NYZS The WILDLIFE CONSERVATION SOCIETY

EXPLORATION OF THE MAÏKO NATIONAL PARK OF ZAIRE 1989 - 1992

HISTORY, ENVIRONMENT AND THE DISTRIBUTION AND STATUS OF LARGE MAMMALS

John A. Hart
The Wildlife Conservation Society
Bronx, New York

and

Claude Sikubwabo
Institut Zairois pour la Conservation de la Nature
Bukavu, Zaire

Working Paper No. 2

June 1994

The Wildlife Conservation Society,
formerly the New York Zoological Society and its field division,
Wildlife Conservation International, has been dedicated
to understanding and protecting the earth's wildlife and ecosystems
since 1895. The Wildlife Conservation Society (WCS) has
the largest field-based research staff of any international conservation
organization, and currently operates more than 150 field projects
in over 40 countries throughout Africa, Asia, and Central and
South America. WCS scientists have conducted pioneering,
long-term field studies; played direct roles in
establishing over 100 national parks and reserves;
trained conservation professionals in developing countries;
helped to strengthen the local institutions in which they work;
and contributed key ideas to on-going debates about
tropical resource management and conservation.

WCS Working Papers represent preliminary results
of basic and applied field work supported by
The Wildlife Conservation Society. The purpose of
WCS Working Papers is to distribute project reports,
benchmark data sets of historical significance,
and other timely technical material in its entirety,
and with as little delay as possible.

Copies available at cost from:
The Wildlife Conservation Society
International Conservation
185th St & Southern Blvd.
Bronx, NY 10460-1099
TEL: (718) 220-5155
FAX: (718) 364-4275

Wildlife Conservation Society
Bronx, New York, USA, 10460

Working Paper No. 2

EXPLORATION OF THE MAÏKO NATIONAL PARK OF ZAIRE 1989 - 1992

HISTORY, ENVIRONMENT AND THE DISTRIBUTION AND STATUS OF LARGE MAMMALS

John A. Hart
The Wildlife Conservation Society
Bronx, New York

and

Claude Sikubwabo
Institut Zairois pour la Conservation de la Nature
Bukavu, Zaire

Centre de Formation et de Recherche en Conservation Forestière
Epulu, Zaire

June 1994

CONTENTS

ACKNOWLEDGMENTS

We would like to acknowledge the Institut Zairois pour la Conservation de la Nature (IZCN) and in particular its Director, Dr. Mankoto ma Mbaelele, for authorizing *Projet Maiko* and for encouraging a long term program of exploration and research in this important rain forest park.

The project would not have been possible without the sustained financial and logistical support of the Wildlife Conservation Society (WCS) throughout the entire period. Funding for the first expeditions in 1989 was also provided by the World Bank, the European Community and the World Wide Fund for Nature (WWF). Bergorilia und Regenwald Direkthilfe provided financial and material support for the 1992 expeditions and in 1993 during the preparation of this report.

A number of colleagues have made significant contributions over the course of the project. In particular we would like to acknowledge Marcel Alers who led the first mission to the southern sector of the park and generously made his entire data set available for this report. Richard Barnes provided advice on survey methodology and analysis of results. Terese Hart advised on botanical aspects of the study. The manuscript was improved by critical reviews by Terese Hart, Amy Vedder, Hilary Simons-Morland and Ann Edwards. Charles Beier aided in preparation of the photographic plates and Dennis Mirewa assisted with graphics.

We appreciated the contribution of all of the IZCN staff of the Maiko National Park who, despite their remote posts and difficult situations, nevertheless received us with hospitality and generosity during the time we spent with them. We wish especially to acknowledge the assistance of Conservateurs Batechi, Masasu and Kajuga who provided administrative support at various times during the project.

We owe a special thanks to Reverend Pere Mondri and Eugene Mabruki of the Catholic Mission of Opienge, whose hospitality and assistance greatly facilitated our work in the northern sector of the park

This project has benefited more than most from the contributions of our local guides, assistants and field crew who participated in the difficult and sometimes dangerous expeditions. We would especially like to acknowledge here Alphonse Tabu, Wilson Ombengo, Kambale Kabwe, Kambale Albert and Messieurs Magatanga, Mabruki, Mabiki Etienne and Tshamala for their special dedication and loyalty to the project, and in particular for the courage and good sense they showed during the period they were held prisoners by the Simba Rebels. To these and all of our assistants we extend our deepest gratitude.

SUMMARY

The Maiko National Park, created in 1970 with an area of about 10,800 km 2, lies in center of one of the largest and most remote rain forest blocks in Zaire. This report presents the results of 11 expeditions to the Park and surrounding area between 1989 and 1992. The objectives of the expeditions were to investigate the distribution and abundance of large mammals, to evaluate the presence and impact of human activities and to assess the conservation needs of the area.

To assist in quantifying the results of the inventory the Park was divided into 1 00 km **2** quadrats. Surveys were conducted by teams walking 5 km transacts along established compass bearings. Vegetation type, evidence of human activity and presence of all large mammals and their sign seen along transacts were recorded. The same information was also collected by walking along established paths in the Park. Interviews with local guides and villagers complemented the transect data. In total, 74 quadrats including 60 of 1 1 8 quadrats covering the Park area, were visited. A total of 73 transects covering 389.5 km and an additional 557.5 km of path were surveyed during the study.

The majority of the Park area consists of an undulating peneplain with an average elevation of 850 m. Ranges of hills and isolated massifs rise steeply from the plain throughout the Park area. The maximum elevation of the Park is about 1200 m.

Forest covers essentially the entire Park area. Mature, mixed, broadleaf, evergreen formations are the principal forest types, but monodominant *Gilbertiodendron dewevrei* forest covered nearly 30 % of the area surveyed. Distinctive formations on hill slopes, and swamp forests along larger rivers comprised smaller percentages of the Park area. Secondary forests and other early successional vegetation occurred throughout the Park, with large stands to the north in a region opened by gold miners between 1935 and 1950

Human occupants of the Park numbered less than 1500 during the study period. This includes 200 to 300 anti-government rebels who occupied small scattered villages in the center of the Park, gold panners, prospectors, hunters and fishermen. Most current gold panning operations are small and temporary. Their impact is localized. Ivory hunters operated freely throughout the entire Park during the 1980's. When ivory prices fell in 1990 their numbers dropped. Subsistence hunting in the Park was limited mainly to the areas around gold camps and settlements. There was no hunting for the commercial wild meat trade in the Park.

There are currently two Park headquarters, Opienge and Lubutu. Both are located over 40 km from the Park borders and Park personnel spend little time inside the Park boundaries. A third headquarters at Mangurudjipa, also outside the Park, was recently abandoned.

A total of 30 species of large mammals or their sign were recorded during surveys.

Elephants were widely distributed through the entire Park and surrounding area. Densities estimated from dung counts ranged from 0.39 / kM2 in quadrats outside the Park to 0.90 / km2 in quadrats inside the Park. The total elephant population in the Park is estimated between 6000 and 7000.

Gorilla sign was seen in four areas within the Park boundaries and in two areas outside the Park. Within the areas where they occurred, an average 0.09 observations of gorilla sign / km of transect were recorded. Gorillas within the Park are not currently threatened, but gorillas outside the Park are hunted, and at least two populations have disappeared since they were first surveyed in 1959.

Chimpanzees -have a wide distribution throughout the Park. The average encounter rate of chimpanzees or their sign was 0. 1 5 / km of transect. Throughout the area surveyed there were on average 0.07 nest groups / km of transect (mean 1.9 nests per group). Chimpanzees co-occur with gorillas in many areas where secondary vegetation is abundant.

An additional ten species of anthropoid primates were recorded in the Park with an average 0.32 groups / km of transect observed.

Okapi occur throughout the Park. Okapi sign was recorded frequently north of the Maiko River. The Oso River and Uvia River appear to constitute the southern limit of the okapi's range. Buffalo, two species of pigs and at least seven species of small ungulates (duikers, chevrotain and pygmy antelope) were observed throughout the Park.

Sign and sightings of all large mammal species surveyed were more frequent in areas containing stands of regenerating vegetation. Animal sign was less frequent in large areas of monodominant *Gilbertiodendron* forest. However, several species including elephant, buffalo and pigs, move into *Gilbertiodendron* stands seasonally to feed on mast seed fall.

Relative densities of several large mammal species were correlated, and concentrations of overall high faunal abundance were identified. These concentrations usually contained a diversity of habitat types including hill forests and secondary vegetation. They were not necessarily remote from human settlement

In comparison with other forest sites, estimated elephant densities in the Maiko area are among the highest for an area,of its size, and comparable to densities reported from sites near the savanna border. Chimpanzee densities are similar to those reported from other closed forest sites, while gorilla densities in the Maiko appear to be very low relative to other areas where they have been observed

With the possible exception of the elephant, wildlife populations in the Maiko Park are not currently threatened by hunting or habitat destruction. The relative isolation of the Park will be breached, however, upon completion of a paved section of the Trans-African Highway linking Kisangani with Bukavu. The new road passes within 5 km of the southern limit of the Park. Increased immigration, forest clearing and hunting are anticipated upon completion of the road. These will pose the most significant threat to the Park in its entire history.

Immediate conservation priorities should include further surveys to identify factors permitting high faunal densities in specific areas, investigation of the status of potentially vulnerable species such as the gorilla, and development of strategies to assure their continued protection. An effort should be made to begin inventories of other taxa, in particular birds and plants.

The Maiko National Park is likely to prove to be one of the most biologically diverse lowland forest parks on the continent.

INTRODUCTION

Covering over 10,800 square kilometers, the Maiko National Park (FIGURE 1) lies at the heart of the largest contiguous roadless area in eastern Zaire, and one of the largest wilderness areas in forested Africa. Although established over 30 years ago to preserve Zaire's endemic rain forest fauna, including Grauer's gorilla *(Gorilla gorilla grauen), okapi (Okapiajohnstont)* and the Congo peacock *(Afropavo congensis), the* Park has remained nearly unknown to biologists until the present (Verschuren 1975).

The first naturalist to visit what is now the Maiko National Park was James Chapin, the American ornithologist who arrived at Angumu in 1936 and collected the first specimens of the peacock in the area (Chapin 1948). It was not until 1989, however, that biological surveys reached the Park's interior. In March of that year, M. Alers and C. Sikubw I abo surveyed the Uvia and Mua valleys in the southern sector of the Park under the auspices of the European Community / Wildlife Conservation Society forest elephant survey. In June, J. Hart and C. Sikubwabo reached Angumu and the Ogombo Massif in the north on a mission for the World Bank / Zaire Environment Project. These first surveys revealed that the Maiko region contained potentially major concentrations of elephants and other fauna, but that gold prospectors and ivory hunters had also reached the area (Barnes et al 1989, Barnes et al 1993).

Motivated by these initial results, The Wildlife Conservation Society (WCS) in collaboration with the lnstitut Zairois pour la Conservation de la Nature (IZCN), agreed to support a major effort, the *"Projet Maiko",* to explore the Park and survey its fauna. Over the three year period, 1990 - 1992, Claude Sikubwabo led nine expeditions to the Park and surrounding areas, resulting in the first comprehensive documentation of the large mammal fauna and human activities throughout the area.

Objectives

This report presents the results of the *Projet Maiko* expeditions, including the first two 1989 surveys. The specific objectives of the report are to provide:

1. A basic description of the geography and vegetation of the Maiko National Park and information on the status, distribution and relative abundance of the large mammal fauna with attention to species of special conservation concern.

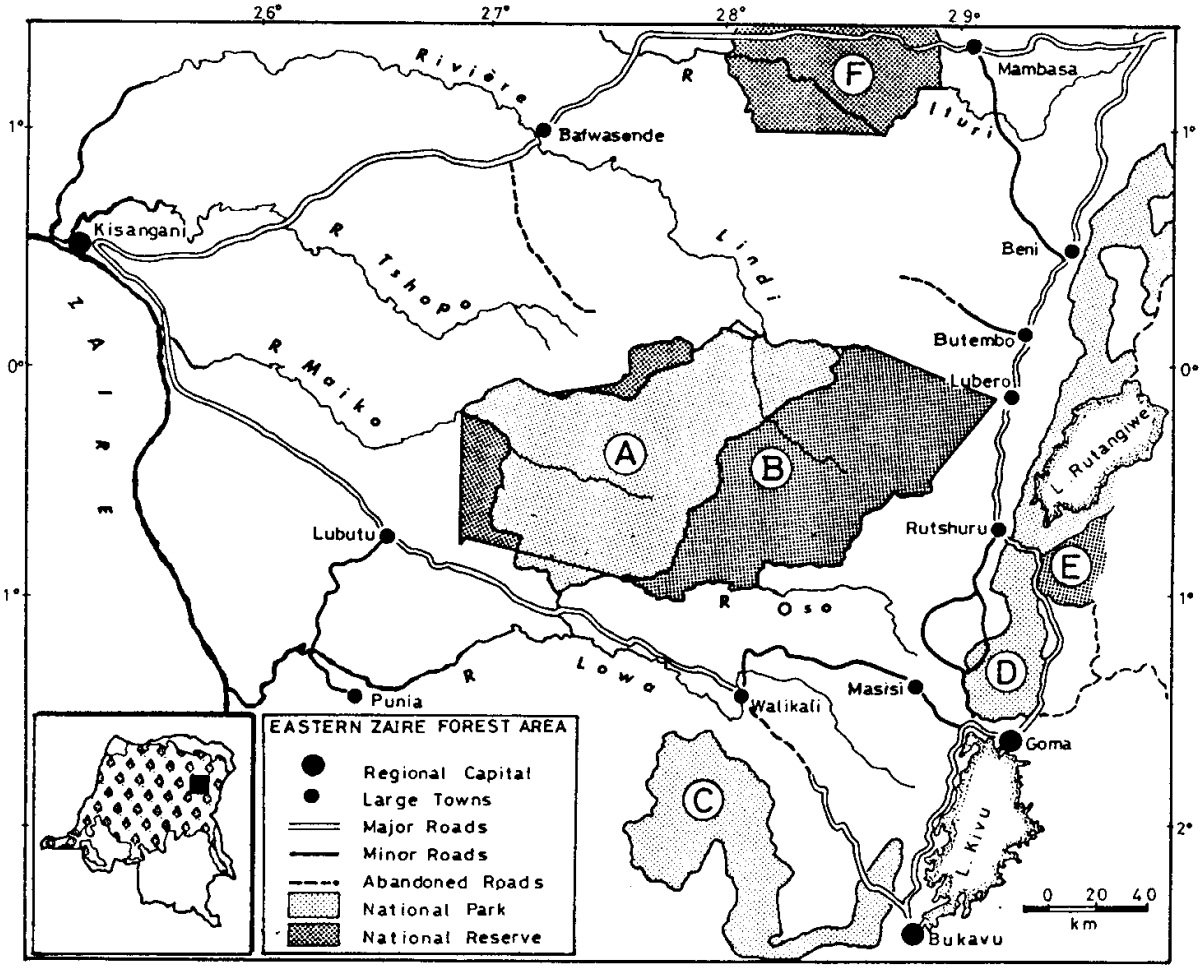


FIGURE 1. Eastern Zaire Forest Region.

Three major national parks and wildlife reserves, the Maiko National Park (A), Kahuzi-Biega National Park (C) and the Okapi Wildlife Reserve (F) protect the geographically varied and species-rich rain forests of the eastern rim of the Zaire River basin. The Virunga National Park (D) and Rutshuru Hunting Reserve (E) contain only small areas of rain forest. The Bakumu Hunting Reserve (B), created in 1949, is no longer functional.

2. A history of the human presence in the Park and a report on the impact of current human activities on the wildlife.

The principal method used in this study, line transect counts of animals and human sign, allowed an assessment of relative abundance and distribution of large mammals in relation to human activities over very large areas. Inventories for smaller, more cryptic mammals, as well as birds will necessitate other methods. The botanical exploration of the Park remains to be undertaken.

BACKGROUND

Geography

The Maiko National Park (FIGURE 2) straddles the equator between 10 North and 111 South latitude, and between 270 and 280 30' East longitude. The Park's boundaries have been inaccurately represented on many maps due to confusion in the names of some boundary rivers and an incomplete knowledge of their locations. We have created a map of the Park from a composite of maps coupled with field checks where possible (See ANNEX for text of the Presidential Ordinance creating the Park).

Most of the park is composed of a gently undulating peneplain between 750 m and 1 000 m (mean 850 m) in elevation, overlying weathered Gondwanan granites and Precambrian sandstones. The plain is punctuated by isolated ranges and massifs of hills that rise steeply 1 00 m to 300 m, attaining elevations of nearly 1 000 m in the west and north, and about 1200 m in the south and east (FIGURE 3). Except for localized areas of highly organic soils on the seasonally inundated flood plains of larger rivers, the underlying soils are highly weathered clays and sands.

No meteorological data exist for the park area. Average annual rainfall is likely to range from 1800 to 2000 mm (Bultot 1971). The Park is abundantly watered with black, clear and white water streams. Major drainages include the Lindi, Loya Monene, Loya Moke, Maiko and Oso. All are subject to periodic flooding, at least locally. All rivers in the Park, including the largest, are broken by rapids and falls and are essentially unnavigable.

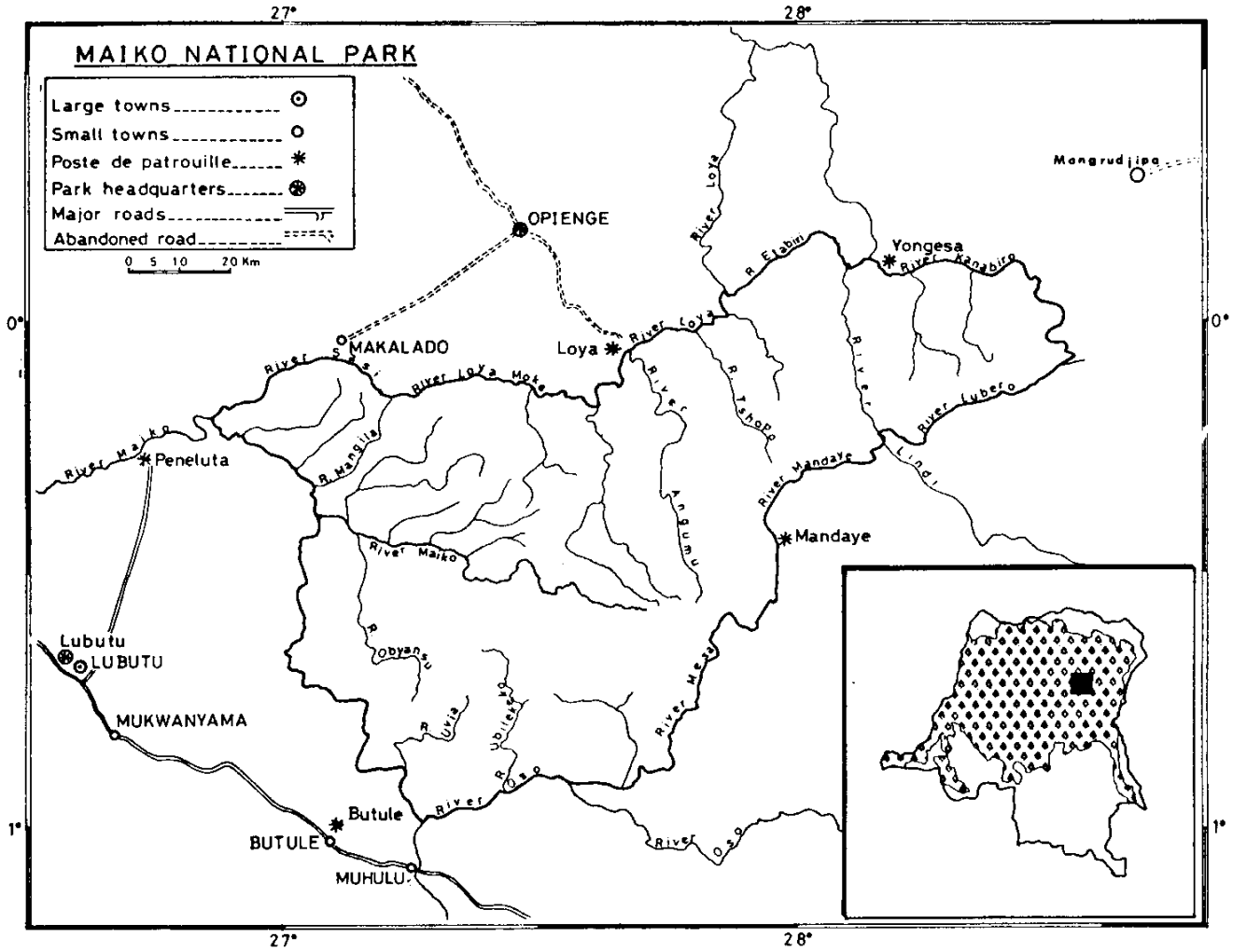


FIGURE 2. The Maiko National Park, Zaire.

The Maiko National Park covers approximately 10,800 km^2. Park headquarters are located outside the park at Opienge (Secteur Nord) and Lubutu (Secteur Sud). Headquarters at Mangurudjipa were abandoned in 1990.

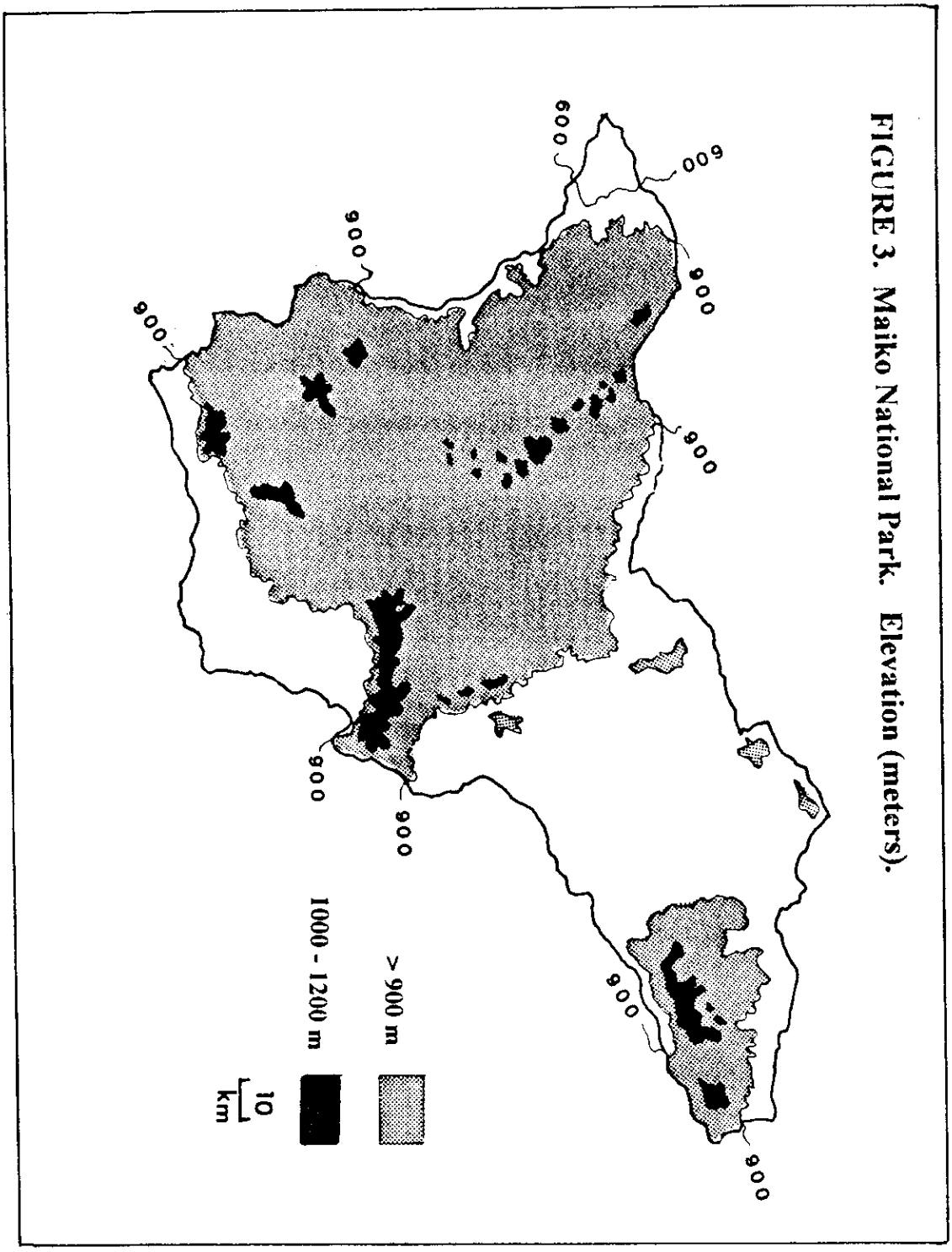


FIGURE 3. Maiko National Park. Elevation (meters).

History of the Park and Surrounding Region

Traditional inhabitants. The Maiko National Park includes the traditional homelands of the Bakumu, a Bantu speaking forest people who occupy a large forest region between the Lindi and Zaire Rivers. The economy of the Bakumu is based on long-fallow shifting cultivation, fishing and hunting. Fishing and hunting (including traditionally snares and net drives, and now at least to some extent, 12-gauge shotguns) are seasonal activities with families returning to traditionally claimed hunting grounds that are often a long distance from their base settlements and gardens.

The first opening to the outside world. The late nineteenth century saw the first penetration of the Maiko region by ivory and slave traders from Africa's Swahili coast. While some of the network of trails that cross the Park today likely date from this era, it appears that major settlements were not established in the region. Belgian colonial presence in the Maiko region was not effected until the first decade of the 20th century. The major colonial impact on the region came with the advent of World War 11 and the establishment of gold mining in what would become the northern sector of the Park .

The mining era: 1936 - 1950. In the mid 1930's the Societe Miniere de Bafwaboli (SOMIBA) opened a road stretching over 200 km from the Route Ituri to the alluvial gold fields in the watersheds of the Loya, Angumu and Maiko Rivers. Within a few years SOMIBA had established a network of settlements and mines linked by roads to a major ore treatment complex at Angumu. During the period of its operation, SOMIBA moved hundreds, perhaps thousands, of miners, road workers and support personnel into a region of over 5000 kM2 that extended west nearly to Peneluta, east to the Lindi River and south to the Maiko River. Large areas of forest, including hundreds of square kilometers in what is now the Park area, were cleared to produce food crops to feed the workers. As the boom years peaked, further agricultural developments including rubber, cotton, rice and oil palm plantations were established along the entire SOMIBA road from the settlements of Loya and Opienge north to the Route lturi.

In 1949, SOMIBA discontinued its operations and moved its employees out from the area south of the Loya River. As the abandoned road became overgrown, markets for agricultural products became inaccessible and the plantations were abandoned. By independence in 1960, most people who were not traditional inhabitants of the area

(Bakumu, Barombi and Babali) had left. With the arrival of the anti-government Simba Rebellion during the 1960's, the depopulation of the region accelerated, leaving secondary forests overgrowing abandoned villages the length of the entire road.

While it seems that wildlife populations in what was to become the Maiko National Park were only marginally affected by the Swahili coast trade era, the impact of the mining era was dramatic and is still apparent today. In addition to forest clearing, wildlife was hunted intensively to supply the mining settlements with meat. Despite these depredations the SOMIBA concession continued to support exceptional concentrations of some wildlife species. Peacocks were caught and exported to zoos from Angumu. The colonial administration also established a capture station for Grauers gorillas and okapi at Etabiri that functioned until the early 1950's. When the road fell into disrepair the capture station was moved to Epulu in the Ituri Forest.

Establishment of the Park. The first faunal reserve in the region, the Reserve de Chasse des Bakumu (RCB) was established in 1949 by colonial decree as SOMIBA was leaving the area. The RCB covered nearly 20,000 kM2 from Lubero to Peneluta, and included most of what would eventually become the Maiko National Park. The RCB's creation may not have been entirely motivated by a desire to protect the region's wildlife. Even in colonial times this vast, roadless wilderness was not patrolled. The fact that the RCB contained proven mineral and ore deposits suggests that the reserve may have been established to control settlement and unauthorized mining in the area.

At the time the Maiko National Park was created in 1970, IZCN personnel had scarcely begun reconnaissance and exploration of the Park area. Even today, many sectors of the Park remain little known and beyond their control.

The Simba and the ldom. After the nation wide rebellion by anti-government forces in the years following independence was suppressed, remnant rebel bands in the eastern regions of the country, who called themselves the Simba (lion in Swahili), retreated into the Park's interior. There they declared independence from the central government, and referred to the ill-defined area they occupied as a popular republic, with a king, currently Wilson Pedro, at its head.

The government of Zaire has been content by and large to leave the rebels in the heart of the Park, and there have been no military operations aimed directly against them. Their numbers dwindling each year, the old guard that still remains today includes a handful of genuine ideologues, associated with a disparate group consisting in part of social outcasts, military deserters and wanted criminals from as far away as

Kisangani. The Simbas have also attracted local Bakumu whose motives appear to be to return to their traditional homelands now included in the Park. The rebels live in scattered small settlements near the headwaters of the Maiko River. Some individuals move freely back and forth between their villages in the Park and government controlled areas outside.

As the Maiko region slipped into isolation in the years following Zaire's independence, other groups followed the Simba into the forest refuge including several syncretic religious sects escaping persecution and / or renouncing contact with the outside world. In the early 1980's a military command dispatched by the national government was able to negotiate without bloodshed, the return of one of these sects, the ldom, to government controlled areas near Opienge. The Simba themselves who were armed, retreated further into the Park, threatening retaliation against any perceived aggression.

Within just a few years of its creation, the Maiko National Park was declared off limits to all visitors and the IZCN Park headquarters were removed to Lubutu, Opienge and Mangrudjipa, all over 40 kilometers from the Park border.

Return of ivory and gold. In the early 1980's the isolation of the Maiko region was broken when the government of Zaire removed controls on private, small-scale mining activities and the worldwide price for raw ivory skyrocketed. The opportunities of an essentially uncontrolled gold and ivory trade, in the face of declining options in the formal economy, led to a major invasion of prospectors and ivory hunters into the most remote areas of the Park.

As the illicit commerce in gold and ivory grew, the Simba rebels, competing at times for the lucrative trade with the Park wardens, used their control of gold-bearing streams and elephant herds in the heart of the Park to extract tribute from the incoming fortune seekers, including clandestine representatives of the most highly placed government and military authorities of the land. Since 1989 villagers around the park reported a decline in elephant hunting. However, panning for gold, and more recently prospecting for diamonds in selected areas, remain significant activities in the Park. Many of the local Bakumu have integrated gold panning into their seasonal economic cycle, with gold supplanting the sale of dried wild meat and fish as the preferred source of cash income.

New road, new threat. While ivory and. gold extraction have opened the Park to exploitation, a far more significant threat will arise with the completion of the paved

road linking Kisangani on the Zaire River with Bukavu, capital of South Kivu Province, over 800 km to the east. Work on the road, which passes within 5 kilometers of the southern border of the Park at the Oso River, was halted, at least temporarily, in 1993, by the German concern that held the contract for the job. The Chinese team working on the road from the east has also abandoned the project.

Once completed the road will provide a corridor of access from the densely settled and ethnically divisive highlands of Zaire's eastern Rift borderlands to the forests to the west. As a sign of what will surely follow, most of the immediately accessible forest along the road has already been claimed by new logging concessions and villages have begun to spring up.

METHODS

Exploration and inventory of the Park was accomplished on 11 surveys of 15 to 45 days duration between 1989 and 1992. Surveys were conducted in different seasons and covered a total 947 kilometers of transect and path within and adjacent to the Park (TABLE 1). The objective of each expedition was to travel through a designated area and to record as much as possible of the large mammals and their sign as well as pertinent habitat and topographic features and human activity found along the path of travel.

Data Collected

A total of 73 transects covering 389.5 kilometers of transect were surveyed in this study. Census transacts followed designated compass bearings across the forest. Distances were measured by topofil or topofil calibrated pedometer. For each observation or sighting, the distance along the transect, relative age of sign and other pertinent notes were recorded. For elephant dung, distance from dung piles to center line of travel was also noted on about half of the transects.

Observation teams included a "guide / pisteur" along with the authors, who recorded data on prepared sheets. Each mission was accompanied by 5 to 1 0 porters who contributed occasional observations of animal sign.

An effort was made to standardize transect length to 5 kilometers (km). Mean transect length was 5.3 km. Fewer than 20 % of transacts were under 4 km or over 8 km. Cutting and disturbance of vegetation along transect lines was minimized.

TABLE 1. Expeditions to the Maiko National Park and vicinity.

Zone	Dates		Transect (km)	Path(km)	Total (km)
Uvia-Lowa	Feb-Mar	1989	38.0	77.5	115.5
Angumu-Ogombo massif	Jun	1989	26.0	32.5	58.5
Oso-Ubilikeko	Oct	1989	0	22.0	22.0
Angumu-Lindi-Mandaye	Jun-Jul	1990	50.5	155.0	205.5
Lindi-Kanabiro-Lubero	Aug-Sep	1990	77.0	40.5	117.5
Ubilikeko-Fifo	Feb-Mar	1991	15.0	15.5	30.5
Maiko-Peneluta	Mar	1991	22.5	5.0	27.5
Angumu-Loya Moke	Jun-Jul	1991	58.5	11.0	69.5
Sasi-Mangila-Maiko	Sep-Oct	1992	45.5	58.0	103.5
Loya-Lengelenge	Jul-Aug	1992	22.0	39.0	61.0
Mua-Ongeno	Oct-Nov	1992	34.5	101.5	136.0
Totals			389.5	557.5	947.0

Transects were divided into 500 m segments as they were traveled. Each segment was classified by the major forest type or habitat formation occurring over most of the distance (TABLE 2, PART A). The occurrences of small scale habitat features (TABLE 2, PART B) were noted for each 500 m segment as they were encountered .

Animal sign and descriptions of different human activities recorded on surveys are given in TABLE 3 and TABLE 4. Relative frequency of animal sign is reported as number of records/km of transect, or by the proportion of 500m segments containing animal sign or human activity. For statistical tests individual transacts are treated as independent observational units.

Observations of animal sign, human activity and habitat type were made also on 401.5 km of foot paths in the Park and its vicinity. Distances were measured and information recorded as on transacts. Path and transect data are combined for primates and apes, as well as for vegetation mapping.

Interviews with porters (some of whom were familiar with the survey areas), residents in villages around the Park, or people encountered in camps along the way complemented information from quantitative surveys.

Sampling Intensity and Area Covered

Survey results were mapped by dividing the Park and surrounding area into 1 0 km by 1 0 km quadrats along latitudinal and longitudinal lines. A quadrat was considered to have had LEVEL 1 coverage if at least 5 km of transect data were recorded within the area. Quadrats with LEVEL 2 coverage had no transect data but did have information recorded from established paths. Quadrats with less than 5 km of path or transect data, or for which non-quantitative notes only are available were classed as having LEVEL 3 coverage.

In total, 74 quadrats were surveyed. Fifty one percent (60 out of 1 1 8) of the quadrats within the Park interior or on its borders were surveyed. An additional 14 quadrats outside the Park were surveyed. LEVEL 1 coverage was obtained for 39 (53 %) of the quadrats surveyed, including 35 within or bordering the Park and an additional 4 on the exterior. LEVEL 2 coverage was obtained for 20 quadrats, while 15 quadrats had only LEVEL 3 coverage (FIGURE 4).

FIGURE 4. Maiko National Park. 1989 - 1992 Survey Coverage.

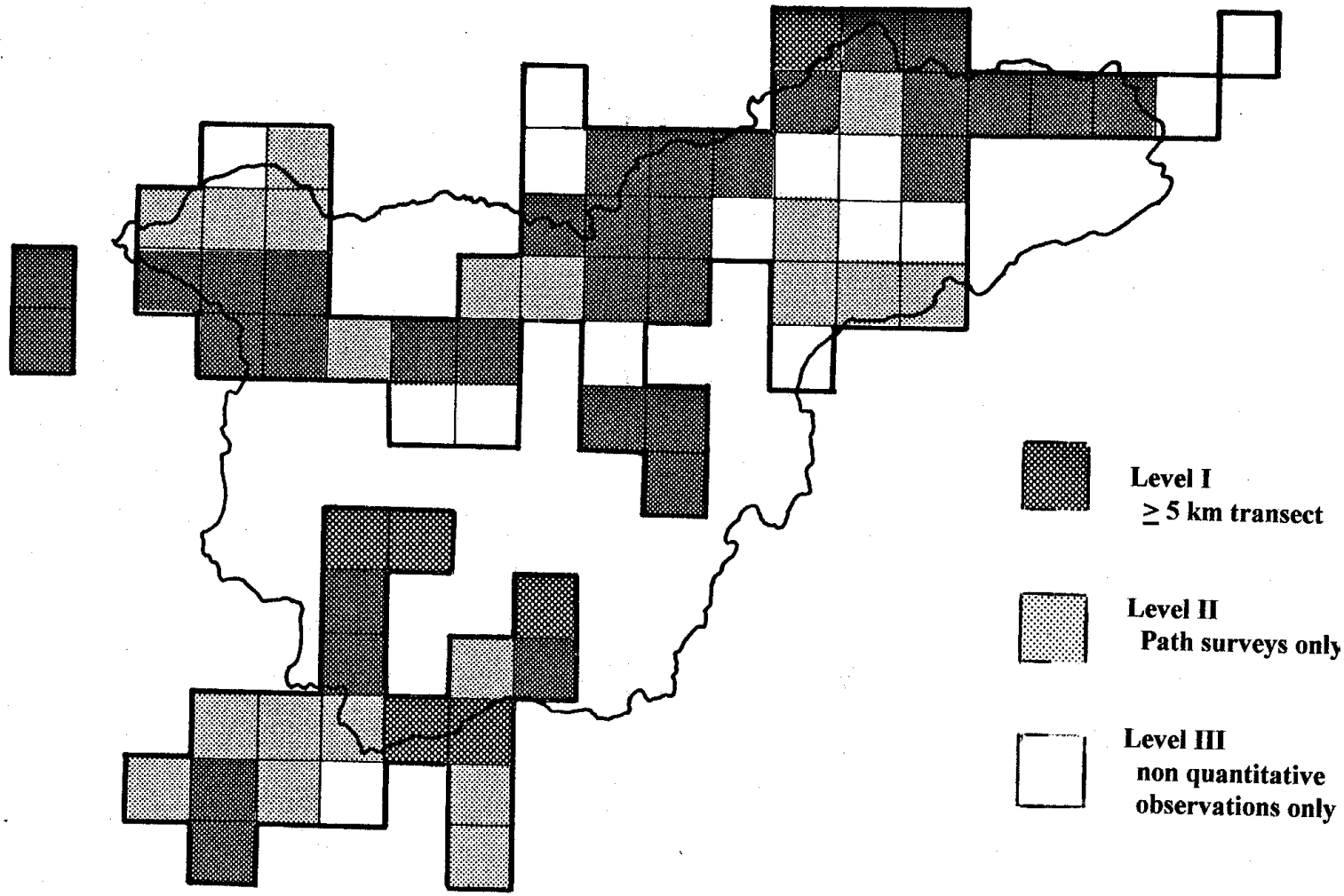


TABLE 2. Vegetation and habitat features recorded on surveys in the Maiko Park.

A) MAJOR FORMATIONS

Mature Evergreen Forests

Mixed forests. Multi-layered, closed canopy (> 30m). Most abundant species <30% of canopy. Large lianas, emergents present. Disturbance localized to treefalls. Understory variable, often open, dominated by woody treelets and shrubs. Herbaceous growth and liana tangles limited to regenerating treefalls.

Monodominant forests. closed canopy (>30m). One species > 30% of canopy. Few large lianas and emergents. Understory often open. Dominant species-.

- *Gilbertiodendron dewevrei*
- *Uapaca guieensis*

Swam2 forests. Seasonally or permanently inundated substrates. Multi-layered, variably open canopy. Understory variable, often dense Marantaceae. Canopy composition may overlap with mixed upland forest. *Nauclea, Hallea and Raffia* abundant.

Hill forests. Mature mixed formations on steep **slopes.** Diverse botanical composition. Canopy up to 30 m, often broken. Understory variable, often dense.

Regenerating Forest

Younq secondary forest. Regrowth following clearing. **Canopy < 20** m, **open. Trees small.** Understory **dense** with abundant liana tangles and herbaceous thickets.

Old secondary forest. Canopy < 30 m, variably open, few emergents. High representation of trees with light demanding regeneration requirements *(Musanga cecropioides, Trema guineensis, Macaranga spp, Alstonia boonei, Croton spp)*

B) SMALL SCALE FEATURES

Edos. Open pans or wallows, usually < 2 ha. May include active mineral or clay lick. Dominated by low herbaceous growth (<3m). Concentrated large mammal activity.

Herbaceous thickets. Open canopy, 3-5m. Understory dense, dominated **by** Marantaceae, Zingiberaceae, Comelinaceae.

Gardens., Active garden, farmed bush, or fallow regrowth.

Degraded forest. Exploited mature stands with broken canopy and depleted understory.

TABLE 3. Animal observations and sign recorded on transect surveys.

Taxon	**Seen/ heard**	**Dung**	**Track**	**Nest**	**Feeding site**	**Scrape**	**Digging**
Pangolins							x
Monkeys	x		x				
Apes	x	x	x	x	x		
Carnivore		x	x			x	
Aardvark							x
Elephant	x	x	x		x		
Ungulate	x	x	x		x		

TABLE 4. Definitions of human activities and sign recorded on transacts.

Category	Activity or sign	Description/Note
Passage	Track	Human foot prints, single passage
	Machete cut	Cut vegetation, single passage
	Small path	Occasional use
	Main path	Frequent use
Settlement		
Camp	Abandoned	Temporarily or permanently not in use
	Occupied	Temporary, <50 people
Village	Small	Permanent, < 50 inhabitants
	Medium	Agriculture, 50-250 inhabitants
	Large	250 - 5000 inhabitants
Mine	Test pit	Prospecting site, no further use
	Small	Itinerant, 4-15 people
	Medium	15-50 miners, satellite camps
	Large	Permanent, >50. miners, mine network
Hunting	Cartridge	Spent 12 gauge shotgun ammunition
	Snare	Functional or abandoned
	Carcass	Elephant bones
Fishing	Weir	Sites for fish traps
	Camp	Temporary shelter, active or abandoned

RESULTS

Vegetation and Habitats

The Maiko National Park contains no natural grasslands. Essentially the entire Park area is covered by forest. Over 75 % of transect and path segments surveyed (760 km) were classified as one of the mature evergreen or semi-deciduous formations (FIGURE 5A). Mixed forest accounted for nearly half of the 500 m segments surveyed, while about one third were classified as monodominant *Gilbertiodendron* forest. Uapaca dominated forest, swamp forest and hill forests represented only a small portion of the area surveyed.

Large expanses of *Gilbertiodendron* forest covered the northeastern sector of the Park, in particular on the east bank of the Lindi River. Smaller stands occurred in the mountainous central headwaters region, while further extensive stands were found on the plain between the Maiko and Sasi Rivers. South of the Maiko River, *Gilbertiodendron* forests were either absent, or limited to small, isolated stands (FIGURE 6).

Uapaca dominated forests were noted in scattered locations throughout the Park, extending south of the Oso River, and in the Peneluta area in the far west (FIGURE 6). Most Uapaca stands were small, occurring on less than 25 % of transect segments in the quadrats where they occurred, and only about 3.5 % of the total area surveyed.

Hill forests and swamp forests characterized together less than 1 0 % of the 500 m segments surveyed.

Regenerating forests, ranging from farm bush to well developed secondary forest, were recorded in over 60 % of the quadrats surveyed, and accounted together for nearly 25 % of path and transect segments throughout the Park and vicinity (FIGURE 5A). Most regenerating forest areas were small. However, in the abandoned SOMIBA concession many areas that had been cleared over 50 years ago were still covered by an arrested succession of impenetrable woody thicket and herbaceous regrowth with few taller trees.

Small scale natural features that are of special interest as focal points of animal activity include open pans, mineral licks and wallows (locally termed edos), recorded in about 5 % of quadrats surveyed, and Marantaceae thickets, recorded in 18 % of

FIGURE 5 A. Major Vegetation Formations.

Frequency of vegetation type (percent total 500 m segments, n = 1520) recorded on transect and path inventories in the Maiko National Park.

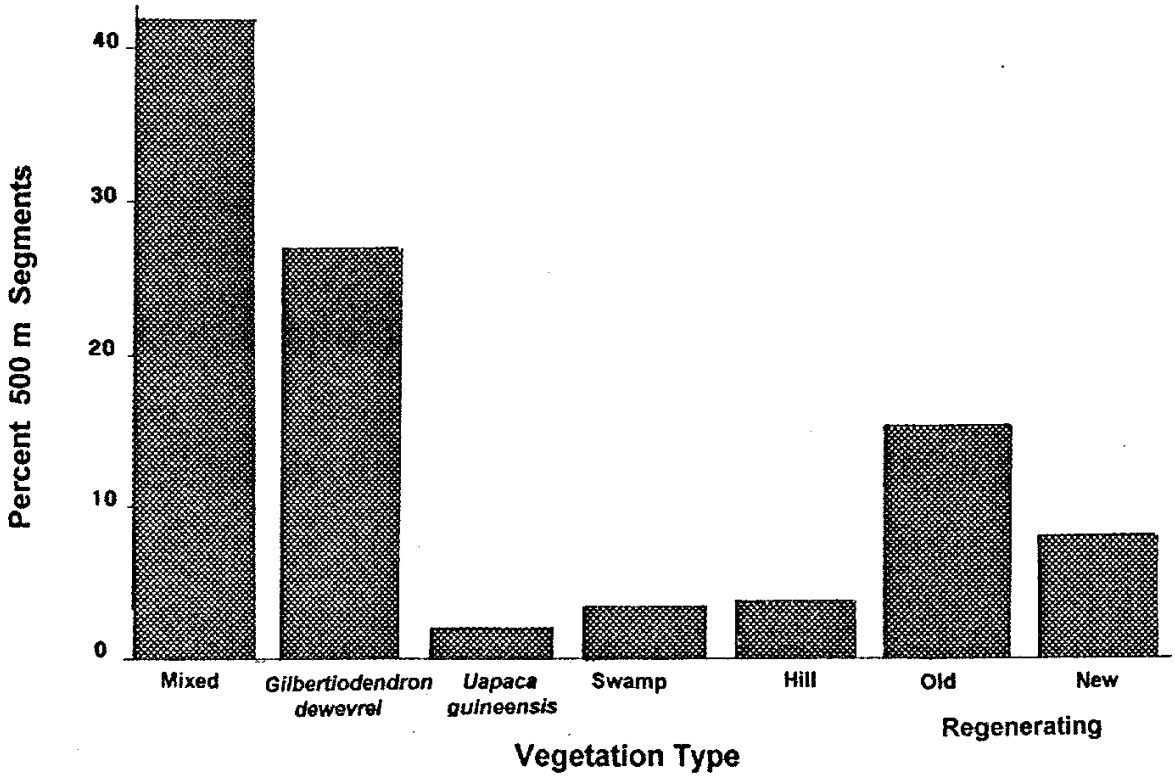


FIGURE 5 B. Small Scale Habitat Features.

Occurrence of habitat features in 10 km x 10 km quadrats (n = 60) surveyed in the Maiko National Park.

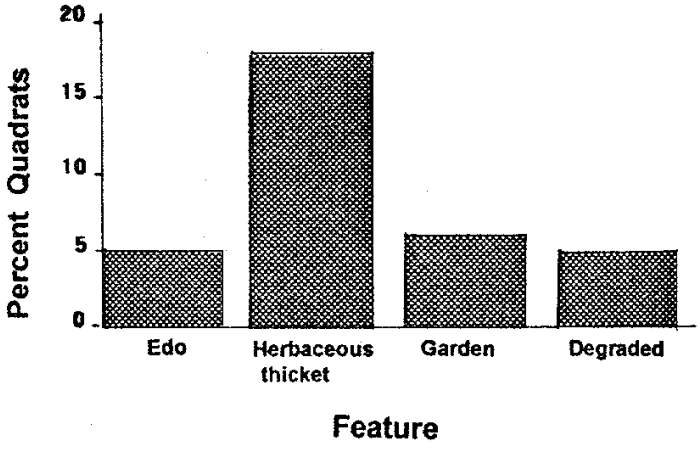
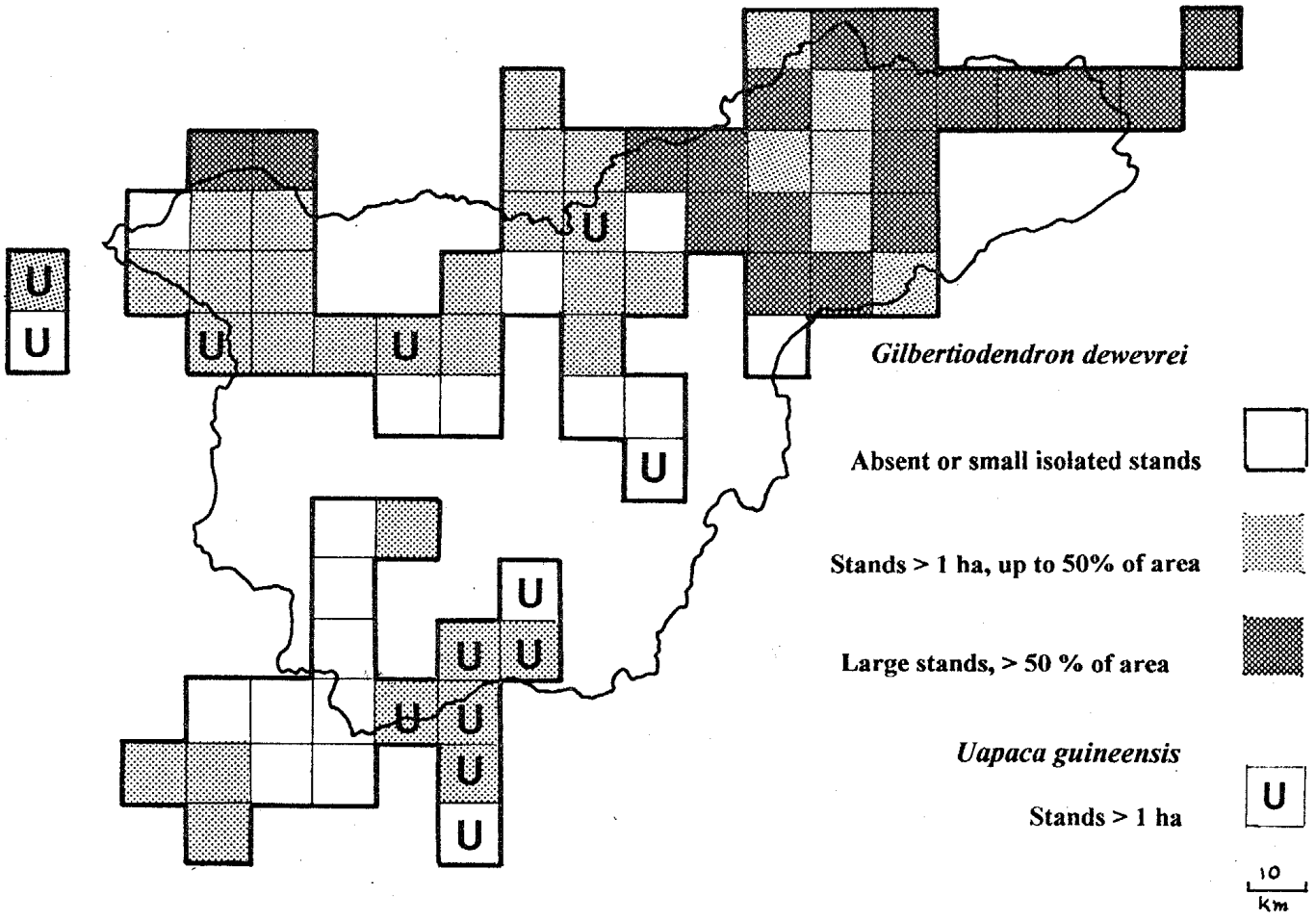


FIGURE 6. Maiko National Park. Species Dominant Forests.



quadrats. Areas of current human activity (gardens and degraded forest) were found in 8 % of quadrats surveyed. These areas are widely scattered and represent no more than 2 to 3 % of the Park area (FIGURE 5B).

Current Human Activity

Settlement.

The Maiko National Park and surrounding area is today the least populated region in eastern Zaire (TABLE 5). In 1982, population densities in the two main administrative zones that include park area, Bafwasende and Lubutu, averaged less than three inhabitants per square kilometer. The zone of Lubero, which includes the northeast corner of the Park, had an average of 33 inhabitants / kM2. However, most of this settlement, then and now, is concentrated in the Rift Highlands, over 60 kilometers east of the Park border. While there have been no national censuses since 1980, the basic patterns still pertain.

TABLE 5. Human population densities of the Maiko National Park region (Source: 1980 National Census).

Political zone	Total area (km2)	Percent Park area in zone	Population density (per km2)
Bawasende	60000	45	<1.0
Lubutu	16200	40	2.8
Lubero	17300	15	33.0

Within the Park itself, permanent settlement is limited to larger mining camps and the rebel capital of Silisa (A in FIGURE 7). None of these villages contains more than 150 people. We estimate that at any one time there are from 500 to 1500 people in the entire Park (1 person per 1 0 to 20km^2).

The nearest town to the Park is Lubutu, nearly 40 km west of the Park border. Small scattered villages skirt the Park border to the north and west along abandoned roads. Settlement in these areas is in decline, and many settlements occupied even 10 or 20 years ago have been abandoned. By contrast, a major zone of increasing settlement borders the Park to the south along the partially completed KisanganiBukavu leg of the Trans-African Highway.

FIGURE 7. Maiko National Park. 1989 - 1992 Human Settlement and Small-scale Mining.

Lettered quadrats refer to larger mining sites and villages in the Park (TABLE 6).

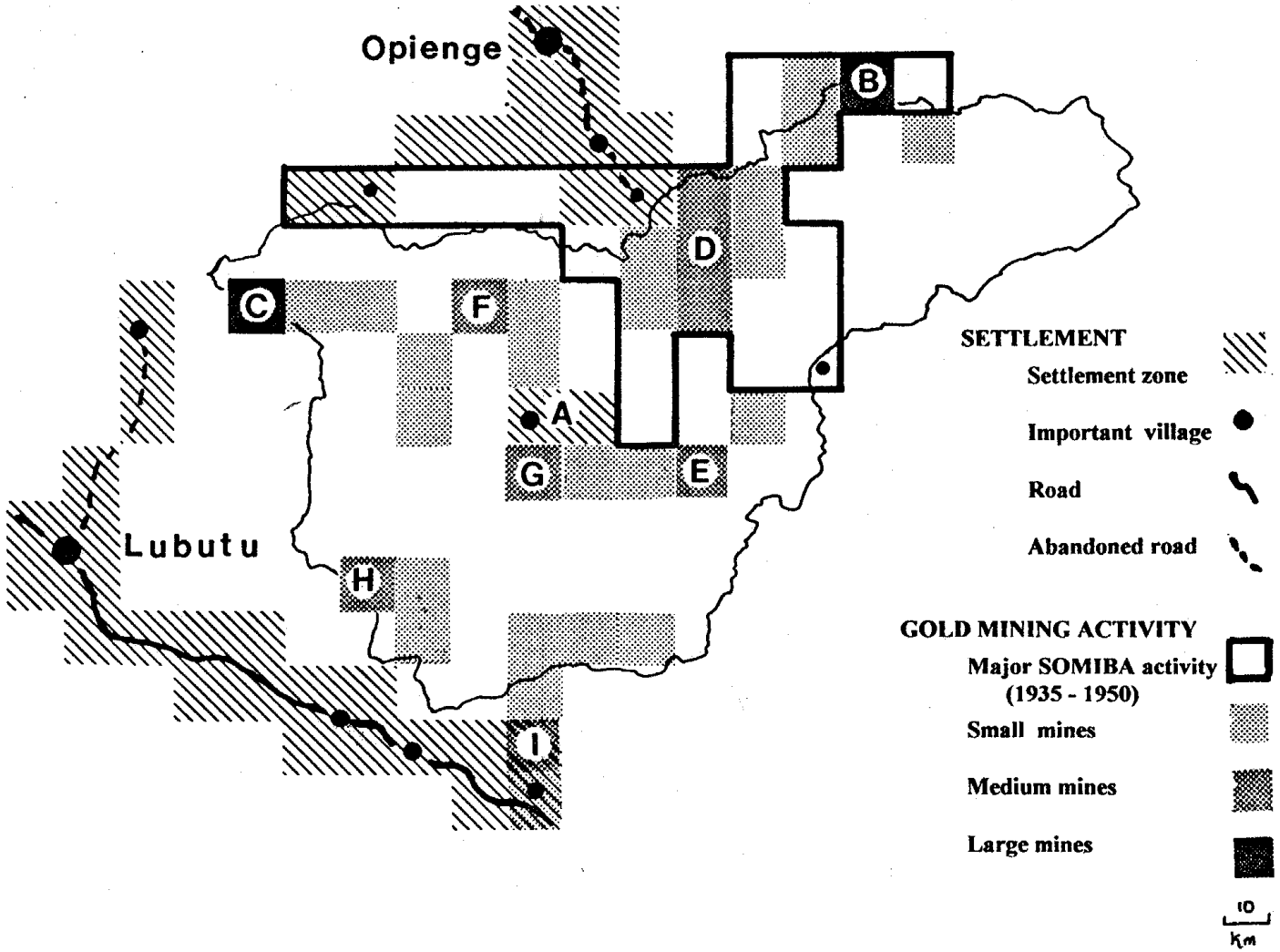
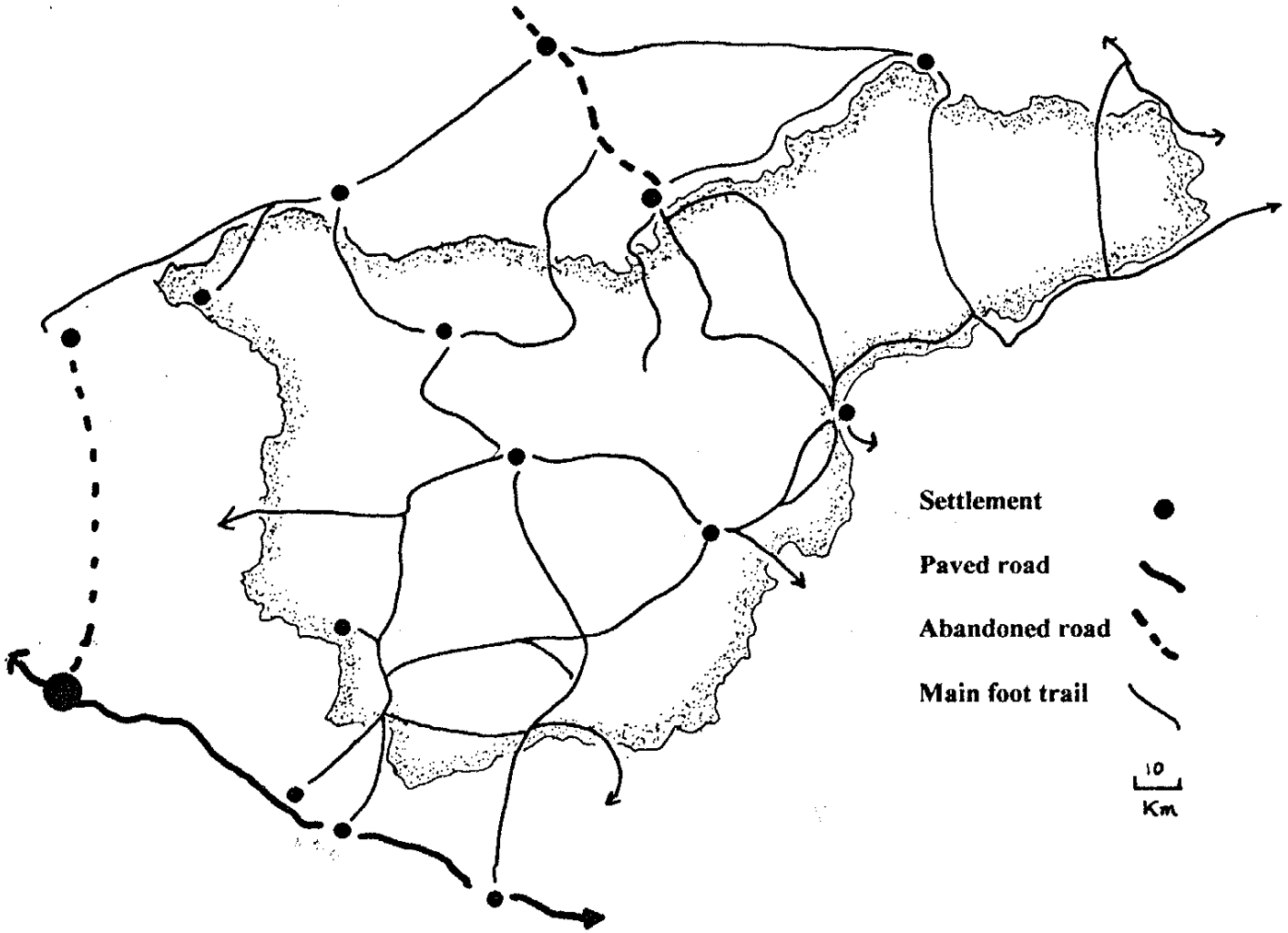


FIGURE 8. Maiko National Park. Path Networks.



Despite its remoteness from settlement, an extensive system of foot paths and trails crisscrosses the Maiko National Park (FIGURE 8). Several of these are well established caravan routes that link the oil palm groves of the Barombi and Bakumu land with villages on the Kivu frontier 10 to 14 days (by headload and tumpline) across the Park. Other trails link gold panning and fishing camps with settlements outside the Park border.

Human Activity in the Park.

Sign of human activity was recorded in nearly every quadrat sampled. It is likely that the entire Park and surrounding area has been visited by humans within the last 5 years. Almost 75% of transects sampled (41 of 60) and 26.1% (171 of 654) of 500m transect segments within the Park borders had at least one record of human sign (mean 0.7 observations /km, 327 total). Nevertheless, except for a few areas, most of this sign was widely scattered, with little evidence of intensive use. Over half the transects surveyed in the Park (33 of 61) had fewer than two observatins of human activity, while on only 10 transects were there more than 2,500m segments with human sign.

Machete cuts marking a single passage were the most frequently recorded sign and were noted on 15% of 500m segments sampled (FIGURE 9A).. These cuts remain detectable for at least 6 months (and probably for more than a year) after they were made and are a measure of accumulated human use in an area. Human tracks, recorded on 4.4% of transect segments, vary in their detectablity and duration, but provide a measure of the current human presence in the Park.

Signs of gold panning and prospecting were the most frequently recorded exploitative activity in the Park and were found on about 5 % of transect segments sampled. Most of these records were of small exploration pits seen near streams. Full fledged panning operations were recorded only once along transacts.

Mining

Gold mining operations in the Maiko Park consist entirely of non-mechanized, small scale panning operations along streams. Canalization and removal of overburden are limited and the direct impact on the adjacent forest is local. Panning operations were seen or reported in nearly one third of the quadrats within the Park (FIGURE 7); however, this may be an underestimate of their true numbers as informants were often reluctant to divulge to us the presence and location of gold panning.

FIGURE 9 A. Types of Human Activity Recorded in the Maiko Park.

Frequency of human sign or evidence of activity as percentage of 500 m segments on 327 km of transect in the Maiko National Park.

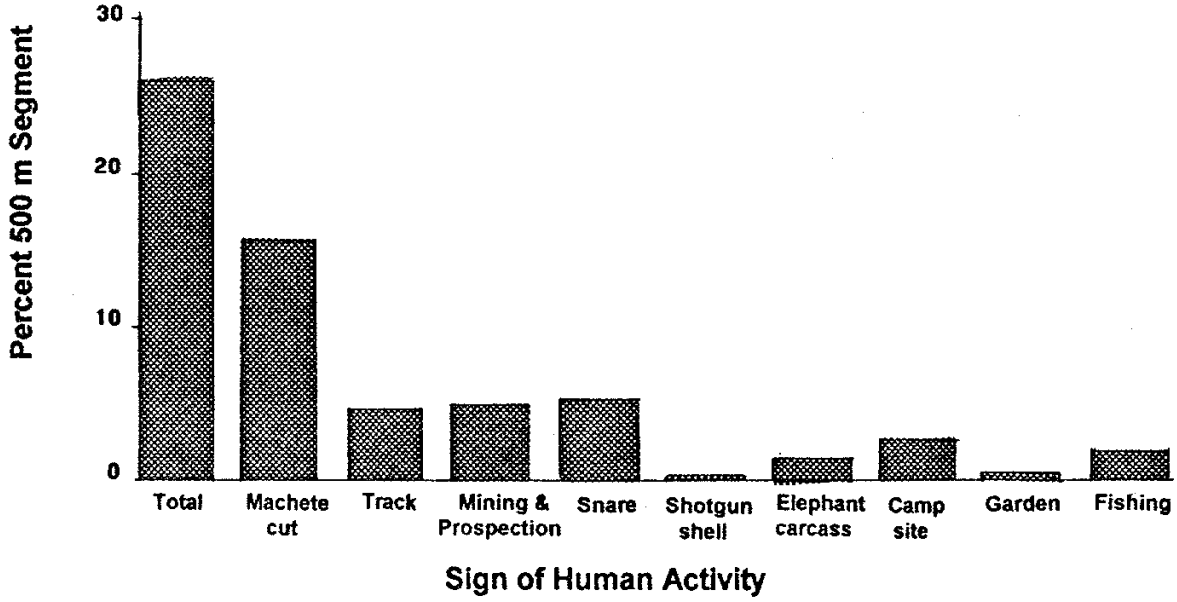
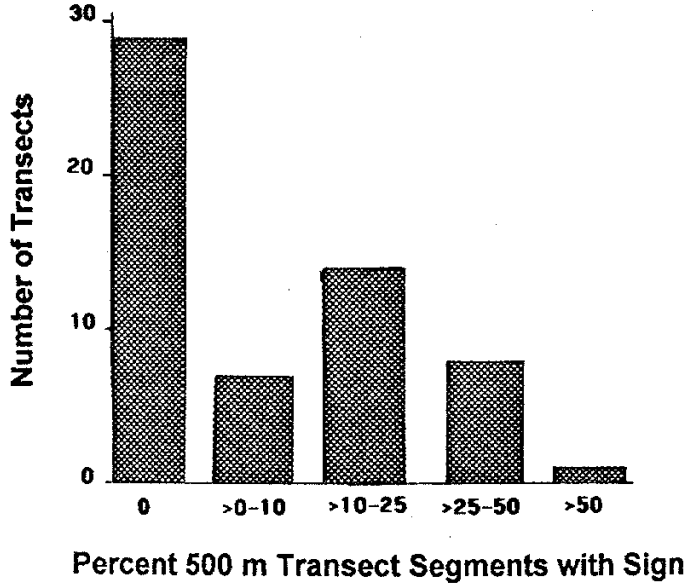


FIGURE 9 B. Distribution of Human Activity in the Maiko Park.

Proportion of 500 m segments per transect with evidence of human activity, excluding signs of passage only (machete cuts and tracks).



Most mining sites within the Park are small and only seasonally exploited by local Bakumu, with fewer than 15 people in residence when the site is active. Larger mining sites have more or less permanent activity and have a sizable representation of residents who are not native to the region. Large and medium sized mining operations identified during the course of the surveys are listed in TABLE 6.

TABLE **6.** Major small-scale gold mines and villages in the Malko National Park (1989 1992).

Name	Symbol [a]	Population	Note
Silisa	A	100 -150	rebel capital and satellite villages, no mine
Etabiri	B	100 -150	
Amedue	C	100	
Angumu	D	>50	numerous small satellite mines in area
Paris	E	25	location approximate
Maisha	F	15-30	
Okolodja	G	15-30	
Osea	H	15-30	
Biruwe	I	?	temporary diamond mine 1990-92

Note: [a] Refer to FIGURE 7.

Hunting

Evidence of hunting was recorded on about 5 % of segments sampled. Almost all of this consisted of abandoned snare sets. Only one spent shot gun shell was recorded in the Park. Because of its remoteness from markets, there is essentially no commercial meat hunting in the Maiko Park. Subsistence hunting is largely limited to the vicinity of gold camps. Hunting camp sites were recorded 25 times (2.7 % of 500 m segments); however, only two camps were in use when found.

The only major hunting in the Park is for ivory. Between the early 1980's and 1989, ivory hunters penetrated to the most remote areas of the Park. Elephant skeletons with skulls from which tusks had been hacked, are direct evidence of recent elephant poaching and were recorded 5 times on transacts. Elephant hunting decreased in intensity over the period of the study, but appears to continue at a low level.

Fishing

The Park's rivers have traditionally been used by Bakumu fishermen. Like hunting, fishing is mostly a seasonal subsistence activity. Traditional methods include use of nets, traps, hook and line. Smaller streams may be poisoned using toxins prepared on site from forest plant products. We found no evidence of use of industrial poisons (acid, pesticide) to kill fish. Although suitable riverside sites were often surveyed, sign of fishing was found on less than 2 % of transect segments sampled in the Park.

Faunal Surveys

Sign or sightings of 30 species of mammals were made during the survey (TABLE 7).

Animals and their sign were recorded with lower frequency on inventories done on established paths than on inventories done on transect lines cut across the forest (FIGURE 10). While some species may avoid paths, and other sign may be obliterated by human passage, the lower rates of sightings are likely due to a more rapid pace of travel and less careful searching for sign by observers walking on a well established track. Only transect data are used to provide measures of relative abundance except for observations of primates for which all available records are used due to their infrequency.

In total, animals or their sign were recorded on every transect and on over 95 % (742 of 779) of 500 m transect segments surveyed. Elephant tracks and dung and duiker tracks were the most frequently recorded animal sign. Elephant sign was recorded on all but six transacts and on over 60 % of 500 m segments surveyed. Duiker sign was recorded on all but two transacts and on 70 % of 500 m segments. Sign of other large ungulates: pigs, buffalo and okapi were recorded on over 80 % of transacts and nearly 30 % of segments for each species. Monkey sightings occurred on 73 % of transacts and on about 20 % of 500 m segments. Evidence of the two apes was less frequent. Chimpanzees or their sign were recorded on 64 % of transacts, but only 13 % of 500 m segments, while gorilla sign was found on only 19 % of transacts and on less than 5 % of transect 500 m segments surveyed.

FIGURE 11 shows the frequency distribution of sign and sightings of each of the animal species for the 73 transacts (plus 25 paths for primates) that were surveyed.

Name	Genus & Species	Observation [a]
PHOLIDOTA		
Giant pangolin	*Manis Gigantea*	Sign
PRIMATES		
Baboon	*Papio anubis*	S
Agile mangabey	*Cercocebus agillis*	S
Gray-cheeked mangabey	*Cercocebus albigena*	S
Red-tail	*Cercopithecus ascanius*	S
Blue monkey	*Cercopithecus mitis*	S
Mona monkey	*Cercopithecus wolfi-denti*	S
L'hoest's monkey	*Cercopithecus l'hoesti*	S
Owl-faced monkey	*Cercopithecus hamlyni*	S
Angolan colobus	*Colobus angolensis*	S
Red colobus	*Colobus badius*	S
Gorilla	*Gorilla gorilla graueri*	Sign
Chimpanzee	*Pan troglodytes*	S
CARNIVORA		
Leopard	*Panthera pardus*	Sign
TUBULIDENTATA		
Aardvark	*Orycteropus afer*	Sign
HYRACOIDEA		
Tree hyrax	*Dendrohyrax arboreus*	S
PROBOSCIDEA		
Elephant	*Loxodonta africana*	S
ARTIODACTYLA		
Red hog	*Potamochoerus porcus*	S
Giant hog	*Hylochoerus meineertzhageni*	Sign
Chevrotain	*Hyemoschus aquaticus*	S
Okapi	*Okapia johnstoni*	Sign
Sitatunga	*Tragelaphus spekei*	Sign
Yellow-backed duiker	*Cephalophus sylvicultor*	Sign
Peter's duiker	*Cdephalophus callipygus*	Sign [b]
Bay duiker	*Cephalophus dorsalis*	S
White-bellied duiker	*Cephalophus leucogasster*	Sign [b]
Black-fronted duiker	*Cephalophus monticola*	S
Blue duiker	*Cephalophus monticola*	S
Bates pygmy antelope	*Neotragus batesi*	S
Buffalo	*Syncerus caffer*	S

Note:

[a] S: sighting, Sign:indirect evidence only

[b] Tracks and dung of middle-sized, upland duikers are not always possible to distinguish to species

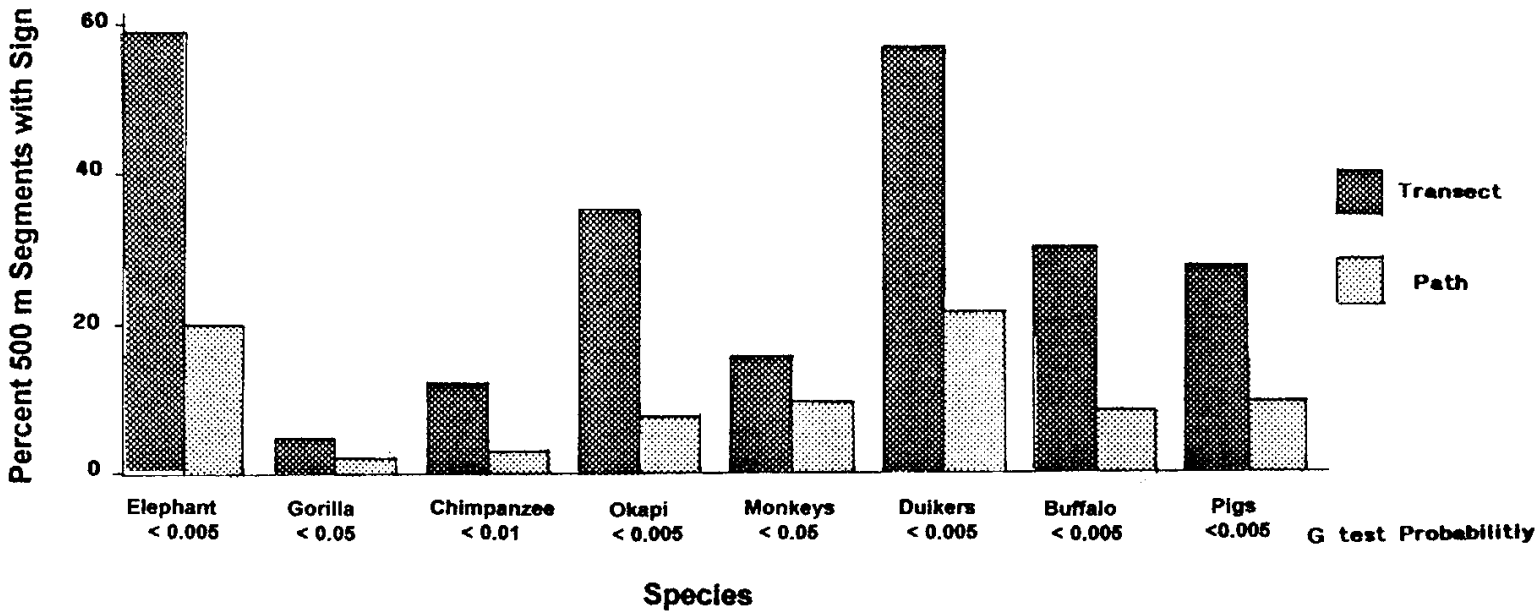


FIGURE 10. Faunal Survey Results: Transects versus paths.

Sightings and sign of all large mammal species inventoried were less frequent for surveys conducted on established paths (373. 5 km) than on transects (389.5 km) conducted along compass lines across the forest. Statistical Probabilities (G test) evaluate hypothesis of equal path and transect frequencies.

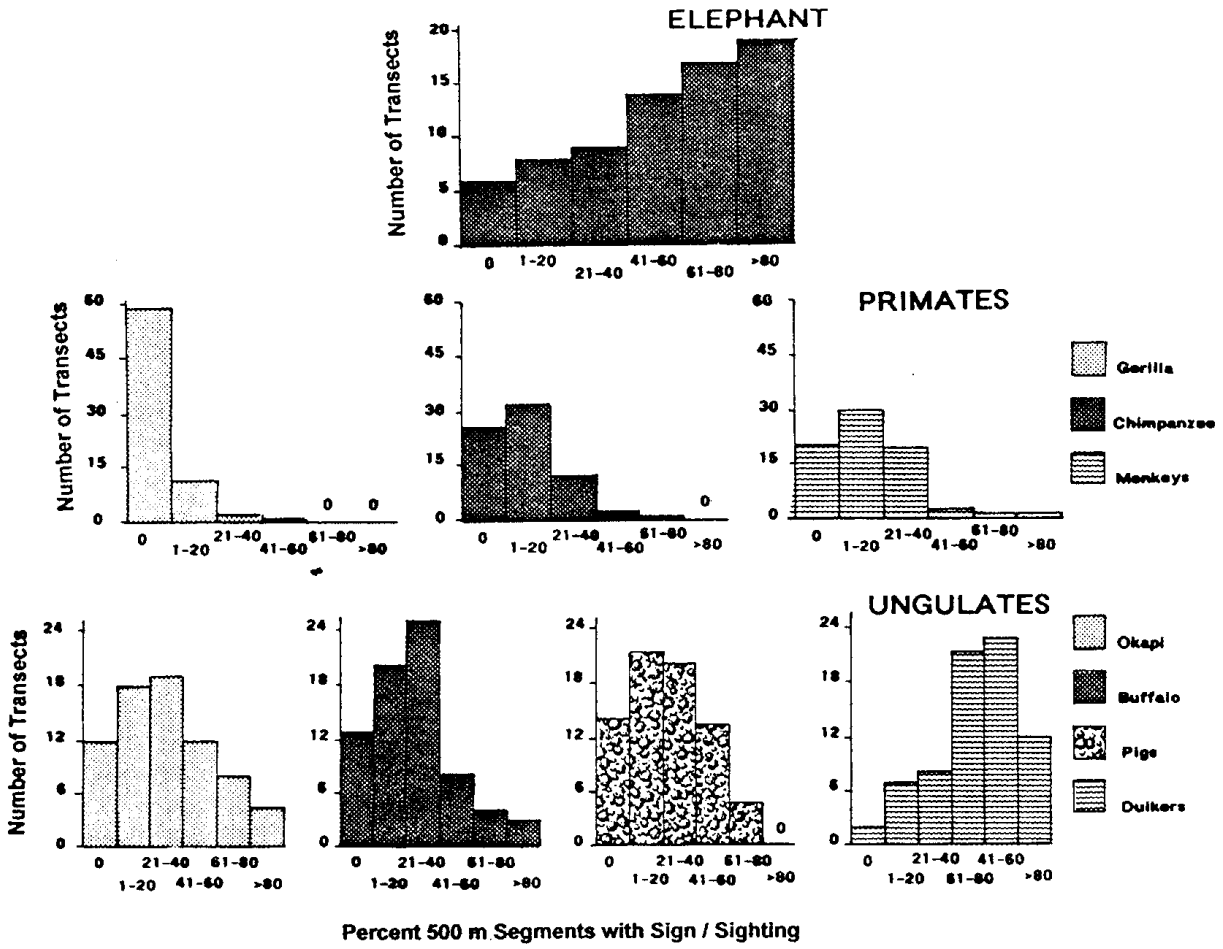


FIGURE 11. Distribution of Large Mammal Sign on Transects.

Proportion of 500 m segments per survey path and/or transect containing sign or sighting of large mammals in the Maiko National Park. Both transect and path data are presented for primates. Transect data only utilized for all other species. Frequency distributions of chimpanzees, gorilla and buffalo sightings are clumped (deviation from expected poisson distribution, G test, $p < 0.10$).

The distributions of chimpanzee, buffalo and gorilla sign are skewed, with a tendency for observations to be concentrated on some transacts and underrepresented on others. This suggests an association of these species with particular locations or habitat types (see below). Observations of monkey and elephant, okapi, pig and duiker sign were uniformly distributed among transacts.

For each species surveyed, transacts were classified as having a high relative density of sign if the percentage of 500 m segments that contained sign was greater than the median percentage. Transects were classified as having a low relative density of sign when the percentage of segments containing sign was less than or equal to the median percentage. The relative abundance of each species is mapped for the 1 0 km. by 10 km quadrats surveyed based on the criteria shown in TABLE 8.

TABLE 8. Classification **of** relative density **of large** mammal sign and human activity

Species or Category	% **500** m segments with sign: Low density	High density
FAUNA		
Elephant	< 50	> 50
Gorilla	< 1 0	> 1 0
Chimpanzee	< 20	> 20
Monkeys	< 20	> 20
Okapi	< 30	> 30
Buffalo	< 30	> 30
Pigs	< 30	> 30
Duikers	< 50	> 50
HUMAN ACTIVITY		
All sign	< 15	> 15
Passage excluded	< 5	> 5

Elephant

Density estimates. Problems and assumptions of estimating forest elephant densities from dung counts are discussed by Barnes and Jensen (1 987) and Barnes et al (1989). Precise estimates require concurrent studies of dung decay rates and deposition rates. These were n ot conducted for this survey- nevertheless, we present estimates of Maiko elephant densities using values for these parameters developed in other studies. We ourselves did not detect seasonal differences in dung counts in areas we censused on a repeated basis over the three years of the study. We assume that seasonal and site-specific conditions observed at other forest areas will not preclude application of these parameters to the Maiko data. In any case transect encounter rates are provided so that density estimates can be recalculated if better estimates of these parameters becomes available. Our purpose in presenting these estimates is to permit a rough evaluation of the size of the Maiko elephant herd and to allow comparisons with other forest areas.

A total of 876 elephant dung were counted on 389.5 km of transect in the Maiko Park and vicinity (mean 2.25 dung / km).

FIGURE 12A shows the distance from the transect line for a sample of 694 dung piles recorded from throughout the study area. A very high proportion of sightings were made within less than 0.5 m of the transect line with only a few sightings beyond 1.5 m. Most published distribution curves (Barnes and Jensen 1987; Carroll, 1986; Strohmeyer and Atanga 1991) do not show such a steep decline. Given the skewed distribution of sighting distances, it is not possible to estimate an effective transect width for the Maiko dung counts.

Barnes et al (1989) have established a linear relationship between dung density (Y) and the presence of dung in 500 m transect segments-

$$Y = 38 + 1149\ P,$$

where P equals the proportion of transect segments containing 2 or more dung records.

FIGURE 12B shows the proportion of 779 transect segments containing from 0 to > 6 dung per segment for all sample transacts. A total of 325 segments (41.7 %) contained at least one dung and 216 (27.7 %) contained at least 2 dung, yielding an overall estimate of 356 dung / kM2.

Elephant density (E) may be estimated from dung density (Y) as-.

$$E = Yx\ (rlD)$$

where D and r are daily dung deposition and decay rates per elephant respectively (McClanahan 1986).

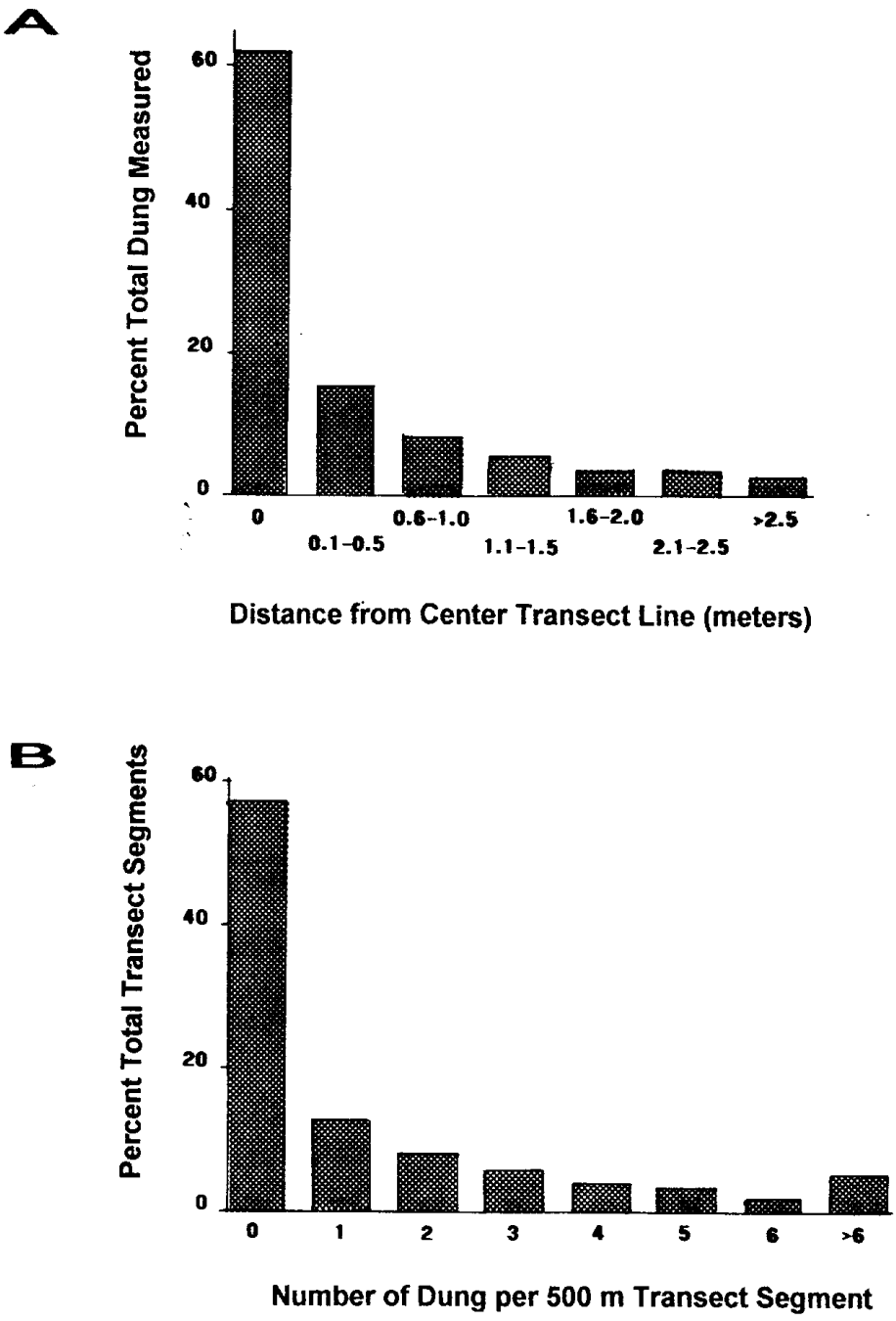


FIGURE 12 Transect Counts of Elephant Dung in the Maiko Park and Vicinity.

(A) Measured distances of 694 elephant dung from the transect lines.

(B) Number of elephant dung counted per 500 m transect segment (73 transects, 389.5 km total).

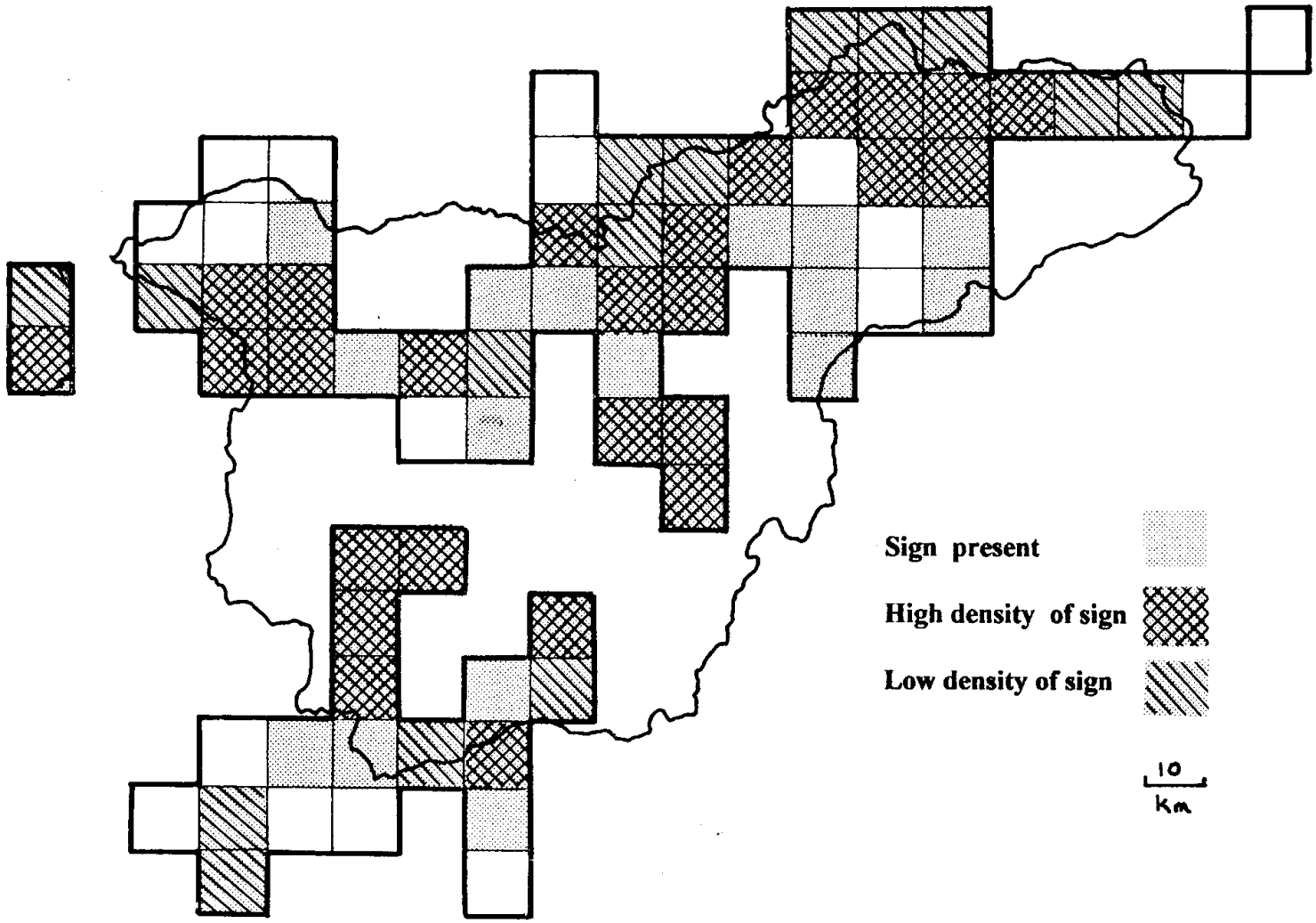
Using estimates of D = 17 dung per elephant per day, and r = 0.03 (Barnes and Jensen 1987), these observed frequencies yield an overall estimate of 0.63 elephants / **kM2** for the Park and neighboring areas. Based on these figures, total elephant numbers in the Malko National Park can be estimated between 6,000 and 7,000 animals. -

Human settlement and elephant distribution. Elephants occurred over the entire Maiko Park and in much of the adjacent area (FIGURE 13). Elephant sign was significantly **less** frequent in quadrats sampled outside of the Park than in quadrats on the Park border or in its interior (FIGURE 14A, TABLE 9). The negative relationship between human settlement and elephant density that has been documented at other forest sites (Barnes 9-t al 1991) was not found in the Maiko region. Transects in quadrats where villages or mining settlements were located yielded lower average' estimates of dung density than did transacts in quadrats without villages. However, high concentrations of elephant activity were sometimes noted in village zones. Because of the highly variable distribution of elephant activity, differences in estimates of dung density are not significantly different between inhabited and uninhabited sites (1 -way **ANOVA,** $p > 0.05$) (FIGURE 14B

Habitat associations. Elephant activity was concentrated in open habitats within the forest. Edos had the highest frequency of sign, but only a very small proportion of the Park area is represented by these sites. Elephant sign was found in nearly equal frequencies in both regenerating and mature forest types (FIGURE 15). Averaged over the entire year, there was a tendency for elephants to avoid large stands of monodominant *Gilbertiodendron* forest (FIGURE 16), although we found concentrations of sign in *Gilbertiodendron* areas after seed fall suggesting that elephants may migrate to these areas on a seasonal basis to feed on mast.

Conservation status. While we found ample evidence that ivory hunting had been widespread in the recent past, even in the most remote areas of the Park, it is not known how significantly the Maiko elephant herds were reduced. When we began the project in 1989 we found small scale but systematic elephant hunting and a clandestine ivory trade based at remote outposts, such as Opienge. By the end of the study in 1992 this was much reduced, although some hunting seems to continue on a sporadic basis.

FIGURE 13. Maiko National Park. Elephant Distribution and Relative Abundance.



Gorilla

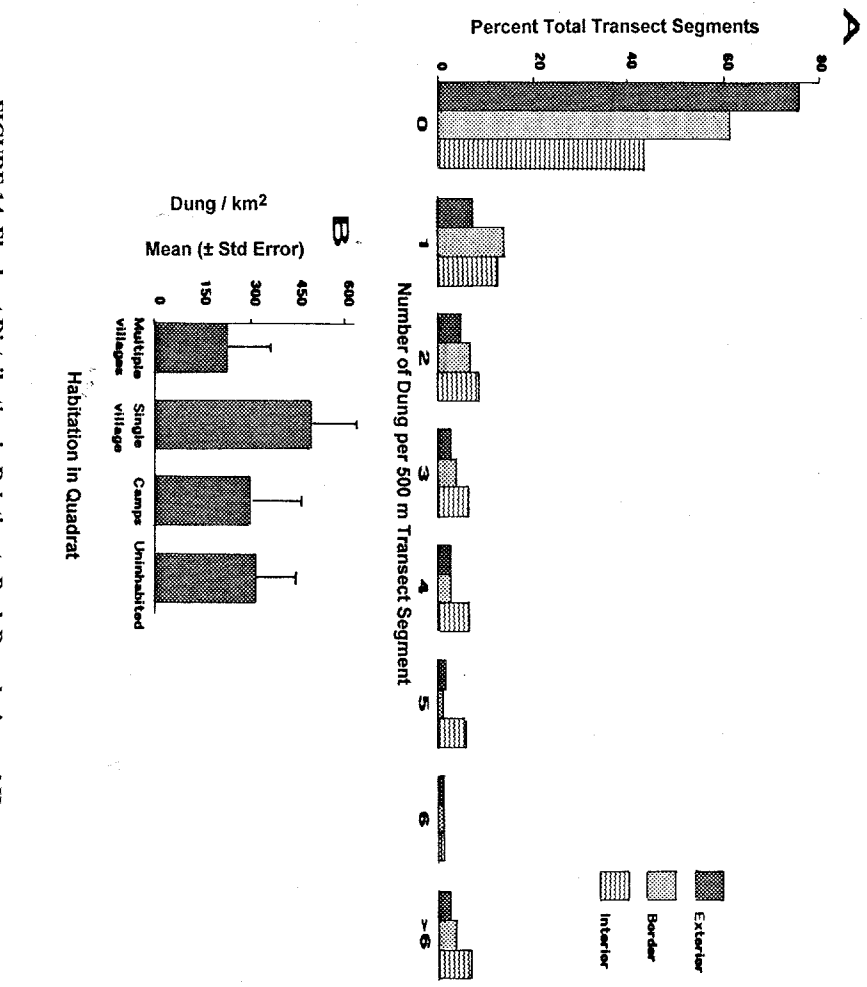


FIGURE 14 Elephant Distribution in Relation to Park Boundaries and Human Settlement.

(A) Number of elephant dung counted per 500 m transect segments in quadrats in the Park Exterior (62. 5 km), Park Border (187.5 km) and in the Park Interior (139.5 km). Total 73 transects. Abundance of elephant dung was higher in quadrats in the Park Interior and on its Border than in the Exterior quadrats sampled ($G = 8.23$, $P < 0.05$).

(B) Estimates of mean elephant dung density on transects (± Standard Error of the Mean) based on Barnes et al (1992) in relation to type of human settlement in quadrat sampled. Differences are not significant (1-way ANOVA, $P > 0.05$).

TABLE 9. Estimated elephant densities in the Maiko National Park and vicinity.

Zone	Number Quadrats	Number Transects	Total km	Percent Segments ≥ 1 dung	Percent Segments ≥ 2 dung	Dung Density (km^{-2})[a]	Elephant Density (km^{-2})[b]
Outside Park	7	12	62.5	24.8	16	222	0.39
Park Border	19	36	187.5	37.1	21.6	286	0.50
Park Interior	16	25	139.5	55.9	41.2	511	0.90
TOTAL	42	73	389.5	41.8	27.7	356	0.63

Notes:

[a] Dung density (Y) estimated as Y = 38 + 1149 p, where p = proportion of 500 m transect segments with ≥ 2 dung records (Barnes et al. 1989).

[b] Elephant density (E) estimate as E = Y (D/r), where daily dung deposition rate per elephant (D) = 17, and daily dung decay rate (r) = 0.03 (Barnes and Jensen 1987).

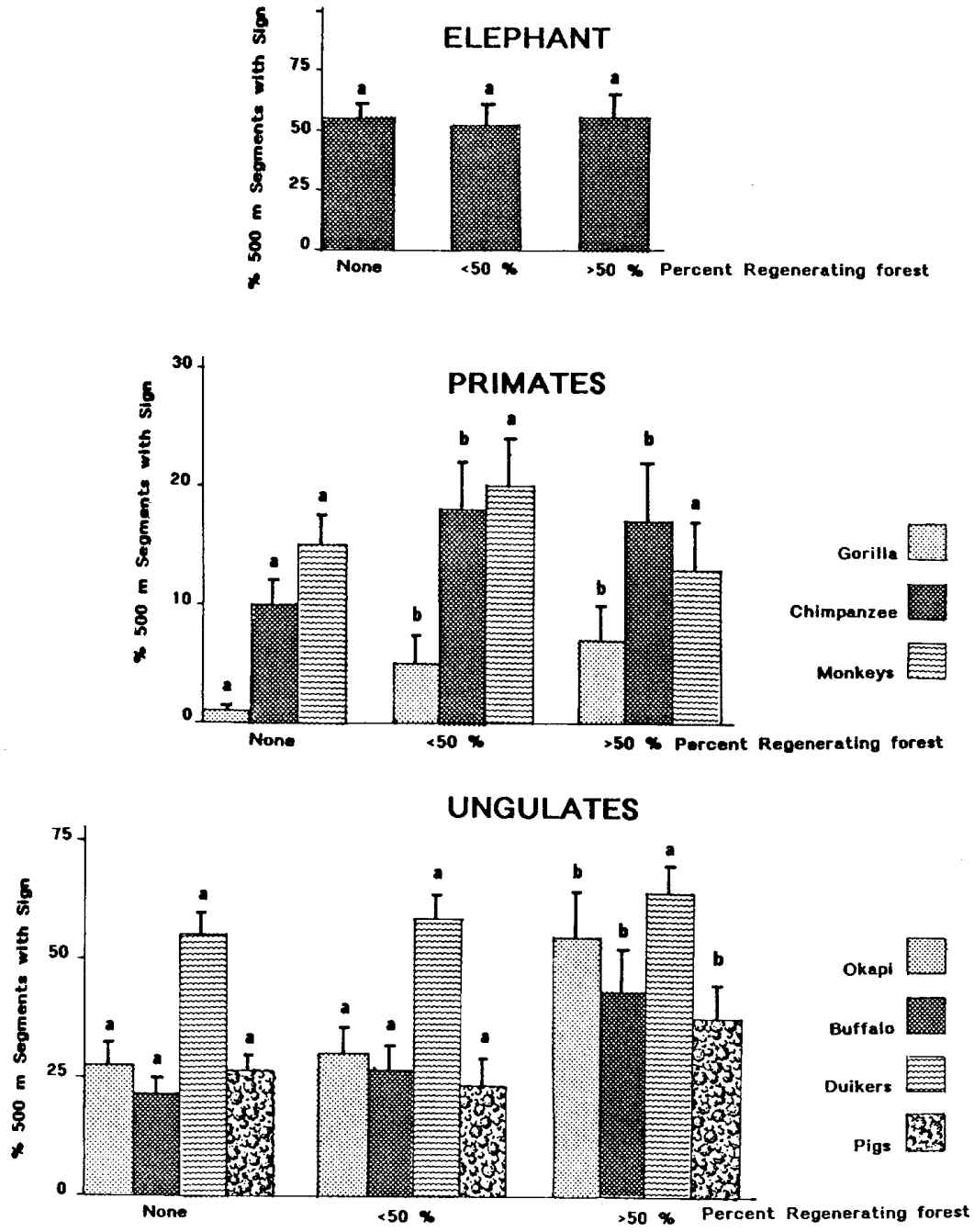


FIGURE 15. Large Mammal Abundance and Secondary Forest.

Estimates of relative frequency of animal sign and sightings on transects in relation to percentage of 500 m segments with regenerating forest types. Values shown are the mean ± Standard Error. For each mammal species, the same low case letter over the histograms indicates mean values that are not statistically different (ANOVA, Tuckey-Kramer's test).

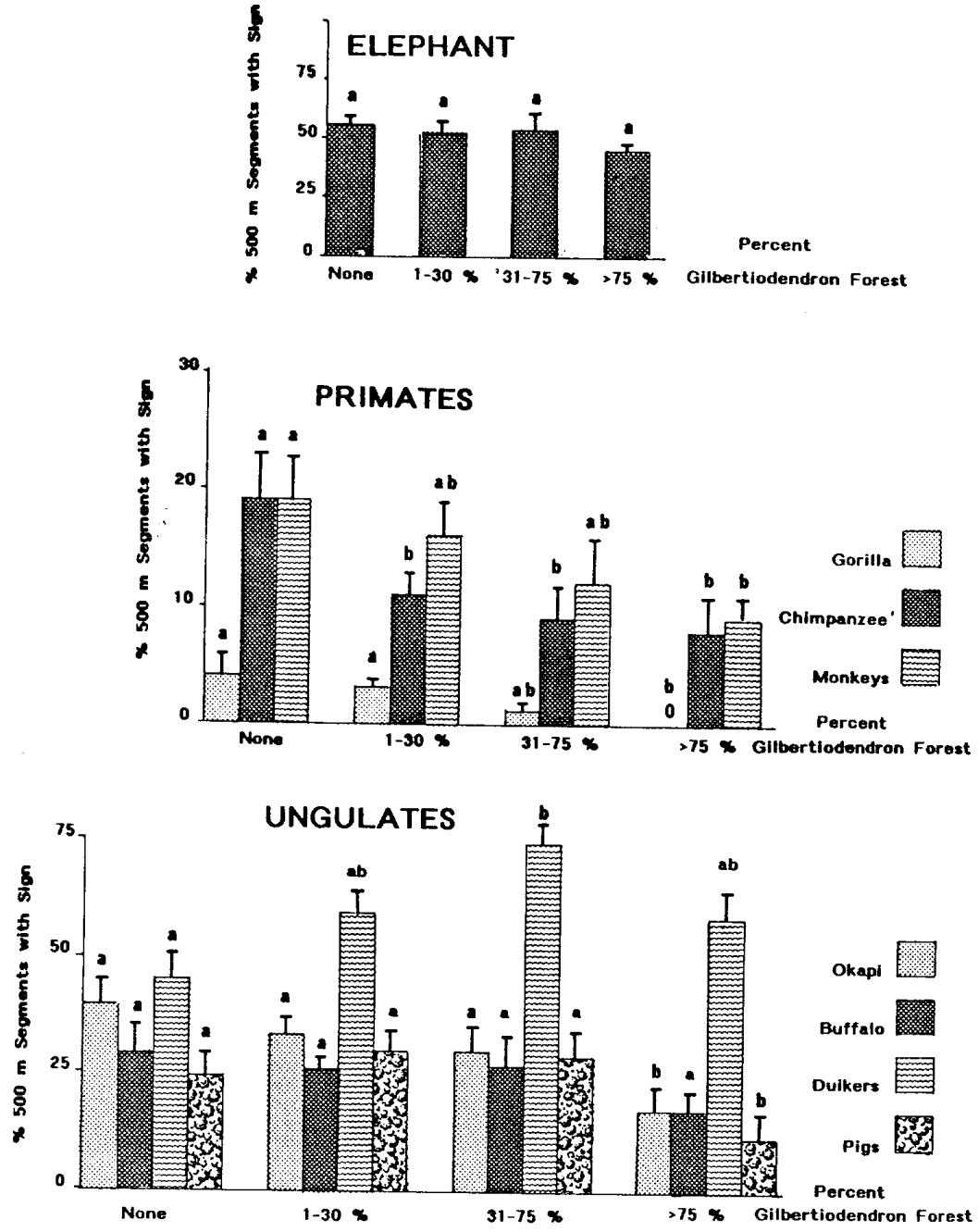


FIGURE 16. Large Mammal Abundance and *Gilbertiodendron* Forest.

Estimates of relative frequency of animal sign and sightings on transects in relation to percent of 500 m segments with *G. dewevrei* coverage. Values shown and statistical interpretations as in FIGURE 15.

Distribution. In the Maiko region gorillas occur in more or less discrete areas with some groups apparently separated from their nearest neighbors by up to 60 kilometers. We identified 6 areas of confirmed occurrence and one additional area of probable occurrence in the area surveyed. Five areas were contained within the Park borders and two in areas surveyed outside the Park (FIGURE 17). Gorillas may occur in additional areas, especially in the southern half of the Park where exploration was less comprehensive.

Gorilla sign was recorded on only 4.5 % of 500 m transect segments in the zones where they occurred. Highest frequency of sign was found in the Uvia valley (11.8%ofsegments)AndtheBilota/Etabiriareas(8.6%ofsegments). IntheFifo area, gorillas were reported in interviews with local people, however, no sign was recorded on 8 km of transect surveyed (TABLE 1 OA).

The most frequently recorded gorilla sign were tracks, feeding sign and dung. **Nests** represented 14 % of recorded sign (0.01 / km). Only one direct encounter with gorillas was recorded during the entire study.

Among the zones we identified as containing gorillas, the Angumu area covers at least 700 **kM2,** with gorilla sign recorded irregularly throughout. Within this area there appear to be significant concentrations of gorillas in the Ogombo Massif and toward the headwaters of the Loya and Maiko Rivers. Gorilla sign was recorded in the Bilota / Etabiri area over an area of almost 400 kM2.

Habitat associations. Gorilla sign was found in a variety of forest types including mature lowland formations (TABLE 10B). Gorilla activity was most evident in secondary forest, in farmed bush (the Peneluta area), and in areas where terrestrial herbaceous vegetation predominated. Frequency of gorilla sign was significantly higher on transacts with regenerating forest than on transacts in mature forest only (FIGURE 15). Slopes were preferred, probably because in many areas they support dense ground vegetation under a more open forest canopy. Monodominant *Gilbertiodendron* forests were less favored, and gorilla sign was never found in the larger stands (FIGURE 16).

At least several of the areas of gorilla concentration in the Maiko region have been stable over the last 50 years. According to local informants, gorillas were captured by colonial authorities for export in the Angumu, Ogombo and Etabiri areas in the 1940's. Gorillas occur in the same areas today.

TABLE 10A. Observations of gorilla sign in the Maiko National Park and vicinity.

	Kilometers			500 m segments			Sign counted				
Population	Transect	Path	Total	Total	All sign	Percent	Track	Feed	Scat	Nest	Call
A. Peneluta	22.5	5.0	27.5	55	1	1.81		1			
B..W.Loya	37.5	33.0	70.5	131	2	1.52				2	
C. Angumu	120.5	117.0	237.5	475	22	4.63	8	5	7	1	1
D. Bilota	28.5	12.0	40.5	81	7	8.64	1	6			
E. Fifo	8.0	0.0	8.0	16	0	0.00					
F.. Uvia	17.0	0.0	17.0	34	4	11.76	1	1		2	
G. Bitule	0.0	5.0	5.0	10	0	0.00					
TOTALS	234.0	172.0	406.0	802	36	4.49	10	13	7	5	1
Number / km					0.09		0.02	0.03	0.02	0.01	0.002

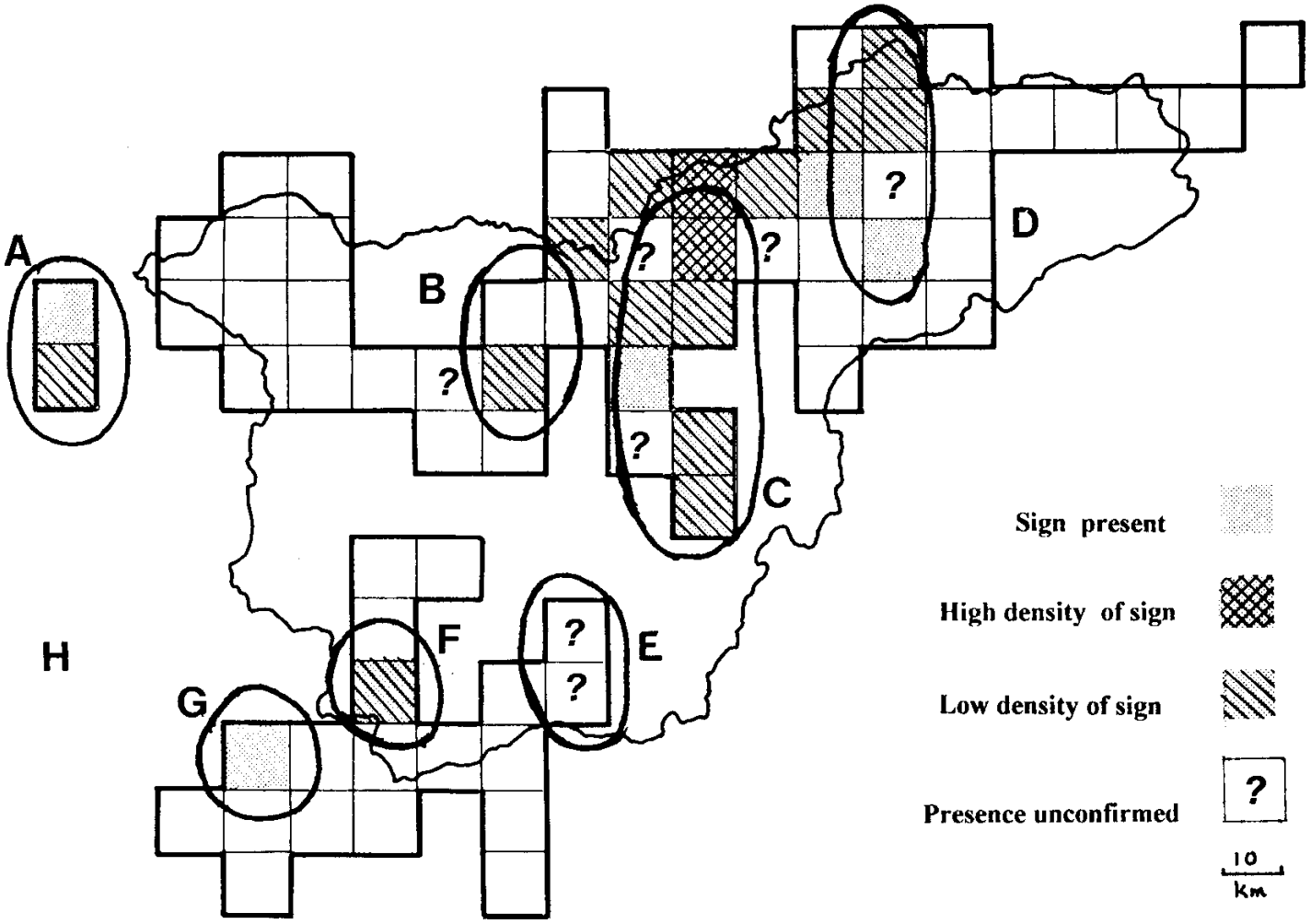
TABLE 10B. Topography and habitat associations of gorilla sign in the Maiko National Park and vicinity.

Population	Hill site	Lowland site	Secondary forest	Mature forest	Terrestrial herbaceous vegetation
A. Peneluta	+	+	+	+	
B..W.Loya	++				+
C. Angumu	+	+	++	+	+
D. Bilota	++	+	++	+	++
E. Fifo					
F.. Uvia	++			++	+
G. Bitule					

NOTE: (+) Habitat feature associated with gorilla sign ≤ 50 % of records. (++) Habitat feature associated with gorilla sign > 50% of records.

FIGURE 17. Maiko National Park. Gorilla Distribution and Relative Abundance.

Eastern lowland gorillas (*Gorilla g. graueri*) occur in geographically discrete areas in the Maiko Park and vicinity. Gorilla populations identified during the surveys are enclosed in curves and lettered to correspond with data presented in TABLE 10. Locations where local informants indicated gorillas but where no sign was recorded are mapped as unconfirmed presence (?).



Conservation status. Gorilla populations found within the Park are not directly threatened, though a number of groups occur in areas where gold panners are active. Outside the Park, the population near Peneluta may be threatened by hunting. The Butule gorillas near the newly paved Kisangani - Bukavu road (G on FIGURE 17) are significantly threatened by hunting. One animal was reported killed here in 1985. We found no current gorilla sign in the area in 1989. The Butule population is the only group in the Lubutu region that Emlen and Schaller (1 960) contacted during their 1959 survey that may still be extant. Two other populations, Lubutu and Ntufia (H and I on FIGURE 17) are now extinct.

Chimpanzee

Distribution. Chimpanzees or their sign were observed in 50 % (37 of 74) of quadrats sampled and recorded on 15.6 % (113 of 722) of 500 m transect and path segments surveyed (FIGURE 18). The most frequently recorded sign were nests. A total of 54 nest groups were recorded on surveys (0. 1 5 groups / km). A total of 93 individual nests were counted in 42 groups (1.9 nests / group). Tracks, feeding sign and scats were also noted. Chimps were seen or heard on 22 occasions (0.06 encounters / km) (TABLES 1 1 A and 1 1 B).

TABLE 1 1 A. Chimpanzees and sign observed on 722 km of path and transect survey in the Maiko Park and vicinity.

	Seen / heard	Nest groups	Tracks	Feeding sign	Dung	TOTAL
Number observations	22	54	13	16	8	113
Sign I km	0.03	0.07	0.02	0.02	0.01	0.15

TABLE 1 1 B. Numbers of Chimpanzee nests per group

	Nests per group						
	1	2	3	4	>4	not known	Total
Groups	27	8	3	3	1	12	54
Total nests	27	16	9	12	15	---	79

Although chimpanzees have a wide distribution in the Malko Park, they appear to be uncommon in some areas. Chimpanzees were recorded in only 2 of 1 0 quadrats sampled in the northwest quarter of the Park (Mangila and Sasi watersheds). There were similarly few observations on the upper Etshopo and Bilota Rivers. In contrast, , high densities of chimpanzee sign were noted in the Peneluta and Angumu areas.

Habitat associations. Though not as clearly marked, chimpanzees show the same general habitat associations as gorillas. Transects through areas with regenerating forest had significantly more chimpanzee sign than did transacts through mature forest only (FIGURE 15). Relative to other mature forest types, chimpanzees avoid areas with a high percent cover of monodominant *Gilbettiodendron* forest (FIGURE 16).

Monkeys

Distribution. Monkeys were observed over the entire Park and surrounding areas (FIGURE 19). Ten species of monkeys were recorded on path and transect inventories (TABLE 12). The most frequently identified species were red colobus and gray-cheeked mangabey. Red-tail monkeys, blue monkeys, Dent's monkey and baboons were also commonly observed. A total of 223 primate groups were recorded over 690 km of path and transect (mean 0.32 groups / km). These encounter rates probably underestimate actual relative abundance. Transect cutting created a disturbance from which some monkeys may have retreated before being detected. In addition, many transacts were conducted during midday hours when some species are inactive and likely to be overlooked.

FIGURE 18. Maiko National Park. Chimpanzee Distribution and Relative Abundance.

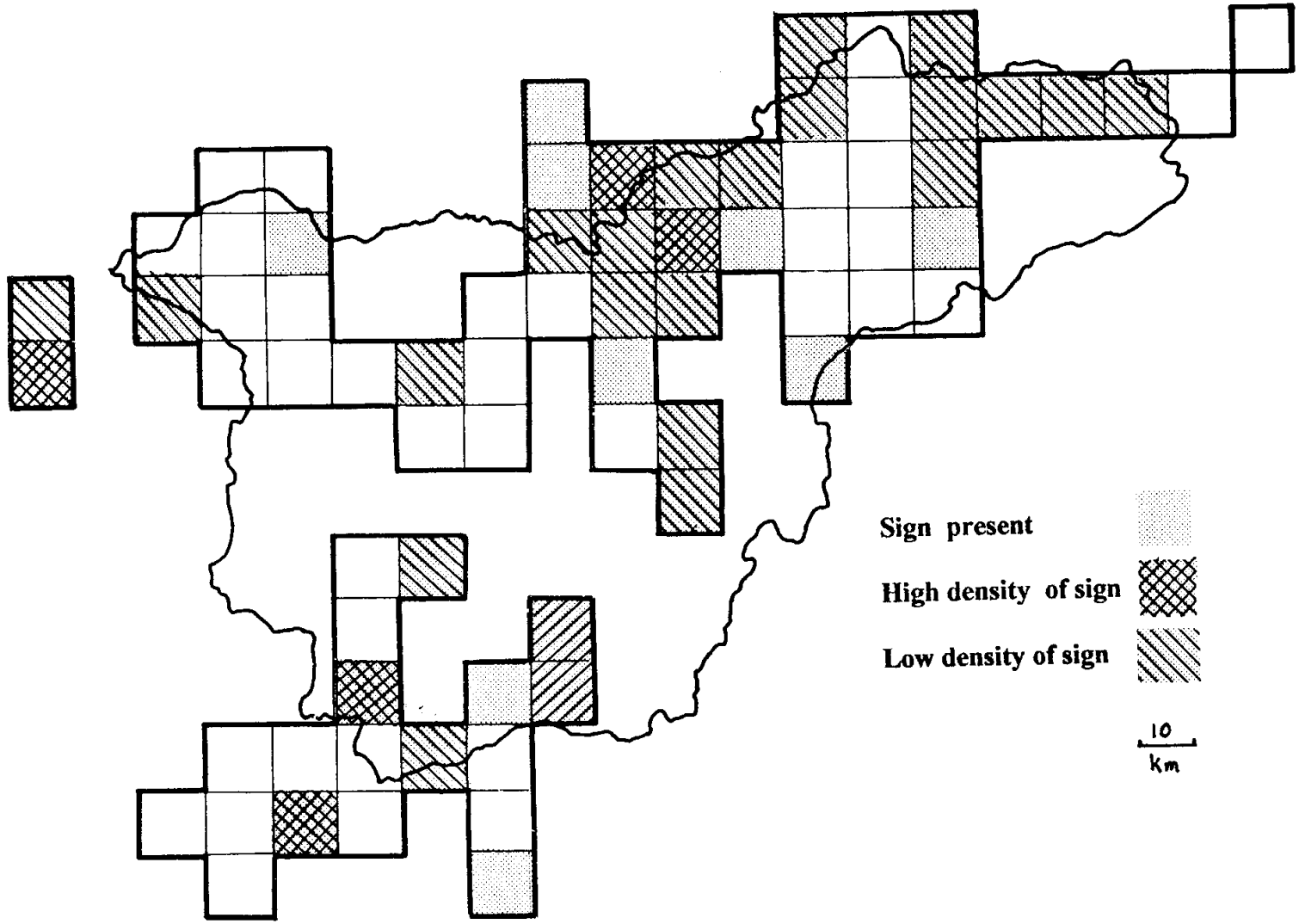


FIGURE 19. Maiko National Park. Monkey Distribution and Relative Abundance.

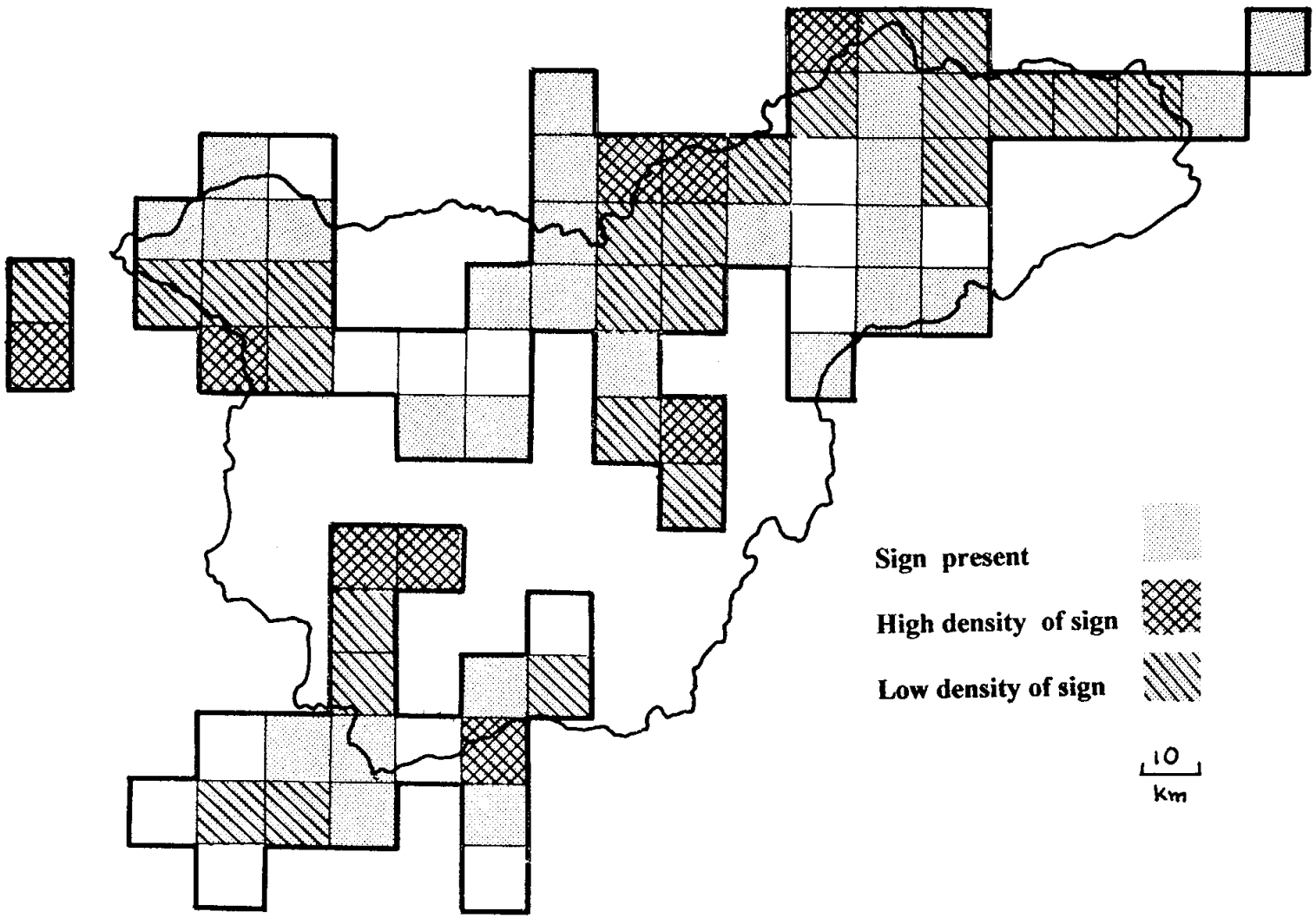


TABLE 12. Anthropoid primate groups (excluding apes) observed on 690 km of transect and path in the Maiko National Park and vicinity.

Species	Number observations	Number /km	% Total
Colobus badius	49	0.07	22.0
Cercocebus albigena	40	0.06	17.9
Cercopithecus ascanius	24	0.03	10.8
Cercopithecus mitis	18	0.03	8.1
Cercopithecus wolfi-denti	13	0.02	5.8
Papio anubis	10	0.01	4.5
Cercopithecus I'hoesti	4	0.006	1.8
Colobus angolensis	3	0.005	1..3
Cercopithecus hamlyni	2	0.003	0..9
Cercocebus galeritus	2	0.003	0..9
Unidentified	58	0.08	26.0
TOTAL GROUPS	223	0.32	100.0

Two species that were not recorded on the surveys, but that may be expected in the Park are Brazza's monkey *(Cercopithecus neglectus)* and the guereza colobus *(Colobus guereza)*. The overall range of Brazza's monkey includes the Maiko area and the species has been recorded in riverine forests in the adjacent Ituri Forest. It would be expected to occur along the larger rivers in the Malko Park as well. The guereza also occurs in the Ituri Forest, and west at least to the Lindi River. The species has not been reported west of the Tshopo River- however, there are reported sightings between the Lindi and the Tshopo in the Opienge area (Alan Root, pers Comm). While the guereza is to be expected to occur in the Maiko Park on the east bank of the Lindi at least, its actual status remains to be established.

Habitat associations. Habitat associations of monkeys (all species combined) differed from the apes. Sighting frequencies were not correlated with occurrence of regenerating forest. Sighting rates were higher on transacts where regenerating forest was present but comprised less than half the area, than on transacts in mature forest

only or on transacts where more than half the area was regnerating forest. These differences were not statistically significant, however (FIGURE 15). Primate sightings declined linearly with increasing percent cover by monodominant *Gilbertiodendron* forest on transacts (FIGURE 16).

Ungulates

Thirteen species of artiodactyl ungulates were observed or their sign recorded in the Maiko Park and vicinity. An additional species, the bongo *(Boocercus euryceros)* has been recorded in the forests between the Tshopo and Uma Rivers, northwest of the Park (Colyn 1986), and may occur in the Maiko.

Okapi

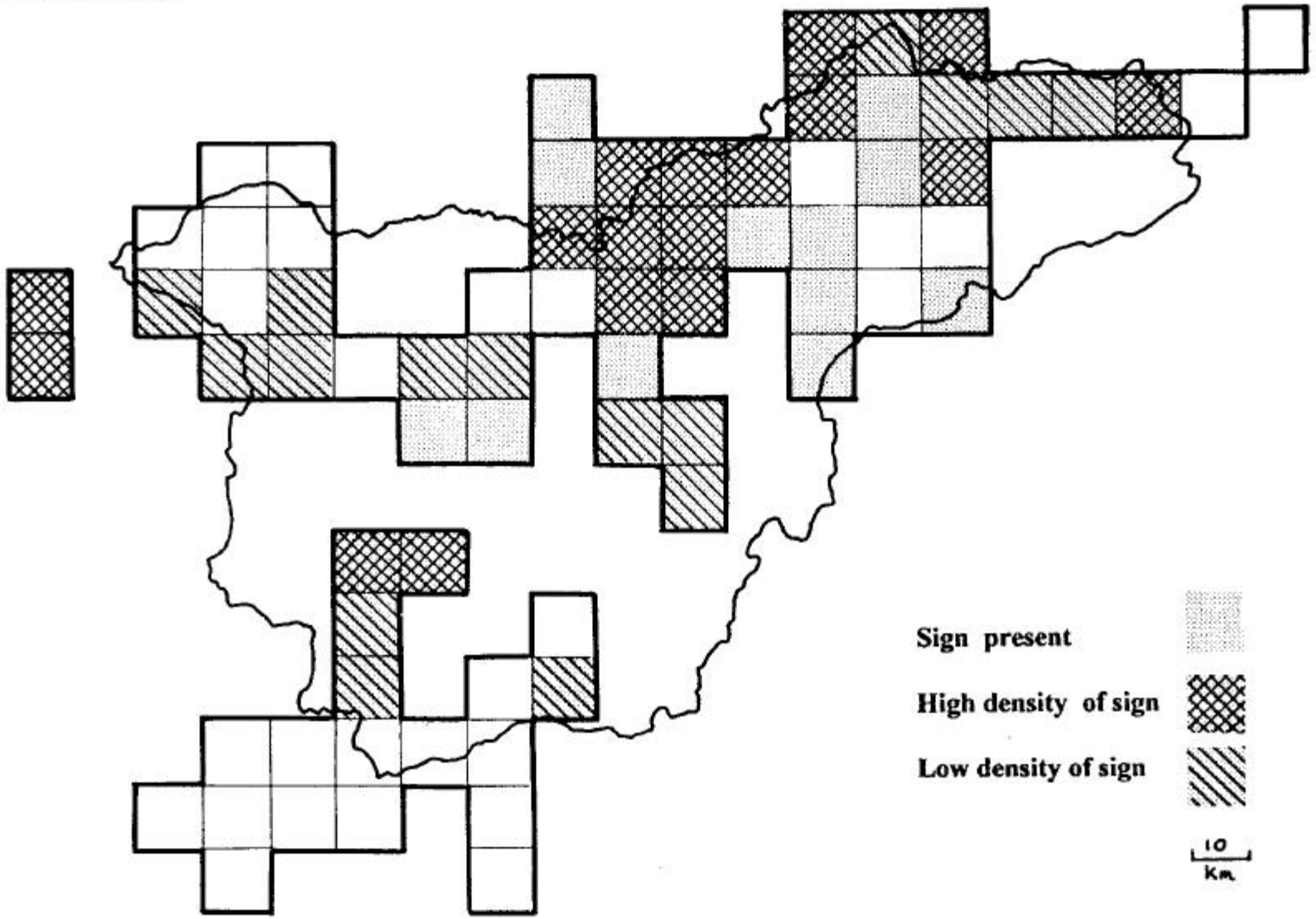
Distribution. The okapi is a solitary species. Okapi sign included mainly tracks, and stripped and browsed twigs. Dung was found only infrequently. Okapi tend to defecate in the same limited areas and rates of dung removal by beetles may nearly equal deposition rates (Hart & Sikubwabo, unpublished observations).

Okapi occur throughout the entire Maiko Park. Observed sign on transacts diminished in frequency from north to south across the region (FIGURE 20). Okapi sign was most abundant in the northeastern third of the Park and in the northwest in the Peneluta area. Okapi sign was observed less frequently south of the Maiko River, and was completely absent south of the Oso and Uvia Rivers. These rivers appear to constitute the southern limit of the okapi's range.

We could identify no clear ecological or biogeographical reasons why okapi should not occur on the south banks of the Oso and Uvia Rivers. These watersheds mark neither an abrupt altitudinal gradient nor a major shift in forest type. While the rivers themselves must represent a physical barrier to an animal not known to swim, okapi nevertheless have breached larger and longer rivers, including the Zaire (Hart & Hart 1988). Therefore, it seems possible that the okapi has not reached its ecological limits on the southern edge of its range.

Habitat associations. Okapi sign was infrequently found in the vicinity of settlements, and they avoided large areas of open, farmed bush. Secondary forests, however, were preferred . Okapi sign was recorded with nearly twice the frequency on transacts where over half the area included regenerating forest compared to transacts in mature forest or where regenerating forest comprised less than half the area (FIGURE 15). Large stands (> 75 % of area) of *Gilbertiodendron* contained low

FIGURE 20. Maiko National Park. Okapi Distribution and Relative Abundance.



levels of okapi sign (FIGURE 16). Forests with relatively open understory intermixed wi 'th treefalls showed the highest frequency of use by okapi. Dense thicket, including some of the areas of arrested succession in the old SOMIBA clearings, were avoided.

Buffalo

Distribution. Buffalo occurred throughout the Park and surrounding areas (FIGURE 21). Both red and darker individuals were seen. The main sign recorded on surveys included dung and tracks. Most of the observed sign appeared to have been made by small groups of 3 to 5 individuals, though tracks of solitary animals were also seen regularly. Evidence of larger aggregations was found in open areas, in particular wallows and edos.

Habitat associations. Buffalo showed a marked affinity for regenerating forest. Buffalo tracks, dung and feeding sign, like that of the okapi, were significantly more frequent in areas of > 50 % cover by regenerating forest than in areas where more mature forest types predominated (FIGURE 15). Habitat associations of the two species differed, however. Buffalo preferred open areas and young secondary growth while the okapi preferred older secondary forests. Large stands of monodominant' *Gilbertiodendron* forest had lower frequencies of buffalo sign than did mixed mature forests, however, the differences were not statistically significant (FIGURE 16). Buffalo, like elephant, moved into *Gilbertiodendron* forest during periods of mast seed fall to feed on the germinating seeds.

Pigs

Distribution. Local informants report that two species of pigs, the red hog

(Potamochoerus porous) and the giant hog *(Hylochoerus meinertzhagent)* both occur in the Maiko National Park. The red hog was observed during surveys. The presence of the giant hog was confirmed by its tracks in combination with distinctive fibrous dung. It was not always possible to distinguish between the two species based on tracks alone.

Pigs occurred throughout the Park and surrounding area (FIGURE 22). Red hogs were the most common species, often moving in large sounders of 15 or more individuals that left abundant sign. Giant hogs occurred in smaller groups, possibly as few as 2 or 3 individuals.

FIGURE 21. Maiko National Park. Buffalo Distribution and Relative Abundance.

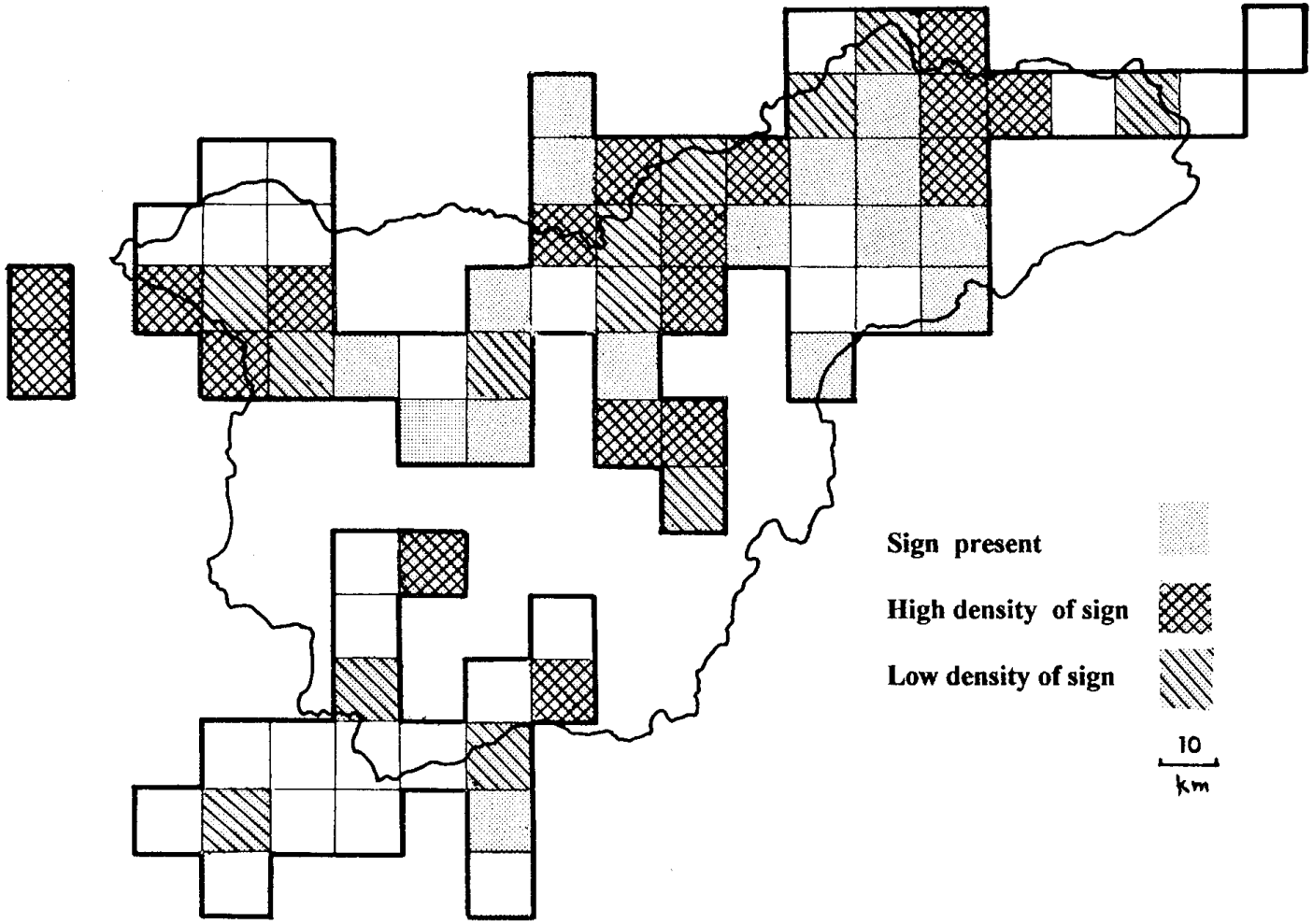
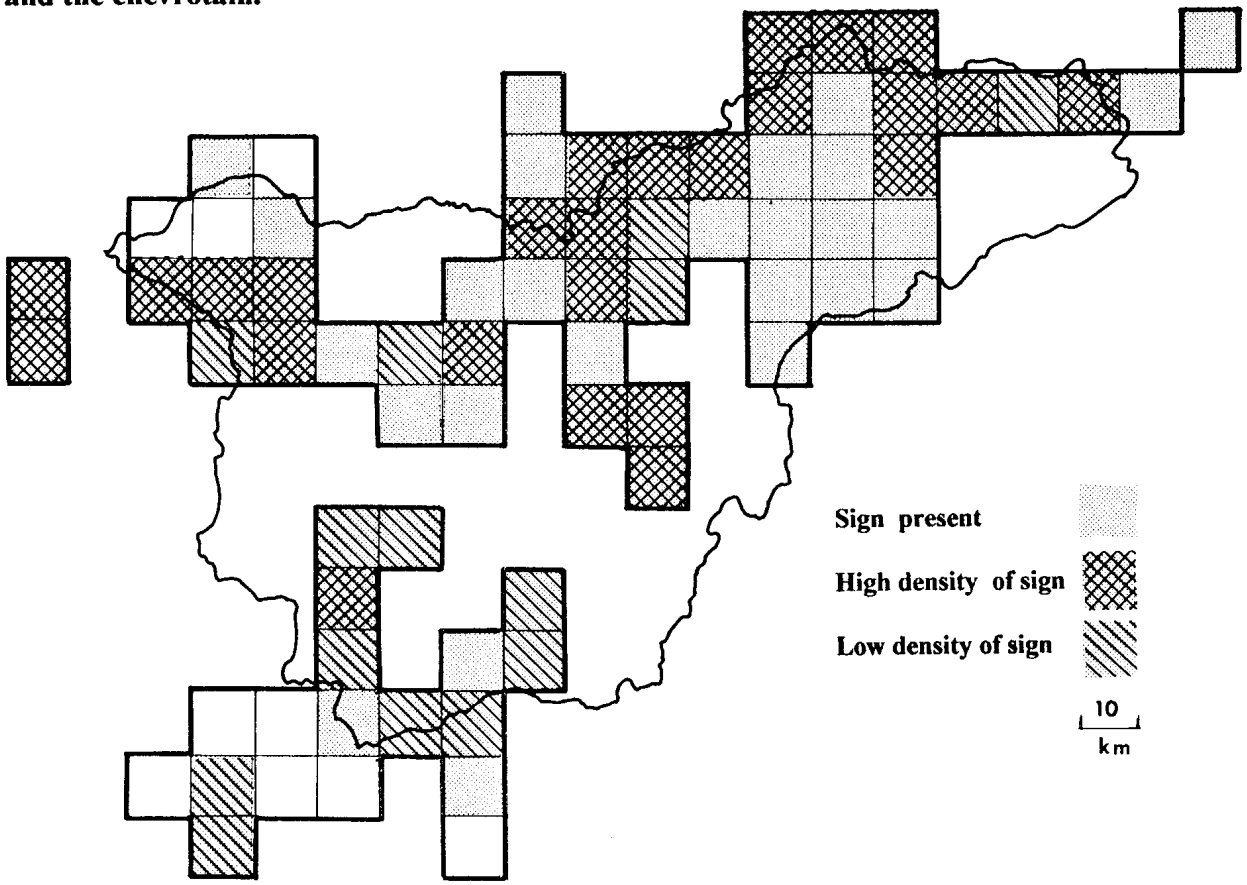


FIGURE 23. Maiko National Park. Distribution and Relative Abundance of Small Ungulates.

Small ungulates censused include 6 species of duikers, Bates' pygmy antelope and the chevrotain.



Habitat associations. Pig sign was recorded most frequently on transacts where regenerating forest comprised more than half the area (FIGURE 15). Areas of > 75 *% Gilbertiodendron* cover were avoided relative to other mature forest types.

Red hog tracks and rootings were frequently found along streams where our guides said the animals came to feed on worms. Sign was also frequently concentrated where the animals came to feed on fallen fruits and seeds beneath certain trees (principally *lrvingia spp, and Autrenella cogensis).* Based on dung composition, giant hog appeared to be more folivorous than red hogs. Both species rooted for tubers and corms.

Small Ungulates

Distribution. According to local informants, seven species of small ungulates, ranging in body size from 2. 5 to 45 kg, occur in the Maiko Park. Five duiker species *(Cephalophus spp),* the water chevrotain *(Hyemoschus aquaticus)* and the pygmy antelope *(Neotragus barest)* were observed during surveys. A sixth duiker species also probably occurs in the area (TABLE 7).

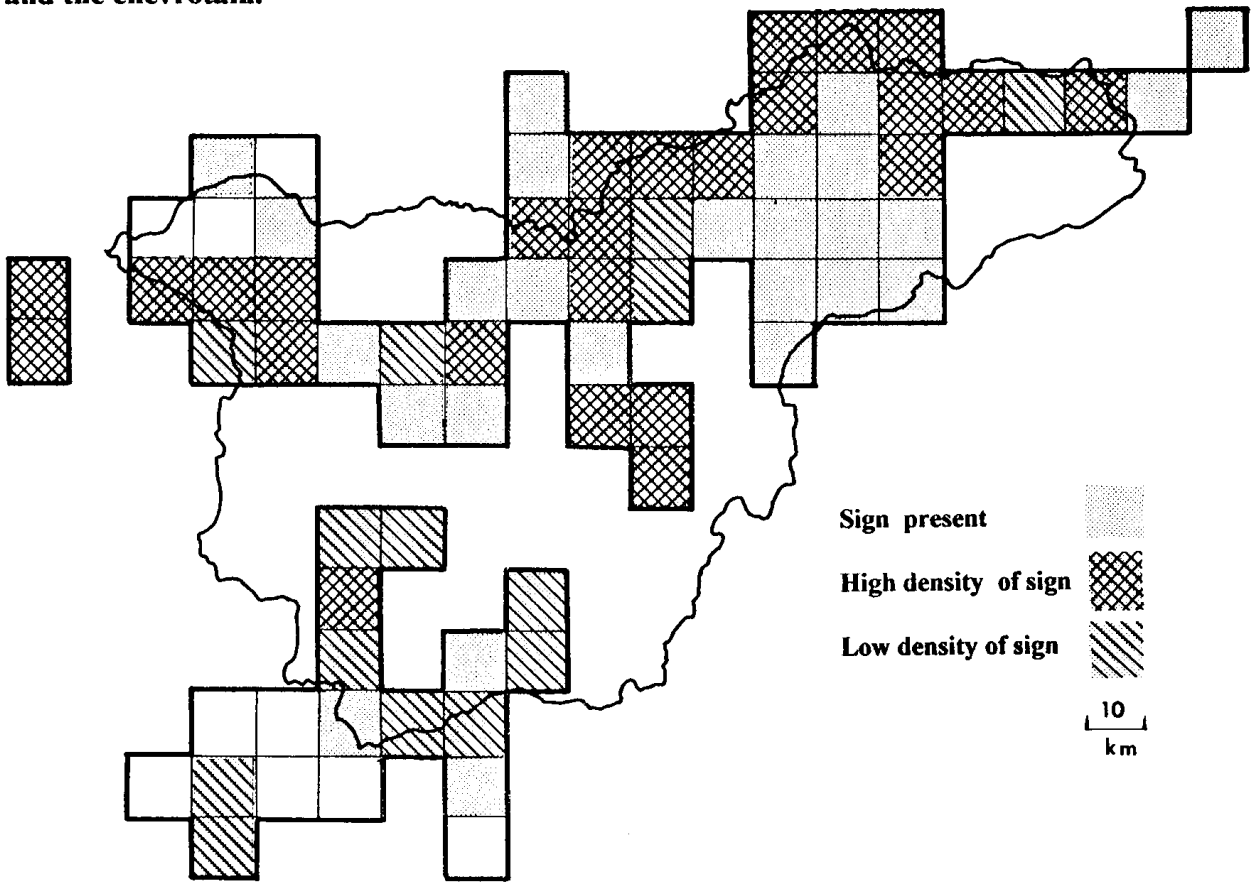
Track and dung of duikers and the chevrotain were usually difficult to attribute to a given species. In addition, the sign of large species is more likely to be detectable than the sign of smaller species (Koster & Hart 1988). therefore, records of all the small ungulate species are combined and reported as "duikers" in the figures and discussion that follows.

Small ungulates occurred widely over the entire Park and surrounding area (FIGURE 23). As a group they are the most abundant of the larger terrestrial mammals.

Habitat associations. Small ungulate sign was recorded in every habitat type on the study area. Some specific habitat preferences were noted: black-fronted duikers *(C. nigrifrons)* favored swamp forests. Chevrotain were localized to upland forests in the vicinity of streams. We recorded a slight increase in relative numbers of duiker sign with increasing coverage of regenerating forest on transacts, however, differences were not significant (FIGURE 15). Duiker sign was also abundant in mature forests, including monodominant *Gilbertiodendron* stands (FIGURE 16). Relative densities of small ungulates were lower in younger regenerating forest and in farmed bush than in older formations. Most small ungulate species are frugivorous and these habitats have lower numbers and diversity of fruiting tree and liana species.

FIGURE 23. Maiko National Park. Distribution and Relative Abundance of Small Ungulates.

Small ungulates censused include 6 species of duikers, Bates' pygmy antelope and the chevrotain.



DISCUSSION

Factors Affecting Mammal Distribution and Abundance

TABLE 13 provides pair-wise correlation coefficients for the frequency of sign of all species pair combinations on the 73 inventory transacts. Significant ($P < 0.05$) correlations in relative abundance were found between chimpanzees, gorillas and okapi; between buffalo and elephant, and between pigs and small ungulates. These correlations point to the importance of habitat and diet as determinants of the distribution and relative abundance of the large mammal fauna in the Maiko Park.

Habitat and Oiet. For most of the large mammal species surveyed, there was a positive correlation between relative abundance and the presence of regenerating vegetation on transacts. The relationship was strongest for the mainly folivorous gorilla, buffalo and okapi, but was also statistically significant for chimpanzees and pigs (FIGURE 15). All of these species prefer secondary forests and disturbed areas where understory vegetation is diverse and productivity is high (Wilkie & Finn 1989).

The preference of chimpanzees and gorillas for secondary forest and the importance of terrestrial herbaceous vegetation in their diet is reflected in the significant spatial association of the species in the Maiko Park and vicinity (TABLE 14). All 15 of the quadrats in which both chimpanzees and gorillas were recorded had higher than average coverage by regenerating vegetation types.

The preference for open edges and wallows by both buffalo and elephant is indicated by the significant correlation of their relative abundance, while that of pigs and small ungulates reflects shared habitat associations of these mainly frugivorous species.

Productivity and diversity of available plant food resources also appear to determine patterns of large mammal use of mature forest types. Transects in areas of greater than 75 % coverage by monodominant *Gilbettiodendron* forest had lowest relative large mammal densities (FIGURE 16). Although *Gilbertiodendron* forests produce huge crops of mast when the trees drop their seeds, these periods of abundance last only two to three months. They are followed by a dearth of available fruits and seeds that may last over two years in a given stand while the trees are non-

TABLE 13. Associations of large mammal fauna in the Maiko National Park. Significant ($p < 0.05$) product moment correlation coefficients (r) of occurrence of sign on the same 500m transect segment are indicated in bold by an astrisk (*).

	Elephant	Gorilla	Chimpanzee	Okapi	Monkeys	Duikers	Buffalo	Pigs
Elephant	- - -	0.12	0.01	0.17	-0.01	-0.05	**0.20***	0.19
Gorilla		- - -	**0.25***	**0.33***	0.13	-0.04	0.12	0.05
Chimpanzee			- - -	**0.28***	0.02	-0.05	0.19	0.09
Okapi				- - -	0.14	0.16	0.12	**0.25***
Monkeys					- - -	0.15	0.13	0.06
Duikers						- - -	0.04	**0.48***
Buffalo							- - -	0.11
Pigs								- - -

TABLE 14 Association of Gorilla and Chimpanzee sign in the Maiko National Park.

		Chimpanzee sign in quadrat		
		Present	Absent	**Total**
Gorilla sign in quadrat	Present	15	5	20
	Absent	23	30	53
	Total	38	35	73

$G = 3.031$, $0.10 < p < 0.05$.

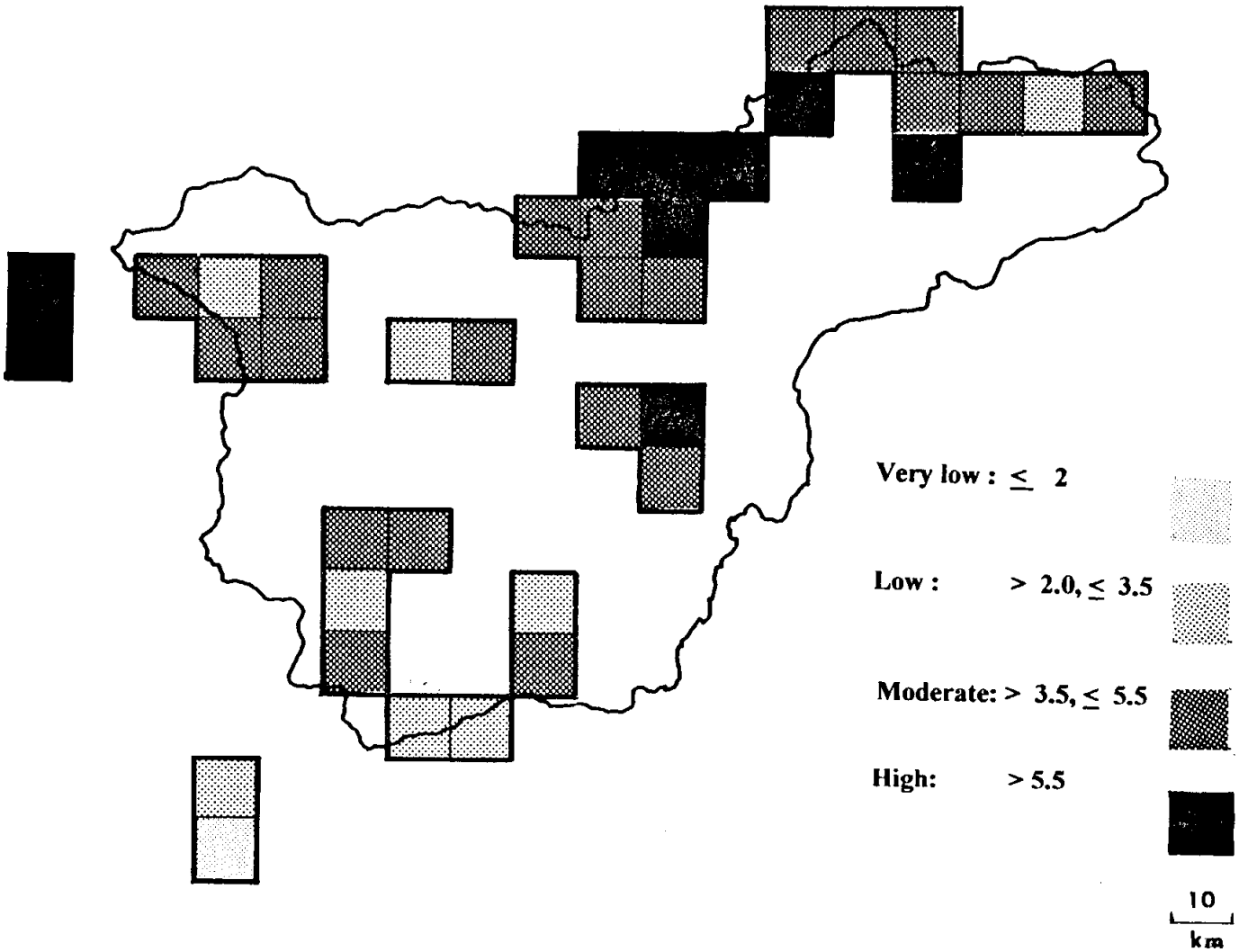
reproductive. Pigs, elephant and buffalo that feed on fallen mast show less avoidance *of Gilbertiodendron* forest than do folivores such as okapi and gorilla. The extent to which any of these species utilize *Gilbertiodendron* forest during non-mast seasons remains to be determined.

Gilbertiodendron dewevrei canopies produce new leaf flush over most of the year (T. Hart, unpublished phenological data). *G. dewevrei* foliage, however, contains high levels of anthocyanins and possibly other secondary compounds (J. Hart, unpublished data). Despite its nearly continuous availability, few large mammals appear able to specialize on it.

One species of duiker, *Cephalophus leucogaster,* appears to prefer *Gilbertiodendron* forest. In both the lturi Forest of Zaire (Hart 1986) and the NouabaleNdoki area of Congo (Fay 1993), *Cephalophus leucogaster,* though not restricted to *Gilbertiodendron* forest, is nevertheless more abundant there than in adjacent mixed forest. *C. leucogaster* appears to be a common species in the Maiko. Frequencies of small ungulate sign increased with increasing dominance by *Gilbertiodendron* up to 75 % coverage.

FIGURE 24. Maiko National Park. Composite Large Mammal Abundance.

Summed relative abundance scores for 8 classes of large mammals in the Maiko Park. High scores indicate highest relative frequency of sign or sightings. See text for details.



Faunal Hot spots. In order to evaluate the geographic distribution of large mammal abundance we created a composite score for each quadrat that was surveyed by transacts. Scores were based on relative densities of all eight taxa combined. Species observed at a low relative density, or with no recorded sign contributed a 0 to the composite score. Species with a high relative density of recorded sign contributed a score of 1.

Quadrats with highest relative large mammal abundance were concentrated in the northern sector of the Park and neighboring regions (FIGURE 24). A number of these "hot spots" were located in the old SOMIBA concession where a diversity of habitats are juxtaposed, including both hill forest and lowland forests as well as a variety of regenerating forest types .

The southern sector of the Park had fewer areas with high composite scores, although this area contained the same range of natural habitat types as in the north. Lowest scores were recorded on transacts in the vicinity of the Kisangani - Bukavu road. The Peneluta area, which is outside the Park, had high faunal scores.

Human Activity. Hunting, with the possible exception of elephant poaching, currently appears to have little impact currently on the fauna of the Maiko Park. Historically, however, there was intensive hunting in what is now the Park area during the SOMIBA mining era when wild game was used to feed the miners (Chapin 1948). The colonial government also maintained a capture station for gorilla and okapi at Etabiri that functioned for nearly ten years until the early 1950's. Many forest taxa, in particular primates, are vulnerable to hunting pressure . When protected areas are opened to hunting, faunal declines may be precipitous (Wilkie *et al.* 1992). While the extent of reduction of wildlife populations during the SOMIBA era is not known, high densities of many species in the area today, including gorillas, suggest that forest wildlife populations can recover from hunting if conditions are favorable.

Large areas of the SOMIBA concession were also cleared for agriculture. Animal sign was recorded abundantly in many of these secondary forest areas. It is possible that the clearing and disturbance associated with contemporary gold panning activities will also contribute to a diversification of habitats that favors the large fauna.

Populations of nearly every large mammal species surveyed appeared to be lower along the new Kisangani - Bukavu road than elsewhere in the Park and surrounding area. Reduced faunal densities extended beyond the immediate proximity of the road to include some of the southern sector of the Park. Four of the nine

quadrats surveyed in the southern sector of the Park (south of the Maiko River) had low composite scores (< 3.5), and none had high scores (> 5.5). In contrast, only 3 of the 26 quadrats surveyed in the northern sector of the Park had low scores, while 9 quadrats had high scores.

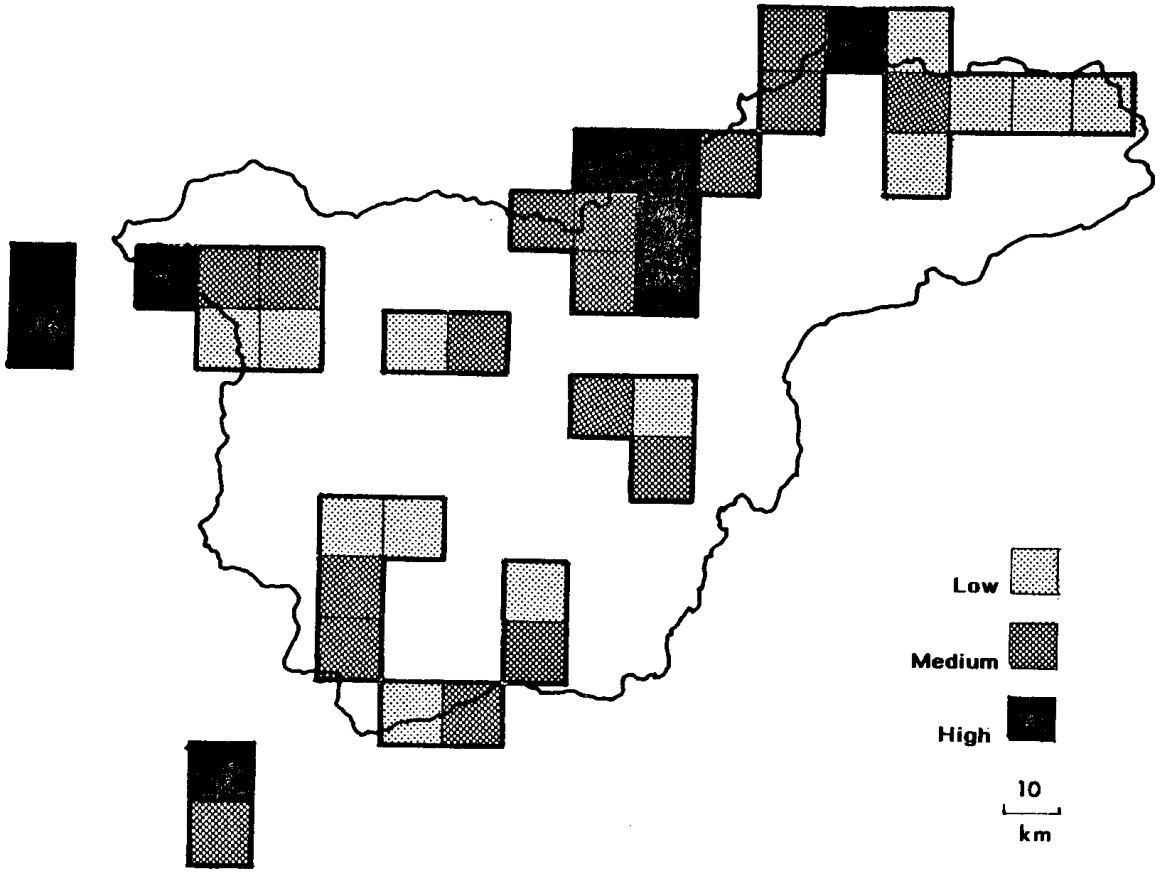
Differences between the northern and southern sector of the Park can not be associated with current human settlement patterns alone. Elephant densities in the Maiko area were not significantly lower in quadrats with human habitation than in uninhabited quadrats. This pattern appears to hold for other large mammals as well.

FIGURE 25 maps an index of relative human impact in each of the quadrats surveyed by transect. This measure incorporates the permanence, size and intensity of human activities in a quadrat that are associated with villages, mining operations and other exploitative actives including fishing and hunting. Permanent settlement in the quadrat was scored as 0 (no settlement), 1 (small settlements only), 2 (mid-sized settlements) and 3 (large settlements and village zones). Mining activity in the quadrat was scored as 0 (no activity or only small ephemeral sites only), 1 (scattered small panning sites), 2 (mid-sized, permanent operations), or 3 (mining complex). Scores for all other,exploitative activators combined including hunting, ranged from little (0) to considerable (3). Scores were summed to produce a composite score for the quadrat. Quadrats with a low level of human activity scored from 0 - 1. Moderate levels of activity are associated with scores of 2 - 4 while high levels of human activity had scores above 4.

Permanent villages are located on the northern border the Park at a number of points between Loya and Peneluta. Human settlement in these areas is currently declining. In the process, large areas of regenerating forest are becoming established as gardens and village sites are abandoned. This process of succession on formerly cleared or partially cleared land appears to favor the large mammal fauna. In contrast, the clearing and forest destruction that takes place during an active human colonization phase, as is currently the case along the new Trans-African highway, appears to have a negative impact on most species. Thus, even though human population densities are currently comparable in the two regions, their relative impact on the fauna is not. A more thorough investigation of differences in hunting pressure between the declining northern frontier and the southern colonization frontier, as well as intrinsic factors such as differences in forest type and overall productivity at the two sites, is needed to further evaluate this hypothesis.

FIGURE 25. Maiko National Park. Human Occupation and Impact.

Relative scores are based on size, permanence and intensity of exploitation associated with village settlements, mining activites and hunting and fishing in the quadrat. High scores indicate quadrats with the higher levels of human activity. See text for details.



Comparisons with Other African Forests

The large mammal fauna,of the Maiko National Park shares basic patterns of species composition and community structure with other large forest areas across the continent. For both ungulates and primates, these include:

-A diverse fauna with highest diversity of mainly frugivorous species.
-Few habitat specialists other than several species restricted to riverine forest or swamps.

The Maiko forest contains at least one ungulate species, the okapi which is unique to the northeastern Zaire region and appears to lack the bongo, a species which has a wide distribution elsewhere but is primarily associated with forests with a more open canopy or with the forest - savanna ecotone. Primate diversity in the Maiko Park is very high. One species of guenon, the owl-faced monkey and the Grauer's gorilla, are endemic to the eastern Zaire forest region and a few adjacent forests of the Albert Rift Highlands. Most of the other large mammal species found in the Maiko have a wide distribution.

Few studies have been able to provide estimates of the numbers of forest mammals even of prominent species. While the methods used in the current study do not permit precise estimates of abundance, densities can be estimated within broad limits thus permitting comparisons between other forest areas, at least in terms of major trends.

Elephants. Estimated elephant densities of 0.4 - 0.9 per kM2 in the Maiko Park and vicinity are higher than earlier.estimates that were based on transacts in the southern sector of the Park only (Barnes *et al* 1992). Our results indicate that Maiko elephant densities are comparable to reported densities at some of the elephant rich sites in Congo, Gabon and CAR (TABLE 15). The estimated Maiko elephant herd of 6000 to 7000 is among the most significant forest elephant populations on the continent.

Highest recorded densities of African forest elephants have been reported from southeastern Cameroon, Dzanga-Sanga in the Central African Republic, and Lope, Gabon. These sites are characterized as having large stands of dense understory vegetation with relatively open upper canopy and abundant Marantaceae. At least two of the sites are located near the savanna ecotone. Estimated elephant densities in the Maiko Park are among the highest for a forest far from the savanna edge.

Barnes *et al* (1 99 1) have pointed to the importance of secondary vegetation as prime elephant habitat in many forest areas. The distribution of elephants in the Maiko supports this generalization, but some mature forest habitats, in particular monodominant *Gilbertiodendron* stands, are preferred seasonally as specific food resources such as mast become available.

TABLE 15. Estimated elephant densities at selected African forest sites.

Site	Density (per km^2)	Reference
Southeastern Cameroon	0.2 - 2.6	Stromeyer & Atanga 1991
Dzanga-Sanga, CAR	0.02 - 2.63	Carroll 1986
Lope, Gabon	0.3 - 3.0	White in press
Northern Congo	0.3 - 0.9	Fay & Agnagna 1991
Maiko NP, Zaire	0.39 - 0.90	This study
lturi, Zaire	0.10 - 0.59	Alers *et al* 1992
Salonga NP, Zaire	0.10 - 0.28	Alers *et al* 1992
Korup NP, Cameroon	0.3	Powell *et al* 1993
Bia NP, Ghana	0.3	Short 1983
Tai NP, Cote d'lvoire	0.2	Mertz 1986
Lomami, Zaire	0.07 - 0.21	Alers *et al* 1992

Gorillas.

Our survey data are not comprehensive enough to permit an estimate of total gorilla numbers in the Maiko National Park. Encounter rates of all gorilla sign were very low, however, and it appears that gorilla densities in the Park are among the lowest of any forest area reported to date (TABLE 16).

Recent analyses of nest construction and decay rates in Lope (Tutin *et al,* in press) have shown that gorilla nests on the ground decompose more quickly than those in trees. Thus gorilla nest groups that include both terrestrial and arboreal

TABLE 16. Estimated gorilla densities at selected sites.

Location	Habitats	Densities (per km^2)	References
Virunga Volcanoes	High elevation forest and bamboo	0.7 - 1.0	Aveling & Aveling 1987; Murnyak 1981
Western Rift	Mid elevation forest and bamboo	0.4 - 0.6	Emlen & Schaller 1960; Yamagiwa et al. 1993
Dzanga Sanga	Logged and unlogged lowland forest	0.89 - 1.45	Carroll 1986
Northern Congo	Lowland forest and swamp	0.1 - 2.4	Fay & Agnangna 1992
Gabon	Lowland forests (varied)	0.01 - 3.2	Tutin & Fernandez 1984
Gabon (Lope)	Forest / savanna ecotone	0.3 - 1.0	White (in press)
Equatorial Guinea	Lowland forest	0.58 - 0.86	Jones & Sabater Pi 1971
Maiko	Lowland forest	< 0.1	This study

nests may become tree nest groups only over time, and could be mistaken for chimpanzee nests. If nest building behavior in the Maiko and Lope are comparable then our survey might have misclassified or failed to count up to 26 % of the gorilla nests encountered since only nest groups with at least one nest on the ground were recorded as belonging to gorilla. Even if this correction factor is applied to crude encounter rates, and assuming a mean nest decay rate of 129 days (Tutin *et al* in press) and an effective strip width of 1 0 m for a nest group counts, gorilla densities still average < 0. 1 /km2 in the Maiko Park.

It is not clear why gorilla densities should be so low in the Maiko. Terrestrial herbaceous vegetation, a key food resource for gorillas everywhere in other areas where they occur, is both diverse and abundant in the Maiko Park. We observed many stands of Marantaceae and Zingiberaceae that appeared to be suitable for gorillas but that were completely unexploited. The overall impression is that gorilla populations in the Maiko are well below their ecological carrying capacity, and in many areas there are no apparent geographic or ecological impediments to their increase in both numbers and range.

The Maiko Park currently constitutes the northwestern limit of the global range of Grauer's gorilla. The localization and apparent geographic stability of gorilla populations in some areas such as the Ogombo massif where the species has been known for the last 50 years, suggests that colonization of unoccupied forest in the region is episodic, if it is occurring at all.

Although gorilla densities appear to be low, there are over 2000 kM2 of the Maiko Park that are likely to include Grauers gorilla range. The total Maiko gorilla population therefore could be significant for conservation, especially since populations in the Park are not threatened by hunting or habitat loss, in contrast to those in many other areas of the species' range (Hall & Wathaut 1992).

Chimpanzees. Chimpanzees have a considerably wider distribution and are more abundant than gorillas in the Park and surrounding area. Overall Maiko chimpanzee densities are highly variable. However, encounter rates of nest groups and estimates of chimpanzee densities appear to fall within the range for populations at other lowland sites in the main forest block (TABLE 17). The average of 1.9 nests per nest group in the Maiko is comparable to group sizes reported in Gabon (Tutin & Fernandez 1984).

TABLE 17. Estimated chimpanzee densities in forest habitats.

Location	Forest types	Densities (per km2)	Reference
Budongo	Mid elevation	6.7	Sugiyama 1968
Kibale	Mid elevation	2.5 - 3.8	Ghiglieri 1979
Gombe	Gallery woodlands	4.2	GoodaII1965
Dzanga Sanga	Lowland (varied)	0.01 - 0.13	Carroll 1986
Gabon	Lowland (varied)	0.03 - 0.50	Tutin & Fernandez 1984
Equatorial Guinea	Lowland (varied)	0.31 - 1.53	Jones & Sabater Pi 1971
Maiko	Lowland (varied)	< 0.01 - 3.0	This study

Though not as clearly marked, the irregular distribution of chimpanzees in the Maiko Park, with areas of apparent concentration separated by less occupied forest, resembles the pattern found for gorillas. Given the overlap in distribution of the two species (TABLE 14) and their similar preferences for secondary forests, it seems possible that this pattern could be a function, at least in part, of the distribution of habitat in the Park.

Priorities for Research and Conservation

Effect of the Park. Overall, the Maiko National Park supports significant populations of all large mammal species surveyed. This is certainly due to the vast size and remote location of the Park, and to the low level of current exploitation of the region. It clearly has little to do with the IZCN whose presence in the Park is minimal.

An important dilemma is posed by the strong positive relationship between the diversity and abundance of large mammal populations and the presence of secondary and successional vegetation in the area. Zairean legislation precludes any human modification of natural ecosystems in national parks. It remains unclear how the cycles of forest renewal that have favored the fauna of the Maiko National Park can be assured in the future without opening the Park to uncontrolled exploitation.

Research Priorities. The Maiko Park still remains a large unknown. While patterns in the distribution of large mammals are beginning to emerge, the inventory and status of essentially all other taxa remain to be discovered.

Birds are among the priority groups for inventory. The Maiko National Park was established in part to protect the Congo Peacock. We were able to document the occurrence of peacocks in several quadrats in the northern sector of the Park, but a more comprehensive assessment of the species' status will necessitate different methods than those used in this study.

Probably the most significant unknown is the Park's flora. Given the region's high annual rainfall and range in elevation, a high diversity of plants including endemics is to be ex - ected. Of particular interest will be the floras of the many massifs that occur throughout the Park.

Conservation recommendations. The isolation of the Maiko National Park, in particular its northern sector, will remain the single most important factor contributing to its protection in the future. Everything to assure the continued isolation of some of the biologically most significant areas should be encouraged, particularly given the IZCN's lack of infrastructure and personnel essential for the protection of the Park.

Isolation is not an option for the southern sector of the Park, as the impact of the first immigrant farmers and loggers moving into the region on the new KisanganiBukavu road has already begun to be felt. Further exploration and inventory are among the priorities for this region, with an emphasis on identifying faunal "hot spots" and the factors that maintain them.

While the new road brings threats it also will bring opportunities. Ecotourism will have potential for at least some areas in the southern sector of the Park. Preparations for this should begin now to maximize options and prevent haphazard developments.

The IZCN's current presence in the Maiko Park is minimal and ineffective. Local antipathy toward the Park and the IZCN are among the most important factors that will ultimately limit the potential for conservation.in the Maiko region. Several changes that could ameliorate relations with local communities and put the Park on a more positive standing regionally include:

-- Relocation of the Park headquarters to the Park borders.

-- Establishment of patrol posts in the local chiefdoms.

-- Recruitment, hiring, and training of local Bakumu and even Simba Rebels as Park guards, guides and wardens.

REFERENCES

Alers, M., A. Blom, C. Sikubwabo, T. Masunda and R. Barnes. 1992. Preliminary assessment of the status of the forest elephant in Zaire. *African Joumal of Ecology 30:* 279 -291.

Aveling, C and R. Aveling. 1987. Report from the Zaire Gorilla Conservation Project. *Primate Conservation* 8: 162 -164.

Barnes, R. and K. Jensen. 1987. How to count elephants in forest. *IUCN African Elephant and Rhino Specialist Group Technical Bulletin 1*-. 1 - 6.

Barnes, R., **M.** Alers and **A.** Blom. 1989. The Poor Man's Guide to Counting Elephant Faeces in Forest, First Draft. Unpublished Field Report. WCI.

Barnes, R., K. Jensen, M. Alers, A. Blom. 1991. Man determines the distribution of elephants in the rain forests of northeastern Gabon. *African Joumal of Ecology* 29: 54 - 63.

Barnes, R. M. Alers, A. Blom, C. Sikubwabo, T. Masunda. 1993. elephants and ivory poaching in the forests of equatorial Africa. Oryx 27 (l)-. 27 - 33.

Bultot, F. 1971. *Atlas Climatique du Bassin Congolais.* INEAC, Bruxelles.

Carroll, R. 1986. The Status, Distribution and Density of the Lowland Gorilla *(Gorilla gorilla gorilla,* Savage & Wyman), Forest elephant *(Loxodonta africana cyclotis* Matschie) and Associated Dense Forest Fauna in Southwestern Central African Republic: Research towards the Establishment of a Reserve for.their Protection. Unpublished Masters Thesis, Yale University, New Haven, CT, USA

Chapin, J. 1948. How the Congo Peacock was discovered. *Animal Kingdom* 51: 67-73.

Colyn, M. 1986. Les mammif6res de la for6t ombrophile entre les rivi6res Tshopo et Maiko (R6gion de Haut Zaire). *Bulletin de 17nstitut Royal de Science Naturelle de Belgique*.- *Biologie* 56: 21 -26.

Emlen, J. and G. Schaller. 1960. Distribution and status of the mountain gorilla (Gotilla *gorilla beringei)* -- 1959. *Zoologica* 45- 41 - 52.

Fay, **M.** 1991. **A** population survey of forest elephants in northern Congo. *African Joumal of Ecology* 29-.177 - 187.

Fay, M. 1993. A Survey of the Proposed Nouabale Ndoki National Park Conservation Area, Northern Congo. Unpublished Field Report. WCI / USAID / Govt Congo / GTZ / World Bank.

Fay, M. and M. Agnagna. 1991. Forest elephant populations in the Central African Republic and Congo. *Pachyderm* 4- 3 -19.

Fay, M. and M. Agnangna. 1992. Census of gorillas in northern Republic of Congo. *American Joumal of Pilmatology 27-.275* - 284.

Ghiglieri, M. 1979. The Socio-ecology of Chimpanzees in Kibale Forest, Uganda. Unpublished PhD. Thesis, University of California, Davis CA, USA.

Goodall, J. 1965**.** Chimpanzees of the Gombe Stream Reserve. in Devore, I (ed) *Primate Behavior.* pp 425 - 473. Holt, Rinehart & Winston, NY, USA.

Hall, J**.** and W. Wathaut. 1992. A Preliminary Survey of the Eastern Lowland Gorilla. Unpublished Field Report. WCI.

Hart, J. 1986. Comparative Dietary Ecology of a Community of Frugivorous Forest Ungulates in Zaire. Unpublished PhD Thesis, Michigan State University, E. Lansing, M 1, USA.

Hart, J. and T. Hart. 1988. A summary report on the behavior, ecology and conservation of the okapi *(Okapiajohnstont)* in Zaire. *Acta Zoologica et Pathologica Antverpiensia* 80: 19 - 28.

Jones, C. and **J.** Sabater Pi. 1971. Comparative ecology of *Gorilla gorilla* (Savage & Wyman) and *Pan troglodytes* (Blumenbach) in Rio Muni, West Africa. *Bibliotheca Primatologica 13*

Koster, **S.** and **J.** Hart. 1988. Methods of estimating ungulate populations in tropical forests. *African Joumal of Ecology* 26: 117 - 126.

Merz. G. 1986. Counting elephants *(Loxodonta africana cyclotis)* in tropical rain forests with particular reference to the Tai National Park, Ivory Coast. *Joumal of Ecology* 24: 37 - 39.

McClanahan, T. 1986. Quick population survey method using faecal droppings and steady state assumptions. *African Joumal of Ecology* 24-. 37 - 39.

Murnyak, D. 1981. Censusing the gorillas in Kahuzi-Biega National Park. *Biological Conservation* 21: 163-176.

Powell,,J, M. Powell and P. Elkan. 1993. Korup Forest Research Project: Status Report. Unpublished Field Report. WCI / USAID.

Short. J. 1983. Density and seasonal movements of forest elephant *(Loxodonta africana cyclotis,* Matschie) in Bia National Park, Ghana. *Mammalia.*

Strohmeyer, C. and E. Atanga. 1991. Report of the Lac Lobeke elephant Survey. Unpublished Field Report. WCI.

Sugiyama, **Y.** 1968. Social organization of chimpanzees in the Budongo Forest, Uganda. *Piimates* 9: 225 - 258.

Tutin, C. and M. Fernandez. 1984. Nationwide census of gorilla *(Gorilla g. gorilla)* and Chimpanzee (Pan *t troglodytes)* populations in Gabon. *American Journal of Primatology* 6: 313 - 336.

Tutin, C, R. Parnell, L. White and M. Fernandez. *in press.* Nest building by lowland gorillas in the Lop6 Reserve, Gabon- environmental influences and implications for censusing. *African Journal of Ecology*

Verschuren, **J.** 1975. Wildlife in Zaire. *Oryx.* 13: 25-33; 149-163.

White, L. *in press*. Biomass of rain forest mammals in the Lope Reserve, Gabon. *Joumal of Animal Ecology.*

Wilkie, D. and **J.** Finn. 1989. Slash-burn cultivation and mammal abundance in the lturi Forest. *Biotropica* 22: 90-99.

Wilkie, D., **J.** Sidel & **J.** Boundzanga. 1992. Mechanized logging, market hunting and a bank loan in Congo. *Conservation Biology* 6:570-580.

Yamagiwa, **J., N.** Mwanza, **A.** Spangenberg, T. Maruhashi, **T.** Yumoto, **A.** Fischer and B. Steinhauer-Burkart. 1993. **A** census of the eastern lowland gorillas *Gorilla Gorilla graueti* in Kahuzi-Biega National Park@with reference to mountain gorillas *G.* **g.** *beringei* in the Virunga region, Zaire. *Biological Conservation* 64- 83 - 89.

ANNEX

ORDONNANCE No 70-312 DU 20 NOVEMBRE 1970
CREANT UNE RESERVE NATURELLE INTEGRALE DENOMME
"PARC NATIONAL DE LA MAIKO"

La Prdsidence de la R6publique,

Vu l'ordonnance-loi **NO** 69-041 . du 22 ao0t 1969 relative 6 la conservation de la nature, notamment I'article 1 er,

ORDONNE:

Article ler: 11 est cr66, dans les territoires de Lubutu, Bafwasende et Lubero, une r6serve naturelle intograle d6nomme' "Parc National de la Maiko."

Article 2-. Les limites du Parc National de la Maiko sont fix6es ainsi qu'll suit-.

La rivi&re Sasi, depuis son embouchure dans la Maiko jusqu'6 sa source- la

I

ligne de crdt, 6 hauteur de la source de la Sasi, jusqu'6 la Rivi6re Loya Moke (1 1 km); la rivi6re Loya Moke'usqu'6 la rivi6re Loya- la rivi6re Loya, jusqu'A 1' embouchure de la i I rivi6re Tabili 1; la rivi&re Tabili 1, vers I'amont jusqu'6 sa source;

De la source de la rivi6re Tabili 1, une droite jusqu'@ la source de la rivi6re Wanza (1 km); la rivi6re Wanza jusqu'@ son embouchure dans la Lindi; la rivi6re Lindi, vers I'aval, jusqu'6 son confluent avec la rivi6re Kanabiro-, la rivi6re Kanabiro vers I'amont, jusqu'b son confluent avec la rivi6re Lulinga; la Lulinga, vers I'amont, jusqu'@ son confluent avec la rivi6re lmbi- la rivi6re lmbi, vers I'amont jusqu'a sa source.

I

De la source de l'imbi, une droite'usqu'A la source de la rivi6re Lokomone, la

i

Lokomone, depuis sa source jusqu'A son confluent avec la rivi6re Lubero, la Lubero, vers I'aval, jusqu'@ son confluent avec la rivi6re Lindi; la Lindi, vers I'amont, jusqu'6 son confluent avec la rivi6re Mandaye (limite Est de la Province Orientale); la -Mandaye jusqu'A 1'embouchure de la rivi6re Nyala (limite Est de la Province Orientale); la rivi6re Nyala jusqu'A sa source (limite Est de

la Province Orientale),

De la source de la **Nyala,** une droite jusqu'6 la source de la rivi6re Mesa (limite Est **de** la Province Orientale); la Mesa jusqu'6 son embouchure dans la rivi6re **Oso; l'Oso** jusqu'@ son embouchure dans la rivi6re Uvia; l'Uvia, vers I'amont, jusqu'@ a son confluent avec la rivi6re Kiambi- la Kiambi, vers I'amont'usqu'6 sa source-

i I

De la source de la Kiambi, une droite'usqu'@ la source de la rivi6re Amanasa,
i

I'Amanasa jusqu'6 son confluent avec la rivi6re Usabidi; l'Usabidi; vers I'aval, jusqu',! son confluent avec la rivi6re Lubutu- la Lubutu, vers I'amont, jusqu'6 sa source, 6

proximit6 de la rivi6re dite Mikulu;

76

De la source de Lubutu, une droite jusqu'6 la source de la rivi&re Ukungu orientate; la rivi6re Ukungu orientale- jusqu'6 son confluent avec la petite rivi6re Bukombo;

Du confluent des rivi6res Ukungu et Bukombo, une drolte jusqu'6 la source de la rivi6re Bali; la Bali ver I'aval jusqu'A son confluent avec la rivi6re Maiko, la Maiko jusqu'@ son embouchure dans la rivi6re Sasi.

Article 3- Dans le cas oCi il seralt constat6 que les terres situ6es 6 l'int6rieur du parc forment le si6ge de droits coutumiers oO autres, une ordonnance d6terminera s'il y a lieu au rachat des autres drolts.

Article 4: La pr6sente ordonnance entre en vigeur **ci** la date de sa signature.

Fait 6 Kinshasa le 20 novembre 1970.

(sd) J.-D. MOBUTULieutenant-G6n6ral.

PLATE 1. ACCESS TO THE MAIKO NATIONAL PARK

A. Bicycles are used to transport beer, kerosene, salt, soap, cloth, fish hooks and other manufactured goods from the Route lturi west of Bafwasende to isolated settlements along the abandoned SOMIBA track. Three to five days are needed to push a standard load of 1 00 to 1 50 kg to Opienge, 1 1 0 kilometers south of the Route lturi roadhead.

B. Claude Sikubwabo on an overgrown stretch of the SOMIBA track north of Opienge. This abandoned road, the only access to the northern sector of the Maiko National Park, ends at the Park's northern boundary on the Loya River, 200 kilometers from the Route lturi.

C. The 800 kilometer Kisangani - Bukavu leg of the Trans-African Highway under construction in 1990 east of the Oso River. When completed, a paved, two-lane road will pass within 5 kilometers of the southern boundary of the Park. Once completed, the new road will become a major corridor of immigration from the densely settled Rift Highlands to the lowland forests of the Maiko Region.

A.

B

C

PLATE 2. TRAVEL WITHIN THE PARK

A. Members of the expedition team on the banks of the Lindi River in the northern sector of the Maiko National Park.

B. Crossing a tributary of the Lindi River in flood on a raft of *Miusanga cecropioides* logs bound with lianas.

C. Crossing the Loya Moke River on a fallen tree during low water.

A

B

C

PLATE 3. LARGE MAMMAL HABITATS

A. An Edo, or large mammal wallow and meadow along a small stream in the Lenge Lenge basin, Northern Sector of the Maiko National Park.

B. *Edos* often contain sites where animals excavate and eat earth, possibly containing high concentrations of minerals. Elephants are prominent visitors to edos and their activity helps to maintain the clearing.

C. A Marantaceae thicket in the northern sector of the Park. Gorilla nests and feeding sign were found immediately nearby.

A

B

C

PLATE 4. GOLD MINING IN THE MAIKO NATIONAL PARK

A. The first gold mines in what is now the Maiko National Park were established during the colonial era in the 1930's by the SOMIBA mining company. Ore crushers and other machines were abandoned by SOMIBA at their headquarters at Angumu in the Northern Sector of the Park when they pulled out about 1950. During the years of peak operation SOMIBA moved hundreds of workers into the area. The old villages and mine sites are now covered by dense thickets and secondary vegetation.

B. Small numbers of free-lance prospectors and gold miners continue to comb the Maiko Park for alluvial gold. Most excavations, such as the one illustrated, are small and quickly overgrown when abandoned.

C. An abandoned excavation pit from a mid-sized modern panning operation in the Angumu area.

D. Few trained geologists are associated with modern gold panning operations in the Maiko Park. Some prospectors rely on traditional divinators to identify placers and to protect claims. This small clearing in the Angumu area contained a -shrine and altar with offerings to the ancestors left **by** hopeful gold panners.

A

C

D

B

PLATE 5. SETTLEMENTS IN THE PARK

A. and B. Villages associated with active gold panning sites in the Etabiri area, Northern Sector **of** the Maiko National Park.

C. The expedition team pauses to rest at an abandoned camp, erected **by** elephant poachers in the Park.

A

B

C

PLATE 6. PEOPLE OF THE MAIKO.

A. A traditional Kumu fisherman with his catch netted in a tributary **of** the Loya

River.

B. Claude Sikubwabo with a "military attachment" of Simba Rebels during happier times in 1991 near the rebel capital, Silisa, in the center of the Maiko National Park. One year later Claude and his team were held as prisoners for over a month by the rebels. After their defeat in the mid 1960's by mercenary and government armed forces, the rebels, who called themselves Simba, (Swahili for lion), fled into the remote forest region near the headwaters of the Maiko River. There they set up a "popular kingdom" that encompassed most of the Park area. Simba numbers in the Park have dwindled steadily since the late 1970's. The Simba are not considered players in the current political transition in Zaire.

C. **The** Zaire National Parks Institute **(IZCN)** patrol post at Loya on the northern border **of** the Maiko National Park.

A

B

C