Annex II
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A RECONNAISSANCE SURVEY IN THE LIKOUALA SWAMPS OF NORTHERN CONGO AND ITS IMPLICATIONS FOR CONSERVATION

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Abstract

A five week pilot study was conducted in the Botala region of the Likouala swamps, northern Congo. The aims of the study were as follows: To obtain preliminary information on distribution and density of large mammals in the swamps, particularly elephants and gorillas. To collect preliminary data on hunting practices and the importance and extent of the bushmeat trade in the Botala region. To assess the possible impact of hunting on large mammal populations in the swamps. To discuss the potential and/or need for conservation in the Likouala swamps. Swamp vegetation where *Raphia* sp. is dominant contained exceptionally high gorilla densities strongly suggesting that the Likouala swamps offer primary habitat and hold a high population of gorillas. Elephants use the swamps during the dry season as part of an annual migration from *terra firma* forests and the motivation is apparently to feed on *Raphia* sp. and for water. Poaching at this time is heavy. Monkey densities were low though they increased with distance into the swamps. Hunting is extensive in the region, with a system of canals allowing pirogue access deep into the swamps. Market hunting, the loss of traditional hunting methods, customs, and land tenure systems, appear to be primarily responsible for increased hunting and reduced large mammal abundance. The rural economy is based almost entirely on natural resources, of which bushmeat is by far the most important component. Sustainable management of wildlife is therefore essential for human welfare and conservation of the swamp ecosystem. The swamps have very high conservation value and a project of integrated land management based around core areas where mammal densities are high is suggested as an appropriate management strategy.

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CHAPTER 1

INTRODUCTION AND OBJECTIVES

CONGO

The Republic of Congo is situated in central Africa directly on the equator, at 3°34°N to 5°S, and 11°11'E to 18°35'W. It has a surface area of 342,000km^2 and is bordered by Gabon, Cameroon, Central African Republic, Zaire, and has an Atlantic coast. In the south, the climate is dry sub-equatorial, and in the north equatorial. Mean annual temperatures range from 23 to 27^{0}C. Rainfall is between 1,200 and 1,800 mm per year. There are two major vegetation types in Congo: Forests, which are found predominantly in the north of the country but are also present in the south, and savannahs, which are most widespread in the raised *'Plateau Batéké'* and other regions of south and central Congo (from UICN, 1989; World Bank, 1992).

The population of Congo is ca. 2.6 million, approximately half of which live in the two major cities, Brazzaville and Pointe Noire. At the regional level, the population is concentrated in the south of the country with up to 13.5 inhabitants per km^2 in some southerly regions and only 1-3 inhabitants per km^2 in the north (Likouala and Sangha regions) (IUCN 1992). The annual population growth is ca. 3.5% pa., and some 67% of the population are under 20 years old. However, rural population growth is negligible, primarily due to continued urban migration.

Agriculture is considered the main activity of rural areas (IUCN, 1992), with traditional methods producing 98% of the country's food needs. Until the 1970's timber was the major source of foreign exchange for Congo, however this has now been displaced by the oil industry.

FORESTRY AND WILDLIFE IN THE NORTH OF CONGO

The most impressive feature of Congo's forests are their size, which at 213,000km^2 are rivalled only by those of Zaire. There are two main forest types, dry lowland forest occupying ca. 150,500 km^2, and swamp forest which covers some 62,500 km^2 (Figure 1.). The forests are distributed predominantly in the north of the country (170,000 km^2), but to date forest exploitation has been most intense in the south. This has left huge areas of the north unexploited and intact (FAO/UNEP [1981] reported that only 1,200 km^2 had been exploited out of a total exploitable area of 99,000 km^2). As a result of this, the northern Congo holds probably the largest and most intact forest

ecosystem left in central Africa. Not surprisingly, these forests have recently been identified by several independent studies as containing some of the highest large mammal populations left in central Africa with outstanding conservation and scientific value. (Fay and Agnagna, 1991, 1992; Fay, 1993a, 1993b; Mitani 1990; Mitani, Oko, Moutsambote, Yamagiwa, Maruhashi, and Yumoto, 1992; UICN, 1989, 1991; World Bank 1992).

Unfortunately, it appears that this situation will change in the near future with the opening up of the north to forest exploitation. Of the total forested area of the north (17,000,000 hectares) some 8,984,749 ha is considered to be exploitable (World Bank, 1992). Of this, 4,356,095ha has already been taken up by logging firms, with an additional 852,112 ha likely to follow soon (World Bank, 1992). This makes 5,208,207 ha, or 58% of the total exploitable area. The relatively intact nature of much of the northern Congo will therefore be lost.

In the longer term, it is likely that the only intact forest will be represented by 'island' national parks and other protected areas. The detrimental effects of reduced area and fragmentation on the viability of populations are well known (Diamond, 1975; Lovejoy *et al.*, 1986; Poole and Thompson, 1989; Simberloff and Abele, 1982;). Even with the current interest in conservation in Congo, the total area currently under protected status in the north is the 130,000ha Parc national d'Odzala to the west of the Sangha river (UICN, 1991), with an additional 448,000 ha planned to the east (proposed Nouabale-Ndoki national park), or 6.4% of the exploitable area and only 3.4% of the northern forest area. Given the adverse effects of large scale logging on animal populations already demonstrated in Congo (Wilkie *et al.,* 1992), plus permanent changes in watersheds and human demographics (World Bank 1992) the prognosis for wildlife populations in Congo is apparently grim, despite the huge conservation potential.

The above situation has led to recommendations from both UICN (1989) and the World Bank (1992) that more suitable areas for conservation management must be identified and projects implemented as soon as possible. One potential conservation area identified by Hecketsweiler (UICN, 1989) is the Lake Telle area in the Likouala swamps to the north-east of Congo.

THE LIKOUALA SWAMPS

The entire Likouala swamps cover an area of some 62,500 km^2 composed of swamp forest, flooded forest, limited *terra firma* forest, and seasonally inundated savannahs. Biological data on the swamps are extremely limited, but it has been shown that they may contain important populations of elephants and gorillas (Fay and Agnagna, 1991, 1992). This and the low human population density (ca. $1/km^2$) concentrated along major rivers suggests that the Likouala swamps have high conservation value. Due to poor timber quality and logistical difficulties, the Likouala swamps are deemed unexploitable and are therefore free from the direct effects of logging described above. However, expansion of concessions in the Sangha region will soon mean infrastructure development and increasing population to the west.

In the absence of logging, the only likely threat which could face animal populations in the Likouala swamps in the near future comes from hunting. It has been noted (Agnagna, pers. comm.) that large quantities of bushmeat leave Impfondo on the riverboats bound for the Brazzaville markets. Stories of large scale buffalo hunting in the savannahs of the Likouala aux Herbes river during the wet season are common and Fay and Agnagna (1991) have also shown that elephant poaching has been high in the heart of the swamps.

As long as humans have lived in tropical forests their hunting has been an integral part of the forest ecosystem and until recently the hunter-gatherer communities of the world's tropical forests with their inefficient hunting techniques and very low population densities usually posed no threat to wildlife populations (Caldecott, 1988; Vickers, 1991). This situation has now changed in many areas of Congo with increasing populations, guns and wire snares now readily available, and improved transport infrastructure which has facilitated the bushmeat trade and the possibilities for market hunting (Wilkie *et al.*, 1992). Despite the argument of Caughley (1977) that very few animal populations are in decline because of hunting alone, the adverse effects of market hunting as opposed to subsistence hunting on wildlife populations have now been documented from many sites (eg. Caldecott, 1988; Hart, 1978; Fragosa, 1991; Kyle, 1987; Justel *et al.*, in press.), including Congo (Wilson and Wilson, 1991; Wilkie *et al.*, 1992). The continued growth of Impfondo (currently 17,000 inhabitants) and the completion of the Impfondo-Epena road (figure 2), all the factors which encourage increased market hunting are present into the heart of the Likouala swamps.

In the light of the above, this project was initiated with the following objectives.

OBJECTIVES

1. To obtain preliminary information on distribution and density of large mammals inhabiting the swamps, particularly elephants and gorillas.

2. To obtain preliminary information on hunting practices, the importance and extent of the bushmeat trade in the Botala area of the swamps, and collect anecdotal information on hunting throughout the region.

3. To investigate the impact of hunting on large mammal populations in the area.

4. To discuss the potential and/or need for conservation in the Likouala swamps.

CHAPTER 2

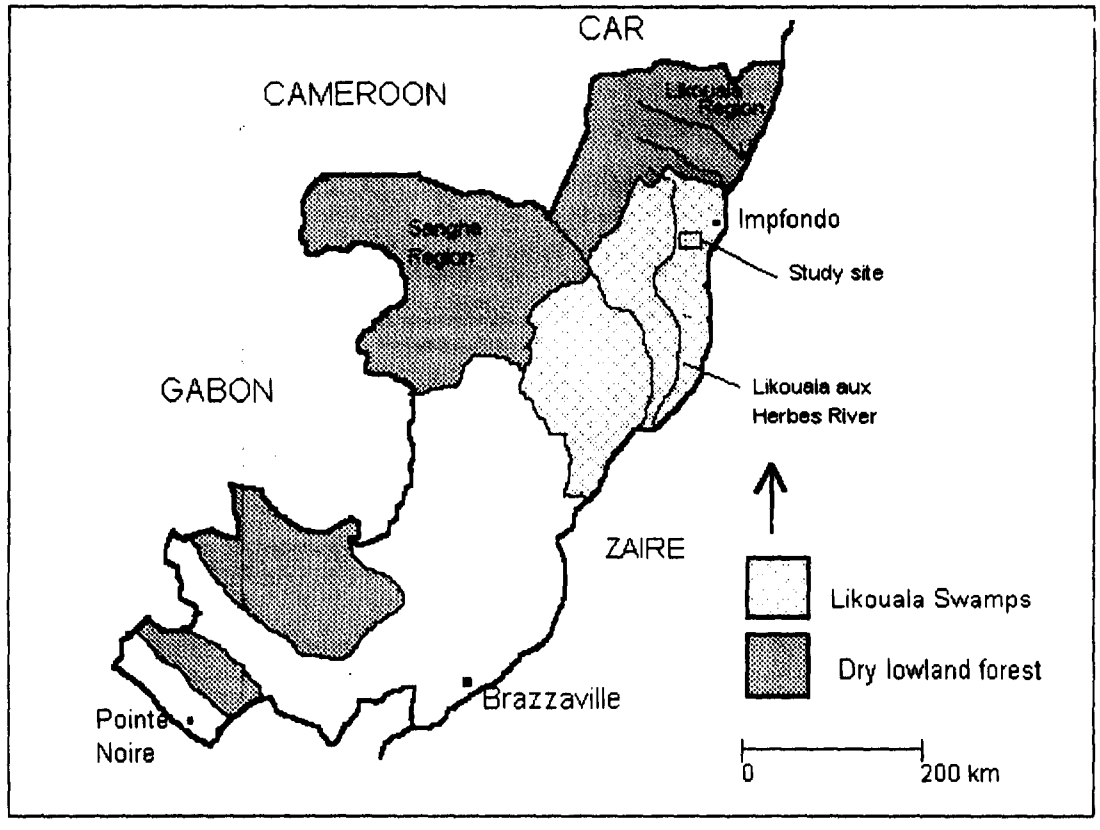
STUDY SITE AND INTRODUCTION TO METHODS

STUDY SITE

The Likouala swamps are found in the *Cuvette Congolaise* , a sedimentary basin which straddles the equator. The topography of the region is a featureless alluvial plain at an altitude of 300-350 m. Soils are predominantly ferralitic and hydromorphous alluvials of acid pH and corresponding low fertility. The climate is equatorial with an annual precipitation of ca. 1800mm, and a dry season from January to April. Mean temperature is 26°C, and there is an annual variation of 2 - 2.5^{o}C (Vennetier, 1977). The biological status of the Likouala swamps is poorly known, but major vegetation types in the swamps have been described by Begué (1967). From his description, the major forest type is 'fourrés marecagéux et forêt marécageuses', (swamp thicket and swamp forest), with 'raphiales', (*Raphia* forest), and limited 'forêt dense de *terra firma*', (*terra firma* forest). Vegetation has also been described in localised areas by Hecketsweiler (UICN 1989), and Fay *et al.* (1990). No exhaustive inventory of fauna has been carried out (UICN, 1989), and with the exception of Fay *et al.*, (1990), and Fay and Agnagna (1991, 1992) information is anecdotal (Regusters, 1983; Mackal, 1985).

The human population density of the Likouala region is ca. 1 inhabitant/km, with a high proportion living in Impfondo (Vennetier, 1977), and almost all habitations found close to the major rivers or the Impfondo-Epena road (Figure 2.). There are four major ethnic groups in the region; **Bomitaba**, found in Epena, along the Likouala aux Herbes River, and north to Minganga; **Mbounzu**, found in Impfondo and south along the Oubangui river; **Bondongo**, found in the Dongou district and further north; **Bambinga**, (pygmies) who are found throughout the region, but with a somewhat nomadic lifestyle.

Figure 1. Congo, showing extent of major forests and Likouala swamps.



This study took place in and around the village of Botala located (Figure 2) on the Tanga river, and the Impfondo-Epena road some 65 km from Impfondo. Historically, Botala was and still is an important village in the region, being the centre of traditional and colonial administration for the following group of ten villages; Botala, Boseka, Bonganzi, Bosela, Bonsimba, Boleke, Bimbo, Ibanga, Ibaki, and Liouesso. The number of inhabitants in each village is given below (Table 1).

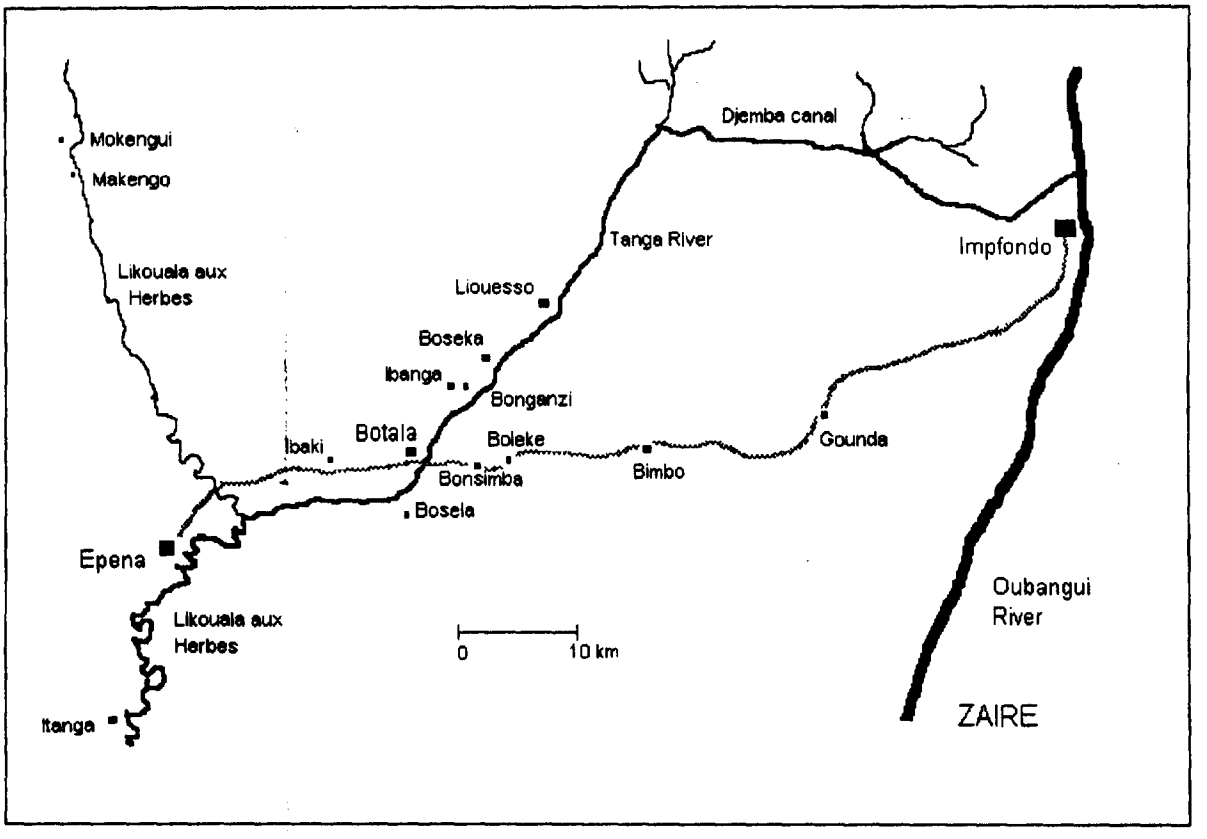
This region was chosen as the focus of this study for several reasons. Firstly, Botala market is one of the two major sources of bushmeat supplying Impfondo, and so it is probably an area of concentrated hunting. Secondly, as the focal point for ten villages it was thought that it would provide an opportunity to interview people from many villages. Thirdly, data already exist from the Djeke region to suggest the Likouala swamps are important for gorilla and elephants (Fay *et al.*, 1990; Fay and Agnagna, 1991, 1992), and data from a second site in the swamps are important to verify this. Fourthly, as the road is thought to be an important trade route within the swamps, an impression of trade to Impfondo from the Likouala aux Herbes river could be gained.

Table 1. Number of inhabitants for each village in the study site

Village	N inhabitants
Ibanga*	309
Botala*	223
Liouesso*	213
Bosela*	181
Bonganzi*	171
Ibaki*	90
Boseka*	86
Bonsimba	100
Boleke	100
Bimbo	40
Total	1513

* = Figures from Agent of *Operation Pilote de Vulgarization Agricole*, Botala.
Others estimated from direct observation.

Figure 2. Map of study site



INTRODUCTION TO METHODS

Personnel:

There were three permanent team members on the expedition. Stephen Blake, M. Sc. student, University of Edinburgh; Marcel Ngangoué, Agent of Ministry of Water and Forests, representative of Congolese Government; Guy Ebéké, research assistant and translator. In addition, a total of seven temporary workers were hired locally at various times during the project as guides and survey assistants.

Itinerary:

The study took place in June and July 1993, with a total of five weeks in the field;

18-6;	arrived in Botala village from Impfondo,
19-6;	went to Bosela via the Tanga river,
20-6 to 29-6;	Bosela forest survey,
30-6 to 8-7;	stayed in Botala for village based surveys,
9-7 to 13-7;	Botala forest survey,
13-7;	arrived in Liouesso,
15-7 to 21-7;	Liouesso forest survey,
22/23-7;	stayed in Bimbo and Botala,
23-7;	returned to Impfondo.

Almost all sources of data for a study of this kind are dependent on local people. Everything from discussing hunting practices, to hiring guides or simply staying comfortably in a village depends on their co-operation. A new white face arriving in a village to ask questions, live with people, and go out into the forest is regarded with suspicion. Therefore, although the project was an official mission with formal permission from the Ministry of Water and Forests, it was considered both necessary and good manners to ask permission of village chiefs and committee before beginning the study. Village committees consist of three respected villagers; the chief, the *notable* (responsible for local traditional government and smooth running of villages), and the secretary. Once good relations had been formed in this way and the work schedule discussed, the committee showed their appreciation for having been consulted and in all cases went to considerable lengths to help the project.

In order to meet the aims of the project described earlier, the methodology was divided into three units; 1, forest surveys; 2, discussion and interviews with villagers regarding the forest, animal populations, and hunting etc. 3, a survey of produce sold at

the Botala meat market. The first days after arrival in a village can be uncomfortable for both researcher and villagers, and so it was decided to begin the study with forest surveys. This allowed initial contacts with villagers to be made and guides hired, but the period of discomfort was avoided for all. In the forest good relations were established with the guides, and on return to the village the team was introduced by the guides as friends leading to smooth acceptance by the villagers.

CHAPTER 3

FOREST SURVEYS

In this chapter, the first systematic survey of large mammals in the Likouala swamps to take place in the wet season is described. The aims of this section of the study were the following;

1. To provide a preliminary inventory of large mammals inhabiting the Likouala swamps.

2. To provide baseline information on the distribution, density, and ecology of large mammals in the swamps, particularly elephants and gorillas,

3. To obtain preliminary data on hunting and the level of human impact in the swamps, and its effect on animal populations.

METHODS

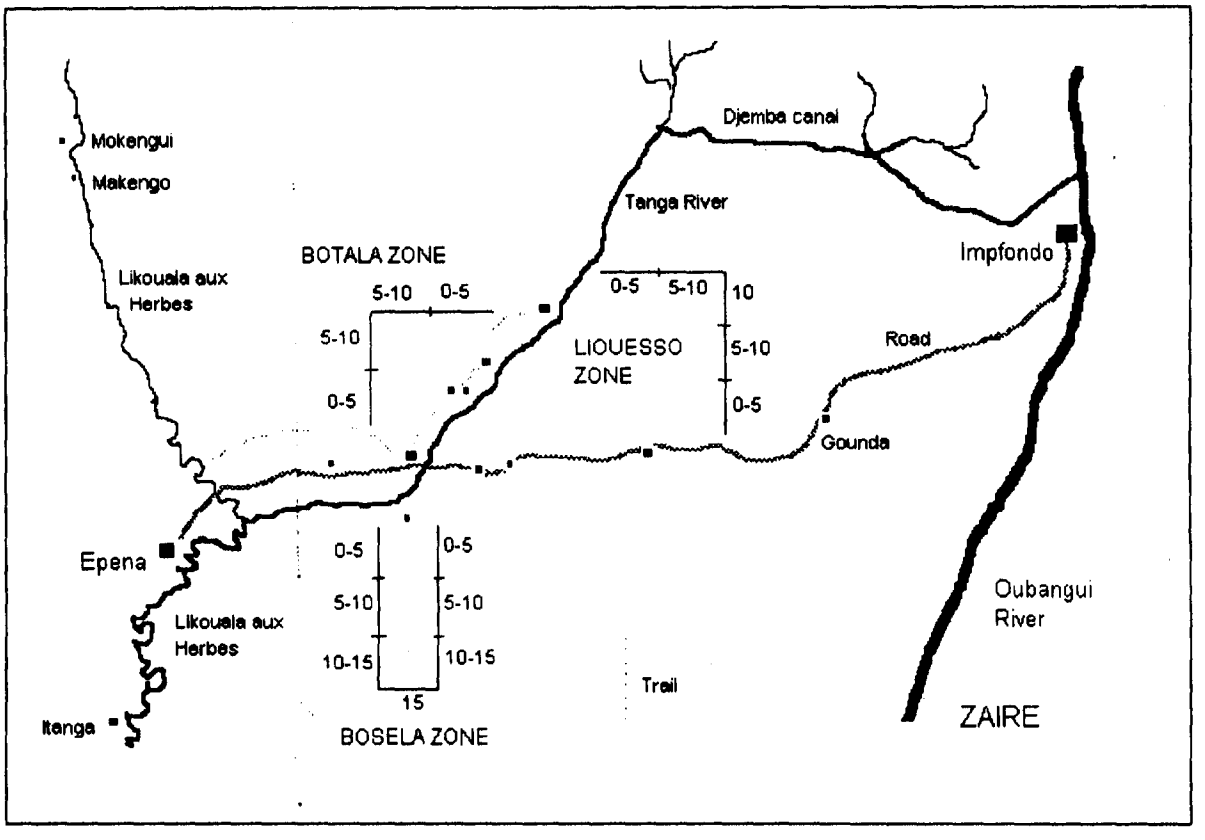
Modified line transects were used to collect systematic data on the above variables simultaneously. These have been used extensively for large mammal population surveys in central African forests (Barnes and Jensen, 1987; Barnes *et al.*, 1991; Carroll, 1988; Koster and Hart, 1988; Tutin and Fernendez, 1984: Whitesides et al. 1988), including Congo (Fay et al., 1990; Fay and Agnagna, 1991; Fay, 1993a, b; Wilkie, 1992). Such surveys have produced consistent results at a number of different sites (references above), and it was considered important that the results of this study would be directly comparable with those from other study areas.

The route was positioned in the light of interviews with hunters, after having gained preliminary information on hunting pressures and different vegetation types present in the region. The final position of each route was chosen in an attempt to stratify the sample according to distance from human habitation and hunting pressure, within the limitations imposed by time, logistics, and finances. In all cases, survey trails began from a well used hunting camp in inundated forest close to a village.

The transects were run on fixed compass bearings as shown in Figure 3, with five observers throughout. For data analysis, the final linear distance walked was divided into 'sample units' or transects of 5km (after World Bank, 1992), and at the following distances into the swamp; 0-5km, 5-10km, 10km, 10-15km, and 15km (see Figure 3). Distances were measured using a topofil (from Barnes and Jensen, 1987) or in some cases, pedometers (less than 10% of total transect distance). When used, pedometers

were calibrated daily for at least 20% of total distance walked. Topofil was used whenever possible, as pedometers are rather inaccurate, particularly in swamp forest. Transects were walked slowly, stopping frequently to listen and observe the forest. All animal signs and qualitative changes in vegetation type were recorded with distance along the transect. Only those signs that could be verified by the principal observer were recorded in an attempt to reduce errors induced by guides of differing ability. The number of replicates of sample units was limited due to time constraints, and they could neither be randomly positioned to provide a representative sample nor could they be considered independent 'observations'. These factors violate the assumptions of probability - based statistical analysis, and therefore inferential statistics with attached significance levels have not been used in data analysis.

Figure 3. Position of transects



Note! The '10km' transect in the Liouesso zone was considered to be 10km into the swamp because there are well used hunting camps at about 10km to the east, used by the Impfondo hunters.

Vegetation

Due to the author's limited botanical experience, a full classification of vegetation was beyond the scope of this study. Vegetation was therefore classified into broad categories only. Throughout the survey changes in the vegetation types with distance was recorded. *Terra firma* forest was present near villages, but was not encountered on transects.

Hunting activity

All signs of human activity seen from the transects were recorded with distance. Signs included well used trails, machete cuts, hunting camps, felled trees (for honey collection), shotgun shells and shots heard. For data analysis, occurrence of machete cuts per km was used as an index of hunting activity. Any two or more machete cuts within 100m were noted as a single record, unless there were distinct age differences.

Gorillas

The census method for recording gorilla distribution was modified from that of Tutin and Fernandez (1984), as used by Fay and Agnagna (1992). A fixed width transect of 20 metres was used, and all signs of gorillas recorded, including direct encounters, dung piles, feeding signs (with details of species, age, etc.), trails, and nests. For each nest encountered, age class, height, construction type, species used in construction, number of nests in the group, and group spread in metres was recorded. Distance from the centre of the transect was measured with a tape, and if more than half the nests in a group fell outside the transect width, the group was excluded from the sample. A group was defined as a collection of nests of the same age not more than 25m apart. It was judged that the limits of nest visibility were similar in all vegetation types and fell outside the 20m transect strip width. 100% observer efficiency was therefore assumed. This was considered a safe assumption as if incorrect it would lead to a consistent bias toward under-estimates of gorilla density.

Nest count data was used to estimate gorilla density. It is known (Tutin and Fernandez, 1984) that one weaned gorilla builds a fresh nest each night. If mean nest degradation rate, the area sampled, and the number of nests are all known, gorilla density can be estimated from the equation below;

Nesting gorilla density = (N nests/area sampled) / mean nest life span
(from Fay and Agnagna, 1992)

No data have yet been collected on nest degradation in Congo, and so the figures calculated by Tutin and Fernandez (1984) have been used here. Their estimates were based on observations of degradation rate of the following nest construction types in Gabon; no construction, minimal construction, herbaceous, mixed herbaceous and woody, and woody. Mean degradation rates depend on the number of nests of each construction type in each vegetation type. As degradation rates may be different in Congo, particularly in swamp forest, the final density estimated should be regarded with caution.

Elephants

All signs of elephants visible from the centre line of the transect were recorded, including feeding traces, tracks and rubbing sites. No dung piles were seen.

Chimpanzees

An accurate census of chimpanzees was not carried out as nests are usually high in trees and extremely difficult to see in thick forest, particularly when wading in deep water. However nests were recorded when observed, as were feeding signs, calls, etc. This gives a general idea of abundance throughout the study site.

Other diurnal primates

All sightings, calls, and feeding signs of primates were recorded along the transects. Direct encounters were usually brief and no attempts were made to follow groups from the transect line, therefore estimates of group size were not made. Calls of the same species heard within 500m of each other were recorded as a single vocalisation unless the presence of more than one group could be confirmed. Identification of primates from observations and calls was made with confidence, however there is a bias towards recording the more vocal species (e.g. *Cercopithecus nictitans and Colobus badius*), and larger groups.

Other large mammals

All signs of other large mammals were recorded along the transects, along with notes estimating group sizes, activity, etc. It was not always easy to identify animal tracks etc. accurately, and if there was doubt over a sign it was excluded from the sample. In the case of red forest pigs, due to their often large group size and general level of disturbance, any tracks or feeding signs within 100m and of the same age were recorded as a single sign.

Anecdotal information from guides and hunters

Anecdotal information was also obtained from discussions and interviews with guides and other hunters on large mammal populations present in the swamps. For interview methods used, see chapter 4.

RESULTS

Vegetation

Throughout the survey the forest was flooded with approximately 0.5m, and sometimes 1m, of standing water. Small islands of dry ground were occasionally seen, but these were never more than a few metres across, except for the transition zones to *terra firma* forest near villages. Water levels were remarkably consistent throughout the survey. Hunters and guides said that during the dry season the forest dries out completely and water is hard to find and that water levels remained at their present level even in the height of the wet season.

A total of four broad vegetation types were recorded along the 80 km of transects. Names are based on Bomitaba names for dominant trees in each vegetation type. Precise identification was impossible in the time, therefore Bomitaba names are used throughout. Table 2. shows the number of kilometres of each vegetation type encountered during the survey.

Table 2. Vegetation types recorded from all transects

Distance into swamp (km)	N transects	Total distance sampled (km)	Vegetation type esenge (km)	esenraf (km)	mixed (km)	rafdom (km)
0-5	6	30	13.5	4.5	5	7
5-10	6	30	12	8	3.5	6.5
10	1	5	1	0.5	0	3.5
10-15	2	10	0	7	0	3
15	1	5	0	0	0	5
Grand total	16	80	26.5	20	8.5	25
% of total			33.2	25.0	10.6	31.3

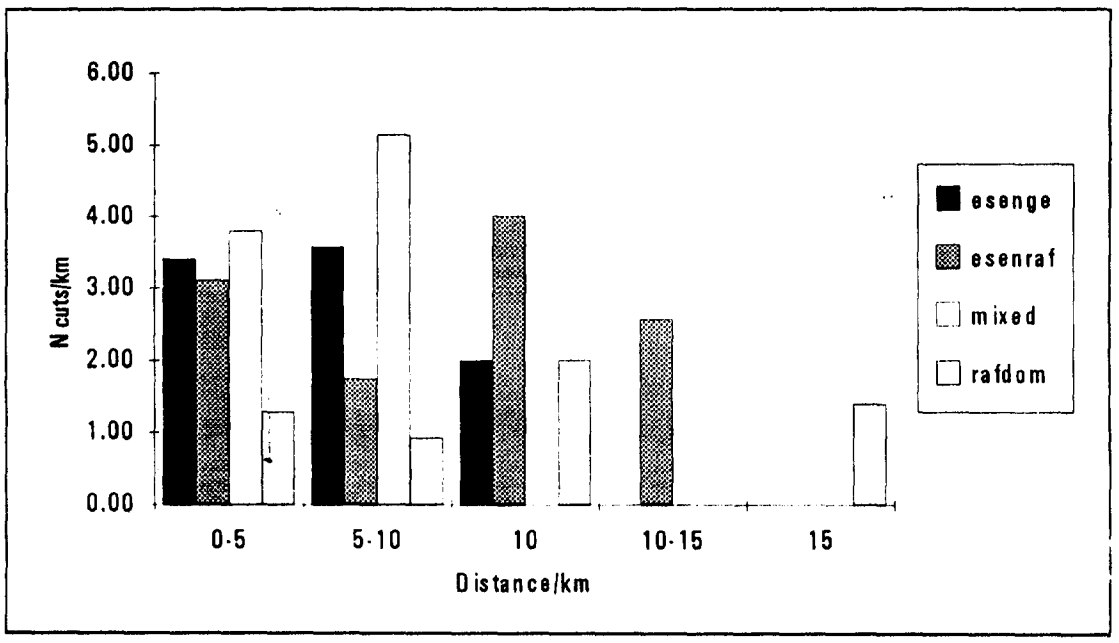
Table 2 shows that 'esenge' forest was the most commonly encountered vegetation type at 33.2% of total transect distance. The dominant tree species in this forest type is esenge (*Uapaca* sp) with high proportions of molaka (*Symphonia globulifera*), boese (*Cola.* sp.) and elonzu (*Uapaca* sp.). The canopy is usually 20-30 m and there is a high density of lower storey saplings and small trees. *Raphia* is absent. 'Esenraf' was the next most abundant vegetation type, and is characterised once again by a high proportion of esenge. Boese and molaka are present as the other main tree species, but there is also a high proportion of *Raphia* in the understorey. Boyo (*Entandrophragma palustre*) is the dominant emergent. The canopy of this vegetation type is rather more open than esenge forest and is generally slightly lower at 20-25m. 'Mixed' species forest accounted for 10.6% of total transect distance. In this vegetation type, no single species or group of species appears to be dominant, and tree species diversity is much higher than in any other forest type encountered. The canopy is closed by comparison to the other types, and higher at 25-35m. 'Rafdom' forest accounted for 31.3% of total transect distance. The canopy is very low at about 15m, and extremely open. Here the vegetation is completely dominated by *Raphia* spp. The most abundant tree species are esenge, boese, ekoko (*Xylopia* sp.), mola (*Xylopia* sp.), with boyo once again the major emergent. Tree density is low. In all vegetation types and with the exception of *Raphia* spp., monocotyledons were generally uncommon, of those present *Pandanus candelabrum*, and *Aframomum* spp. were the most abundant.

Hunting activity

Signs of human activity were recorded throughout the study site. Figure 4. shows that, in general, hunting pressure as measured by number of machete cuts per km, declines with distance into the swamp as would be expected. For mean distance plotted against mean machete cuts per km, a correlation coefficient of -0.84 is obtained. Old

hunting camps were seen several times, though none was in current use. Fresh human hunting trails were only seen on the Liouesso transect near to the road, where shots were also heard on several occasions. Hunters were encountered only once, at the start of the Liouesso transect. The two hunters had come from Mokengui in order to hunt deep in the Liouesso forest. They had come from a camp one day's walk into the forest, where they had hunted for a full day. Both were porting twelve gauge shotguns and backpacks full of meat, twelve monkeys and a red forest pig in total. They were going to Impfondo via the Djemba canal to sell their meat at the market. When asked why they come so far from their village to hunt they said it was because there was nowhere to sell meat near Mokengui, and so little point in hunting there. They often came here to hunt during the wet season when the Djemba canal was navigable, and this was their first such trip of this wet season. They said they could not use the road to get to Impfondo as the Botala hunters were not happy with them coming to their region to hunt.

Figure 4. Machete cuts/km with distance into swamp.



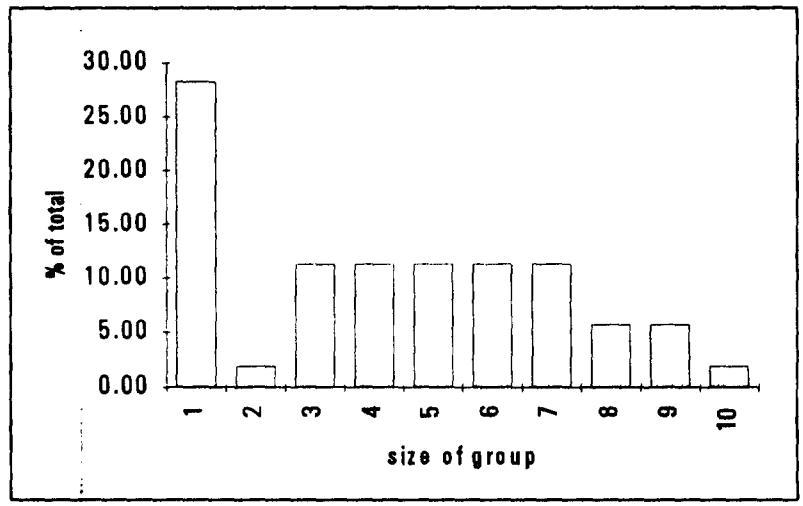
A second, and very surprising sign of hunting activity came in the form of pirogue canals cut into the forest. These canals were dug in ancient times to facilitate access into the forest during the wet season, and are used exclusively by hunters to penetrate deep into the swamps. Canals were seen in all zones, one in the Bosela zone, five in the Botala zone, and one in the Liouesso zone. Six canals were also pointed out during a journey up the Tanga River. For a full description of the canal system see chapter 5.

Large mammals

Gorillas

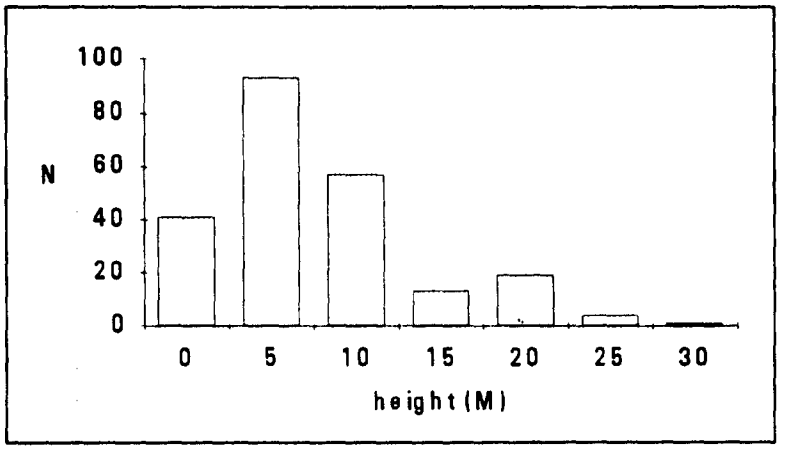
From the 80 km of transects walked during the survey, a total of 228 gorilla nests were recorded. The distribution of nests was concentrated in two vegetation types, rafdom swamp and esenraf swamp. These two vegetation types accounted for 31 and 25 percent of total transect distance yet contained 72.2 and 26.8 percent of nests respectively. Mean group size was 4.3 (N = 53, SD = 2.7), modal class was 1, and the maximum was 10. If solitaries are excluded, mean nest group size was 5.6 (N = 38, SD = 2.0), and mode 3 - 7 (Figure 6).

Figure 6. Gorilla nesting group size.



The majority of nests were constructed on the ground or below 5 m, but there was a significant number over 10 m, reaching a maximum of 30 m (Figure 7).

Figure 7. Gorilla nest heights (m)



The majority of nests (52.2%) were constructed from *Raphia*, by breaking off the ends of fronds and laying them in the crowns of individual plants or on the ground. In some cases the gorillas had carried *Raphia* high into trees to construct their nests. Woody nests were most often found in trees or on platforms made by fallen trees, and were constructed either by breaking off branches to form a platform for leaves or *Raphia* fronds or by folding small branches back on themselves. In many cases nests were found directly over standing water.

The mean nest degradation rate was calculated to be 53 days in esenraf swamp and 57 days in rafdom swamp. However there is potentially a high degree of error associated with this figure as this is the first time gorillas have been seen to use *Raphia* in nest construction, and there are no data on degradation rates for this construction type. From comparisons with other nests of the same age in a group, it appears that *Raphia* nests may have a slower degradation rate than those with a herbaceous construction, which would lead to an over-estimate of gorilla density. The density estimates shown in Table 3 should therefore be regarded with caution.

Table 3. Nesting gorilla densities recorded in the Likouala Swamps.

Vegetation type	km sampled	km^2	Total nests	Mean nest duration	**Gorilla density (/km^2)**
esenge	26.5	0.53	1	62	**0.03**
esenraf	20.0	0.40	61	53	**2.88**
mixed	8.5	0.17	0	-	**0**
rafdom	25.0	0.50	166	57	**5.88**

When gorilla density is plotted against distance into the swamp (Figure 8), it can be seen that density increases dramatically with distance in all vegetation types where gorilla were found, up to a maximum of 13 nesting gorillas/km. When feeding signs are also used as an index of gorilla abundance, a similar pattern emerges (Figure 9). In addition, there is a strong negative correlation between feeding signs and machete cuts per kilometre (r = -0.8) in all vegetation types (Figure 10).

Figure 8. Gorilla density/km^2 with distance into swamp

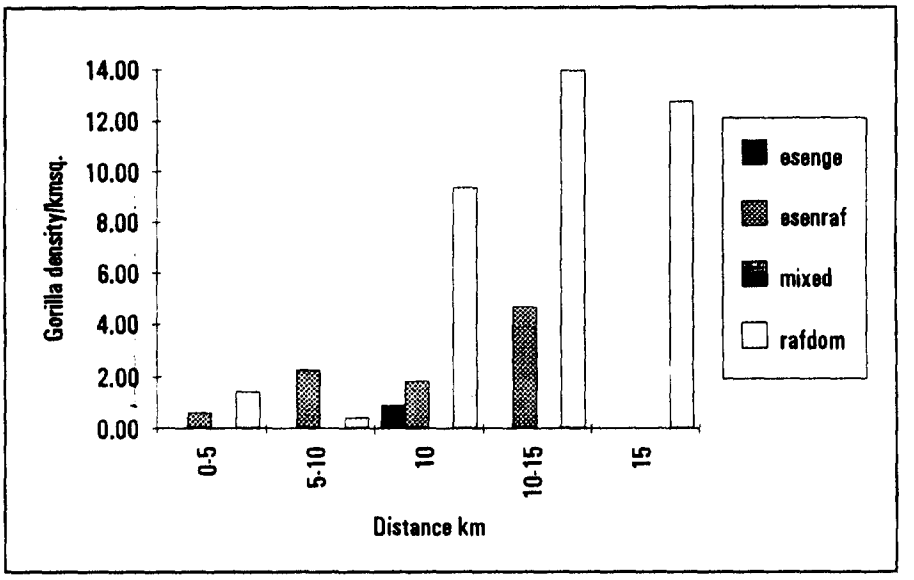


Figure 9. Gorilla feeding sign per km with distance into swamp

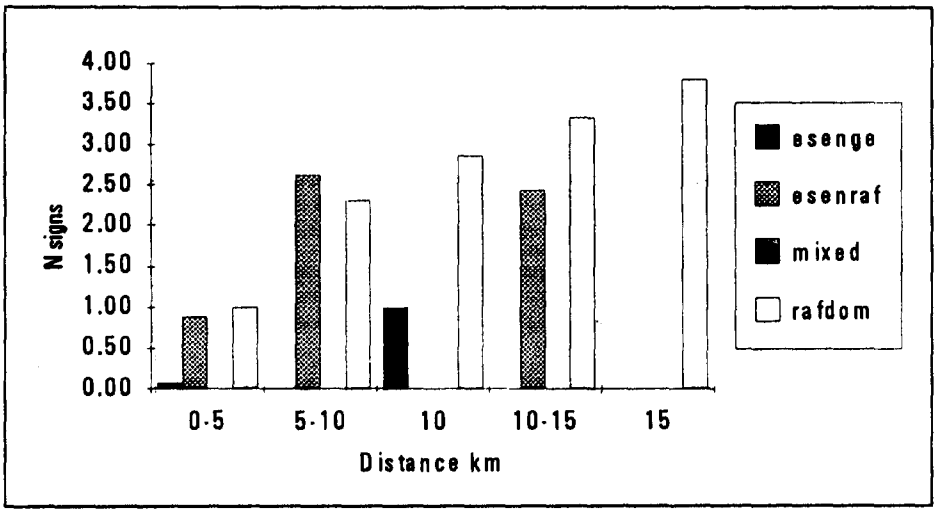
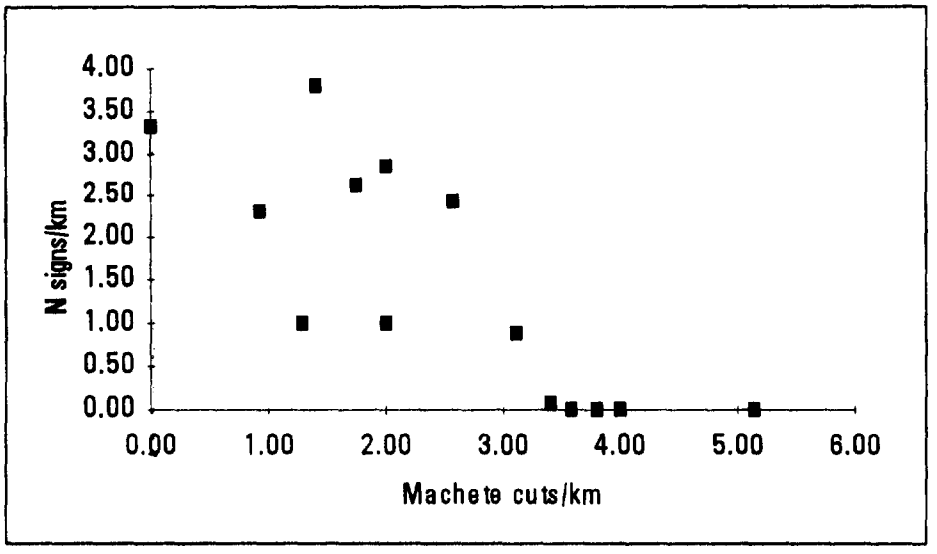


Figure 10. Gorilla feeding sign per km against machete cuts per km



A total of 109 gorilla feeding sites were recorded throughout the survey. Most feeding sites were of *Raphia* sp., with a total of 94 sites; *Aframomum* sp. and *Pandanus candelabrum* accounted for 7 signs each. For all species, the pith and young leaves were consumed. Only one other feeding site was recorded where esenge leaves and possibly fruit had been eaten. Fresh dung piles were seen a number of times both on the transects and around nest sites. Dung consisted almost exclusively of fibrous material, with seeds recorded in only two piles.

Elephants

Signs of elephant activity were clumped through the survey, and in general was rare with no encounters and no dung piles recorded. Therefore systematic data are not included. Extensive old tracks and feeding signs were recorded in the vicinity of Liouesso and the Tanga River, many under 5km from the village and river, both east and west. These signs were dated from the dry season. Fresh feeding signs on *Raphia* sp. were recorded only twice, both at 15 km south of Bosela.

Chimpanzees

A total of only 4 nest groups of chimpanzees was recorded during the survey. Densities are therefore assumed to be low, though a reliable estimate cannot be made. Of the four nest groups, two were fresh, which shows that chimpanzees are able to cope with inundated forest conditions. Chimpanzees were heard calling on several occasions at night in both the Bosela and Liouesso zones and once in the Botala zone, but there were no direct encounters on transects.

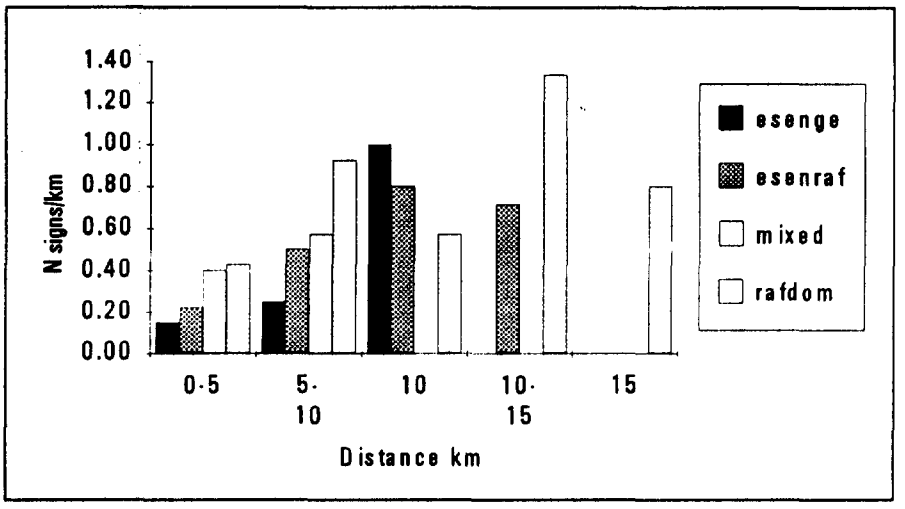
Other diurnal primates

A total of four species of monkeys were encountered during the survey. These were greater spot nosed monkey (*Cercopithecus nictitans*), crowned guenon (*C. pogonias*) , agile mangabey (*Cercocebus galeritus*), and red colobus (*Colobus badius*). Only 7 groups were observed, giving a mean encounter rate of 0.11 groups/km for all transects. Groups were heard vocalising on 33 occasions. Most commonly detected (50% of the total) was *Cercopithecus nictitans*. Mixed groups accounted for 27% of detections, and on one occasion all four species were present in a single group. Not a single primate group was detected in the Botala zone, and uneaten fruit fallen to the forest floor was conspicuous throughout the zone

The behaviour of primate groups when encountered was markedly different for different sections of the survey. With increasing distance from villages groups became bolder, in particular red colobus. At about 10km into the forest, groups could be called in using a whistle which imitates the call of the crowned hawk eagle, a predator of monkeys, and several times in the Bosela and Liouesso zones they approached to within 10m. Nearer to the villages, monkeys fled whenever the eagle call was tried.

Figure 11 shows that primate group detection rate, including vocalizations, increased noticably with distance into the swamps, although there is no clear correlation (r = -0.58) between machete cuts/km and primate encounter rate.

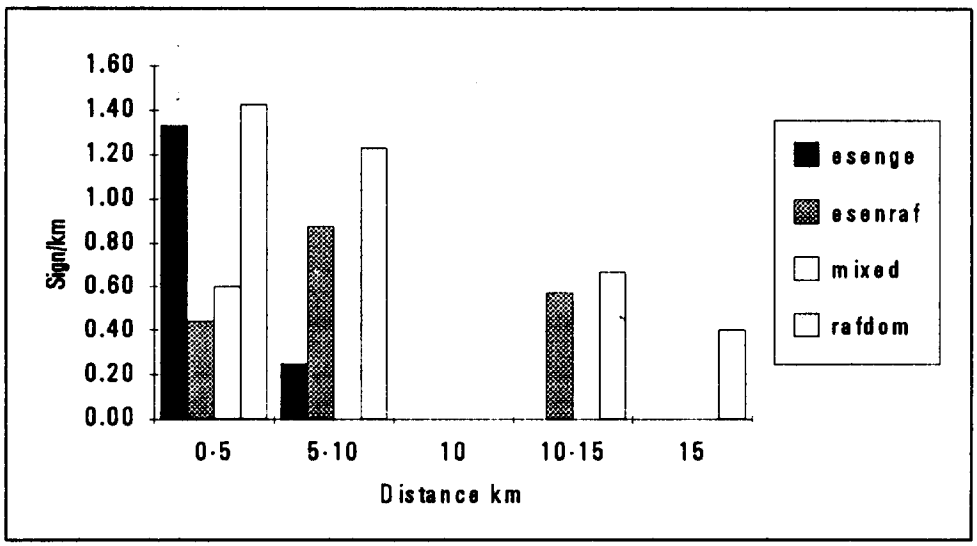
Figure 11. Primate group detection rate, including vocalizations, per km.



Duiker

Black-fronted duiker (*Cephalophus nigrifrons*) was the only species encountered on transects. From the data it appears this species is present throughout the study site with numbers declining with distance into the swamps (Figure 12). There is no correlation (r = -0.42) between duiker sign abundance and machete cuts. Tracks and dung of blue and yellow-backed duiker (*Cephalophus monticola* and *C. sylvicultor*) were seen infrequently along trails in *terra firma* forest near villages, but were not recorded from the swamps.

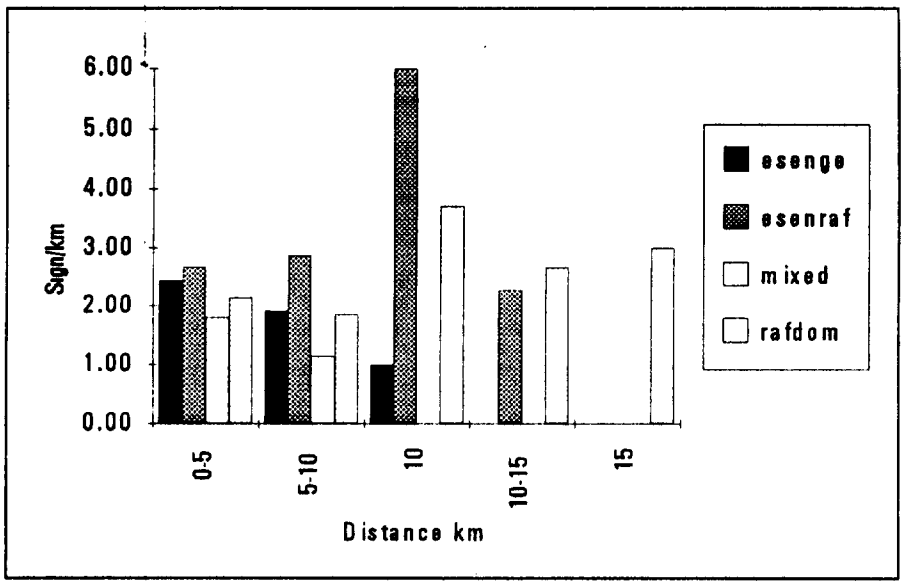
Figure 12. Duiker sign per km with distance into swamp



Pigs

Red forest hog (*Potamochoerus porcus*) sign was common throughout the survey site. There was little variation in distribution with distance from village or habitat type (Figure 13), except that qualitatively it appeared that group sizes (as estimated by ground area covered by sign) were particularly low in the Botala zone and increased with distance into the swamp. Evidence of **giant forest hogs** (*Hylochoerus meinertzhageni*) was not seen during the survey.

Figure 13. Pig signs per km with distance into swamp



Other large mammals

Of the remaining large mammals, sign of **sitatunga** (*Tregalephus spekei*) was the most common. They appear to be present though not abundant throughout the swamp forest surveyed. An estimate of density or trends in distribution is not possible, as signs were so infrequent. No sign of **buffalo** (*Syncerus caffer*), or **bongo** (*Tregalephus euryceros*) was recorded during the survey, nor surprisingly, **water chevrotain** (*Hymenochus aquaticus*). Sign of **leopard** (*Panthera pardus*) was seen only twice during the survey, at 10-15 km from Bosela (see Figure 3) in rafdom swamp forest. On both occasions broken monkey bones were associated with prints and dung.

Anecdotal information from guides and hunters

Gorillas

Gorillas were said to be present throughout the swamp region, though rarely found near to villages. Present populations were said to be most concentrated in the Bosela area south of the road, and near the Djemba canal. To find gorillas from Botala requires a two day canal journey. Gorillas remain in the swamp forest throughout the year and do not retreat to *terra firma* forest in the wet season, the reason being that there is continuous abundant food (*Raphia* spp.). Villagers said that in the past, gorillas were a menace as they would frequently raid plantations causing considerable damage, though this has not occurred in any village visited for at least ten years. When the road was under construction, gorillas were often seen crossing it, but apparently they are never seen near the road now. Gorillas are always keenly hunted - one hunter said he had killed 18 in the past year to sell in Impfondo.

Elephants

Guides revealed that elephants use the swamps on a seasonal basis. During the wet season, they inhabit the dry forest to the north and west of the Djemba canal towards the Motaba river and across to the Sangha region. Then with the approach of the dry season when food and water become scarce in the *terra firma* they migrate to the swamps to be near water and to feed, in particular on *Raphia*. They begin arriving in February, stay for March, and then leave in April. The hunters said that they are present in very high numbers, and are at their most concentrated around the Tanga river north of Liouesso to the Djemba canal. Before the road was built the migration carried elephants well into the forest south of Bimbo and Botala, and during its construction signs of

elephants crossing were often seen. However, since completion of the road this movement appears to have stopped. Large populations of elephants were said to be present in the Djeke and Lac Telle region.

It was said that poaching of elephants is high whilst they are in the swamps, with many hunters from Impfondo and the rural areas concentrating along the Djemba canal. Although it was sometimes difficult to collect information on elephant hunting, several hunters gave good accounts. One of the guides revealed that in March of 1992, he knew that Liouesso hunters had killed over 30 elephants, and that in March 1993, 23 had been killed, one man alone having killed 14. The same guide described a hunting trip he had made in April 1993 along the Tanga river. Several hours paddle north of Liouesso he encountered a group of four elephants in the river bank feeding on *Raphia*. He had nine shotgun cartridges and shot them all at the four elephants in the knowledge that he would have probably needed all nine to kill a single elephant. The four elephants dispersed in panic, and he followed one. After two days tracking he gave up the chase, but was confident that at least several of the elephants would have died from their wounds. He and all hunters said that although still common, elephants were declining significantly.

Chimpanzees

Chimpanzees are widely distributed though uncommon in the swamps. Primarily this was attributed to a general lack of fruit trees and consequently a limited food supply. Though killed readily, chimpanzees are not a preferred prey species.

Other Diurnal Primates

In addition to the primates identified on transects, the following were also said to occur in the area: grey-cheeked mangabey (*Cercocebus albigena*, N'Kakala or Tamba), de brazza's monkey (*Cercopithecus neglectus,* mfounga), moustached monkey (*C. cephus,* Kwetu)and black and white colobus (*Colobus guereza*, Magistrat). In the case of *C. guereza* this is doubtful as only Botala hunters indicated their presence, and this could not be corroborated in the other villages. Most monkeys were said to be widespread, except for *Cercopithecus cephus* which inhabits only *terra firma* forest and *C. neglectus* which is confined to riverine forest. All the primates found in swamp forest remain throughout the wet season.

Duiker

According to the villagers, the only species of duiker inhabiting the swamps is the black-fronted duiker (Njombi), which is widespread throughout the region. They said that this species migrates to near the terra firma forest during the wet season. The blue duiker (M'boloko) and yellow-backed duiker (Bemba) only exist in the dry forest around the villages.

Pigs

Red forest pigs were said to inhabit the entire region, and like duiker, concentrate near the *terra firma* forest during the wet season. Of all large mammals, the red forest pig was the preferred prey of the vast majority of hunters because it is easy to kill, tastes good, and gives a lot meat for food or sale. **Giant forest pigs** were said to be absent from the study area.

Other Large Mammals

Villagers said that **buffalo** and **bongo** are not found in the swamps in the study area, though buffalo are found in high numbers in the savannahs of the Likouala aux Herbes River. The nearest bongo population is apparently found in the dry forests of Minganga. **Sitatunga** are found in the swamp forest all year round. **Leopards** are found throughout the study area though they avoid humans. However, several snare hunters in Bosela and Liouesso said they sometimes took snared game near the village. Leopards were said to live in the swamps even at the height of the wet season.

DISCUSSION

Large mammals and the Likouala swamps

Gorillas

The results of this study have confirmed that the Likouala swamps are a primary habitat for western lowland gorillas. This contradicts earlier notions that gorillas avoid swamps (e.g. Groves, 1971). The only previous survey in the region (Fay *et al.*, 1990) confirmed for the first time that gorillas live east of the Likouala aux Herbes River and at high densities, but because their's was a dry season survey two important questions

remained. Could gorillas utilize the swamp forest in the wet season, and could they remain permanently in swamp forest even during the wet season without having to retreat to *terra firma* forest?

This study has appears to have answered both questions, since it took place during the wet season when water levels are at their highest, and the high densities recorded plus many fresh signs confirm that gorillas can live in the swamps during the wet season. In addition, the survey was conducted in a region with very little *terra firma* forest, and surveyed to a distance of 15 km from the little that does exist. This shows that gorillas are capable of living in the swamp forests for extended periods of time without the need to retreat to dry forest even in the wet season, which confirms the suitability of the swamps as a permanent habitat.

The density estimate of 5.8 nesting gorillas/km^2 in rafdom swamp in this study is the second highest recorded for any vegetation type, after 'thicket' vegetation in Gabon (7.3 nesting gorillas/km^2 from Tutin and Fernandez, 1984), and the highest recorded for Congo, though comparable with estimates from the Ndoki forest (*Mitani et al.*, 1992). The distribution of gorillas in relation to vegetation type in the swamps is interesting. Previous studies have shown that herbaceous monocotyledons particularly those belonging to the families Marantaceae and Zingiberaceae, are important dietary items for lowland gorillas (Carroll, 1988; Fay *et al.*, 1990; Rogers and Williamson, 1987; Rogers et al., 1988, 1990; Tutin and Fernandez, 1985; Williamson *et al.*, 1990;). Several authors have suggested that gorilla density and distribution is correlated with the density of these plants (Schaller, 1963; Groves, 1971; Fay and Agnagna, 1992). Wrangham *et al.*, (1993) suggested that gorillas could not survive in the Kibale forest because herbaceous vegetation density is too low. This study adds a new dimension to this notion, as in the swamp forests at this study site, herbaceous vegetation was scarce and for the most part absent yet gorillas were recorded at very high densities. In this study site it is *Raphia* sp. and not herbaceous plants which determines gorilla distribution and density.

In the Ndoki forest of northwest Congo, gorilla densities are also high (Mitani, 1992;. Kuroda, pers. comm; Blake, pers. Obs.) and Mitani *et al.*,(1992) have shown that gorillas spend a large proportion of their time in swamp forest. In the same study he suggested it is the high productivity of aquatic vegetation which allows them to exist at high densities. Williamson *et al.*, (1988) suggested that swamp vegetation may be important for gorillas because it provides minerals, fibre and water. Fay *et al.*, (1990) (like Mitani et al., (1992)) emphasised the more obvious fact that swamps simply offer huge

quantities of food. The very high density of *Raphia* sp. seen in this study, suggests a similar explanation. Vegetation in the Djeke area where Fay *et al.*, (1990) also foung high gorilla densities appears to be rather different from that in this study. There it seems the dominant understorey vegetation was the African ginger, *Aframomum angustifolium.* That gorillas have now been found at a second site in the swamps in a different forest type and at high densities, suggests they have a widespread distribution in the Likouala swamps.

Gorillas are affected by hunting activity in the Likouala swamps, but in the study area it appears that at distances of only 10km from villages given suitable habitat they can achieve very high densities. While reduced by hunting, gorillas are under no immediate threat in this region. With an area of 62.500km^2 and two studies at very different sites showing gorilla densities of over 2 gorillas/km^2, the gorilla population in the Likouala swamps could be enormous. Total population estimates and conservation status of the western lowland gorilla may need revision.

Elephants

The information obtained in this study confirms previous reports from northern Congo and Central African Republic (Fay, 1989, 1993a, 1993b. pers. comm.) that some elephant populations undergo a seasonal migration. In the Ndoki area this migration appears to be north-south. Fay proposes two reasons for the migration. Firstly, elephants are responding to fruit abundance determined by rainfall patterns, a response seen in savannah elephants (Moss, 1988; Sikes, 1971; Western and Lindsey, 1984) and in forest elephants (Short, 1983; White, 1993a, b), Secondly, they travel to the Likouala swamps to feed on *Raphia* spp. which are very abundant. The observations reported here included no data on fruiting patterns but they certainly support the second proposal.

Elephant movements in and out of the swamps in the study area appear to coincide almost exactly with reported movements further to the northwest in dry forest. Observations over several years in the Ndoki forest and the Dzanga region of CAR have reported low elephant numbers in the dry season, particularly in February and March (Fay, 1993b), with numbers increasing to reach a maximum during the wet season. Late February and March is exactly the time that elephants are reported to arrive in the Djemba canal/Liouesso area. It may or may not be the Dzanga/Ndoki elephants that arrive in Liouesso, but one can be confident that if not, the same factors are at play in initiating the movements in other populations.

Whatever the reason it is clear that the seasonal use of swamps in the Liouesso area is very important for elephants for the following reason. Previous studies have shown that the major determinant of elephant distribution in central African forests is not vegetation but human activity (Barnes et al., 1991; Fay and Agnagna, 1991; World Bank, 1992). Barnes *et al.*, (1991) showed that elephants in north-eastern Gabon avoid the zone within 7 km of roads, which was considered a low density stratum. Both Barnes *et al.*, (1991) and Fay (World Bank 1992) conclude that elephants alter their behaviour to avoid human disturbance even in relatively undisturbed forests. The fact that elephants use the area within 7 km of Liouesso and the Tanga River in seemingly high numbers despite the heavy human disturbance contradicts this and shows that the motivation to use this area must be extremely strong.

If local people are correct, the completion of the Impfondo - Epena road appears to have greatly reduced or perhaps even stopped elephants from travelling further south. The possible significance of this for both elephants and forest is unknown but termination of migratory routes of savannah elephants can have disastrous consequences for habitats (Laws, 1970). Barnes (IUCN, 1992) described the mechanism and some of the adverse effects of a new road in fragmenting a forest elephant population, and it is likely that the Impfondo-Epena road has had a similar impact.

That elephants apparently undergo some form of migration as described above has important conservation management implications. There is now considerable time, effort, and money being spent on forest conservation in Congo and elephants are a high priority target species, because of their keystone role in forest ecology (Prins and Reitsma, 1989). There are currently two major conservation areas, the Odzala National Park, and the Nouabale-Ndoki proposed National Park. While the importance of parks such as these cannot be overstated, it is clear that if conservation of forest elephants (and perhaps therefore the forest itself) is to be successful, an integrated land management plan is needed for the entire north of the country. Island conservation areas, no matter how big, will simply not be enough if elephants are roaming the forests on the scale implied by this and other recent studies.

Chimpanzees

The results of this study have shown that the Botala region is not a favourable habitat for chimpanzees, and this may be the case in the swamps as a whole. Two reasons are put forward for this. Firstly, chimpanzee diet in tropical forest is largely dependent on fruit (Suzuki and Nishihara, 1992; Tutin and Fernandez, 1993) and it

appears that the swamp forest surveyed does not offer sufficient food to support them throughout the year. It is also well known that Chimpanzees avoid water (though in the past the same was thought of gorillas). An extensive survey is required to determine the likely distribution of chimpanzees within the swamps, and the importance of this habitat for them.

Other diurnal primates

At only four, the number of species of monkeys seen was poor compared to other sites so far surveyed in Congo (Fay, 1993a; Wilkie et al., 1992; World Bank, 1992;). There are four possible reasons for this. First, with only 80 km of transect in an area of generally high hunting pressure and corresponding timid behaviour of primates, the sample size may have simply been too small to record all species present. Second, cutting and walking transects in swamps is noisier than in other forest types, and many groups of monkeys may have simply been scared away. Third, primate hunting in the region is high, and some species may have been reduced to such low numbers that they cannot be easily detected. Fourth, the low diversity of swamp vegetation encountered may not support a high primate diversity. Further study is needed to answer this question.

At only 0.11 groups/km the number of groups encountered was also much lower than other areas in Congo (World Bank, 1992; Fay, 1993a). Even Wilkie (1992) recorded an encounter rate of 0.16 groups/km, which he described as 'exceedingly low'. Again the reasons above may apply, but it is also likely that hunting is having a major impact in primate populations and this is supported by the distribution data in this study.

Duiker

Duiker species appear to be extremely under-represented in swamp forest compared to *terra firma*, with only the black-fronted duiker seen. A reduction in duiker sign density with distance into the swamp forest was seen in this study. This is an interesting trend and is the opposite of that seen in primates (including gorillas), and is counter to the intuitive notion that density should increase with distance from human activity. This suggests strongly that swamp forest, at least during periods of inundation does not constitute good duiker habitat, as has been reported from other sites in Congo (Garabinzam, World Bank, 1992: Nouabale-Ndoki, Fay, pers. comm.). Nothing can be said of the dry season use of swamps by duikers, though hunters say they migrate into the forest during the dry season, and to *terra firma* in the wet season. Such a response

to flooding is also reported for some ungulate species (red brocket deer (*Mazama americana*), grey brocket deer (*M. gouazoubira*), and white-lipped peccary (*Tayassu tajuca*)) in floodplain forest of south America (Bodmer, 1990). In the Botala region this behaviour probably increases their vulnerability to hunting in the wet season, a situation confirmed by hunters.

Pigs

Red forest pig sign was seen frequently throughout the survey, suggesting that swamp vegetation is a primary habitat for them. They were seen several times on transects but always fled when detected. Groups of up to 40 were seen in the Bosela zone. The wet season appears to present little problem for them and numbers do not appear to be significantly affected by hunting levels or by habitat type. Giant forest pigs are probably not found in inundated areas.

Other large mammals

Little can be said about the status of other large mammals inhabiting the study area. It is probable that **sitatunga** and also **leopards** are present throughout the swamp forests. It can be said with some certainty that **bongo** and **buffalo** are not found in inundated areas - no signs were encountered on transects and hunters also said they were never seen.

CHAPTER 4

HUNTING PATTERNS AND WILDLIFE: PAST AND PRESENT

This chapter describes hunting practices and patterns in relation to other aspects of village life. Changes in traditional hunting practices, village customs, and the effects of regional development on village life as perceived by villagers are also presented. The relationship between these changes and changes in animal populations in the swamps is discussed.

METHODS

Direct observation and interviews were used to collect information in this section of the study. The interview methods used range from completely informal to more formalised methods such as semi-structured individual and group interviews (Chambers, 1983). Several formal interviews were held with village committees and elders, primarily because they seemed more comfortable with this approach. In all cases emphasis was placed on talking to as many people as possible in order to obtain a representative and unbiased sample of opinion, and to cross-check the validity of answers already given. As the author did not speak Bomitaba and most villagers were more comfortable speaking in that language, formal interviews were always held using a translator (Guy Ebéké). The author wrote notes as the interview progressed after having asked permission to do so. Usually the interview ended in a social occasion, which always proved at least as productive as the interview. The three interview methods used are described briefly below.

1. Individual semi-structured interviews were used frequently to ask about an individual's perceptions and opinions on a particular matter. Interviews with 'key informants' i.e. a person regarded by many others in the village as being particularly knowledgeable on a certain subject, eg. hunting or farming, were particularly productive. The time span for these interviews ranged from several minutes to over an hour. Over 50 such interviews were conducted, in French or Bomitaba.

2. Informal group interviews with up to 10 people to discuss general topics such as "what are the annual movements of elephants in the region?" or "are there any animals

you don't hunt?". Here the consensus opinion was sought after noting all opinions from usually vigorous discussion. Interviews usually lasted for over half an hour, and were mostly conducted in Bomitaba. About 15 such interviews were held.

3. Formal interviews with the village committee and key informant hunters. Only five such interviews were carried out during the study, one at each village visited (Bosela, Botala, Liouesso, and Bimbo) plus one in Botala with the *Notables* from the ten villages. These interviews were arranged formally by the chief of each village, and involved between 2 and 20 people. They took the form of questions based around a list of topics pre-determined by the author. The interviews were not rigidly structured, so that if a point of interest arose from a particular answer the interview was steered to explore the subject, before going on to the next pre-arranged topic. Villagers were asked to draw maps of the forest and their hunting zones either on paper or on the ground.

The themes for all the interviews in no significant order can be summarised as follows;

- Village population changes
- Animals hunted and those not hunted
- Habitat preferences of animals
- Location and use of hunting zones
- Hunting methods used and those preferred
- Seasonality and preferred vegetation types for hunts
- Animal population changes
- Village economics
- Changes in village life and hunting since the road
- Contact with Ministry of Water and Forests
- Knowledge of hunting laws
- Attitudes to conservation

RESULTS

Hunting patterns

Hunting techniques

Traditionally, hunting methods in the Likouala region consisted of net hunting with dogs and spears, spear hunting alone, trapping with snares, and crossbow hunting with poison-tipped arrows. Though spears, nets etc., were often seen in huts and hunting camps, they were usually old and in poor repair and it was apparent that with the

exception of snaring, hunting with guns has largely superseded the traditional methods in the Botala area. Pygmies interviewed in Impfondo said they preferred to hunt with traditional methods, but this may be because they cannot afford guns.

Snare hunting was practised in all villages visited. Spring snares were made either of thick nylon fishing line or metal wire. Most common target species were porcupines and blue duiker, though several snares laid for larger game such as red forest pig were also seen. Snares were usually laid close to the village often at the edge of a plantation. Not only does this facilitate checking the snares, but in the case of porcupines, their density seems to be far higher near to manioc plantations than in the surrounding forest. It is quite possible that there is a form of symbiosis here, as super-abundant food in the form of manioc allows densities to reach very high levels, therefore allowing easy capture. Snares provide a financially cheap form of hunting, with ten metres of nylon costing only 200 CFA. This will make about four porcupine snares, each of which can be re-used several times.

Shotgun hunting was by far the most common method seen, and was said to be the preferred method by all hunters in the immediate study area. No quantitative estimate of the number of guns per household or hunter (Caldecott, 1988) was made, but it was clear that most adult males had access to a gun when required. According to the hunters, virtually all large mammals can be killed with a shotgun, and with a far higher success rate than traditional methods. Both day and night-time hunting using a torch are practised, although night hunting appears to be largely restricted to *terra firma* forest

Elephant hunting was said to be common in the study area and in the Likouala swamps as a whole. Three main methods of elephant hunting are used all of which have been noted in other regions of the Congo (World Bank 1992, Fay, pers. comm). The first involves the use of heavy calibre rifles, in particular 10.75mm. The second method involves shooting the elephant in the belly with a spear fired from a double charged shotgun. The third is more opportunistic and is merely shooting an elephant as many times as possible with a 12 gauge shotgun in the hope of wounding it fatally. The animal is then tracked until it dies. [For a full description of hunting methods used in the northern Congo, see UICN, 1991].

All hunters said that they kill any edible forest animals with the exception of nocturnal primates which are not eaten. Although they have preferences such as red forest pig, they will kill whatever they encounter with similar enthusiasm. When asked if

they target hunting to common species for reasons of conserving the rare ones, the response was nearly always laughter, and the stock answer ' *Dans la forêt, c'est la guerre, il faut tuer tous les animaux*' - in the forest it's war, you must kill all the animals.

The canal system

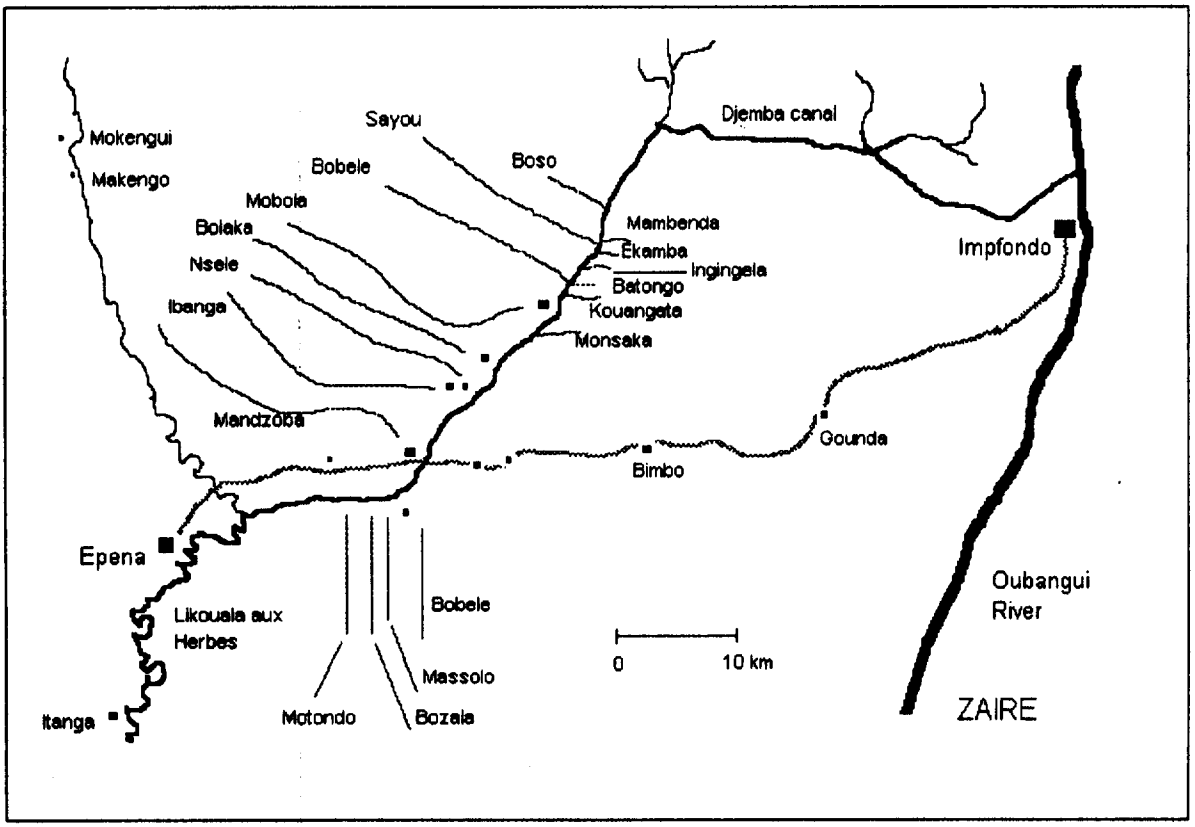
The canals were dug to provide easy access by pirogue into the heart of the swamp forests to facilitate hunting. It could not be determined with any certainty from villagers when they were dug, but it appears to have been before the colonial epoch, as even the oldest of villagers claimed that it was before their grandfathers had been born. The canals are between three and four metres wide and usually many kilometres long (see below). In the wet season the canals provide excellent opportunities to hunters as they can travel easily deep into the forest, to areas which would be inaccessible on foot. During the dry season however all the canals are dry and cannot be used, so restricting significantly the possibilities for hunting .

The extent of the canal system in the Botala/Liouesso area is enormous. (see schematic map, Figure 14). It can be seen that at least one canal is associated with every village along the Tanga, with many more cut into the forest north of Liouesso, approaching the Djemba canal. The positioning of some of the canals reflects human demographics in former times. For instance, the four canals associated with Bosela actually originate from ancient village sites, in this case, the villages of Bobele, Massolo, Bozala, and Motondo. These sites remain as important hunting camps and plantation sites today.

Many of the canals penetrate far into the forest, and their construction must have required a considerable effort. The longest are those west of the Tanga river north of Botala. Accurate estimates of the linear distance could not be obtained, but many hunters said the end of the canals on the west bank between Botala and Liouesso could not be reached in two days paddling. None of the hunters interviewed had ever been to the end of these canals. Hunters said that when camping at two days paddle from Botala, they could hear the drums from Mokengui (see figure 14), further verifying their length . The canals north of Liouesso to the west of the Tanga are apparently of comparable length, however those to the east usually terminate after about one hours paddling. This was borne out by direct observations. The Bosela canals terminate after one days paddle. Guides on the Bosela transect (both very experienced hunters in the

area) said they had never been to the forest beyond about the twelve kilometre point on the transect suggesting the canals terminate some distance before this.

Figure 14. Schematic map of canal system, showing appriximate positions as drawn by the *Notables* of the ten villages.



Note. Very little information was obtained on the relative positions of the Bosela canals, and their positions in this map are hypothetical only.

Seasonality of hunting

From interviews with villagers it became clear that the ability to hunt in the swamps is controlled largely by the seasons, resulting in large differences in hunting patterns in the wet season compared to the dry. In the wet season, hunting is easier for a number of reasons. Firstly, the canal system is entirely navigable so access deep into the forest is possible and transport of large quantities of meat is easy. Secondly, hunters said that tracking and stalking animals is easier in the wet season as one can walk silently in the forest (in the dry season when the forest floor is covered in dry leaf litter walking is always noisy). A third reason given was that terrestrial animals such as duiker tend to leave the swamp forest and concentrate on or near the *terra firma* forest during

the wet season. The higher density makes hunting easier, particularly jack-lighting at night. Fourthly, one of the biggest limiting factors for hunting is the availability of shotgun shells. Like all other commodities, the only way shotgun shells can reach the Likouala region is via the riverboats from Brazzaville or Bangui. In the dry season, the boats do not operate because the waters of the Oubangui are too low. Shells, like everything else, are therefore in short supply. When the boats start running, shells are once again readily available. At the beginning of this study, an acute shortage of shells was noted - some guides asked to be paid in ammunition rather than money, and in Impfondo when the first boat for several months arrived, its cargo of shotgun shells was sold almost immediately, and hunters complained of having had none for many weeks.

Another major factor in determining seasonal hunting patterns is the varying ease of fishing. During the dry season river water levels are considerably lower than in the wet season, which has the effect of concentrating fish into high densities in a limited volume of water. This makes fishing relatively easy, which in view of the apparent richness of fish populations coupled with the corresponding difficulties of hunting, means that the majority of people switch from hunting to fishing throughout the dry season. This study took place during the transition from predominantly fishing to predominantly hunting activity, and hunters said that hunting levels would increase over the next several months.

Traditional hunting rights

Traditionally, the forest in the study site was divided into hunting zones in which hunters from a specific village had exclusive rights. The zones were largely based on accessibility, i.e. the Botala forest was to the north and west of Botala village, and stopped when the Ibanga forest zone began. The divide between hunting zones was largely naturally defined as a result of the canal system, the line being somewhere near the mid-point between two adjacent canals. There must have been considerable overlap between zones, though the canals did and still do serve to channel hunting activity. From Botala to Liouesso, the hunting zones were north and west of the Tanga river (see Figure 2), stopping at the Tanga to the east. The hunting zone of Bosela was south of the village, and those of Bosemba, Boleke, and Bimbo went from the respective villages to the Tanga river to the north, and into the forests to the south.

An interesting difference from the general pattern of proximity leading to 'ownership' existed north of Liouesso. Each canal here, though not adjacent to a

particular village was nevertheless assigned as the exclusive zone of one of the villages along the Tanga. No reliable information was obtained on how these canals were divided but each village was represented. This co-operative use of the forest shows that a traditional form of resource management was in operation in the study area. Elders and the *notables* from all villages said that the zones were respected by all hunters, and in ancient times, a violation of the law could lead to confrontation and perhaps violence between the villages involved.

Diminishing wildlife populations

No villages had contact with the Ministry of Water and Forests, and considered it amusing to be asked whether they had. They also had no knowledge of Congolese hunting laws with the exception of the '*Fermature*' or closed season, when hunting by other than traditional means is banned (May 1 to November 1), and the elephant hunting ban. No one interviewed throughout the study had a hunting licence, and even in the presence of the Ministry of Water and Forests agent, this did not worry them. The notion of conservation was usually considered a good and necessary thing, as all people were aware of diminishing wildlife stocks.

All people interviewed without exception said that all animal populations had diminished and were continuing to do so. In all villages, elephants and gorillas were said to have caused a great deal of disturbance to plantations in the past but to have not done so for at least ten years. Every formal interview revealed that monkeys used to be seen commonly around the villages and plantations but once again have not been seen this close for many years. All hunters reported having to go further into the swamps each year to catch the same quantity of game.

There was a distinct difference in the perception of this depending on age. The old saw it as a very sad and worrying problem, whereas almost all the young, while acknowledging the problem, appeared to see it simply in terms of making life harder, but expressed no emotional feelings either way. Several reasons emerged from direct observations and interviews which appear to have been or are responsible for the reduction in wildlife populations. These are discussed below.

1. Breakdown of traditional hunting practices and laws: During much of the colonial epoch and before, the traditional land tenure system described above was practised.

However, after the First World War, the French colonial administration decided that government would be easier if the dispersed rural population was condensed into larger population centres near or on transport routes. Bosela was therefore formed from the four villages above plus ancient Bosela village, and Botala from Eleke, Boenza, Dzenza, Madzobo, and ancient Botala. The intimicy of village association with the forest was reduced. Then with independence came a directive from the Congolese government that the forests were the property of state, and as a result traditional tenure rights gave way to open access. The villagers of Botala recounted that this was when hunting began to increase significantly. In the Botala region, this gave anyone the right to use hunting zones traditionally under exclusive ownership, and resulted in a loss of the sense of collective responsibility for the forest, a general lack of respect for it, an increase in the number of hunters in the region (people began coming from as far away as Mokengui and the headwaters of the Likouala aux herbes River), and subsequent over-exploitation leading to diminishing animal populations.

The *notables* stated that before independence it was the law that every gun had to be licensed, and that a maximum of 25 shotgun cartridges could be bought per six months per licence. This meant that traditional hunting methods were still used, and guns were effectively rationed. Legally, guns must still be licensed in Congo but independence saw an end to effective control of the law and a proliferation of firearms, which led to increased hunting and, according to the villagers, reductions in animal populations.

2. The Road: The Impfondo-Epena road has had a profound effect on almost all aspects of life in the study area, and villagers say that life has improved enormously since its completion in 1989. Before this, villagers in the Botala region were extremely isolated from Impfondo, the only links being a two day pirogue journey via the Djemba canal which was only possible in the wet season; or a two day walk across '*La Vassiere*' - the local name for the swamp forest between Botala and Gounda. Trade possibilities were extremely limited, and even necessities such as salt, soap, paraffin, and basic medical supplies were difficult to obtain. Villagers now say that they can get all these things more easily than before, there is a regular medical visit from the Catholic nuns from Epena, and most importantly there are opportunities to make money through trade with Impfondo. This improved lifestyle has meant that village populations are now growing.

The most dramatic impact of the road has been on hunting. All villagers said that before the road, hunting had been mainly for subsistence needs with only a small fraction going for sale in Impfondo. Since completion of the road, the motivation for

hunting has changed totally from subsistence to market hunting, significantly increasing its intensity. The Botala market did not exist before the road, and it can be confidently stated that nearly all of the animals sold there (a biomass of 1689.5kg in three weeks from this study) are hunted as a direct result of the road. The road has not just increased hunting by the Botala region hunters, but has allowed hunters from Impfondo to hunt in areas which would have been inaccessible to them several years ago. Hunters from Bimbo were angry that these hunters were exploiting their forest, and all along the road one can see isolated hunting camps of Impfondo villagers. This ease of access has further diminished respect for traditional hunting grounds.

DISCUSSION

Implications of the canals for hunting

Perhaps the first point to acknowledge from this study is the ingenuity and extent of the canal system in the study area, and its implications for conservation in the Likouala swamps. It had been assumed (Blake pers. obs. in the Ndoki forest) that hunting in the swamps was comparatively more difficult than in *terra firma* forest. In *terra firma* a hunter can walk perhaps 15-20 kilometres in a single day, set up camp and begin hunting the following day. In swamps it seemed likely that this distance would be reduced to perhaps 5-10 km, therefore the radius of impact from a village through hunting would be considerably smaller in swamps simply for logistical reasons.

In fact, due to the canal system, hunting in the swamps is made considerably easier than in dry forest for the following reasons. Firstly, in dry forest a major limitation in a hunting trip is the amount of game which can be carried home on the backs of the hunters. In a rich hunting zone, the hunt may be terminated earlier than the hunters would like because they cannot transport any more game home. In the swamps there is no limit to this except the size of the pirogue, which in practice is not a significant limiting factor (unless they kill an elephant). Second is distance of penetration into the forest. In *terra firma* hunters seldom travel further than one days walk into the forest, unless specifically for poaching elephants, but in the study area not only do they travel faster along the canals, but the only limit is the length of the canal which in many cases is probably more than 20 km. The canal system has some similarities to the role of logging roads used by hunters in *terra firma* forests. Here the hunters hitch a ride to previously inaccessible areas of the forest, set up camp, hunt, and have their game transported

back to the village by a logging vehicle (Wilkie *et al.*, 1992; Blake, pers. obs.). The logistical difficulties of hunting on foot are thus overcome as in the canal system.

There are disadvantages to the canal system and hunting in swamps. First, the canals are only navigable in the wet season, which severely limits hunting possibilities and second, hunters are restricted to a particular area of forest. A similar situation exists in *terra firma* as hunters are restricted to well used trails to get deep into the forest.

A positive feature of the Likouala swamps with regard to conservation appeared previously to be that vast areas were too distant from human presence to be adversely affected by hunting. However if canals such as those seen in this study are widespread and allow access deep into the swamps, this may not be the case. Further study in other areas is necessary.

Wildlife decline

Breakdown of traditional laws and practises, as a result of government directives and disruptive infrastructural and economic developments leading to over-exploitation of natural resources has been widely documented (Myers, 1980; McNeely *et al.*, 1990; IUCN, 1992). Caldecott (1988) notes that because of only short term residence, a 'free for all' attitude toward hunting exists in parts of Sarawak because there is little sense of ownership of animals in particular areas. He suggested that 'with no incentive for anyone group to restrain itself or others, over-exploitation is almost inevitable'.

This study has shown that exactly these factors have been at play in the Botala region with similar results. The proliferation of fire power led to hunting becoming easier; then there was a decline in the ability and desire to uphold regulation of guns and ammunition coupled with a loss of traditional rights including a sense of responsibility over the forest, and finally improved infrastructure have all added to hunting pressure and subsequent decline of wildlife in the Botala region.

CHAPTER 5

HUNTING, THE BUSHMEAT TRADE AND VILLAGE ECONOMICS

This chapter presents preliminary quantitative information on hunting levels and the financial value of hunting to villagers in the Botala region. The aim is to show the importance of wildlife utilization in the lives of local people and its role in the rural economy compared to other economic activities. A possible relationship between harvest and animal populations is described. The implications of the results for both wildlife, people, and conservation in the Botala region and the swamps as a whole are discussed.

METHODS

Originally, it had been planned that information for this section of the study would come mainly from interviews, with quantitative data from daily inspection of hunting party success in each village visited. However, in Impfondo it was learned that the Botala meat market is one of the two most important sources of bushmeat for the town, and on arrival at Botala it was immediately recognised that the best source of systematic data in the study site would be the daily market for the following reasons:

1. Botala is a focal point for the ten villages in the study site, and bushmeat hunted in all villages for sale to Impfondo comes through the market. Therefore details of species, weight, origin, and price for each piece of meat were easily noted.

2. Hunters usually sold their own meat at the market, so the genuine sale price was obtained, not an inflated price which may have been given if the author had asked directly.

3. The market was a social meeting place for the villagers and people were usually relaxed and friendly which facilitated asking questions on hunting etc.

For all meat arriving at the market data were collected on the following; species, weight of each specimen, whether the meat was fresh or smoked, region of origin, sale price, destination, in addition to hunt details if brought in by the hunter. The buses were checked frequently though unfortunately not every day, when they stopped at Botala on the return trip to Impfondo in order to get an idea of the quantity of bushmeat coming from Epena, and the Likouala aux Herbes River area.

Interviews were also carried out in accordance with the motives and methods described in chapter 4. Due to the limited time scale of this study, the author could only remain in the village for a week and therefore a local hunter was hired (after an initial period of training in data collection and an assessment of his reliability) to monitor the market whilst the rest of the team carried out further forest surveys.

A further brief survey was carried out during the time spent in Botala to examine the importance of bushmeat in the diet of the villagers. This involved a tour of the village every other day, stopping at each household and asking the women of the house what they and their family had eaten in the past two days. It proved too difficult to collect information to the species level, and so simply presence or absence of bushmeat was recorded unless more detailed information was available.

RESULTS

Wildlife harvest and economics of hunting

The Botala market was surveyed over a total of three weeks. The market is active from Monday to Saturday, with little or no activity on Sunday. Primarily, this is because a regular bus service from Impfondo to Epena does not run on Sunday and so there are few opportunities for trading. During the week, there are three buses per day, and usually at least one market trader from Impfondo is on each bus. It is these traders who buy the vast majority of the bushmeat sold at the Botala market.

With the exception of crocodiles and several porcupines, all bushmeat recorded in the market had been hunted with shotguns. While initial outlay for a gun is high and the cost of ammunition is far higher than other more traditional hunting equipment, the returns are potentially much higher. The cost of a twelve gauge shotgun in the Likouala region is in the order of 120,000 CFA, which represents a major investment for a hunter. A box of 25 cartridges is 5000 CFA, and when individually sold in the villages may be 250-300 CFA each. Almost without exception, hunting was said to be the most popular and lucrative way of earning money. The reasons for this are both traditional and financial. In the study area hunting has been a culturally important activity, but with changing attitudes to traditional practices, earning money is now the primary motive for hunting.

The total weight of bushmeat sold at the market in 18 trading days plus one Sunday (or three weeks) was 1689.5 kg, representing 273 animals (see Table 4). Figures 15 and 16 show the relative weights and sales of each taxanomic group. The total sale price was 565,450 CFA (ca. US$1850). The mean number of animals per day was 14.4 (N = 19, SD = 9.4). Mean weight per day was found to be 88.9 kg per day (SD = 60.6) with a maximum of 283 kg. The majority of meat both in terms of number of animals and total weight was provided by *Cercopithecus nictitans* at 121 animals or 44% of the total number, and 532 kg or 31.4% of the total weight. Primates accounted for 772 kg or 45.7% of the total weight of bushmeat. They represent the most important group both in weight, number, and total sale price. Duiker were second at 378.5 kg, and pigs third at 325 kg.

Table 4. Bushmeat recorded in Botala market

Species	Number	Total kg	Total CFA
A. africanus	15	50	19200
C. badius	16	83	34000
C. cephus	12	40	12700
C. galeritis	11	29	13100
C. nictitans	121	532	179650
C. pogonias	20	74	25100
Non-id. monkey	7	14	7000
C. monticola	17	95	25000
C. nigrifrons	24	270	70700
C. sylvicultor	1	13.5	11200
T. spekei	2	33	12100
P. porcus	15	325	127900
P. pardus	1	16	3200
O. tetrapsis	2	98	20900
Non-id. tortoise	9	17	3700
Total	273	1689.5	565450

Figure 15. Distribution of weight (kg) of bushmeat in the market by taxonomic group.

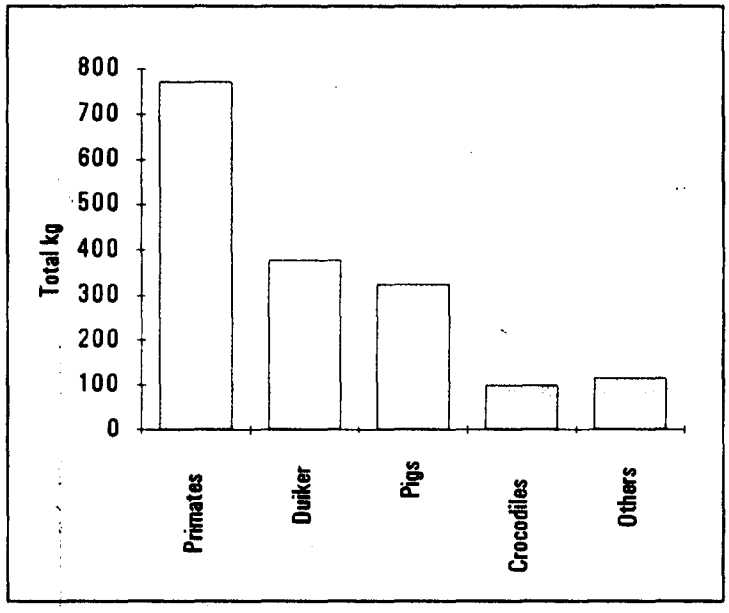
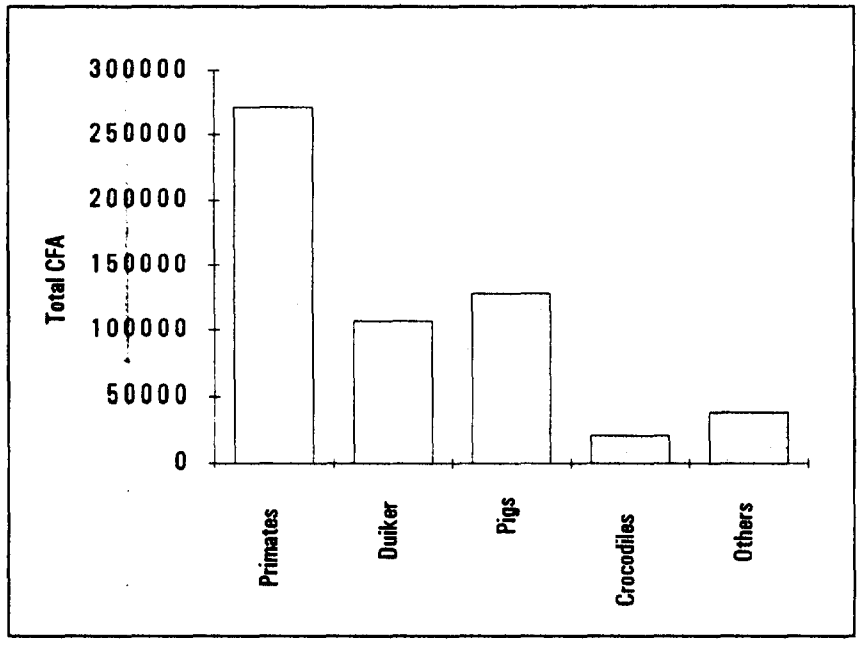


Figure 16. Total sales (CFA) of bushmeat for each taxonomic group



A large variation was seen in the prices of different species and between fresh or smoked meats. Table 5 shows the price range for all species and with Figure 17 shows that almost without exception, smoked meat is more expensive than fresh. Overall, the

mean price for all fresh meats sold was 290CFA/kg, and that for smoked meats was 426 CFA/kg.

Table 5. Mean price per kilogramme for all species recorded

	Price CFA	
Species	Fresh	Smoked
A. africanus	384.00	-
C. badius	333.33	430.77
C. cephus	331.82	300.00
C. galeritis	346.67	564.29
C. nictitans	302.21	400.52
C. pogonias	333.82	400.00
C. monticola	263.16	-
C. nigrifrons	251.68	337.50
C sylvicultor	-	829.63
T. spekei	-	366.67
P. porcus	300.00	435.11
P. pardus	200.00	-
Tortoise	217.65	-
O. tetrapsis	213.83	200.00
Means	289.85	426.45

Figure 17. Price differenial (CFA) between fresh and smoked meat

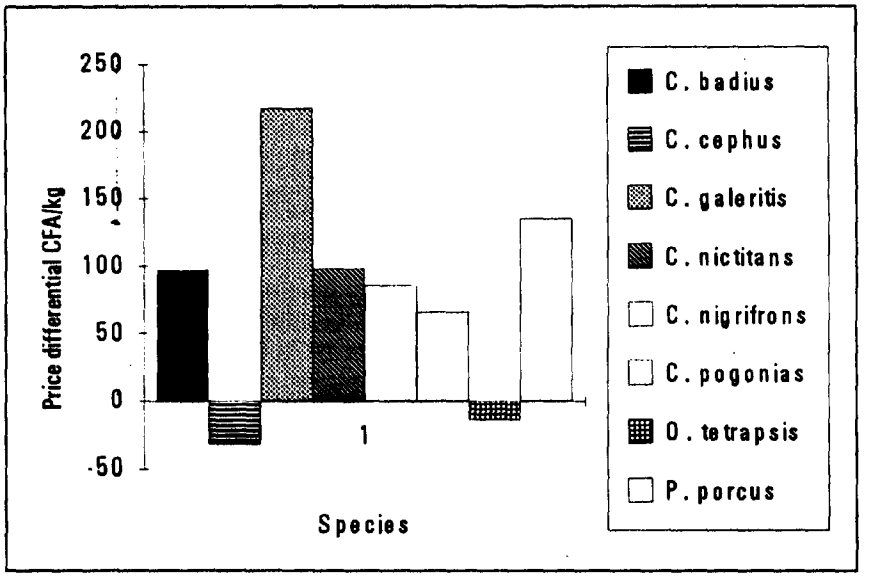
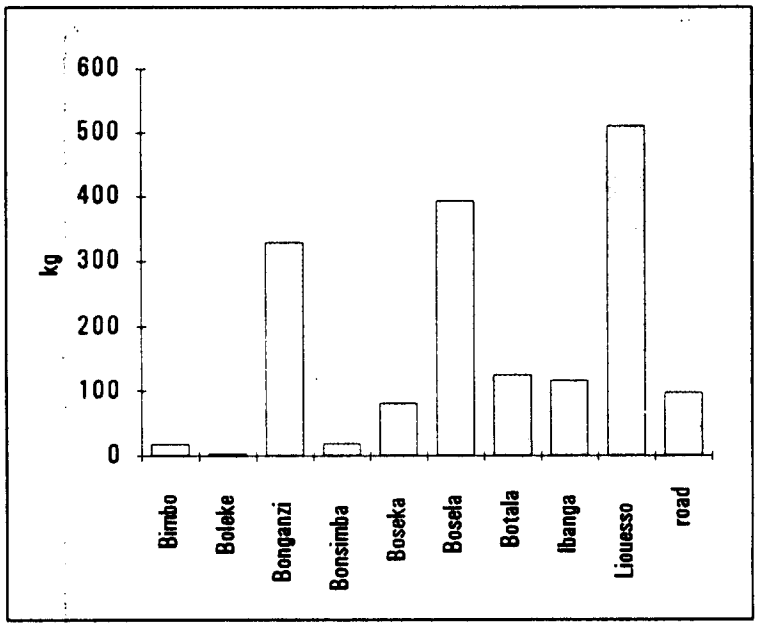


Figure 18 shows the origin of bushmeat coming into the market was localised with by far the majority coming from three villages; Liouesso, Bonganzi, and Bosela, with

Botala, the host to the market and one of the largest villages (Table 1) accounting for only 7.4% of the total. However, it should be noted that Bimbo, Boleke, Bonsimba, and Boseka also sell a large proportion of their bushmeat directly on the road. No meat was recorded from Epena on buses returning to Impfondo, although fish were common. Though buses were not checked every day and the sample is limited, it suggests that there is not a large bushmeat supply from the Likouala aux Herbes River, at least at this time of year,

Figure 18. Total weight (kg) of bushmeat for all villages supplying the market



Other aspects of village economics

Agriculture: At village level in the study area, agriculture is practised on the family plantation scale. Both men and women work. Basic foods such as manioc, bananas, sugar cane, peanuts, palm-nuts and fruits, plus maize for food and alcohol, make up the bulk of the produce. Production appears to be geared to subsistence needs only, and food is sold only if there is a surplus. This was reflected in a general lack of these products in the Botala market, as most days there would be nothing. Prices for some foods are shown below:

Bananas (plantain and fruit)	= 10 CFA each
Manioc stick	= 50 CFA
Oranges	= 25 CFA each
Pineapple	= large 200 CFA, small 75-100 CFA
Sugar cane	= 50 CFA for 1 metre
Palm oil	= 250 CFA per litre

and prices for other commodities;

Cigarettes	= 250/300 CFA per packet
Soap	= 100 CFA per bar
Salt 1kg	= 350 CFA
1 Baguette	= 100 CFA
Spool of cotton	= 75 CFA
Bus ticket to Impfondo	= 750 CFA

Given the effort required in keeping a plantation, it can be seen that there is little incentive for growing food for market sale.

Domestic animals were conspicuous in every village visited, and consisted principally of sheep, goats, chickens, and ducks. Larger animals such as pigs and cattle were not seen. In Botala over 20 men, the majority of whom were old, had some domestic animals. Several of these had over 50 head of sheep or goats. Interviews and observations suggested that livestock production is a rather low input activity. Goats and sheep run loose in the villages with little sign of attention from their keepers. Prices for domestic meats are not fixed and vary considerably. For sheep, the price is 7000-10000 CFA depending on size and sex (large females being the most expensive), and goats from 3500-5500 CFA. Chickens are a fixed price of 500 CFA for a cock, and 750 CFA for a hen.

However sales of domestic meat do not play a large part in the village economy for several reasons. Firstly, bushmeat is traditionally favoured over domestic meat which limits the possibilities for sales. Secondly, there is a general reluctance on the part of the farmers to slaughter their animals and sell the meat. This was said to be because they see their livestock as a safeguard against hard times, i.e., as a source of revenue should they need money quickly. Therefore they do not like to reduce this 'capital' by selling it. Traditionally, when sold, domestic animals are sold alive, and are only killed for special occasions such as fetes or celebrations. Live sales mean that people do not buy domestic meat as a whole animal is too big and the price is too high.

Cacao: Cacao plantations were associated with all villages visited. In the ten villages as a whole in 1992, a total of 18,000kg of cacao was produced. Several figures were given for the sale price so an accurate estimate cannot be made, but was probably ca. 165 CFA/kg, giving a total income of 2,970,000CFA for the 10 villages. Unfortunately the total number of people currently working plantations was not determined, so the revenue to each cannot be calculated. However with a total population of 1500, the income per head is only 2000CFA for the year.

Fishing: Fishing was said to be a major activity and source of income to the villagers. However during this study, while people were observed to go fishing frequently, there was very little evidence of a significant trade in fish at the market. It seems that at this time of year, people fish primarily for subsistence needs. This follows from the general switch from fishing to hunting from dry to wet season. Most households had a small stock of dried fish. Reliable data on prices of fish were not obtained, though several times large fresh fish of between 1 and 2 kg were seen for sale at 1000 CFA. Both fresh and smoked fish was said to be more expensive than bushmeat.

Bushmeat consumption

From the results shown in Table 6 it can be seen that of all meals in the sample those containing bushmeat accounted for only ca. 25% of the total. Of the three staple meal types, fish, vegetables, or bushmeat, bushmeat was the least represented. At this time of year, fish appears to be by far the most important source of protein, and this is supported by interviews with villagers. They say that during the dry season fishing is relatively easy and hunting is difficult so their consumption is high, but that in the wet season fishing is more difficult and hunting easier, therefore they eat more bushmeat. At this time of year, fishing was diminishing and hunting was increasing, though fish was still an important source of food.

Table 6. Details of meals recorded in Botala village

Food type	Number of meals	% of total
Domestic meat	**3**	**1.08**
Birds	**4**	**1.44**
Fish	**130**	**46.76**
Bushmeat		
Monkey	17	6.12
Porcupine	8	2.88
Black-fronted duiker	4	1.44
Blue duiker	4	1.44
Red river hog	2	0.72
Leopard	1	0.36
Pangolin	1	0.36
Crocodile	1	0.36
Tortoise	4	5.40
Non-identified	15	5.40
Sub-total	**57**	**24.46**
Vegetable only	84	30.22
Total meals	278	100

DISCUSSION

Mammals and the market

A relatively low diversity of animals (only 14 species) was recorded at the Botala market, compared to other studies in Congo. For instance, Wilkie et al., (1992) recorded 24 different species hunted in six weeks in a a logging concession in the Sangha region, Wilson and Wilson (1992) monitored the 'Grand Marché' in Pointe Noire for only four days and recorded 25 species, and 28 different species were recorded as hunted in a four week period in Mbandza village near the Odzala National Park (unpublished report). There appear to be several possible reasons for the lower diversity at Botala. Firstly, the almost exclusive use of shotguns may limit the number of target species available, or make killing certain species particularly easy. Second, the sample of 'species hunted' is biased as only those appearing in the market were recorded. The motivation for hunting animals appearing in the market is to make money so hunters may be going only for those species which give a high return on overheads - only species of commercial worth get to the market. However, this was the same in the study of Wilson and Wilson (1992). Third, the swamps fauna may be impoverished by comparison to other regions either because it is a low diversity ecosystem with respect to mammals compared to the other

study sites, or hunting levels have reduced the diversity. Only a more detailed study will determine which of these reasons is correct.

It is surprising that gorilla meat was not recorded in the market as the region contains a large population of gorillas (this study), and villagers say they are preferred prey. The reason is probably that only two of the canals, Bolaka and Mobola, were navigable during the study, which limited the amount of good gorilla habitat available for hunting.

Hunting and mammal distribution

From the mammal surveys (chapter 3) it is clear that the distribution of primates in the swamps is different to that of ungulates. Primate sign density was negatively correlated with hunting pressure and distance into the forest, pig sign was similar throughout the survey, and black-fronted duiker sign decreased with distance into the swamp. This distribution suggests that ungulate populations are less affected by hunting than primates. Possible reasons for this are given below.

It could be that primates in the region are disadvantaged over ungulates because of their comparative reproductive rates. It is known that primates have a lower intrinsic rate of natural increase (r_m) than their body weight would suggest (Western, 1979). It has also been shown that in the Neotropics primates have a mean r_m of 0.15 against 0.64 in ungulates (Robinson and Redford, 1986). Therefore for a given level of predation, primates are more vulnerable to extinction than ungulates, for animals of comparable size.

Bodmer, Fang, and Moya Ibanez (1988) reported from south America that for similar harvesting rates in primates and ungulates (7-8%), ungulates showed no significant difference in biomass from non-hunted sites, yet primate biomass was considerably reduced. If the same relationship exists in Africa, pig and duiker populations would be more robust for a given harvesting level, which would contribute to the result observed here.

When relative harvest of each species group (once again excluding gorillas) as observed at Botala market is considered, probably the main reason for the difference in distribution along transects can be seen. Primates accounted for the largest harvest in terms of numbers (187), weight (772 kg), and total sale price (271550 CFA). Only 15 red forest pigs gave a weight of 325 kg at a price of 127900 CFA, and 24 black-fronted

duiker gave 270 kg and sales of 70700 CFA . Over the three weeks then, 12.5 times more monkeys were killed than pigs, and 7.8 times more than black-fronted duiker. It is this disparity in level of exploitation which could be primarily responsible for the different trends in distribution.

In general primates are more conspicuous than ungulates because they are coloured, vocal, diurnal, live in trees rather than on the ground, and have unsuitable avoidance strategies for human predators (Dasilva, 1993), especially humans armed with guns. Spot nosed monkeys are by far the most conspicuous animal in the forest, and this appears to be reflected in their huge presence in the market. Another factor may be the relative reward of hunting, say, a pig compared to a monkey. A hunter need only kill one red forest pig to gain the same market weight of bushmeat as over three spot nosed monkeys, or gain four times as much money as one spot nosed monkey. So to get the same economic return, a hunter must kill many more monkeys than pigs. Both the ease of hunting and relative effort against economic returns could be responsible for the high levels of hunting of primates seen in this study. The distribution of gorillas with respect to hunting pressure follows the same pattern as other primates, but no gorilla meat came through the market. It is probable that gorillas have modified their behaviour and avoid areas of human impact, rather than hunting exterminating populations near villages.

Village economics and hunting

From this study it is clear that the rural economy in the Botala region is based almost entirely natural resources, in which the bushmeat trade is by far the biggest component. Selling hunted animals is therefore a sure way for a villager to make money. A crude estimate of return against financial investment for hunting is given below.

Results from hunter interviews showed that the ratio of cartridges fired which actually killed game to those fired and missed is approximately 2.8:1 (N = 34 hunts, total animals killed = 165, cartridges fired but missed = 44). If this figure is extrapolated to include all game passing through the Botala market with the exception of crocodiles which were all hunted by hand, the total expenditure for shotgun shells (@ 250 CFA/shell) was ca. 92,500 CFA. If the price of a shotgun is written off (all guns seen were old, and hunters said they will last for over 30 years), shells are the only financial cost involved in hunting. Therefore the direct profit which came into the ten villages over the three weeks as represented by game recorded in the Botala market was (565,500 -

21,000) - 92,500 = 452,000 CFA (net profit = 80% of gross income). Unfortunately, it is impossible to make a good estimate of the number of hunters nor the total time involved.

If one took this situation to be representative of one year, and extrapolated from it, the total profit would be 7,891,600CFA, which represents a per head of population income of 5261 CFA. When compared to the per head income from cacao which is 2,970,000/1500 = 2000 CFA, the merits of hunting can clearly be seen. Extrapolation of a small data set in this way is of course particularly error prone, especially with the fluctuating hunting patterns described earlier, and these extrapolated figures should be regarded with caution pending more information.

The story of cacao production was cited a number of times as being a key factor in increases hunting activity. In the 1950's and 1960's the production of cacao as a cash crop was promoted by the French colonial authorities, and later by the government of Congo. Village-scale collective plantations were set up in many parts of the north in an attempt to bring economic development to the region. During this period and into the 1970's this appears to have been a relatively successful enterprise, with steady growth in both tonnage produced and number of producers (see Vennetier, 1977). This success gave rise to the Office du Café et du Cacao (OCC) at national level. All the villages in the Botala region took part in this enterprise enthusiastically, and apparently with some success. However, in 1980, the fixed buying price offered by the government was cut dramatically. This reduced the opportunity to make money and led many people to discontinue working their plantations, as profits were considered not worth the effort invested.

Today, the situation remains the same, and Hecketsweiler (UICN, 1989) has shown that in a single year the price of cacao may fluctuate by 36% (1988 at 275CFA/kg to 1989 at 175CFA/kg), which inspires little confidence in the market from rural people, who are then understandably not committed to the enterprise. In Botala and the surrounding villages there are many abandoned plantations, and villagers said that up to 60 tonnes had been produced regularly by the ten villages when the price was reliable. A guaranteed reasonable price would encourage hunters, to return to cacao production as a source of income.

The special case of elephant hunting

The preferred method of hunting elephants is with a heavy calibre rifle (see chapter 4). Quoted costs for this kind of firearm were from 300,000 to 400,000 CFA, and ammunition 5000 CFA per round. Even so, the profit margins possible for ivory are potentially very high, even though prices have fallen considerably since the world ban on ivory trading. Several hunters in Impfondo and Liouesso quoted sale prices up to 5000 CFA per kilogramme. This seems particularly high in the light of recent information from Fay (World Bank, 1992) and Fay and Agnagna (1993c) who obtained quotes of 1000-2500 CFA in the Sangha region from more reliable sources than those in this study. At a price of 2000CFA, if a hunter uses two shells (@ 5000CFA each) to kill one elephant with 24kg of ivory (Fay and Agnagna, 1993) his profit margin, will be ca. 38,000 CFA, if the cost of the rifle is written off. This is a considerable sum of money in rural regions and a far higher return than any other activity (see above). For artisanal methods of poaching the overheads are considerably less than this, making elephant hunting an attractive activity.

With the exception of pygmies in Impfondo, all villagers were aware of the ivory ban and said that possibilities for trading had diminished since the ban. They have hunted less as a result. However, all were confident that the ban would be lifted and were anticipating returning to their former hunting levels which would be disastrous for Congo's elephant population (and the rest of central Africa).

(For a full and detailed review of the elephant hunting situation in Congo see Fay and Agnagna, 1993)

Sustainability: Botala and the Likouala swamps

Given the importance of bushmeat to the rural economy it can be stated with confidence that overhunting leading to depleted animal populations would have a huge negative socio-economic impact in the Botala region. People would receive diminishing returns for more effort, wildlife would become more scarce, forcing people to travel ever further to hunt game and make a living , while the standard of their diet and therefore their health would be reduced. Thus the remaining integrity of the rural community and economy, and the swamp ecosystem itself could be lost. This scenario is succinctly put by Robinson and Redford (1991) "A harvest that is not ecologically sustainable cannot be economically sustainable or socially realistic".

Unfortunately, in the absence of long-term data on animal population dynamics and harvesting levels, it is only possible to speculate on the sustainability of hunting in the Botala area. Animal populations in general appear to be doing well at distances over 10 km from villages (this study), though populations in former times are not known. However, in the light of data from this study (see chapters 3 and 4), it is apparent that animal populations are diminishing throughout the study area, most significantly in the area west of the Tanga River between Botala and Liouesso, the zone of highest hunting pressure. This and the continued reductions reported by villagers suggests that hunting at present levels is not sustainable, though Eltringham (1984) points out that a decrease in animal density does not always signify over-exploitation. Further studies of game productivity and harvesting rates are necessary to assess the sustainability of hunting in the region.

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

1. This study has shown that the Likouala swamp region of northern Congo is a site of major biological interest and conservation potential, principally because of its importance for gorillas and elephants (chapter 3). In the case of gorillas, this study is the first proof that the swamps offer year round primary habitat, a discovery with important scientific and conservation implications. Scientifically, only gorillas living permanently in *terra firma* forest have been studied in detail to date. Preliminary evidence (e.g. diet, this study) suggests there may be important ecological differences between gorillas living in swamp and *terra firma* forest. Given the vast area of the swamps and the high densities recorded in this study, the swamps may contain a very large population of gorillas.

2. The Likouala swamps are an important site for the elephants of northern Congo because they offer abundant dry season food in the form of *Raphia* spp.(chapter 3). That elephants migrate in and out of the swamps on a seasonal basis has been strongly supported for the first time from a site in the Likouala swamps. Poaching is having serious consequences for the population and the Impfondo-Epena road has probably affected the migratory pattern into the heart of the swamp. Coupled with observations from the Nouabale-Ndoki National Park that some elephants appear to migrate out of the park in synchrony with observations from this study, it is clear that elephant conservation cannot be successful at just the national park level.

3. With the exception of red forest pigs the vegetation in the Botala region appears not to offer primary habitat for most terrestrial mammals, who may need to retreat to *terra firma* forest for the wet season. The swamps may also not offer sufficient food for frugivores such as chimpanzees, or other primates (chapter 3).

4. The adverse effects of hunting on animal populations in the swamps has been demonstrated by information obtained from villagers and by direct observation. A canal system cut deep into the swamps allows pirogue access and efficient exploitation of wildlife, which in the past appeared to be sustainable (chapter 4). Loss of traditional hunting methods, and a breakdown of traditional local government and hunting laws has led to a lack of respect and sense of ownership of the forest by local people. Coupled with improved infrastructure in the swamps, an expanding urban population and a subsequent increase in possibilities for market hunting this is leading to over-hunting of wildlife in the Botala region (chapter 5).

5. Through a quantitative estimate of the money generated from hunting, this study has shown that animal populations have extremely high monetary value and dominate the rural economy (chapter 5). Over-exploitation of game to very low levels would therefore have severe negative impacts on the socoi-economy of the region, and on the possibilities for conservation throughout the swamps. A system of sustainable and rational exploitation of wildlife is necessary to meet the needs of both.

Given that substantial funding will be made available for implementing a conservation strategy in the Likouala swamps in the near future, a brief list of recommendations which seem appropriate in the light of this study is given below.

1. The Government of Congo should be made aware of the value of the wildlife resource in the swamps. This is considerable, and should encourage a motive for its rational utilisation.

2. A population survey of gorillas should be carried out in the swamps. This could take the form of an aerial survey to determine the distribution of *Raphia* dominated swamp forest, coupled with ground truthing surveys.

3. A regional elephant conservation strategy, on a scale of perhaps the entire northern Congo is necessary, based on ecological data such as seasonal movements, habitat and dietary requirements. A remote sensing study using radio or satellite tracking to monitor large scale elephant movements, plus observational data on the ground is necessary to provide data for planning the strategy. Areas of particular importance to elephants must be identified, and a strict hunting ban should be enforced. The potential value of rational exploitation of elephants as a future development should be acknowledged.

4. Key areas of high animal density in areas of low human impact in the swamps should be identified by the surveys suggested above. These could act as core protected wildlife areas in an integrated land use system. If possible, the core areas should be planned in a co-ordinated way to provide an example of the intact swamp ecosystem.

5. A village based education programme should be implemented aimed at making people aware of the socio-economic consequences of over-exploitation of the region's wildlife. A return to village based land tenure should be encouraged to allow people the sense of

collective responsibility for their resources. Individual villages that continued to over-exploit would bear the consequences of their own actions.

6. Information on hunting practices and the bushmeat trade throughout the swamps is necessary. Market outlets which may stimulate a bushmeat trade into over-exploitation must be identified (e.g. the new logging developments in the Sangha region on the western edge of the swamps). The nutritional and financial needs of local people in the swamps should also be identified to calculate the scale of the wildlife harvest necessary to meet those needs.

7. Long term quantitative studies of harvesting levels and animal population dynamics both in the core areas and throughout the swamps are necessary, to give data on animal biomass, recruitment rate, and therefore productivity of game species. A sustainable harvesting regime could then be calculated (see Robinson and Redford, 1991).

8. A study aimed at identifying and implementing alternative forms of income desirable to villagers should be carried out. Possibilities include small scale agricultural projects, which could provide work and income for hunters, reducing their need to go hunting, and also provide cheap meat which could supplement bushmeat, further reducing the need to hunt.

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