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Forest Management in Africa:
Is Wildlife taken into account?

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Using landscape approaches to improve the integration of wildlife in forest management plans

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SUMMARY

Logging concessions can affect wildlife populations through indirect or direct effects. However, if wildlife is appropriately taken into account in the forest management plans, then logging concessions can become an opportunity for conservation, as they can play a crucial role as buffers around protected areas. In the last decade, large blocks of the Gabonese forests have been surveyed by logging companies to implement the new forestry law. Large data sets were generated with this information but little was done in terms of analysis. In this study we show that this invaluable data, collected during routine management planning processes, can be used to understand the landscape factors that explain mammal distribution in logging concessions and provide very useful recommendations for taking wildlife populations into account in logging operations.

INTRODUCTION

Most of the Gabonese forest is now attributed to industrial logging firms. These concessions can affect wildlife populations through indirect or direct effects (Tutin et al., 2001). Among the direct effects are the modification or destruction of wildlife habitats, the disturbance to animals caused by the noise of logging machinery and the disruption of territorial and gregarious groups of animals. In Lope (Gabon) White (1998) showed that chimpanzee groups, chased from their territory by logging activities, were found to have mortal fights with other chimpanzee groups when trying to settle in an occupied territory. The indirect effects are the increase of hunting activities due to better access to previously remote forest blocks through the development of road networks, the presence of vehicles, etc (Tutin et al., 2001). In numerous cases, logging activities rely on the creation of worker camps in the middle of the forest where the only source of proteins is bushmeat.

However, if wildlife is appropriately taken into account in the forest management plans, then these logging concessions can become an opportunity for conservation, as they can play a crucial role as buffers around protected areas. Since 1996, The Gabonese Law 16/01 (the Forest Code of the Gabonese Republic) requires a detailed and comprehensive forest management plan aimed to maintain the availability of timber over time, but also to limit the negative effects of logging on biodiversity in general and, more particularly, on wildlife species. In the last decade, large blocks of the Gabonese forests have been surveyed by logging companies to implement the Forest Code. These surveys aimed, as a primary goal, at estimating the timber potential from commercial tree species, but they did also consider other ecological parameters including fauna (van Vliet et al., 2004). Although the methodologies used to collect data slightly varied among companies, mammal surveys were generally carried out along parallel and equidistant line transects, also used for the vegetation plots. Indirect signs (dung, footprints, nests etc…) and observed animals were recorded, with information about species, position along the transect, plot number, time of the day and in some cases, perpendicular distance to the transect.

Large data sets were generated with this information but little was done in terms of analysis. At most, the information was used to generate a list of species present in the concession as well as maps showing the spatial distribution of some of the key species. In this study we show that this invaluable data, collected during routine forest management planning processes, can be used to understand the landscape factors

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that explain mammal distribution in logging concessions and provide very useful recommendations for taking wildlife populations into account in logging operations.

MATERIAL, METHODS AND RESULTS

Between 2001 and 2003, the company CBG ("Compagnie des Bois du Gabon") carried out a forest management survey within its Mandji logging concession (Figure 1). The forest inventory was carried out along 159 parallel and equidistant line transects which covered 1 % of the overall concession area. The survey units were 20 m by 200 m adjacent plots (5711 plots) centred on the transect line.

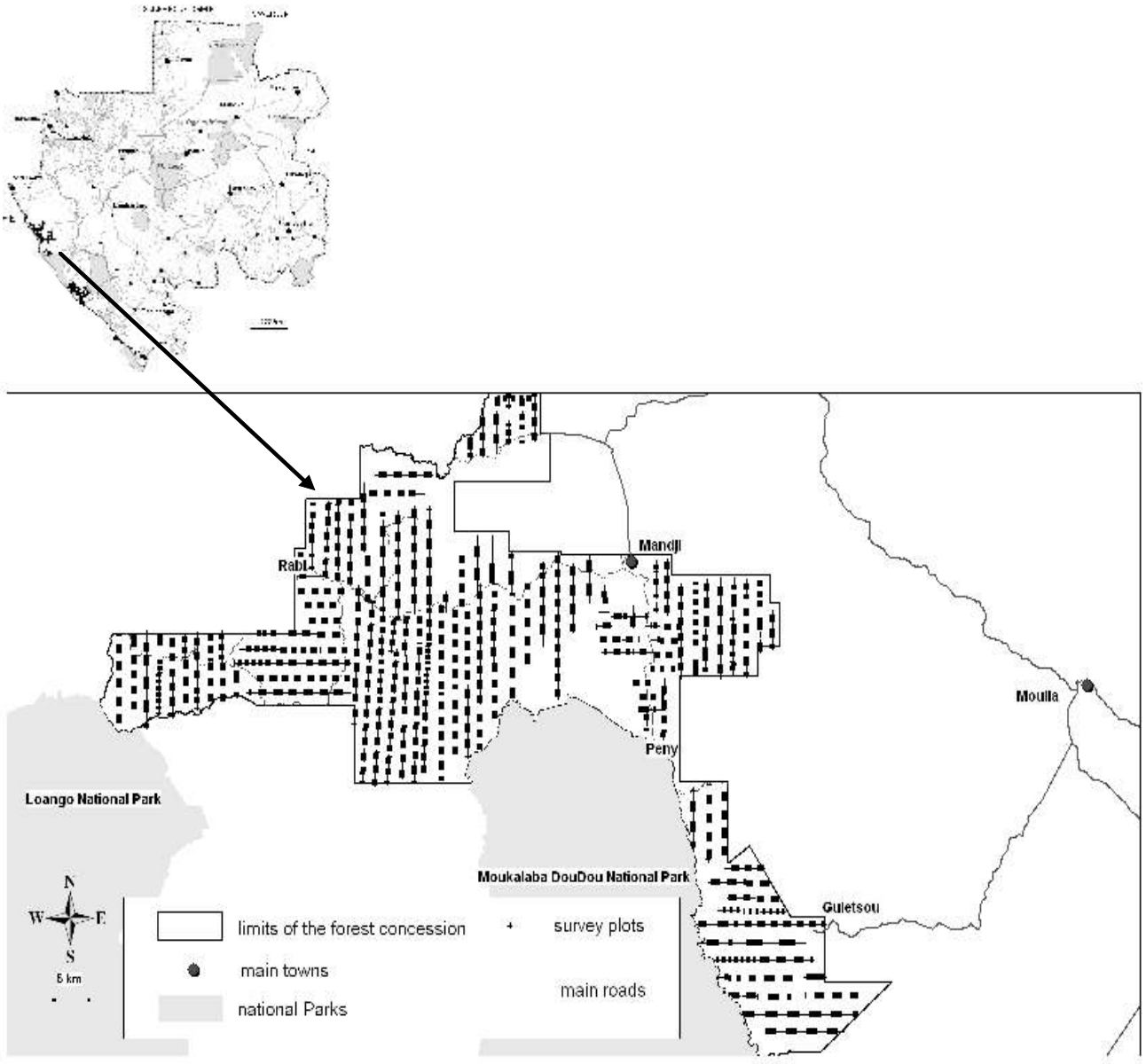

Figure 1 : The Mandji forest concession under sustainable management plan and the system of transects used for "biodiversity surveys"

The mammal survey was carried out using line transect techniques and the information on seen animals and indirect signs (faecal drops) was referred to the corresponding plot. For analyses of the available data we selected species on the basis of 1) importance for local people (duikers (*Cephalophus spp*.), bushtailed porcupine (*Atherurus africanus)*, and small diurnal monkeys), 2) charismatic and international conservation value (gorilla (*Gorilla gorilla)*, chimpanzee (*Pan troglodytes), elephant (Loxodonta Africana)*, 3) total protection status in Gabon (aquatic chevrotain (*Hyemoniscus africanus)* and yellow backed duiker (*Cephalophus sylvicultor)*) (Table 1).

Table 1 : Common and scientific names of the mammal species selected for our analysis

Scientific names	Common names
Atherurus africanus	brush tailed porcupi
Cephalophus. *cephus, C. nictitans, C. pogonias, Lophocebus albigena*	small dirunal monke
C. dorsalis, C. callipygus, C. leucogaster , C. nigrifrons et *C. ogylbi*	red duikers
C. sylvicultor	yellow back duike
Cephalophus monticola	bleu duiker
Gorilla gorilla	gorilla
Hyemoscus aquaticus	water chevrotain
Loxodonta africana	elephant
Pan troglodytes	chimpanzee
Potamochoerus porcus	red river hog
Syncerus caffer	buffalo

Plots were also characterized by a series of biophysical parameters: topographic position, canopy cover, abundance of understorey vegetation, abundance of herbaceous species (*Maranthaceae, Zingiberaceae* or ferns), abundance of lianas and soil type. All plots where characterized by their distance to waterways, to main roads and to villages. Signs of human activities, such as logging damage or infrastructures (gaps, roads, skidding trails, log yards) and hunting indices (snares, cartridges, hunting camps) were also recorded for each plot. Small rivers, villages and main roads where digitised from a 1/50 000 map and integrated on a GIS where the biophysical characteristics of plots and human and mammal signs were also added. A multiple correspondence analysis (MCA) was computed using Xlstat2006® to identify the biophysical and human factors that better explain the distribution of mammal species within the logging concession. A linear regression and Spearman correlation test were also computed to examine if the probability of encounter of a species co-varied with the main discriminant variables obtained with the MCA. For species that showed no linear correlation, we used the t-test to detect significant differences between means.

The GIS maps show that 20% of the concession is located less than 3 km from a main roads and less than 5 km from a village. Most hunting traces are located less than 3 km from the main roads or at less than 5 km from the bigger cities (Rabi, Mandji, Guietsou, Mbongou1). We found a strong significant positive correlation (Spearman Coef. = **0.676;** $p<0,000$) between hunting traces and distance from roads. The habitats that sustain the highest mammal richness are the lowland dense forests and the savanna-forest mosaics. Results of a Multiple Correspondence Analysis show that the distribution of mammals within the forest concession is more influenced by roads and hunting than by the direct effects of logging (figure 2). Small diurnal monkeys were found far from the villages and between 3 and 10 km from the main roads (Figure 3). Elephants were equally found close or far from roads and don't seem to be affected by hunting activities. Red duikers avoided hunted zones and were significantly more abundant far from roads. Other species like gorillas, chimpanzees or forest buffaloes showed no negative relationship with distance to roads and were observed close to villages.

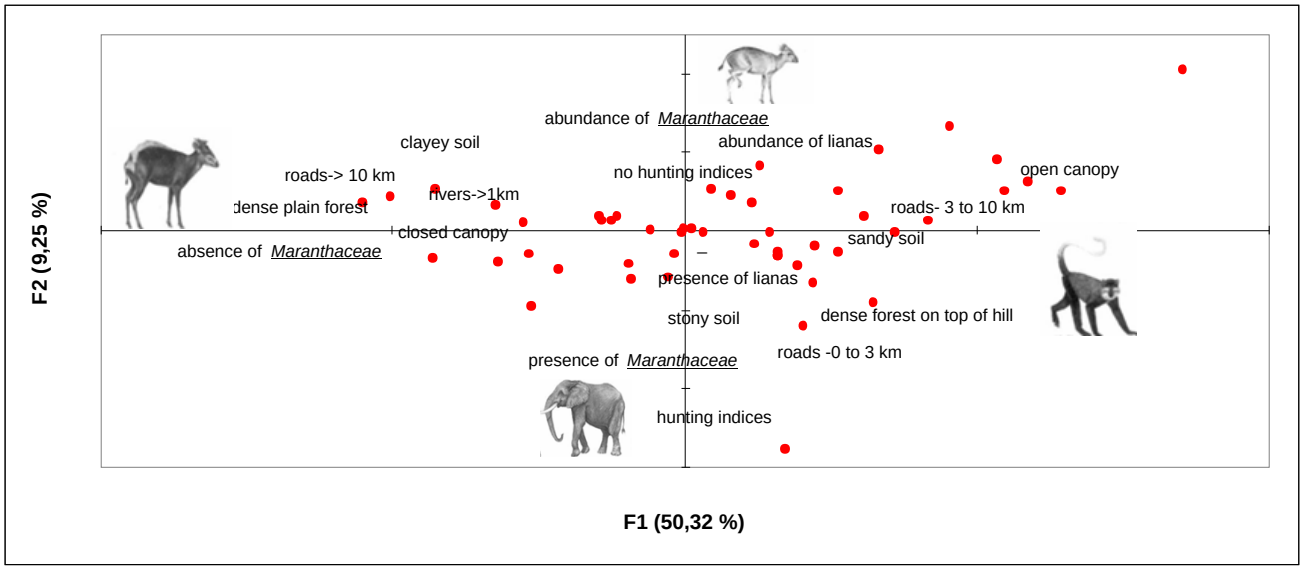

Figure 2 : Relationship between mammal distribution and ecological and human factors as shown by axis F1 and F2 of the Multiple Correspondence Analyses

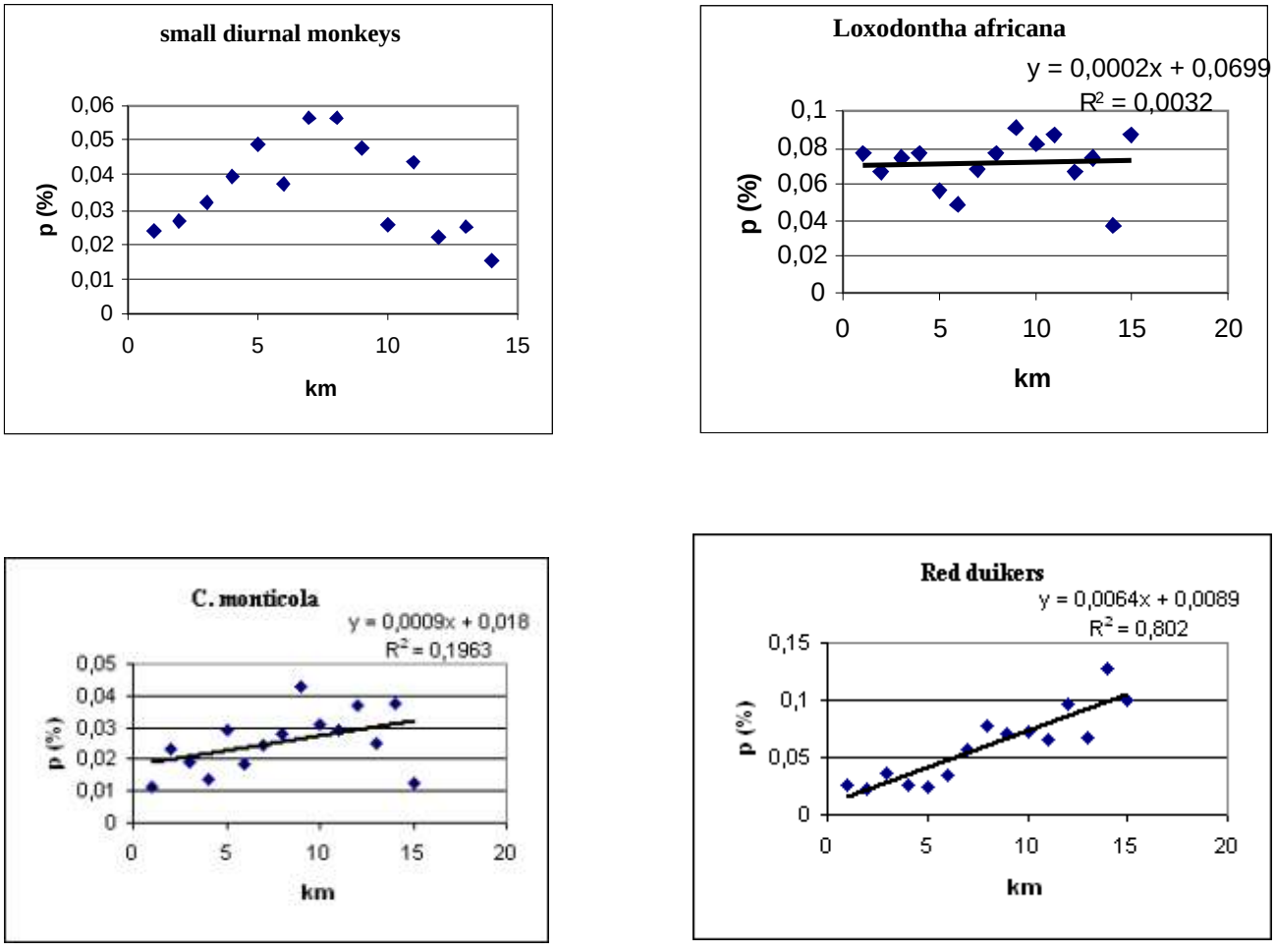

Figure 3 : Species' distribution in relation to distance from roads

DISCUSSION AND CONCLUSIONS

Some of the most hunted species for consumption by local people occur mainly far from areas with a significant human activity. The red duikers and *C. sylvicultor* avoid hunted zones and are significantly more abundant far from roads. Laurance et al. (2006) have shown similar results in South-east Gabon,

concerning the impact of roads on duiker distribution. Small diurnal monkeys are found far from the villages and between 3 and 10 km from the main roads. *Hyemoschus aquaticus*, *Pan troglodytes*, *Gorilla Gorilla, Atherurus africanus, Syncerus caffer* and *Potamochoerus porcus*, show no negative relationship with distance to roads and were regularly observed close to villages. In our study site, elephants were found equally near to or far from roads. This is contrary to what Blom et al. (2004) demonstrated in a Dzanga-Sangha where elephants avoided the proximity of roads. According to Barnes et al. (1991), elephants are attracted by secondary forests given the diversity of available food resources.

Past and present logging activity signs can be found all over the concession, apparently without significantly affecting the distribution of mammals. In Kibale Forest (Uganda), *C. monticola* seemed particularly affected by forest logging activities (Struhsaker, 1998) but this was not the case in our site. At Lopé (Gabon), densities of *Pan troglodytes* dropped about 20% after logging (WHITE, 1998). In our study site, where logging has been more or less continuous since the 50's, *Pan troglodytes* is still present and does not seem to avoid logged over areas.

Our study shows that mammal surveys carried out during routine forest inventories can be used to highlight the relationships between fauna, habitat and human activities. These results provide important recommendations for managers and help limit the negative impacts of logging activities on wildlife. The road network seems to be at the heart of the problem since hunting intensity is strongly correlated with distance to roads. An optimal planning of the road network limits the direct negative impacts while a better control of access limits commercial hunting activities.

The results of this study show that some common game species (mainly *Atherurus africanus but also C. monticola*) are resilient to human pressure such as habitat degradation or hunting . A sustainable hunting management plan could be considered for such species so as to satisfy local people's needs. On the other hand, for vulnerable species, such as *Pan troglodytes*, a monitoring program should ensure the maintenance of its diversity within the logging concessions.

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