealed any significant differences in the data.

During censusing of the 34.2 km Djolimpoum botanical transect, censuses were not limited to 5 km, but were of variable length as recording continued through out the day. One means of increasing sample size is to sample at all times of day and any decrease in activity will be compensated for by the increased length of transects sampled (Chapman *et al*, 1988). Barnes and Jensen (1987) noted the importance of minimising dead time, and of achieving a balance between statistical requirements and logistical constraints.

For most of December we were able to carry out daily censuses. Occasionally the distance between transects exceeded that which we could travel after a census, so the subsequent census got underway later in the day after completing the journey.

During censuses, the team consisted of one or two researchers, accompanied by a local guide. The data collection sheet used together with explanatory notes on how it should be completed were adapted from those prepared by the Ecofac project in Gabon (see Annex 3). All monkeys seen within 50 m of another monkey were considered to form part of a troop; conversely animals seen more than 50 m from a troop were recorded as solitary (*c.f.* Whitesides *et al*, 1988). Because of the critical importance of accurate recording of perpendicular distances, a Topofil was used to measure many sightings distances to monkeys.

II. Elephants, Gorillas and Chimpanzees

Collecting data on all animal signs is compatible with cutting of transects and is in fact preferable, as animals may begin to use transect lines as paths. This change in animal movements would increase the density of trail close to the centre line. The team consisted of one or two researchers, accompanied by a local guide, plus two to four transect cutters and a compass bearer. The data collection sheet and accompanying information were also adapted from the Ecofac-Gabon format (see Annex 4). The presence and distribution of all large mammal signs, such as nests, dung, feeding trail and foot prints were noted, together with human signs, including snares, machete cuts, hunting or fishing camps, paths and footprints. Each transect was sampled twice, at intervals of between five and seven months.

Besides all indications of elephants, gorillas and chimpanzees, we noted those of duiker, bush pigs, buffalo and large carnivores. Footprints were recorded with the intention of converting them into indices of abundance, as has been done successfully for terrestrial mammals elsewhere (e.g. Prins & Reitsma, 1989; Wilkie & Finn, 1990). Footprints were attributed to a particular animal species by the guide, using local names for animal species, which are listed in Annex 5.

Signs were classified by age, but since elephant dung may remain visible for almost a year and tree nests for many months, precise ages are difficult to estimate. The categories “fresh”, “recent”' “old” and “very old” refer to: <7 days (F), > 1 week and < 1 month (R), 1 to 3 months (V), or more than 3 months (TV). These ages do not apply to duiker dung, which ages rapidly and has a mean duration of 4.3 days (White, 1994a) and for which the time scale was reduced to 14 days.

In the case of nests, particular effort is required to search for all nests present at any individual nest site. Once a nest has been detected, observers must leave the centre line to carry out a thorough search and record all nests whether or not they are visible from the transect centre line. Perpendicular distances to the centre of each nest site were calculated from the perpendicular distances measured to each nest (*N.B.* this differs from analyses of nest density, as in Tutin and Fernandez, 1983).

III. Data Analysis

The program DISTANCE was chosen for data analysis because of its superior performance in producing density estimates. It is currently the most robust program developed, which is also readily available and being applied on an ever widening scale. To meet statistical requirements, the number of observations should reach at least 60 to 80 per species, although a sample size of 40 may be adequate for some purposes (Buckland *et al*, 1993).

a) Monkeys: Density calculations incorporate the mean spread of a troop of monkeys and mean troop size. We used distances compiled by White (1994a). Half of the mean troop spread was added to each perpendicular distance recorded before analysis by DISTANCE (*C.cephus:* 15 m, *C.pogonias*: 30 m, *C.nictitans:* 30 m, *C.albigena:* 50 m). DISTANCE produces estimates of the number of troops of monkeys per km2.

b) Elephants: To calculate the density of elephants (E) from the dung piles density (Y) as produced by DISTANCE, we used the formula:

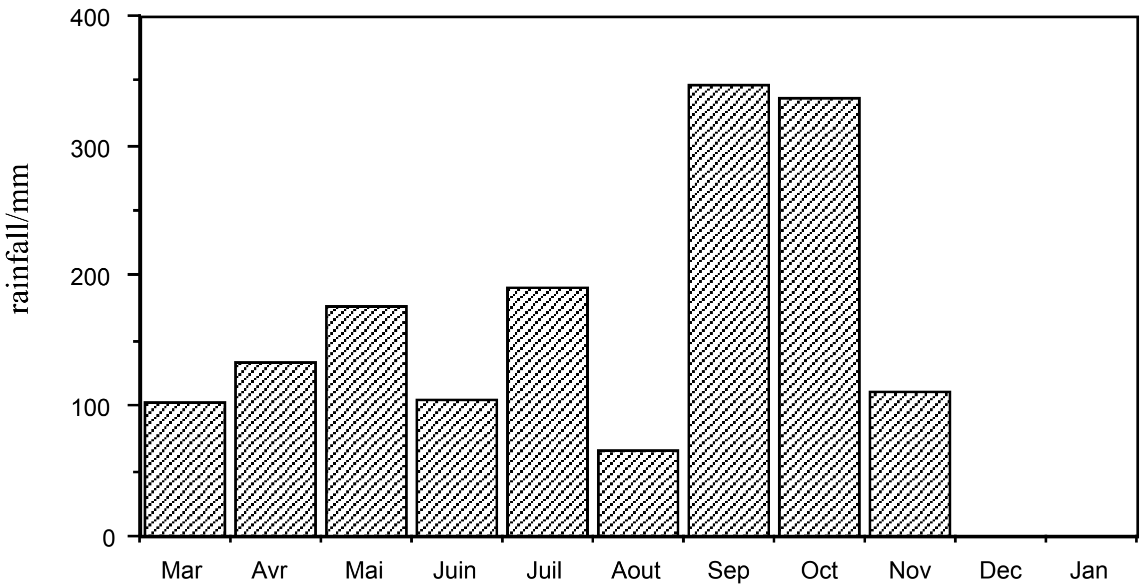
$E = (Y \times V) / D$ (Barnes *et al*, 1995a)

Several estimates of defaecation rate (D) by forest elephants have been published (*e.g.* Merz, 1986); following Richard Barnes' recommendation, that used here is 20 dung piles per day per elephant (Tchamba, 1992).

Dung decay rate (V) varies with many factors, including diet, but climate is a major determinant of the time that dung piles remain visible (White, in press). The best correlation found is with rainfall and temperature in the month of data collection and explains 81% of the variation in elephant dung decay (Barnes *et al*, 1994). Decay rates were calculated with the following equation:

$$V = (-96.498 + (0.063 \times \text{monthly rainfall}) + (4.667 \times \text{mean monthly temperature})) / 1000$$

Fig. 2: Rainfall at Bouamir, Reserve de Faune du Dja



1994 & 1995 (Whitney & Fogiel, unpub.)

Rainfall at Bouamir in the Dja Reserve during the period of these surveys is shown in Figure 2. The mean monthly maximum temperature recorded was 26.0 °C, while mean monthly minimum temperature was 18.4 °C. (unpublished data from Whitney & Fogiel, Projet Calao). Decay rates for each month of data collection range from 0.026 in December (dry season) to 0.285 in September (beginning of the rainy season) (Annex 6).

c) Gorillas and chimpanzees: Densities of gorillas (G) and chimpanzees (C) are calculated from nest site densities (N) output by DISTANCE using the formula:

G or C = (N x mean group size) / mean duration of nest sites

The mean duration of chimpanzee nests in northeastern Gabon was found to be 113.5 days (Tutin & Fernandez, 1983) and this figure will be applied to our data. Mean longevity of gorilla nest sites varies with the types of nests constructed, but we have applied the 78 day mean from studies at Lopé (Tutin *et al*, in press). To make accurate counts of group size, nests sites need to be located within four days of apes having slept there, as some gorillas in CAR and Gabon sleep in “bare ground nests” without vegetative construction (Remis, 1994; Tutin *et al*, in press). Mean group sizes in the Dja will be calculated from the number of nests at fresh nest sites only, including some sites found away from transects.

N.B. The 95% confidence limits produced by DISTANCE take into account the variances of detection and encounter rates, but the estimates of animal density will not include confidence limits, since the variance of some variables incorporated into calculations is unknown. Also the process of adjusting perpendicular distances of monkeys sighting invalidates the confidence limits given by DISTANCE. All data sets were truncated during analysis, once the likelihood of an object being seen (the detection probability) dropped below 0.15.

3. RESULTS

During the first four months of the surveys, activities concentrated on the establishment of 17 transects totalling 94.7 km. (5 x 5 km Djolimpoum; 5 x 5 km Malele; 1 x 15.4, 1 x 3.6, 1 x 5.7 km Ndengué; 4 x 5 km Alat), see Figure 1 and Table 1.

Table 1: Number of kilometres of transects surveyed for animal sightings and trail

Sector	Month	Trail	Sightings	
Djolimpoum	May	21.5 (+34.2)	69.6	
Malele	Jun	25.0	25.0	
Ndengué	Jul	24.7	0	(Tchamba)
Alat	Aug	20.0	2.5	(Usongo)
Djolimpoum	Dec	23.1	59.0	
Malele	Dec	23.0	30.3	
Ndengué	Dec	23.6	23.6	
Alat	Jan	20.0 (+3.8)	23.8	
Djomedjoh	Jan	(9.0)	14.0	
Mekas	Jul-Nov	20.0 †	110.0 †	(Muchaal, Ngandjui)
Ekom	Jul-Oct	25.0 †	105.0 †	(Dethier)
TOTALS		225.9 (+ 47)	462.8	

† subsets of data

Ndengué and Alat are a little difficult to place within a stratification of increasing distance from villages, however, preliminary analyses of the data by transect revealed trends which did not fit simply within the stratification intended. This led to a *post hoc* definition of strata which differs for each species, as detailed below. Two of the transects near to Alat crossed each other. This was not planned, so data were examined for any possible duplicate observations in the region of the overlap; there were none, and the data have been retained. The approximate locations of all transects and nearest villages in the Dja Reserve as a whole are shown in Figure 1 on a small scale map. Transects cut at Djolimpoum, Malele, Ndengué and Alat are positioned on larger scale maps in Figures 3, 4 and 5. GPS references are attached in Annex 2. GPS data are sparse for the transects close to Alat due to adverse meteorological conditions in January 1995. The reference numbers given to each transect can be found in Annex 8 (codes). Note that during collection of trail data during the second mission, a new number was given to each transect, however, data were lumped in most analyses. Also transects longer than 5 km were given separate numbers for each 5 km segment to allow interpretation of strata, but are treated as a one sample in most analyses.

I: Primate Censuses

The number of censuses carried out for this mission was 51, mostly during the month of December.

These add up to 247.8 kilometres of census, and were supplemented by 110 km from Mekas and 105 kms from Ekom, totalling 462.8 kms (see Table 1). (*N.B.*Data from Mekas and Ekom are not included in Annex 7). In the raw data appended, observer-to-animal distances and sighting angles have been converted to perpendicular distances. In all cases where animals were seen, perpendicular distance is given. Values in the column "observer to animal" refer to the distance estimated if animals were heard but not seen. Times for the start and finish of censuses are given as decimal values to facilitate calculations of speed of travel.

Efforts were made to begin censuses between 6.00 hrs and 7.00 hrs, although several previous studies found no evidence of sighting frequency varying with time of day (Thomas, 1991; White, 1992; Whitesides *et al*, 1988), and density estimates are not systematically affected by sampling during periods of inactivity (Chapman *et al*, 1988). Excluding censuses which were started in the afternoon (N = 2), the mean time at which censuses began was 7.30 hr. (R = 6.00-11.50 hr.), ending on average at 12.54 hr. (R = 9.30-17.20 hr.).

An optimum speed of 1.0 to 1.5 km/hr. is recommended for the censusing of monkeys. If travel is too slowly in relation to the animals, observers could encounter the same troop of monkeys more than once. The average speed with which we carried out censuses was 0.95 km/hr. (R = 0.51-1.48 km/hr.) since trail data were usually collected at the same time, and effective searching required that observers move slow to be sure of detecting all trail and animals. This dual collection of data was a compromise to maximise the quantity of all types of data collected during this study, and made necessary by the logistical constraints of sampling in dense forest. White (1994a) found no detectable effect of censusing at these two speeds.

Table 2: Encounter rates for large mammals during censuses

Species	No. Obs	ER (no.obs/km)	No. auditions
Cercocebus albigena	56	0.121	89
Cercocebus galeritus	2	0.004	
Cercopithecus cephus	79	0.171	53
Cercopithecus neglectus	? 1		
Cercopithecus nictitans	103	0.223	141
Cercopithecus pogonias	65	0.140	91
Colobus guereza	9	0.019	23
Miopithecus talapoin	2	0.004	
Gorilla gorilla	0		
Pan troglodytes	6	0.013	35
Homo sapiens (hunters)	8	0.044	1
Loxodonta africana	4	0.022	4
Potamochoerus porcus	0		1
Syncerus caffer	1	0.006	1
Cephalophus dorsalis	7	0.039	
Cephalophus callipygus	2	0.011	

Cephalophus leucogastor	0	
Cephalophus monticola	6	0.033
Cephalophus sylvicultor	0	

The number of sightings of each large mammal species during 483 km of census are given in Table 2, together with encounter rates. The number of observations of all except the four most common monkeys are inadequate for density calculations. The frequency and distribution of sightings and vocalisations of *C.cephus, C.pogonias, C.nictitans* and *C.albigena* are illustrated in Figures 6 and 7. These show that monkeys are common throughout the areas sampled, especially near Alat and in the Mekas sector. Lowest numbers were recorded in the northwest around Ekom and Ndengué. Strong patterns exist in the emission of vocalisations by the guenons which are species specific (see Gautier, 1988). Despite this, the frequencies of vocalisations and observations recorded in this study correlate for individual species (significant at $p < 0.01$ for *C.cephus, C.nictitans* and *C.albigena*, at $p < 0.05$ level for *C.pogonias*).

Densities were calculated for the four common monkey species and are given in Table 3. A summary of the outputs by DISTANCE can be found in Annex 12, which gave Estimated Strip Widths for these four species of 47.7 m, 64.6 m, 66.0 m and 76.9 m respectively. Overall, the most common species is *C.cephus* (1.72 troops/km2), followed by *C.nictitans* (1.57 troops/km2), *C.pogonias (*1.38 troops/km2) and *C.albigena* (0.77 troops/km2) . All species attain particularly high numbers in Alat, with maximum density for a single species (*C.nictitans* 3.71 troops/km2) and for four species combined (9.73 troops/km2). Lowest densities were found for Ndengué (overall 2.22 troops/km2, *C.cephus* 0.089 /km2).

Colobus guereza were seen only nine times, and were certainly under recorded due to their low detectability. They are often high in the canopy and remain motionless for long periods. At the time of our field work one hunter near Alat killed three adult colobus during consecutive hunting trips, confirming their presence in the south west, although none were observed during censuses.

Table 3: Densities of four monkey species by sector

SECTOR	SPECIES				
	C.cephus	C.pogonias	C.nictitans	C.albigena	total
Djolimpoum	0.888	1.574	0.514	0.661	3.638
Malele	1.708	0.981	1.372	0.471	4.531
Ndengué	0.089	0.983	0.321	0.826	2.218
Alat	2.330	1.376	3.706	2.313	9.725
layons botaniques	1.319	1.063	1.821	0.893	5.096
Mekas	2.954	0.844	2.688	0.650	7.137
Ekom	1.298	0.958	0.722	0.681	3.660
overall	1.722	1.376	1.573	0.773	5.443

Fig. 6: Observations of four monkey species per km of census

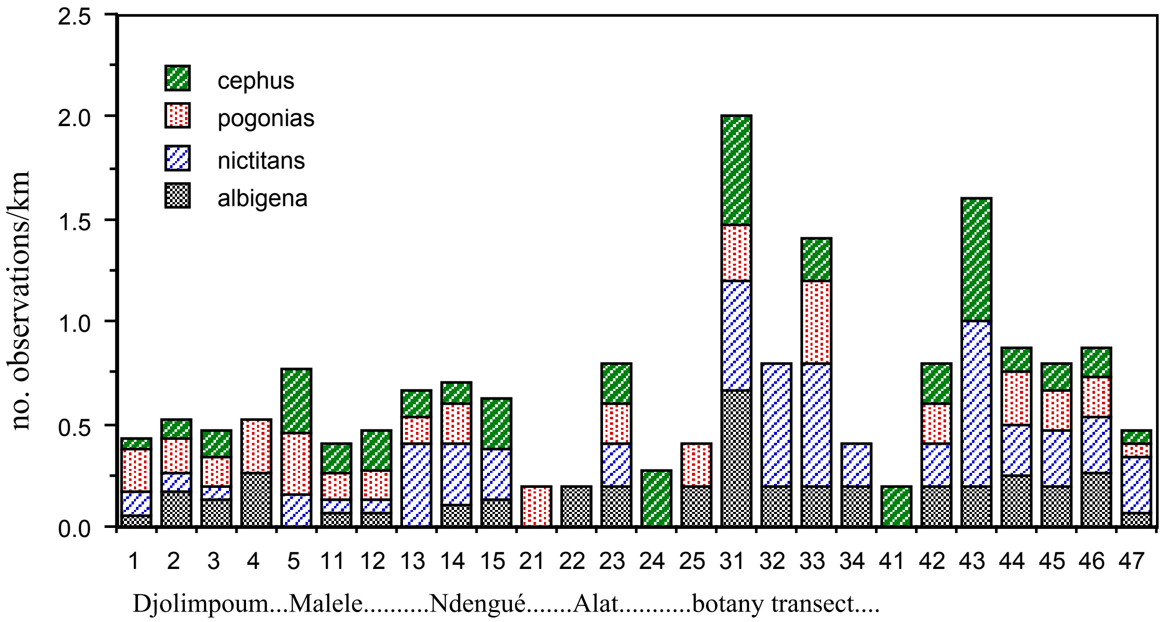


Fig. 7: Vocalisations of four monkey species per km of census

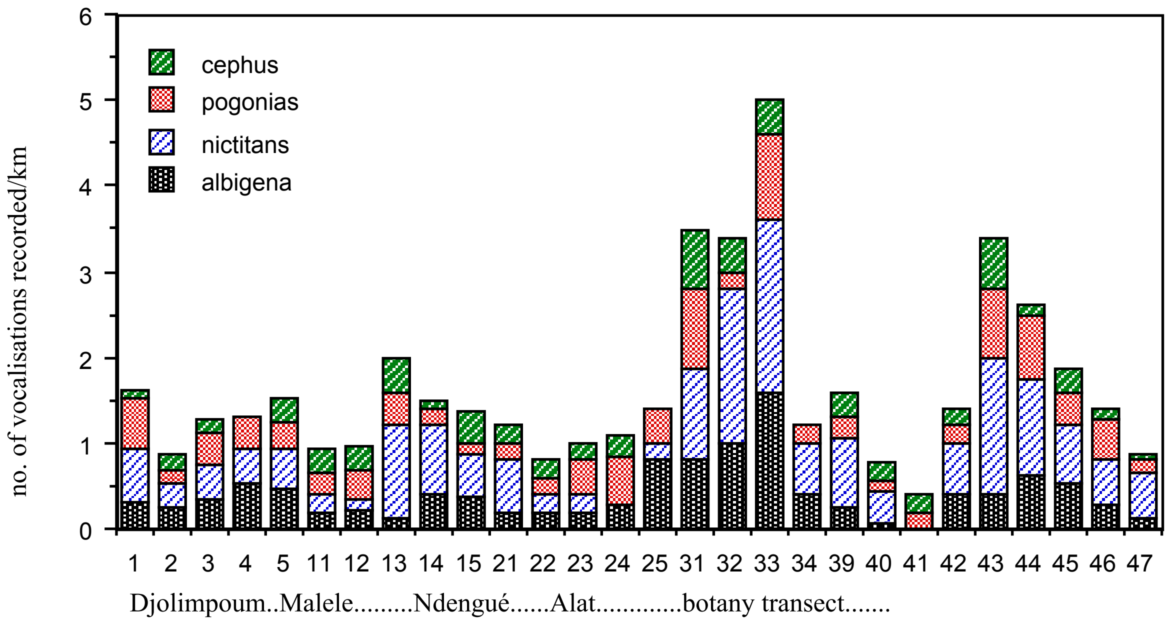
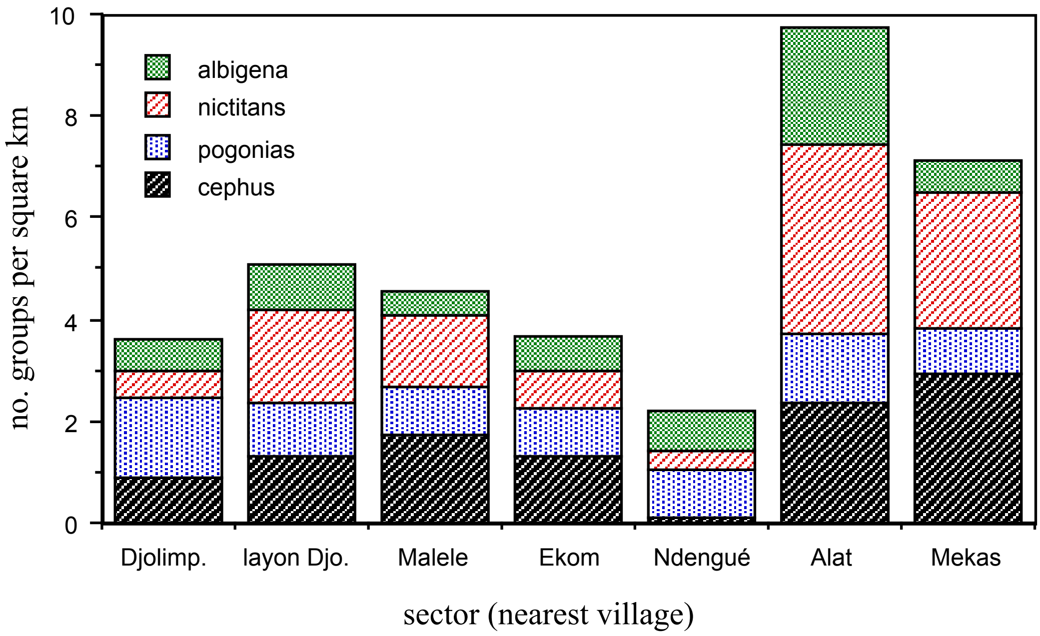


Fig. 8: Densities of four monkey species in different zones of the Dja Reserve



Of the other diurnal monkeys found in the Dja Reserve, C.*galeritus* and *M.talapoin* were each seen only twice, in large troops composed of perhaps 50 individuals, and there was only one probable sighting of *C.neglectus* (Mekas transect near to Bouamir). All three of these species have specific habitat preferences which restrict their distribution, C.*galeritus* and *M.talapoin* being generally associated with riverine forest and *C.neglectus* occurring in swamp forests (Gautier-Hion, 1971; Gautier & Gautier-Hion, 1969; Quris, 1975). Two other species mentioned by Ngandjui (1993) and Bergmans (1994) whose presence was not confirmed are *Cercopithecus mona* and *Colobus satanus. Cercopithecus mona* is reputed to occur in the Reserve, but the present study found no evidence to support this. Some confusion exists since C.*pogonias* is generally referred to as the "mone". *C.satanus* occurs south of the Dja River and is known to occur close to Bi, south-west of the Reserve, but the river seems to form a geographic barrier. Gartlan and Struhsaker (1972) and Mitani (1990) reported the possible presence of *Cercocebus torquatus* in eastern Dja, but again no evidence of this species was found.

Polyspecificity

The composition of 71 troops of two or more species of monkey, when at least one species was seen, is given in Table 4. Using the frequency with which each species was sighted per transect, pair-wise combinations were tested, and found to be significant for *C.nictitans* and *C.cephus* ($p < 0.01$) and between *C.nictitans* and *C.albigena* ($p < 0.05$). The same correlations proved significant when testing species densities.

Of the 201 groupings analysed, 62.7 % were monospecific. *C.nictitans* were alone 53.3% of times they were seen, *C.cephus* 47.4%, *C.pogonias* 27.4% and *C.albigena* 23.7%. Solitary individuals were recorded seven times, four *C.cephus* and three *C.nictitans*. It seems that *C.cephus* and *C.nictitans* have the lowest tendencies of association.

Table 4: Frequency of groupings between monkey species

Monospecific groups (N = 126, 62.7%)		
Cercopithecus cephus	36	
Cercopithecus pogonias	17	
Cercopithecus nictitans	56	
Cercocebus albigena	14	
Polyspecific groups (N = 75, 37.3 %)		
C.cephus + C.pogonias	4	8.2%
C.cephus + C.nictitans	13	26.5%
C.cephus + C.albigena	2	4.1%
C.pogonias + C.nictitans	5	10.2%
C.pogonias + C.albigena	14	28.6%
C.nictitans + C.albigena	9	18.4%
C.pogonias + C.guereza	1	2.0%
C.pogonias + C.galeritus	1	2.0%
Three species		(N = 22, 29.3%)
C.cephus + C.pogonias + C.nictitans	6	27.3%
C.cephus + C.pogonias + C.albigena	5	22.7%
C.cephus + C.nictitans + C.albigena	6	27.3%
C.pogonias + C.nictitans + C.albigena	5	22.7%
Four Species		(N = 4, 5.3 %)
C.cephus + C.pogonias + C.nictitans + C.albigena	4	100.0%

Other large mammals observed

All other species observed are included in Table 2. Elephants were seen four times during censuses and three more times during work on transects. Chimpanzees were observed six times during censuses, and gorillas not at all. Duikers were seen 15 times, whereas buffalo were seen only once where a transect crosses a “rocher” - a grassy area with virtually no trees. Buffalo are easily viewed on the Rocher de Nkoubar and the Rocher de Bouamir. Perpendicular distance was not recorded for encounters with humans as they were seen to be using the transect as a path. All of these meetings took place with hunters from Djaposten on the Ndengué transects.

II: Elephants, Gorillas & Chimpanzees

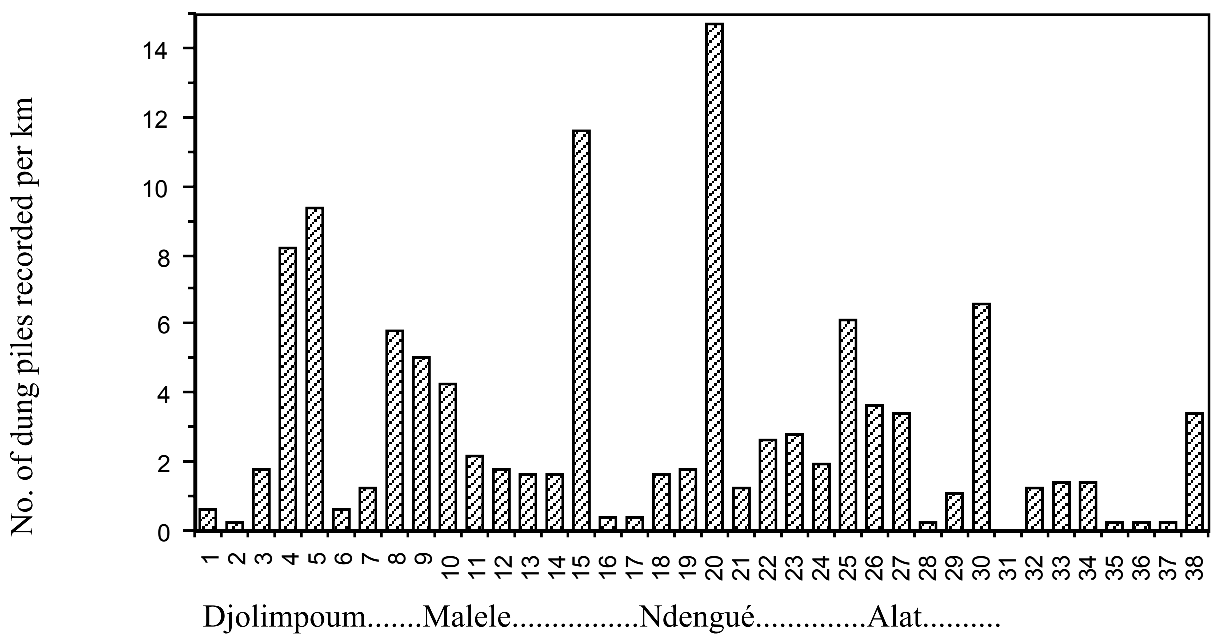
All raw data collected on transects are attached as Annex 8. “Prospection data” or trail recorded on paths are included as Annex 9 (“sentier”). Although all traces seen on botanical transects were recorded and are appended (Djolimpoum, 46.7 km; Alat 4.8 km; Djomedjoh, 9 km), these were excluded from density calculations, as the frequencies with which signs were encountered were considered low and to be biased by animals avoiding these transects. A simple change in the habitat may change the behaviour of large mammals, and human activities which indirectly affect animals may still cause changes in behaviour (Lahm, 1993).

a) Elephants

A summary of DISTANCE outputs is attached as Annex 13. The estimated pooled density of dung piles was 705.9, which with a mean decay rate of 0.0158, translates to an elephant density of 0.56 per km2 (0.33-0.96 per km2). Densities were analysed by transect and by zone, and stratified with respect to distance from the road/nearest village. A strong pattern emerged, indicating that elephant densities are very variable but reach high numbers at restricted sites as shown in Figure 9. Two areas of high density were identified. The first is along the River M'pep from south of Nkoubar stretching to the junction with the layon de Djolimpoum, where the density of elephants was estimated at 1.72 per km2 (0.68-4.37 per km2). A 14 km 'prospection' (rapid collection of data without cutting a transect) effected between these two zones confirmed that elephant dung density remained high. The second area is west of Ndengué, where elephant density averaged 0.72 per km2 (0.16-3.25 per km2). The average density for all transects excluding M'pep and Ndengué is only 0.22 per km2 (0.15-0.33 per km2). The large confidence intervals given are due to an uneven distribution of the population (encounter) not due to detection, and under represent the variation in these estimates as explained in Methods.

When analysed for seasonal differences in densities by sector, the only notable variation occurred at Ndengué where density increased slightly from 0.78 elephants/km2 in July to 0.82 /km2 in December (compare transect numbers 21 to 25 with 26 to 30 in Fig. 9).

Fig. 9: Distribution of elephant dung between transects (N = 502)



b) Gorillas

Gorillas in the Dja built six of the seven nest types defined by Tutin & Fernandez (1983; see Annex 4); only bare ground nests were not seen, which can form up to 44% of sleeping sites (Remis, 1994). Two nest types are shown in Figures 10 and 11 (note the presence of water and mud).

Table 5: Types of nest built by gorillas in the Dja Reserve (N = 147)

Nest type	Number of nests	Proportion of all nests
Herbaceous	118	80.4 %
Minimum	3	2.0 %
Woody	3	2.0 %
Detached Woody	3	2.0 %
Mixed	15	10.2 %
Tree	5	3.4 %

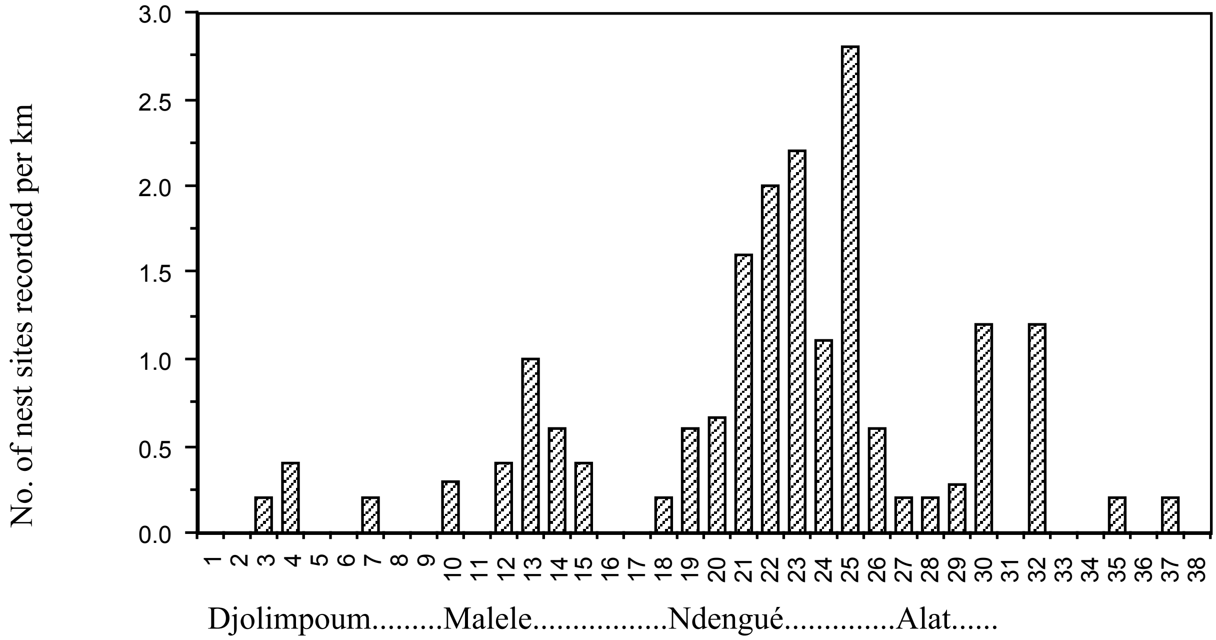
The proportion of tree nests built by gorillas in the Dja is very low at 3 %, but likely to have been underestimate. Herbaceous nests formed only 40% of the Lopé sample (Tutin *et al*, in press) but 80 % of the sample from the present study. Individual nest decay rates given in Tutin and Fernandez (1983) suggest a mean longevity of 59.2 days for nests in the Dja, however, we chose to use the mean duration of 78 days for nest sites at Lopé, since this information is applicable to sites rather than individual nests, and comes from a long term study.

Mean gorilla group size in the Dja was 3.67 ± 3.1 weaned individuals (N = 33, range = 1-12), and the overall density of nest sites was found to be 36.37. This translates to 1.71 weaned gorillas/km2 (range 1.02-2.86 /km2). Distance outputs are summarised in Annex 13.

Fig. 10: Woody gorilla nest in Seasonally Inundated forest (photograph)

Fig. 11: Herbaceous gorilla nest. (photograph)

Fig. 12: Distribution of gorilla nest sites between transects (N = 91)

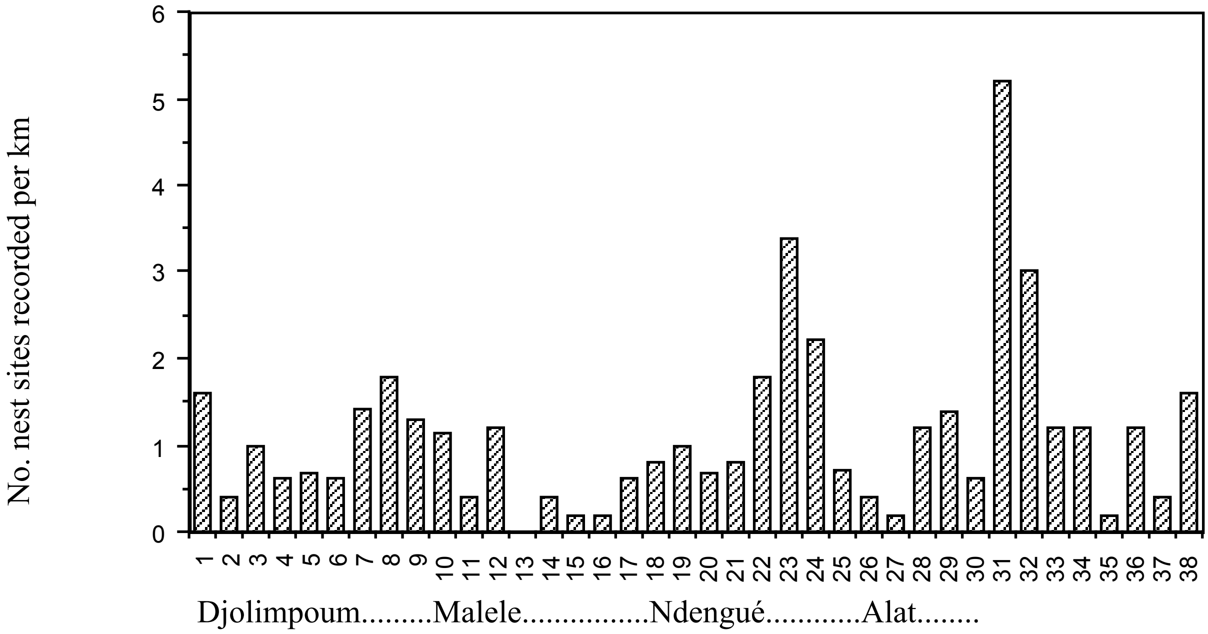


The patchy distribution of nests sites is demonstrated in Figure 12, which shows that many transects were devoid of nests. Again, the strata by which data were grouped for analyses are not strictly defined by distance from a village. The areas of high density show a similar pattern to elephant densities, with concentrations around M'pep and Ndengué. Unlike elephants, the concentration of gorillas around Nkoubar does not extend to the south east, but east towards Ekom (not illustrated). Densities of the two sectors, at least 15 kms south of nearest village, average 1.88 gorillas/km2 (1.33-2.55/km2). Numbers recorded east of Ndengué are extraordinarily high, averaging 5.01/km2. In fact the majority of nests sites recorded were found on the Ndengué transects (61 of 94, 64.9%). A very large difference in density was found between July (7.88/km2) and December (2.69/km2). Overall density excluding these two concentrations is 0.47 per km2 (0.23-0.99/km2).

c) Chimpanzees

Mean group size for chimpanzees was 2.16 ± 1.92 weaned individuals (N = 62, range = 1-9, median = 1), the overall density of nest sites was 41.63 per km2. Since chimpanzee (tree) nests have a greater longevity, this translates to density of 0.79 weaned individuals per km2 (0.60-1.04 per km2).

Fig. 13: Distribution of chimpanzee nests between transects (N=203 sites)



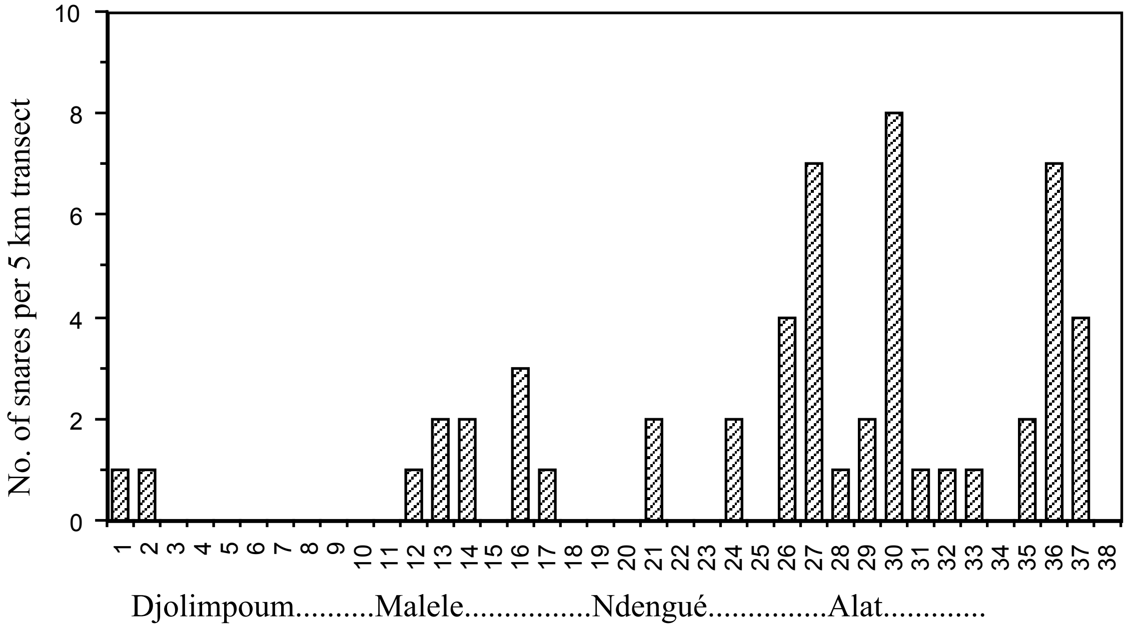
Densities in different sectors were quite variable, but not nearly as marked as with gorillas and elephants. The following mean densities were estimated by sector: Djolimpoum 0.79 /km2, Malele 0.40 /km2, Ekom 1.07 /km2, Ndengué 0.91 /km2, Alat 1.29 /km2, Mekas 0.11 /km2. Seasonal differences were quite pronounced: Djolimpoum May 0.69 /km2, Dec. 0.95 /km2; Malele June 0.35 /km2, Dec. 0.55 /km2; Ndengué July 1.33 /km2, Dec. 0.56 /km2; Alat Aug 2.04 /km2, Jan. 0.67 /km2 (see Annex 13). Despite this variation, the distribution of chimpanzees is relatively even, as shown in Figure 13.

d) Humans

Several indicators of human presence were recorded but only snares and shotgun cartridges are shown in Figure 14, since these were considered to point to recent activity by hunters. The number of snares found was relatively low in all zones, except for Ndengué and Alat. By comparing transects 21-25 and 31-34 with 26-30 and 34-38, it is obvious that hunters profited from the establishment of transects to install trap lines.

Snares and all other indicators of human activity were tested against each of the large mammal species for which we have estimated densities. Although the density of all species showed an inverse relationship with human signs, only one of these trends was significant (*C.albigena*, $p < .05$).

Fig. 14: Snares found along transect lines



e) Other Species

All raw data are included in the trail data annexed, but the analyses presented here are superficial. Footprints have been used as indices in other studies (*e.g.* Wilkie & Finn, 1990), and Figures 15 and 16 present these data for duikers, bushpigs and buffalo. Although some duiker species are assigned to traces in the raw data, we do not have confidence in these identifications, since it is difficult to distinguish the footprints or dung of "red" duikers. Indices for each of these species were highest on transect 14. Very few signs of leopards *Panthera pardus* were seen; the burrows of giant pangolins *Manis gigantea* were common, whereas only one aardvark *Orycteropus afer* burrow was noted.

Fig. 15: Frequency of duiker trail on some transects

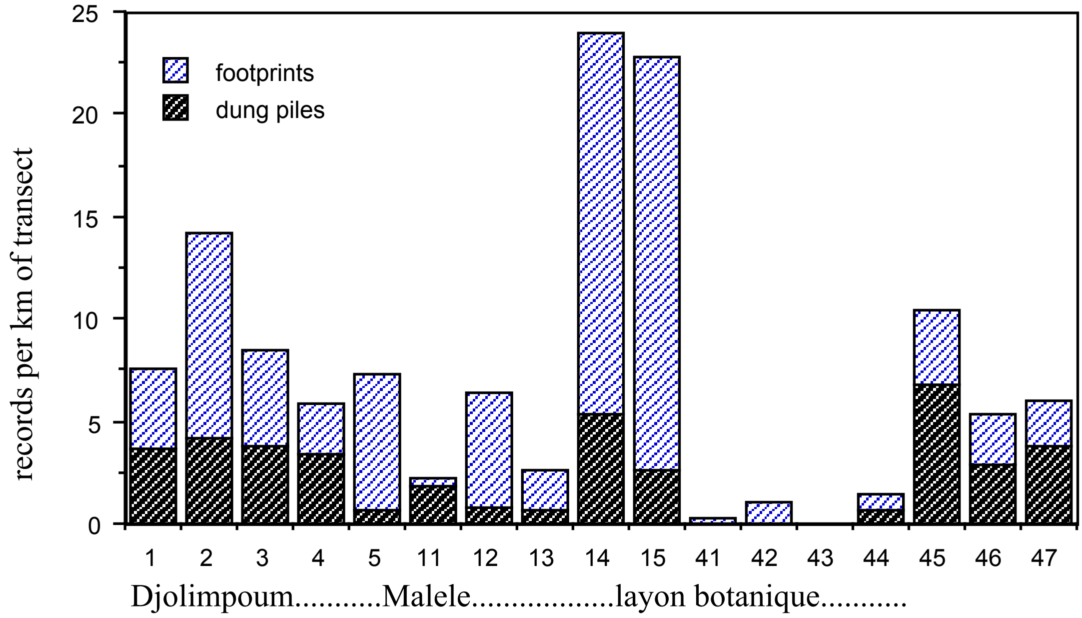
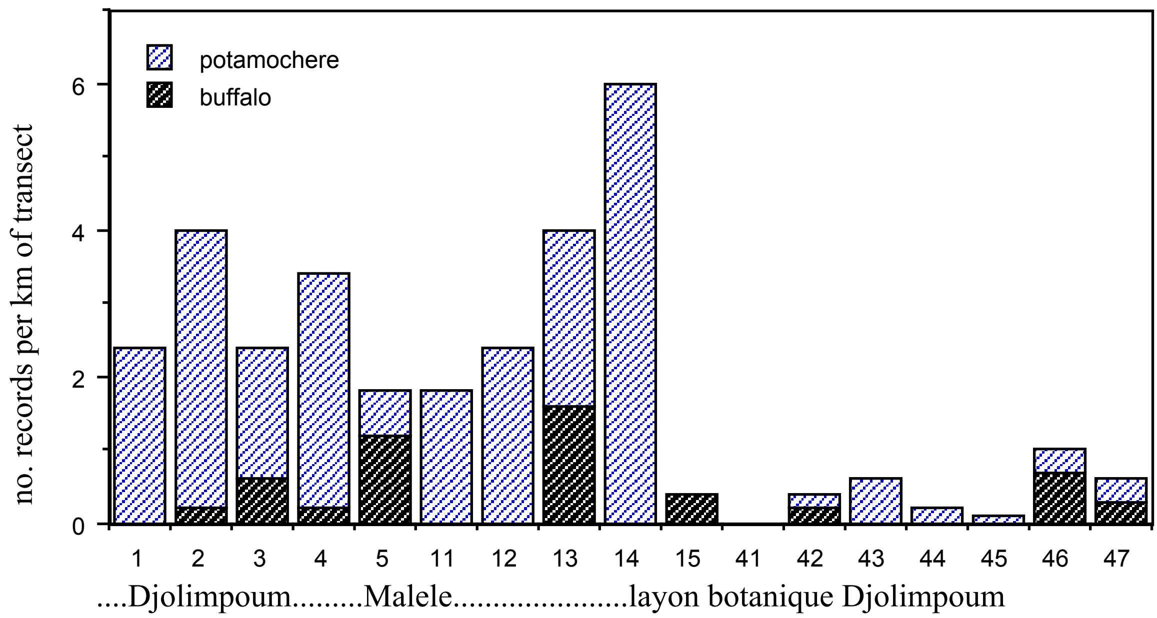


Fig. 16: Distribution of buffalo and potamochere trail on some transects



III. Vegetation

The almost monotonous topography of the Dja Reserve has contributed to the creation of numerous marshes, dominated by *Raphia*,or by *Cyperus* with *Pandanus* (Fig. 17). The forest often has a secondary appearance with an abundance of the lianescent herb, *Haumania danckelmaniana*, and thickets of rattan *Ancistrophyllum secundiflorum* (Fig 18). Despite the presence of this well developed herbaceous stratum, Lejoly (1994) considers that the classification “forêt clairsemée à Marantacée” does not apply to the Dja Reserve.

Due to constraints on the preparation of this report it has not been possible to carry out a quantitative analysis of the information collected on vegetation types and plant species. With respect to large mammals, the importance of *Raphia* swamps should be noted. *Raphia* swamp and seasonally inundated forest with abundant *Uapaca* spp. trees covered large areas of the sectors sampled. An indicator of the dynamics of certain forest types comes from the transects near M'pep: when transects 3, 4, 5 and 15 were revisited in December, they had become quite overgrown. The vegetation of this river basin showed a high rate of regrowth where *Haumania danckelmaniana*, and *Ancistrophyllum secundiflorum* were particularly abundant. By contrast, it was not necessary to re-cut transects 1 and 2, which were dominated by mature forest with a sparse understorey.

Figure 17. Open swamp dominated by *Cyperus* and *Pandanus*. near Ndengué (photograph)

Figure 18. *Ancistrophyllum secundiflorum* on Transect 5. (photograph)

4. DISCUSSION

I: Primates

To evaluate the density estimates obtained from this study, we need to draw comparisons with other primate communities studied in similar habitats. Table 6 presents some of the information available from forests with similar primate species composition, which are geographically close to the Dja Reserve (Doula Edéa in Cameroun, M'passa in northeast Gabon, Lopé in central Gabon). The data show remarkable agreement, however these monkeys should not be considered in isolation from anthropoid primates and colobines. Biomass estimates which incorporate information about C.*guereza, C.talapoin, C.neglectus* and *C.galeritus* will provide a more meaningful measure by which to compare different areas. Nonetheless, the density of monkeys found in this study is high and gives cause for optimism.

The frequency with which we recorded polyspecific associations seems to be low (46.7 to 72.6 % of observations per species). Previous studies of these three guenons have shown that between 73 % and 86 % (according to species) of troops are polyspecific (Gautier-Hion, 1988). The difference in our sample may relate to methodology, as we adhered to Whitesides *et al* (1988) recommendation that observers remain stationary for no more than 10 minutes during censuses. It is possible that we detected only one species in some polyspecific troops.

The data suggest an inverse relationship between the abundance of monkeys and that of gorillas and elephants. It is notable that near Ndengué, where gorillas occurred in their highest numbers, monkeys were relatively rare, and at Alat and Mekas where there were most monkeys, gorillas and elephants densities were quite low. However, no significant trends were identified at the transect level.

II. Elephants, Gorillas & Chimpanzees

a) elephants

The mean density of 0.56 elephants per km2 (0.33 to 0.96/km2) estimated during these surveys is higher than in some other forests, for example Merz (1986) found a mean density of 0.23/km2, and Alers *et al* (1992) considered 0.32 elephants/km2 a "high" density for forests in Zaïre, Dja appears to have a similar population density to parts of CAR (0.48/km2, 0-2.1/km2, Fay, 1991) and Congo (0.7/km2, 0.3-0.9 km2, Fay & Agnagna, 1991). The highest known densities of forest elephants occur in the sparsely populated zone spanning southeastern Cameroun, southeastern CAR, northern Congo and northeastern Gabon (Barnes *et al*, 1995b). Up to 6 elephants/km2 are found in parts of southeastern Cameroun (Stromayer & Ekobo, 1991) however this is not a permanent population as elephants migrate in from Congo and CAR (Ekobo, pers.comm.). And in Gabon, elephant densities reach 4 per km2 at certain times of year when *Sacoglottis* fruits are available in a limited area (White (1994b).

Seasonal movements of elephants can have a large effect on density calculations. These migrations are an adaption to shifts in food availability within their habitat (White, 1994b). We found evidence of small scale migrations in the Dja with the doubling of dung piles recorded on a transect near to Azem between August and January, in forest with strikingly high densities of *Klainedoxa gabonensis, Irvingia gabonensis* and *Panda oleosa* trees. These trees were fruiting in January. Lahm (1993) reported that villages in northeastern Gabon experience marked annual fluctuations in crop-raiding by elephants, and similar claims were made by villagers in the Boucle du Dja. Such seasonal effects cannot be measured in a study of limited duration, but we obtained evidence that they occur.

It is clear that elephants are not evenly distributed in the Dja Reserve. Previous studies have shown that human impacts are the overriding factor in determining elephant distribution on a large scale (Barnes *et al*, 1991). The human population associated with the Dja is of low density. Gartlan (1989) gave a figure of 1.5 inhabitants/km2 for the Reserve, however this population has increased in recent years (Ngandjui, 1984; Seme, pers.comm.) and estimated to be 0.6 to 4 inhabitants/km2 by Joiris and Tchikangwa Nkanje (1994). No clear relationship between elephant densities and human activities was determined in the present study, although the highest densities recorded in all months were found at distances over 25 km from the nearest village. Surprisingly the number of elephants east of Ndengué during December, when hunting activity on the transects was intense, had increased since July. It is likely that hunters were focusing on other species, nonetheless many animals which are seldom hunted are affected by the general disturbance of human activity. Both game and not game species adopt strategies to avoid human contact, such as changes in habitat use (Lahm, 1993).

Perhaps the lack of an identifiable relationship between elephant densities and distance from the nearest village is because hunters in the Dja Reserve are known to travel up to 40 kms to check their snare lines (Ngandjui & Muchaal, pers.comm.), whilst in northeastern Gabon hunting is usually concentrated within 10 or 15 kms of villages (Lahm, 1993). Elephant hunting is specialised and hunters will certainly travel further for the "grande chasse".

Realistically, the patterns we are looking at in the Dja are small scale, and vegetation type will play a major role in determining animal distributions. What might cause the concentrations we observed around M'pep and Ndengué? The Ndengué transect crosses an extensive *Cyperus-Pandanus* marsh (> 700 m) which would provide abundant food and refuge for elephants. The vegetation types which predominate in the M'pep river basin are forest with a sparse upper canopy, old secondary forest with *Haumania* and *Ancistrophyllum* thickets, secondary gaps and *Raphia* swamps. The high density inferred from dung counts was corroborated by encounters with elephants on these transects yet on no others (these were usually auditions only, as the elephants were extremely wary and simply ran once they detected our presence). Perhaps the river itself is an attraction, as some spots along the river bank evidence intensive use by elephants (see Figs. 19 & 20). Affinities for particular rivers by individual elephants have been observed in the Korup National Park, and preferred river basins may form the focus of an elephants home range (Powell, pers.comm.). Lahm (1993) also found that elephants in northeastern Gabon are highly dependent on riverine and seasonally inundated forests.

So if elephant distribution is patchy with localised high density, how do we predict their distribution in other parts of the reserve? Can we extrapolate from these results to the Reserve as a whole? We know little of the west, and even less about the north-east or east-central zones. During prospection up to 18 kms west of Djomedjoh, not one elephant dung pile was recorded, and although surveys in the Mekas area found some indications of elephants (Muchaal, per.comm.) it seems that their densities were low. No attempt was made to evaluate hunting intensity during the present study, but it is known that hunting of elephants occurs around Lomié. We also received reports that hunters are generally active in the north east (evidence of this comes from the Ndengué transects), and in parts of the south due to the high demand for bush meat in Djoum (see Fig. 1). Hunters regularly cross the Dja river to enter the Reserve, and check their trap lines. We found many snares near to Alat, although these may not be a good indicator of the level of hunting with firearms.

Alers *et al* (1992) applied estimates from a stratum with low elephant density to a wider area of Zaïre. A similar extrapolation in the Dja gives an elephant population of 1,157 (789-1,736). This figure gives us an idea of the potential elephant population, however, it would be unwise to assume that elephants are present through out the Reserve without further field work to establish whether or not this is true.

At this point, it should be emphasised that much of the discussion above applies equally to other large mammals, including gorillas and chimpanzees.

b) Gorillas

The estimate of 1.71 weaned gorillas per km2 is surprisingly high, given the impression gained during fieldwork. Gorillas were encountered only twice during the surveys: a lone male was seen on transect 13, and a group was feeding on transect 4 as we returned from cutting. However, we heard frequent chest beats during the night when camped near to transects 5 and 15, both far from villages and in dense vegetation close to the river M'pep, and also at the junction of transects 21 and 25 near Ndengué, where the highest numbers of nest sites were recorded.

Studies elsewhere have estimated average densities of 0.44/km2 (but up to 9.16/km2, Tutin & Fernandez, 1983), 0.89-1.45 km2 in CAR (reaching 5.6/km2 in light gaps and 10.96 /km2 in secondary forest, Carroll, 1986), 1.6 /km2 also in CAR (Fay, 1989), 1.2 /km2 in northern Congo (2.4 /km2 in swamp forest, Fay & Agnagna, 1992) with high densities recorded in the Likouala swamps of Congo (2.6 /km2, Fay *et al*, 1989)

<u>Figure 19. Area along the River M'pep where elephant activity is intense. (photograph)</u>

<u>Figure 20. Bank of the River M'pep associated with a high density of elephants (photograph)</u>

Such high local densities are generally associated with swamp forests, as confirmed by Blake (1993) who estimated 5.88 gorillas/km2 in *Raphia* dominated swamp, and 2.88 /km2 in *Raphia-Uapaca* forest. Lahm (1993) also found that gorillas showed greater association with inundated and riverine forests than with secondary vegetation. In the Dja, most nest sites were found at Ndengué (7.88 /km2 in July) and 49 % of these were in *Raphia* swamp. So the question arises, why are gorilla populations concentrated in swamps? Fay *et al* (1989) found that gorillas in swamps feed on *Pandanus candelabrum* and other plants common in this vegetation type, so food is abundant in this habitat type. Perhaps a minor consideration is the relative lack of suitable nesting material in *terre firme* forest in the Dja. At Lopé *Haumania liebrechstiana* is used in 85% of ground nests. The species which occurs in the Dja, *Haumania danckelmaniana*, is covered with spines and may not be suitable for nesting, whereas other herb species of (*Marantochloa* spp. and *Halopegia azurea*) are abundant in swamps and seasonally inundated forest (pers.obs). Blake (1993) explained use of the Likouala swamps as a modification of the gorillas' behaviour to avoid areas of human impact. Swamps marshes and seasonally inundated forests provide refuge from hunters in northeastern Gabon, and many species survive as a result of behavioural modifications (Lahm, 1993).

The presence of hunters on the transect lines in Ndengué seemed to coincide with the recording of high gorilla density in December, however, the hunters were active on the first two kilometres of transect 30, whereas gorilla nests were encountered beyond this distance.

In this study, nests sites were concentrated on transects between 15 and 25 kms from villages. During prospection west of Djomedjoh six nest sites were found, but none within 10 km of the village. We should consider that the high densities at Ndengué may be artifact of analysing the data on a scale which is inappropriate and statistically invalid. It should also be borne in mind that with an Estimated Strip Width of 5.54 m for gorilla nests, the 25 km of transect at Ndengué represents an area of 0.14 km2 actually sampled. The sample from this study should probably be viewed as a whole without too much dissection. The lower end of the estimate may be the best general indicator of gorilla density (0.47 /km2), but this may not be appropriate for the entire Reserve.

c) Chimpanzees

The estimate of 0.79 weaned chimpanzees /km2 concurs with population estimates given for other regions of central Africa. Tutin & Fernandez (1983) estimated 0.49/km2 (0 to 1.78/km2) chimpanzees/km2 in Gabon, White (1994a) found 0.2-1.1/km2 for Lopé, and Stromayer and Ekobo (1991) reported 0.15-0.34/km2 in south-eastern Cameroun.

Almost all tree nests found during the present study were attributed to chimpanzees, and we must consider the possibility that tree nests could have been misclassified following the recent finding of Tutin *et al* (in press) that "due to the longer lifespan and greater visibility of tree nests, a proportion of gorilla nest sites 'convert' to chimpanzee nest sites when only tree nests remain visible". As a result of this, gorilla nests sites could be mistaken for chimpanzees during surveys, so that chimpanzee numbers would be over-estimated, by as much as 26%. It seems unlikely that such a large number would also be appropriate in the Dja, but it remains to be established how often gorillas build tree nests. Hall *et al* (in prep.) estimate that only 13% of tree nests 'convert' in Kahuzi-Biega, Zaïre.

It is probable that some tree nests were misclassified during the present survey, especially given the very low number of tree nests attributed to gorillas, but it was considered preferable to have a clear categorisation of tree nests, rather than make a guess at the proportion which might have been made by gorillas. Only six tree nests found in the Dja were in association with ground nests, and could thus be confirmed to have been built by gorillas.

Several tree nests were seen to persist for at least six months (183 days) on the Djolimpoum and Malele transects (N = 10 sites). The decay rate used to estimate abundance has a strong influence on the estimates obtained, so if nest duration in the Dja is greater than 113.5 days, the chimpanzee population will have been over-estimated. Studies of nest decay are needed from this site rather than extrapolating from other studies.

If obliged to estimate the population for the Reserve as a whole, we would again chose the lower limit of density estimates (0.60 weaned individuals /km2) which suggests a population of about 3,000 chimpanzees in the Dja reserve.

5. CONCLUSIONS & RECOMMENDATIONS

This study has shown that the Dja Reserve harbours important populations of elephants, gorillas, chimpanzees and at least four species of diurnal monkeys. Four other diurnal monkey species were confirmed to occur at overall low densities, but their status remains to be determined. These preliminary results should be viewed with extreme caution, and further longer-term studies are needed to confirm our findings.

I. Questions to be addressed in future work

Due to the size of the Dja Reserve, and the time allocated for the surveys, there are problems with extrapolating from our small sample. Surveys should be carried out in additional areas of the Reserve, to establish the presence of these patchily distributed animals. Obviously further study is needed to assess the seasonal movements of elephants.

As mentioned above, we need to evaluate decay rates of nests and establish what proportion of tree nests are constructed by gorillas.

Behavioural studies of monkeys are needed to determine troop sizes. It is particularly important to establish the status of *Colobus guereza*. This species is preferred by hunters because of its large body size, and is made vulnerable by its slow movement striking coat colour and high visibility when strategies to locate them are adopted. *Colobus guereza*, together with *Cercocebus albigena, Cercopithecus neglectus* and *Miopithecus talapoin* was eliminated from forests around villages in northeastern Gabon (Lahm, 1993).

II. Conservation priorities

It is clear that the conservation activities of the Projet Ecofac are having an impact, with an apparent decrease of hunting intensity around Djolimpoum and Malele, which increase dramatically east of Ekom. The distribution of snares on transects shows that hunting activities are reduced where the project has a strong presence. Trap lines were rapidly installed after the establishment of transects in areas which are rarely patrolled, namely Ndengué and Alat. The project in conjunction with the Ministry of the Environment should continue to expand the effective area of patrols and prevent transects becoming snares lines or access routes.

Primates and elephants are important seed dispersers (*e.g.* Chapman *et al,* 1993: Gautier *et al*, 1993; Tutin *et al*, 1991; White *et al*, 1992) and as such play a vital role in the regeneration of rain forests. We recommend that species priorities are established for all conservation actions, and that people are helped to differentiate between vulnerable species and others which are more abundant. If hunting by snares is to be encouraged as a form of sustainable forest use, guns should be banned inside the Reserve. Under no circumstances should sport hunting be allowed. The sectors found to support high densities of elephants and gorillas cover a limited area, and these populations remain vulnerable.

Some people encountered in the reserve recognised the importance of conserving the forest, but said that animals should not be protected "just for tourism". Given that one of the people who expressed such a view is an Ecofac 'sensibilateur' (Volet Agroforestry), efforts should be made to increase awareness of the importance of maintaining an intact fauna, beginning with the sensibilateurs, and through them the local population.

Elephants, gorillas, chimpanzees and monkeys are all hunted for their meat, and occasionally for trophies. A problem of particular concern is the killing of gorillas and chimpanzees, especially when their infants are traded. During field work near Ndengué, a hunter shot a female chimpanzee on the transect line. Her infant, in Figure 21, was tied into a gibisière and carried back to the village. The hunter claimed that he could raise the orphan with the aim of selling it to "a white person". The Ministry of the Environment and other authorities responsible for controlling illegal traffic in wildlife should make every effort to stamp out this trade, and to educate tourists and other visitors to Cameroun that it is inappropriate and illegal to buy young apes.

<u>Figure 21: Young chimpanzee whose mother was killed for meat, December 1994 (photograph)</u>

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Annexe 3a: Explication de la fiche de Recensement des Grands Mammifères d'ECOFAC

Il y a certaines règles importantes à respecter pendant les recensements:

Faites des arrêtes de 10 minutes - pas moins et pas plus - chaque fois que vous rencontrez des singes. Cela est important pour vérifier si une espèce et seule, ou s'il est accompagné par d'autres espèces. Souvent vous pouvez constater que plusieurs espèces de singe se trouvent ensemble, et dans ces cas il faut prendre des informations pour chaque sorte de singe.

Marchez lentement - la vitesse idéale est 1 à 1,5 kilomètres par heure. La vitesse est importante pour assurer qu'on voie bien et qu'on entend bien est aussi pour ne pas rencontrer la même groupe de singes plusieurs fois.

Gardez le silence - les voix humaines, les coupes de machettes et d'autres bruits avertissent les animaux que quelqu'un s'approche, et ils se cachent ou ils fuient.

N'appelez pas les animaux.

Recensez un minimum de 5 kilomètres.

Cont: Numéro du contact - 1,2,3 etc. Les espèces vues ensemble (souvent les association de singes mais aussi lorsqu'un céphalophe est détecté sous les singes) sont listés sous le même numéro de contact.

Heure: heure de la première indication de la présence de l'animal (cris ou bruits de déplacement) :

M Det.: Méthode de détection de l'animal:

Cris = vocalisations entendues
Vu = animal vu
E Mvt = bruit de mouvement entendu
V Mvt = mouvement des branches vu
Odeur = animal senti (gorilles, potamochères, éléphants)

H-vue: heure de la première observation de l'animal

Dist sur layon: position de l'observateur sur le layon quand l'animal est détecté

Espèce: Genus et espèce si possible. Pour les céphalophes de taille moyenne si l'observation n'est pas parfaite, marquez "céphalophe rouge".

QUAND VOUS VOYEZ L'ANIMAL:

D-O/A: Distance entre l'observateur et l'animal. Pour les animaux en groupe, la distance de l'observateur au premier individu vu est prise.

Angle: l'angle de vue de l'animal vis-à-vis du layon. L'angle avec la distance 0/è permettra de calculer la distance perpendiculaire post hoc (voir Whitesides et al. 1988).

D-Perp: distance perpendiculaire de l'animal au layon. Cette distance sera utilisée dans les calculs de densité. Il est difficile de l'estimer avec précision, il est plus précis de mesurer.

N° vue: nombre d'individus vus

N° est: nombre additionnel d'animaux dans le groupe par les mouvements ou cris. Surtout important de distinguer entre les solitaires et les groupes pour les primates.

Type de forêt: forêt mature, forêt secondaire, marécage, rocher ou d'autres.

Commentaires: Pour les animaux entendus mais jamais vus, donnez la direction et une idée de la distance des cris repérés. Tout autres renseignements utiles, par exemple, age/sexe de l'animal, présence ventrale des jeunes chez des primates, fruits mangées, etc.

Annexe 4a: Explication de la fiche pour Comptage des Traces sur les layons ECOFAC

Date: jour/mois/année
Layon: location et numéro
Direction: direction de marche
Location début et Location fin: distance au début et à la fin de la prise de données
Type de traces: nid, crotte, empreinte, broutage, pièges, etc.
Distance: Distance sur le layon, estimez la position à 5m près.
Espèce d'animal: n'oubliez pas traces humaines (piège, campement, cartouche, etc.).

Distance Perpendiculaire: distance entre le trace et le layon mesurée au centimètre près pour les crottes et au mètre près pour les nids plus distants.

Age de traces: mettre le nombre de jours, semaines ou mois si possible. Si il n'est pas possible de donner avec certitude, dire fraîches, récentes, vieilles ou très vieilles. Pour la classification des nids:

frais - feuilles toujours vertes, souvent crottes encore visibles (à peu près 1-6 jours) ;
récent - feuilles mortes mais nid toujours intact (à peu près 7-20 jours)
vieux - feuilles complètement mortes et sèches mais toujours rattachées aux branches (21-40 jours)
pourri- nid toujours reconnaissable par sa forme mais pour nids dans les arbres, les feuilles sont tombées des branches cassées et pour les nids au sol, les repousses de la végétation herbacée sont visibles (1,5 à 3 + mois)

L'estimation de l'âge des nids aide à placer les nids du même âge par groupe n'est pas toujours évidente car la végétation utilisée dans la construction vieilli différemment. Excepté les nids très frais ces données seront difficiles pour des débutants. Pour des layons permanents seulement des nids frais et récents seront enregistrés si un recensement est fait tous les 15 jours.

Type de forêt: il est importante à distinguer entre forêt mature, forêt secondaire, rocher et marécage. Si vous connaissez certaines plantes, vous pouvez indiquer leur présence, comme par exemple, *Uapaca, Raphia, Aframomum, Haumania.*

Commentaires: tout autres renseignements utiles, par exemple, identification des graines vues dans les crottes.

Nids de Gorille et de Chimpanzé

Faites attention aux nids des gorilles dans les arbres qui peuvent être confondus avec ceux des chimpanzés. A la Lopé, 35% des nids des gorilles sont construits dans les arbres à une hauteur moyenne de 10 m mais il est assez rare que tous les nids dans un groupe soient dans les arbres (85% des groupes à la Lopé). Il est nécessaire de quitter le layon pour approcher des nids et chercher les nids au sol ou les crottes pour aider à l'identification de l'espèce.

Gauche/Droite: côté du layon du nid (nécessaire pour un calcul *post hoc* de la distance du centre d'un groupe de nids au layon). Visibilité (ou non) depuis le layon est aussi une information très importante.