



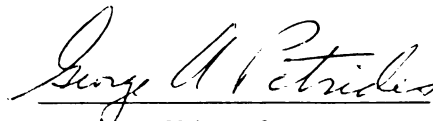
This is to certify that the
thesis entitled

AN ECOLOGICAL SURVEY OF BOUBA NDJIDA
NATIONAL PARK
presented by

Marc Louis Bosch

has been accepted towards fulfillment
of the requirements for

M. S. degree in Fisheries & Wildlife


Major professor

Date November 17, 1977

1876

AN ECOLOGICAL SURVEY OF BOUBA NDJIDA

NATIONAL PARK

By

Marc L. Bosch

A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

MASTER OF SCIENCE

Department of Fisheries and Wildlife

1977

ABSTRACT

AN ECOLOGICAL SURVEY OF BOUBA NDJIDA
NATIONAL PARK

By

Marc L. Bosch

Results of detailed surveys of the vegetation and wildlife of Bouba Ndjida National Park, Cameroon, and recommendations concerning the management of that park are made.

Boubu Ndjida N.P. is a peneplain which supports a shrub and tree savanna. A dense system of watercourses drain the park, and most contain surface water throughout the six-month dry season. Small and medium sized trees of the Combretaceae family dominate the woody vegetation, and woodlands of Isoberlinia doka occur throughout the savanna. Tufted perennial grasses of the genera Andropogon, Hyparrhenia and Loudetia dominate the grass stratum. Fringing forests dominated by Anogeissus leiocarpus occur along most of the streams and rivers of the park, and the few mountains in the park are covered by dense, predominantly woody vegetation. Eight different vegetation types were differentiated and mapped from aerial photographs, and described from field investigations.

The condition of the grasses in the park is degrading, due to uncontrolled annual bush fires which burn most of the park during the dry season. At a critical time of the year for the many herbivores in the park, fire plays an important role in stimulating new growth of perennial grasses and tree leaves and twigs.

The most common large gerbivore species in the park are oribi, hartbeest, reedbuck, Grim's duiker, roan antelope and buffalo, while lions are the most important carnivores. Giant eland are common, and rhinoceros are more abundant in Bouba Ndjida than elsewhere in Cameroon. Descriptions of the distribution, relative density, herd sizes, sex and age structure and habitat preference of the large mammals are given. Fixed standardized transects were established to monitor wildlife distribution and population size fluctuations, and to gather additional information on the wildlife of the park.

Recommendations are made for future park management, specifically concerning personnel, equipment, law enforcement, controlled burning, wildlife viewing, road maintenance, facilities, hunting in zones adjacent to the park, and research.

ACKNOWLEDGMENTS

I would like to thank the government of Cameroon, the United Nations Volunteer Programme, the United States Peace Corps, the Smithsonian Institution, the Food and Agriculture Organization of the United Nations, and the College of Wildlife Management, Garoua, Cameroon, for their support of my work in Cameroon.

I particularly thank the staff of the Garoua Wildlife College for their assistance and encouragement in planning and conducting this study.

TERMS OF REFERENCE AND OBJECTIVES

The author was sent to the College of Wildlife Management, Garoua, Cameroon, in September, 1973 to assist with the teaching program at the college and to conduct research in the national parks of Cameroon, so that the management of the parks and the wildlife of Northern Cameroon could be improved. After consultations and analysis of the needs of the college, and the managers of national parks, wildlife and tourism in Cameroon, it was decided that the author would concentrate his research efforts on conducting an ecological survey of Bouba Ndjida National Park in order to improve and encourage the development of the park. Most of the field work was done between December, 1974, and June 1975, and additional information was collected during the dry seasons of 1973-74 and 1975-76.

A French version of this report (including vegetation map) can be obtained from the Forestry Department of the Food and Agriculture Organization of the United Nations. Bosch, M.L. 1976. Enquete Ecologique du Parc National de Bouba Ndjida. RAF/74/056 Document de Terrain No 2. FAO, Rome.

SUMMARY OF RECOMMENDATIONS

1. Establish and rank by order of priority the objectives of future management of Bouba Ndjida National Park.
2. Increase to three the number of park personnel who have had wildlife and national park management training at the Garoua Wildlife College. Increase to 15 the number of wildlife guards in the park and establish regular on-the-job training for them in anti-poaching procedures; making regular partols in the park; gathering information on the distribution, relative abundance and behavior of wildlife; and the proper use of firearms.
3. Provide one grader, one heavy duty truck, two pick-up trucks and one Land Rover for permanent use in the park. This equipment should be used for road construction, transport of materials and personnel, park surveillance and research.
4. Establish a budget for the park, within which all park activities are planned on an annual or biannual basis.
5. Enforce existing anti-poaching laws. Give park personnel more authority in law enforcement
6. Through education and enforcement attempt to eliminate all unauthorized fires in the park. Inaugurate a program of controlled burning which will improve wildlife habitat and wildlife viewing.
7. Construct a road to the tourist camp which is usable throughout the year, thereby extending the tourist season, facilitate anti-poaching surveillance and improve the provisionment of the camp and park personnel posted there. Improve the condition of existing roads in

the park and construct bridges and drifts at stream crossings to minimize road damage during the rainy season.

8. Establish different entrance fee rates which would attract more visitors and be more convenient to tourists wishing to visit the park.
9. Improve the lodging of park personnel at the tourist camp by constructing permanent "boukarous". Plan future expansion of the visitor camp.
10. Closely supervise all hunting in the hunting zones surrounding the park, and minimize negative human influences on the vegetation and wildlife of these zones.
11. Continue to gather information on the relative abundance and distribution of wildlife in the park by regularly using the six transects established during this study. Continue to investigate the effects of fire on park vegetation.

TABLE OF CONTENTS

	Page
LIST OF TABLES	viii
LIST OF FIGURES	x
INTRODUCTION	
Location and Access	1
History	3
Administration	4
THE ENVIRONMENT	
Topography	5
Climate	5
Hydrology	8
Geology	9
Soils	9
Vegetation	10
Methods	10
Description	12
Condition of Perennial Grasses	24
Succession	27
Growth of Perennial Grasses	28
Value and Use as Wildlife Habitat	32
FAUNA	
General	39
Methods	39
Species Lists	43
Distribution	45
Densities	52
Species Descriptions	53
RECOMMENDATIONS	
Objectives	74
Staffing and Equipment	75
Enforcement	77
Habitat Management and Fire Control	78
Wildlife Viewing	82
Facilities	85
Hunting in Areas Adjacent to the Park	86
Research	91

TABLE OF CONTENTS (CONT.)

	Page
Liturature Cited	92
Appendix A The Plants of Bouba Ndjida National Park . . .	A 1
Appendix B The Mammals of Bouba Ndjida National Park . . .	B 1
Appendix C The Birds of Bouba Ndjida National Park	C 1

LIST OF TABLES

- Table 1. Maximum, mean and minimum daily temperatures ($^{\circ}\text{C}$) of Moundou, Chad based on five years of records (Letouzey, 1968), and of Garoua, Cameroon based on 32 years of records (Cameroon Meteorological Service).
- Table 2. Mean heights and densities of trees and shrubs over one meter in height, and basal cover of perennial grasses in seven vegetation types of Bouba Ndjida N.P., 1976
- Table 3. Relative density, frequency, importance and mean height of tree and shrub species (over one meter in height) in the *Terminalia laxiflora* vegetation type of Bouba Ndjida N.P., 1976.
- Table 4. Condition of perennial grasses in seven vegetation types in Bouba Ndjida N.P., 1976
- Table 5. Number of animals of six ungulate species seen per kilometer travelled in a vehicle and on foot along six transects in different regions of Bouba Ndjida N.P. Mean of Five runs of each transect done between January and June, 1975.
- Table 6. Number of animals of six ungulate species seen per kilometer travelled in a vehicle and on foot in Bouba Ndjida N.P. during five consecutive months. Mean of three vehicle transects and three foot transects done each month.
- Table 7. Population estimates of the large species of mammals in Bouga Ndjida National Park, 1976.

Table 8. Hunting quotas for four hunting zones surrounding Bouba Ndjida N.P., 1974-1975. Figures given are the combined quotas for Zones 10, 11, 12, and 23.

LIST OF FIGURES

- Figure 1. Map of Bouba Ndjida N.P., its roads and watercourses.
- Figure 2. Mean monthly rainfall at Tchollire, Cameroon, based on 22 years of records between 1950 and 1975 (Cameroon Meteorological Service).
- Figure 3. Monthly growth (cm) of perennial grasses, protected and non-protected from grazing, in areas of Bouba Ndjida N.P. which were burned during the month of December, 1974.
- Figure 4. Permanent transects established in Bouba Ndjida N.P. to monitor animal populations.
- Figure 5. Number of ungulates seen per kilometer travelled in a vehicle and on foot along six transects in different regions of Bouba Ndjida N.P. Mean of five runs of each transect done between January and June, 1975.
- Figure 6. Number of ungulates seen per kilometer travelled in a vehicle and on foot in Bouba Ndjida N.P. during five different months. Mean of three vehicle transects and three foot transects done each month.

INTRODUCTION

Location and Access

Bouba Ndjida National Park is located in the northern province of Cameroon between $8^{\circ}21'$ and 9° N. latitude and $14^{\circ}25'$ and $14^{\circ}55'$ E. longitude. Its northern boundary is formed by the Cameroon-Chad international border. The two principal northern towns, Garoua and Ngaoundere, are respectively 140 km northwest and 160 km southwest of the park. Covering 214,040 hectares (826 sq. mi.; Brabant, 1976), it is the largest national park in Cameroon.

Primary access to the park is from Garoua by an all-weather road via Benoue National Park and Tchollire. Almost half of the 250 km of road is paved. Two alternate, shorter routes from Garoua to Bouba Ndjida pass respectively via Pitoa, Dobinga, Bere and Ouarkla; and via Pitoa, Rey Bouba and Tchollire. These routes are passable with ordinary vehicles only between January and May, and are frequently in poor condition. From Ngaoundere the distance to the park is about 275 via an all-weather road, and 250 km via a seasonal road which is passable from January to May.

An 800-meter airstrip is located adjacent to the tourist lodge in the center of the park, and a longer airstrip is located 50 km southwest of the park in Tchollire.

Within the park 300 to 350 km of roads are opened each year at the start of the dry season (Figure 1). Circulation with ordinary vehicles has been easy during the past three dry seasons but road damage caused

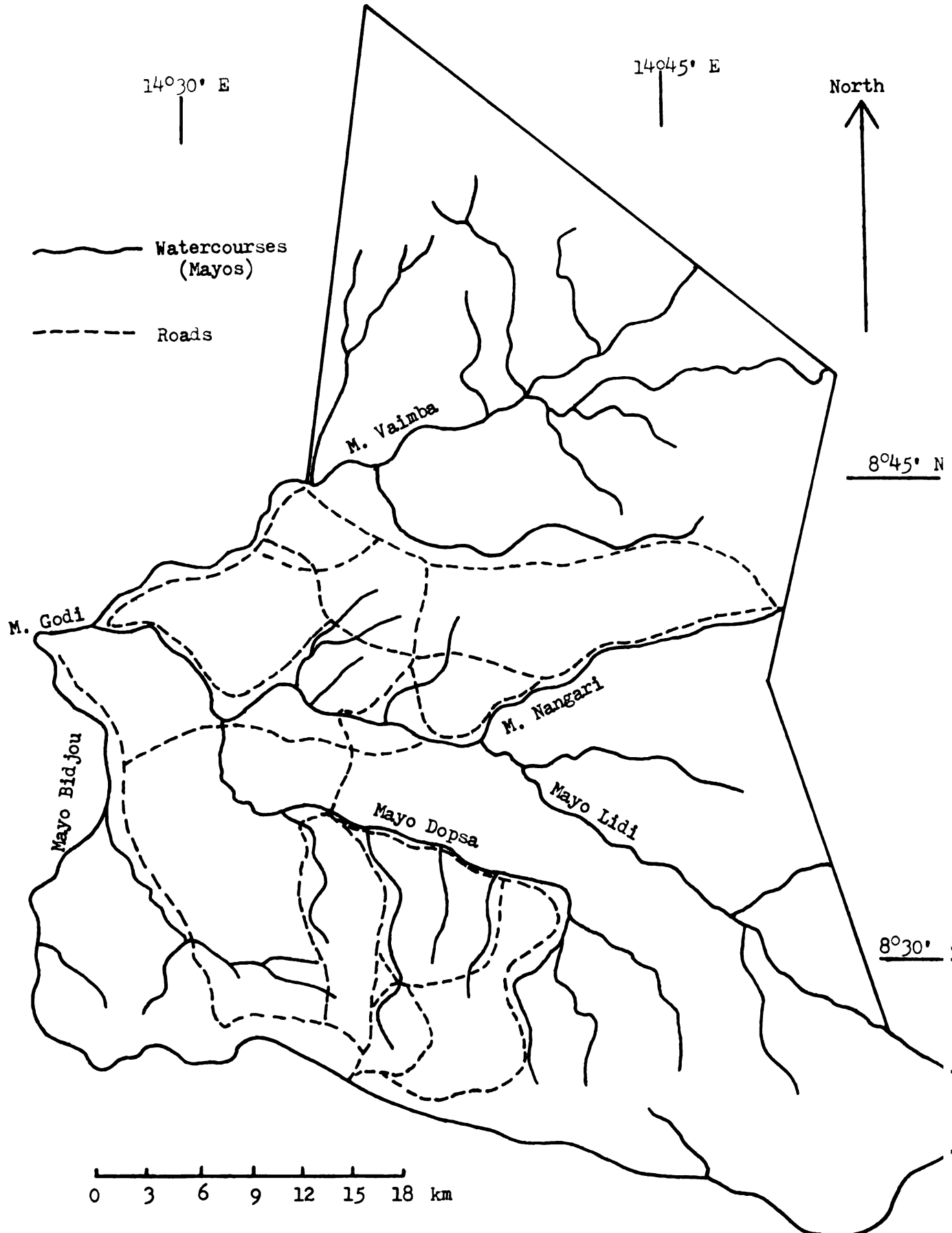


Figure 1. Map of Bouba Ndjida National Park, its watercourses and roads.

by runoff after rainstorms prevents vehicle circulation in the park between May and December.

History

The area now included in the park has been heavily used by people in the previous centuries, but human populations during this century have been low. Their influence on the vegetation and wildlife of the region has been significant through the use of fires and agricultural practices. Few people lived in the area in 1947 when the "Bouba Ndjida Forest and Hunting Reserve" was created. A few game guards were appointed to patrol the reserve, and the people living in the new reserve were slowly evacuated over the following 25 years. During this time woodcutting and agriculture have been virtually eliminated within the park.

Construction of the first roads in the reserve began in 1960, and between 1964 and 1966 a tourist lodge was built in the center of the reserve along Mayo (river) Lidi. The reserve was declared a national park in 1968, and in 1972 the first park conservator was appointed. Lodging and cooking facilities were available to tourists from 1966 to 1973, at which time a full time manager of the lodge was appointed. Complete lodging, restaurant and service facilities have since been available during the tourist season which extends from mid-December until the end of April.

Approximately 500 tourists visit the park each year. They come primarily to view the wildlife, rhinoceros and eland in particular as these species are relatively rare elsewhere in west and central Africa. Tourist use is low because the park is more isolated than Cameroon's other parks, and because Bouba Ndjida has not been adequately publicized in the past.

Some evaluations of the park and its wildlife have been made by (Filizot, 1962, 1970; Taze, 1973), but prior to this study no comprehensive research of the park's vegetation and wildlife had been done, and very little was known of the park.

Administration

The park was administered by the Forestry Department of Cameroon until 1974, when the General Tourism Commission assumed the management of all Cameroon's national parks. The northern tourism delegate (in Garoua) and the park conservator are directly responsible for the functioning of the park. The conservator lives in the park during the dry season and in Tchollire during the rainy season. Six game guards are stationed at posts around and in the park. They are responsible for making regular partols in the park to discourage poaching, to watch over the park and its wildlife, and to assist tourists who visit the park.

THE ENVIRONMENT

Topography

Bouba Ndjida N.P. is primarily a gently undulating peneplain lying between 280 and 400 meters above sea level. There are several low ridges, one chain of mountains and two isolated mountains in the park. Hosere (Mount) Koum is a mountain chain which reaches 900 meters altitude and forms more than 15 km of the southern park boundary. Hosere Vaimba and Hosere Doui rise to 610 and 502 m respectively above the surrounding savanna in the northwestern part of the park.

Throughout the park are several ironstone plateauz (bowe), only a few hectares in area, which generally rest one to five meters above the surrounding terrain.

Most of the park is inclined from the east to the west toward the Benoue River Valley, and almost all watercourses flow toward Mayo Godi in the west-central part of the park. The savanna is drained by a dense system of hundreds of watercourses. The three primary rivers, draining the northern, central and southern parts of the park respectively are M. Vaimba, M. Lidi and M. Dopsa.

Severe gully and sheet erosion has occurred at the confluence of Mayo Dopsa with M. Lidi, and in several other places along Mayos Lidi, Vaimba, Bidjou, Dopsa and Nangari. The present cause of such erosion is the lack of adequate vegetal cover in these areas. Past agricultural practices may have contributed to the extensive erosion which has occurred.

Climate

The climate of Bouba Ndjida N.P. is described by Aubreville (1950) as sudano-guineen. A six month rainy season starts at the end of April

and continues until mid October. No rain falls during the following six month dry season. The park lies between the 1000 and 1250 mm annual precipitation isohyets (Genieux, undated). There are no weather stations in the park, but Tchollire, 50 km to the southwest, has a mean annual rainfall of 1386 mm, based on 22 years of records kept between 1951 and 1975. Moundou, Chad lies 120 km east of Bouba Ndjida and has a mean annual precipitation of 1227 mm based on 21 years of records. Only two years of records exist for Madingrin, 15 km east of the park, where 1017 mm of rain fell in 1974 and 1597 mm fell in 1975. Bouba Ndjida extends up to 60 km north of both Tchollire and Madingrin, so the mean annual rainfall for the park is probably near 1200 mm, although differences in yearly rainfall are often several hundred mm. Rain is registered at Tchollire an average of 77 days each year, while Moundou receives rain on 74 days each year, and Madingrin had 67 rainfall-days in 1974 and 82 rainfall-days in 1975. Over two-thirds of the annual precipitation falls during the months of July, August and September (Figure 2).

Rainstorms typically arrive from the east-southeast. They are often accompanied by strong winds, and last from several minutes to a couple of hours. Large volumes of water fall violently in relatively short periods of time.

There are no reliable temperature data from areas near the park, but temperatures there are similar to those of Garoua and Moundou, (Table 1). Park temperatures probably average 28° C, with a mean maximum of 35° and a mean minimum of 21° .

Relative humidities in the park are also considered similar to those of Garoua, for which data exist for the past 32 years. The mean maximum is 76%, and the mean minimum is 35%, but seasonal differences are great. The most humid month is August, when the mean maximum is 97%,

and the mean minimum is 62%. February is the driest month with a mean maximum of 43% and a mean minimum of 11%.

Between mid-November and April the park is affected by the dry Harmattan wind which carries dust from the Sahara Desert. This wind reduces the relative humidity, and the dust is sometimes thick enough to reduce visibility to 100 meters.

Table 1. Maximum, mean and minimum daily temperatures ($^{\circ}\text{C}$) of Moundou, Chad based on five years of records (Letouzey, 1968), and of Garoua, Cameroon based on 32 years of records (Cameroon Meteorological Service).

	<u>Moundou</u>	<u>Garoua</u>		
	<u>Mean</u>	<u>Mean</u>	<u>Highest</u>	<u>Lowest</u>
Daily maximum	35.3	34.7	39.8(March)	30.2(Aug.)
Daily mean	27.6	28.0	32.4(April)	26.0(Aug.)
Daily minimum	19.9	21.4	25.6(April)	17.1(Dec.)

Hydrology

The watercourses of Bouba Ndjida form a part of the headwaters of the Benoue river system. All but a fraction of the park is drained to the Benoue River via Mayo Godi. Although M. Lidi reaches 100 meters in width, most rivers are 5 to 15 meters wide, and streams are only a few meters in width. M. Vaimba is the only river in the park which flows throughout the year. All other watercourses are temporary, ceasing to flow between October and January each year, and commencing again during June. The riverbeds are always sandy and in numerous places much gneiss and granite bedrock has been exposed by centuries of river action. Water is abundant throughout the park even during the dry season, as bedrock and clay soils often retard water percolation. Mayos Lidi, Dopsa and

Nangari retain very large pools of water during the dry season. Because of the rather steep gradient, runoff after rainstorms is rapid. The only floodplain which has developed is along M. Doumboul in the southeast corner of the park.

Geology

The park rests on gneiss and granite which has been altered to either kaolinite or montmorillonite. Kaolinite is associated with numerous ironstone plateaux and higher areas, and montmorillonite underlies slopes and lower areas (Brabant, 1972). A wide band of micashists is bisected by Mayos Vaimba and Senaroua. Also occurring along M. Vaimba and M. Foro are quartz and feldspar deposities of the quaternary period. The extreme southeastern corner of the park is situated on fossilized ironstone which has a pedologic origin. Along the northern boundary rubified deposits derived from continental formations of the cretaceous period form the bedrock.

Soils

Soil surveys have been carried out in the region by Martin and Segalen (1966), and more intensively by Brabant (1972). Most soils of Bouba Ndjida are leached tropical ferruginous soils (lateritic soils) and mineral hydromorphic soils. The ferruginous soils are usually composed of gray-brown sand on the surface, and coarse, other sand and clay in the lower horizens. They are acidic and quite permeable. There are large accumulations of iron in the B horizen, bound with clay and in the form of hardened concretions. A bedrock of granite or gneiss rich in micas usually lies about two meters below the surface.

The hydromorphic soils are also underlain by gneiss and granite, and average about two meters in depth. They are pale grayish-brown,

acidic, and have a relatively high (30-40%) clay content, especially in the lower horizons. During the rainy season these soils remain extremely moist and often support much earthworm activity, but like the ferruginous soils become completely dry during the dry season.

The above two soil types frequently occur together in the park, the ferruginous soils occupying ridges and hills and the hydromorphic soils occurring on slopes and in valleys. These soils form nearly 90% of the park's soils, and are considerably better than the soils outside the park, based on factors such as clay-sand ratio, compaction, presence of concretions, root penetration and soil depth.

Along M. Vaimba is a wide band of hydromorphic mineral soils on micaschists. They have a low clay content in the A horizon and a high clay content in the B horizons. They are neutral in pH and become extremely dry during the dry season.

Throughout the park are islands of ironstone plateaux (bawe) which support poorly evolved soils up to 20 cm in depth. These bawe were formed by the hardening of ferruginous soils and are up to 250 cm thick.

At the basis of mountains are leached ferruginous soils localized on higher gneiss formations, and along M. Vaimba and M. Foro the same soils form terraced slopes. Shallow soils derived from granite are found in places on the mountains and rocky outcrops of the park where they are protected from erosion.

Vegetation

Methods

The vegetation map was drawn from aerial photographs taken by the "Institute Geographique National" of Paris, and the Garoua sheet of the 1:500,000 topographical map of Cameroon, and also produced by the IGN.

The photos were taken in December, 1969 before the annual bush fires had passed. Boundaries of vegetation formations were therefore easily discernable, and all major formations were mapped. Field work was conducted during the dry season of 1974-75. Much of the park was prospected on foot during which the vegetation was described and analysed. From these known areas vegetative information of non-visited areas was extrapolated using the aerial photos and a stereoscope.

The grass stratum was analyzed for composition primarily in November and December of 1974 and 1975 when perennial grasses were identifiable. Grass density was estimated by measuring the basal cover of perennial grasses by the step-point method as described by Riney (1963). While walking in a straight line, the ground at the end of the operator's shoe was observed after every fourth step. Presence or absence of a perennial grass tussock within 1.5 mm of a point marked on the tip of the operator's shoe was noted. Each transect comprised 100 such points and was about 350 meters in length. The conservation trends and vigor of grasses were assessed at the same time.

Tree and shrub composition, height and density were measured with the point-centered quarter method as described by Cottam and Curtis (1956). At every twentieth step of a straight line transect the ground was visually divided into quadrants, and the nearest tree or shrub above one meter tall in each quadrant was identified and recorded. Its height and distance from the operator were measured. Each transect comprised 100 individual trees or shrubs tallied from 25 different sites, and was about 50 meters in length.

Six exclosures were built in different vegetation types to assess wildlife use of the grasses and to measure the growth of grazed and ungrazed grasses after the passing of bush fires. The exclosures were

were similar to those used by Geerling (1973).

Description

The vegetation of Bouba Ndjida N. lies in a region which Letouzey (1968 described very briefly as having a mid-sudanian and sudano-sahelian type vegetation. Keay (1959) classified this region as part of the sudan zone, which extends from Senegal to the Central African Republic. In fact, the vegetation of the park is composed of species very characteristic of the sudian zone, along with some species more commonly associated with the northern guinea zone. The various vegetative formations can be categorized as shrub and tree savanna, woodland savanna, fringing forest, and a mountainous vegetation which is quite distinct.

Eight different vegetation types have been defined, mapped and analyzed for species composition and structure (see map). Plants recorded in Bouba Ndjida N.P., as well as their habitat affinities are listed in Appendix 1.

Terminalia laxiflora wooded savanna

A dense tree and shrub savanna extends throughout the park, covering a larger area than any other vegetation type in Bouba Ndjida. The trees and shrubs are stunted by bush fires which burn through most of the park between December and March. Their mean height is about three meters - the tallest reach about ten meters tall. The mean density of all trees and shrubs over one meter tall is about one stem per 25 square meters (Table 2). Woody stems less than one meter tall are usually abundant in this type and represent many species. Each year they are burned to ground level by bush fires. A layer of perennial grasses from one to three meters tall dominates the grass stratum. The soils are compact

Table 2. Mean heights and densities of trees and shrubs over one meter in height, and basal cover of perennial grasses in seven vegetation types of Bouba Ndjida N.P., 1976.

Vegetation type	Mean height (m)	Density Nb. stems/ha	Nb. of 100-point sample transects	Basal cover of grasses	
				%	Range
<u>Terminalia laxiflora</u> wooded savanna	2 - 3	400*	60	6.37	2-14
<u>Terminalia macroptera</u> tree savanna	6 - 1	222	5	9.60	7-10
<u>Combretum glutinosum</u> shrub savanna	2 - 3	similar to the <u>T. laxiflora</u> type	5	2.00	1-3
<u>Anogeissus leiocarpus</u> fringing forest	10 - 25	not measured	5	1.80	0-3
<u>Isobertia doka</u> woodland savanna	10 - 15	121	10	3.70	1-6
<u>Monotes keratingii</u> woodland savanna	4 - 6	1500	5	4.20	0-9
<u>I. doka - M. kerstingii</u> woodland savanna	10 - 15	92	5	3.20	1-5
<u>I. doka</u>					
<u>M. Kerstingii</u>	4 - 8	377			

* Density base on all species in this vegetation type; all other densities are those of the type species only (T. macroptera; I. doka; M. kerstingii).

gray-brown sandy-clay and usually measure about two meters in depth.

In measuring 300 trees and shrubs in 30 different areas of this vegetation type, 42 species were recorded. Terminalia laxiflora* is always present and accounts for about 33% of all trees and shrubs of this type, making it by far the most abundant woody species in the park. Other common trees are Crossopteryx febrifua, Burkea africana, Terminalia macroptera, and Combretum glutinosum (often also a shrub). Common shrubs are Piliostigma thonningii, Gardinia aqualla and Maytenus senegalensis. These eight species represent more than three-fourths of all woody stems over one meter tall (Table 3).

Protea elliotii, always a shrub in the park, is widespread on concretious soils of altered kaolinite in the southern part of the park, and in several areas is the most common species. On similar soils some very small Burkea africana woodlands have developed, as well as almost pure stands of three-meter tall Terminalia laxiflora. Maytenus senegalensis and Gardinia aqualla co-dominate the woody vegetation on such soils in the northern part of the park. In general however, there is high species heterogeneity in any given area (Table 3). The mean number of species represented among each 100 stems measured per transect was 13 (range 6-19).

Hymenocardia acida is locally abundant as a shrub, especially on ironstone. Less common trees of this vegetation type include Pseudocedrela kotschyi, Combretum ghaselense, Monotes kerstingii, Detarium microcarpum (usually a shrub), and Isoberlinia doka.

On dark clay soils near streams of very low gradient, thus providing good water availability, small stands of 5-8 meter tall Pseudocedrela

*The authorities for the scientific names of plants are given in Appendix 1.

Table 3. Relative density, frequency, importance, and mean height of tree and shrub species (over one meter in height) in the *Terminalia laxiflora* vegetation type of Bouba Ndjida N.P., 1976

<u>Species</u>	<u>Relative density#</u>	<u>Relative frequency*</u>	<u>Relative importance@</u>	<u>Mean height (m)</u>
<u>Terminalia laxiflora</u>	33.2	69.8	103.0	2.7
<u>Piliostigma thonningii</u>	9.6	27.2	36.8	2.5
<u>Gardinia aqualla</u>	6.8	20.1	26.9	2.2
<u>Maytenus senegalensis</u>	6.2	18.9	25.1	2.2
<u>Crossopteryx febrifuga</u>	6.0	21.5	27.5	3.9
<u>Combretum glutinosum</u>	5.9	17.2	23.1	2.5
<u>Burkea africana</u>	5.1	13.9	19.0	4.4
<u>Terminalia macroptera</u>	3.9	9.2	13.1	6.2
<u>Pseudocedrela kotschyi</u>	2.9	9.3	12.2	3.1
<u>Hymenocardia acida</u>	2.2	6.5	8.7	2.7
<u>Combretum ghaselense</u>	1.9	5.6	7.5	4.5
<u>Protea elliottii</u>	1.9	5.5	7.4	1.6
<u>Detarium microcarpum</u>	1.8	5.7	7.5	1.1
<u>Monotes kerstingii</u>	1.6	5.2	6.8	1.4
<u>Grewia mollis</u>	1.1	4.1	5.2	1.9
27 other species	9.9	-	-	-

- per cent of 300 stems

* - per cent of 750 points where the species is present among 4 stems tallied

@ - relative density plus relative frequency

kotschyi and Afrormosia laxiflora frequently occur and are included in this vegetation type. The sufrutexes Cochlospermum planchonii and Cochlospermum tinctorium are very abundant in this savanna.

The prominent vegetal feature of Bouba Ndjida N.P. is the ever-present grass layer. The grasses of the Terminalia laxiflora wooded savanna are dominated by perennial species of the tribes Andropogoneae and Arundinelleae. Andropogon gayanus is the most common species in the park, occurring almost everywhere. Diheteropogon amplexans and Loudetia flavida are also very common throughout the park. Other commonly occurring species are Hyparrhenia rufa, and Schizachyrium sanguineum. Present but never dominant in the grass stratum are Andropogon schirensis, Beckeropsis unisetata, Cymbopogon giganteus, Hyparrhenia filipendula, H. glabriscula, H. smithiana, Loudetia arundinaceae and L. simplex.

Loudetia flavida, Hyparrhenia rufa and Schizachyrium sanguineum often dominate singly, while Andropogon gayanus, Diheteropogon amplexans and Hyparrhenia subplumosa each usually co-dominate with one or two of the above three species. Hyparrhenia rufa develops best on moist clay soils and is most common in the center of the park. Loudetia flavida tolerates drier, stonier soils and is widely distributed in the northern and southern areas of the park. Diheteropogon amplexans, Schizachyrium sanguineum and Hyparrhenia subplumosa grow well on a variety of soil and moisture conditions. Andropogon gayanus attains excellent development on wider ranges of soil and moisture conditions than any other species, from dry, stony soils to moist, clay soils. A pure stand of the perennial Hyparrhenia quarrei developed on the park airstrip shortly after it was constructed in Terminalia laxiflora savanna.

The percentage of ground actually covered by the bases of these perennials is small, ranging from 2 to 14% and averaging only 6-7% (Table 2). Each tuft is usually 10-20 cm in diameter at ground level and is surrounded by bare soil which gives rise to some annual grasses during the rainy season.

Common, but never abundant, the annuals are represented best by Hyparrhenia involucrata and Sorghastrum bipennatum. On disturbed sites (roads, eroded areas) the following annual grasses develop: Andropogon pseudopricus, Hyparrhenia bagirmica, Aristida kerstingii, Ctenium sp., Digitaria sp., Eragrostis spp. and Panicum spp.

Terminalia macroptera tree savanna

This species dominates in two forms throughout the park. Primarily Terminalia macroptera are trees 6 to 10 meters tall, forming almost pure, well-spaced stands on poorly drained light clay soils. Most common grasses of this type are Andropogon gayanus and Hyparrhenia rufa. Their basal cover extends over approximately 10% of the soil surface.

Often Terminalia macroptera is a shrub or small tree dominant on poorer, better drained soils. In such situations it grows in denser association with Terminalia laxiflora, Crossopteryx febrifuga, Pilostigma thonningii, Protea elliotii, Maytenus senegalensis and Combretum glutinosum, all of 2-4 meter mean height.

Grasses usually present are Andropogon gayanus, Hyparrhenia filipendula, Loudetia flavida, Diheteropogon amplectens, Schizachyrium sanguineum and Hyparrhenia subplumosa. These form a basal cover of 6-7%. This formation could be classified as a subtype of the Terminalia laxiflora wooded savanna, but the successional trend is probably toward mature T. macroptera or Isoberlinia doka woodlands.

Combretum glutinosum shrub savanna

Around Hoseres Vaimba and Doui, and on several ironstone plateaux, a Combretum glutinosum shrub savanna has developed on rocky, sandy ferruginous soils, and very shallow stony, ferruginous soils respectively. Gardinia aqualla is an especially abundant associate species around the mountains, and Terminalia laxiflora, Piliostigma thonningii, Crossopteryx febrifuga, Burkea africana, Monotes kerstingii and Strychnos spinosa are common. Their mean height is 2-3 meters, although Burkea africana is usually a tree five to eight meters tall.

On the bowes Detarium microcarpum is a very common associate species of Combretum glutinosum, while Terminalia laxiflora, Hymenocardia acida, Combretum ghaselense, Burkea africana, Maytenus senegalensis, Gardinia aqualla, Annona senegalensis and Isoberlinia doka are common. Loudetia flavida is the most abundant grass species, and Andropogon gayanus, Loudetia arundinaceae, L. simplex and Diheteropogon amplexans are usually present. On such poor soils grass basal cover is very low, averaging only 2%

Anogeissus leiocarpus fringing forest

The true form of this vegetation type is a narrow belt of trees 10 to 20 meters tall, growing in well drained sandy-clay soils along the banks of most rivers and streams in the park, and dominated by Anogeissus leiocarpus. However, two other related vegetation formations are included under the same map category. One is severely eroded zones along major rivers, characterized by Acacia hockii; the other is dry forests of Diospyros mespiliformes, Prosopis africana or Anogeissus leiocarpus, which have developed away from streams on well drained sandy-clay soils.

The streams and rivers of Bouba Ndjida are, with one exception, temporary watercourses for five to seven months each year, the only exception is Mayo Vaimba, which flows throughout the year. They range from two to fifty meters wide and in some places have formed steep banks up to three meters above the riverbed. In many streams where bedrock has retarded percolation, abundant surface water is present during the dry season.

Resulting streamside vegetation is often a belt, few to 100 meters wide, of well developed trees which form a closed canopy on each side of the river or stream, and occasionally completely over small streams. This fringing forest does not always form a continuous network, but is often interrupted by wooded savanna.

Anogeissus leiocarpus is almost always present and dominant, sometimes forming pure stands 10-20 meters tall. Other common trees of this forest are: Diospyros mespiliformis, which sometimes forms dense stands; Tamarindus indica, Prosopis africana and Lanea kerstingii. Locally abundant are Pseudocedrela kotschyii, Pterocarpus erinaceus, P. lucens, Khaya senegalensis, Daniellia oliveri and Afromosia laxiflora. Other large trees often present are Kigilia africana. Vitex doniana, Acacia sieberiana, and especially along Mayo Dopsa Terminalia laxiflora is a common tree 8 to 10 meters tall.

The secondary stratum of the fringing forest is composed of several small trees and shrubs which tolerate considerable shade. Combretum hypopilinum is always present, and the undershrub Wissadula ampissima is always very common. Very gregarious on sandier soils, and especially common along Mayo Vaimba, is the small tree Combretum nigricans. The shrub Polysphaeria arbuscula is abundant in Diospyros fringing forest.

Other trees and shrubs usually present in the fringing forest are; Piliostigma thonningii, Terminalia laxiflora, Combretum ghaselense, Lonchocarpus laxiflorus and Streospermum kunthianum.

Because of the closed canopy, the herb stratum is rather open. Characteristic grass species are shade-loving Hyparrhenia welwitschii and Beckeropsis unisetata, and shade-tolerating Andropogon gayanus and Pennisetum polystachion. Their basal area covers 2% or less of the soil.

Near the water's edge and in other very moist sites, the tree Syzygium guineense is especially common. Adina microcephala, Allophylus and the shrub Morelia senegalensis are also frequent along stream banks. Nauclea latifolia is locally common, and Mitragyna inermis occurs on a seasonally inundated depression along Mayo Depsa.

Salix ledermanni is very abundant in the streambed of permanently flowing Mayo Vaimba, and the linaas Combretum paniculatum and Acacia ataxacantha are common on the banks.

The shrub Mimosa pigra often grows along the bands of sandy riverbeds. Chloris robusta and Viteveria nigritana are the common perennial grasses in the same habitat, while Saccharum spontaneum and Andropogon gayanus are often present. Along and in the waters of Mayo Vaimba Phragmites kara is abundant.

Severely eroded zones, often several hundred meters in width, occur along the major rivers of the park: Mayos Lidi, Vaimba, Dopsa, Bidjou and Nangari. The soils are shallow and rocky, and underlain with gneiss. Gully and sheet erosion are pronounced on such sites and have prevented high densities of plants, especially of grasses. Very characteristic of these zones is the small tree Acacia hockii. Associate species are

Anogeissus leiocarpus, Combretum glutinosum, Pseudocedrela kotschyi, Combretum ghaselense, Terminalia laziflora, Acacia macrothyrsa, Piliostigma thonningii and Prosopis africana. Large, isolated Tamarindus indica often remains as last remnants of what probably was once a fringing forest of the type described above. Human settlement may have contributed to these degraded zones.

Grasses occurring on these soils are the annuals Andropogon pseudo-pricus, Hyparrhenia bagirmica, Eragrostis sp., Aristata kerstingii and Panicum spp.; and the perennials Andropogon gayanus, Diheteropogon amplexans, Loudetia arundinacea, L. flavida and L. simplex. Basal cover of the perennials is much less than 1%.

Scattered throughout the park on well developed soils are dry forests 12 to 18 meters tall, usually only one to three hectares mespili-formis and the understory shrub Polysphaeria arbuscula. On better drained soils this forest is composed of Anogeissus leiocarpus or Prosopis africana, with the following trees often present: Lonchocarpus laxiflorus, Tamarindus indica, Combretum ghaselense, and Acacia macrothyrsa. Grass species are similar to those of the fringing forest.

Isoberlinia doka woodland savanna

A very characteristic vegetation type in Bouba Ndjida are well developed woodlands of isoberlinia doka, 10 to 20 meters tall. These woodlands develop best on well drained ferruginous soils throughout the park and vary considerable in size and in denseness. Often I. doka are scattered in what would otherwise be termed Terminalia laxiflora savanna, but because of the general dominating presence of I. doka, such formations have been categorized as I. doka woodlands. Although their crowns do not form a closed canopy, I. doka typically are close enough together

to create abundant shade and discourage the growth of other species typically are close enough together to create abundant shade and discourage the growth of other species typical of surrounding vegetation types. Most common woody associates are the shrub Gardinia aqualla and the small tree Pseudocedrela kotschyi. Terminalia laxiflora, Phlostigma thonningii and Ximinia americana are other shrubs frequently present.

Beckeropsis uniseta and Andropogon gayanus dominate the grass stratum. Schizachyrium sanguineum, Hyparrhenia subplumosa, H. rufa, Andropogon schirensis, Ludetia flavida, and the herb Cissus crotalarioides are often common. Basal cover of grasses in these woodlands is low, about 4%.

Isoberlinia doka woodlands also occur around and on many of the bowes in the park. These ironstone plateaux are usually only a few hectares in area, resting three to four meters above the surrounding savanna. I. doka develops best around the edges of the bowes, probably due in part to better year-round water availability on these sites. Especially common associate species are Detarium microcarpum, Burkea africana and Gardinia aqualla. Similar woodlands of mature Isoberlinia dalzielii sometimes occur adjacent to I. doka woodlands.

Another I. doka subtype is formed on large, granitic mountain ridges in the southeastern corner of the park, and on the southern park boundary. I. doka, Prosopis africana and Burkea africana dominate what is often a fairly dense vegetation, especially where soil erosion deposits have accumulated on the boulder-strewn slopes. Other common trees are Butyrospermum paradoxum, Anogeissus leiocarpus and Lanea kerstingii. Ximinia americana, Piliostigma thonningii, Combretum glutinosum and C. ghaselense are frequent shrubs on such ridges.

Isoberlinia doka - Monotes kerstingii woodland savanna

Throughout the eastern and northern parts of Bouba Ndjida N. P. mixed woodlands of Isoberlinia doka and Monotes kerstingii have developed, primarily on sandy ferruginous soils derived from kaolinite. These woodlands are composed of mature I. doka, 10 to 15 meters tall, in close association with younger and more densely spaced M. kerstingii, which is 4 to 10 meters tall. M. kerstingii has invaded established I. doka woodlands, and the successional trend is to the eventual establishment of pure M. kerstingii stands. Often however, the mixture is much less homogeneous, I. doka being more abundant on the sandy-clay soils of slopes and valley bottoms, and M. Kerstingii more abundant on the poorer, rocky, ironstone soils of adjacent ridges and hilltops.

Among the very few associate woody species, Gardinia aqualla, Burkea africana and Ximimia americana are usually represented. With a basal cover of only 3%, Andropogon schirensis, A. gayanus, Loudetia flavida and L. simplex are the common grasses. The herbs Cissus crotalarioides and Asparagus sp. are usually present.

Monotes kerstingii woodland

On sandy well-drained ferruginous soils Monotes kerstingii forms almost pure and very dense stands averaging four to six meters in height. Tree density in five stands ranged from 1000 to 24000 trees per hectare, each tree occupying an area averaging seven square meters (Table 3). These woodlands most commonly occupy low ridges and other elevated areas.

The common grasses of this type, Loudetia flavida, Diheteropogon amplexans and Andropogon gayanus, usually cover 3-5% of the soil surface.

Mountain vegetation

The mountain chain in the southern part of the park, the two mountains in the northwestern part, and other rocky outcrops in the park are

covered with a characteristic heterogeneous vegetation. Much granitic bedrock and boulders are exposed, but these boulders have trapped soil and retarded rainwater percolation, thus providing better water availability throughout the year for plants. The annual bush fires which travel up these slopes each December and January have little effect on the woody vegetation due to insufficient grass fuel among the boulders. As a result of few fires and better water availability, fire tender trees and well developed shrubs and lianas have formed a rather dense forest, especially on northern slopes, where water evaporation is less.

Over 40 species of trees and shrubs occur commonly on these mountains. Especially common on lower slopes are the following: Anogeissus leiocarpus, Boswellia dalzielii, Bombax costatum, Burkea afrivana, Butyrospermum paradoxum, Ceiba pentadra, Entada africana, Kiglia africana, Lanea schimperii, Malacantha alnifolia. Steganotaenia araliacea, Sterculia setigera, Strychnos spinosa, Terminalia brownii and T. laxiflora.

On higher slopes and more shaded exposures the following species are abundant: Anogeissus leiocarpus, Aphania senegalensis, Diospyros mespiliformis, Ficus abutilifolia, Heeria insignis, Lanea kerstingii, Malcantha alnifolia, Nauclea latifolia and Teclea sudanica.

The climber Cissus quadrangularis and the herb Sansevieria liberica are very common on the mountains of the park.

Grasses on the mountains are chiefly the perennials Andropogon gayanus, Diheteropogon amplexans and Loudetia spp.

Condition of perennial grasses

The vigor and conservation trend of perennial grasses was assessed at the same time their basal cover was measured (Table 4). At every tenth observation point of a transect, the grasses within a meter of the

Table 4. Condition of Perennial grasses in seven vegetation types in Bouba Ndjida N.P. 1976.

<u>Vegetation type</u>	<u>Nb transects</u>	<u>Vigor*</u>		<u>Conservation trend#</u>		<u>Overall assessment of transects</u>
		<u>High</u>	<u>Low</u>	<u>Expanding</u>	<u>Not expan.</u>	
<u>Terminalia laxiflora</u>	60	3.1	6.9	2.8	7.2	15 45
<u>Terminalia macroptera</u>	5	5.8	4.2	6.0	4.0	3 2
<u>Combretum glutinosum</u>	5	0.4	9.6	0.4	9.6	0 5
<u>Anogeissus leiocarpus</u>	5	0.0	10.0	0.4	9.6	0 5
<u>Isoperlinia doka</u>	10	2.1	7.9	2.2	7.8	1 9
<u>Isoperlinia - Monotes</u>	5	0.4	9.6	1.4	8.6	0 5
<u>Monotes kerstingii</u>	5	1.4	8.6	1.2	8.8	0 5

* Mean number of high and low vigor stations per 10-station transect

Mean number of stations where tussocks are expanding or not expanding per 10-station transect.

point were carefully inspected. A rating of "high" or "low" vigor was assigned, depending on whether the tussocks exhibited dead centers or dead roots around their edges. The conservation trend (or colonization) was assessed as "expanding" or "not expanding", depending on the presence or absence of colonization, which is visible around the edges of the tussocks. An overall assessment (improving or degrading) of the grasses of each transect was made, based on their vigor and conservation trend. The evaluations were done at least two months after the fires had passed, by which time the perennial grasses had grown 10-20 cm above the ground and such evaluations became possible. Because the Terminalia laxiflora vegetation type is the largest, the majority of the assessments were done on grasses in that type. Sites for transects were chosen at random in different areas of the park.

As can be seen from Table 4, perennial grasses in all but the Terminalia macroptera vegetation type display low vigor, little colonization and an overall degraded condition. This is the result of three basic differences between the T. macroptera vegetation type and the six other vegetation types. First, the soils of the T. macroptera type are better, humid, clay soils, while those of the other types are invariably sandier and drier. This provides better basic habitat for grasses in the T. macroptera zones. Secondly, the grasses in the T. macroptera vegetation type remain green and moist for a longer period than do those in the other types, thus the effects of bush fires are much less severe in areas of T. macroptera. Thirdly, tree density, and thus competition, from trees and shrubs for space, water, nutrients and sunlight is less in the T. macroptera type than in other vegetation types.

Even though the grasses of the T. macroptera vegetation type are in much better condition than those of other types, they nevertheless show

signs of low vigor and poor colonization in many areas. The overall poor condition of perennial grasses in the park should be viewed with concern.

Succession

The original climax communities of the sudan savanna have been eliminated through man's use of fire (Rose Innes, 1971; Hopkins, 1974). Experiments in guinea-sudanian savanna, similar to that of Bouba Ndjida, where areas were completely protected from fire have resulted in large increases in the number of woody species, and a successional trend toward a savanna forest or woodland where trees overwhelmingly dominate the grasses (Ramsay and Rose Innes, 1963).

Many, if not most, woody species of the Terminalia laxiflora and Combretum glutinosum vegetation types of Bouba Ndjida are species characteristic not only of undisturbed wooded savanna, but also of abandoned cultivated fields (Gaston, 1972), and are maintained as shrubs or small trees by annual bush fires. Andropogon gayanus is also characteristic of old fields, and along with other grass species in the park, is quite tolerant of annual fires. Stands of Terminalia macroptera are evidently maintaining themselves due to their unique soil affinity.

The Isoberlinia woodlands are apparently expanding very slowly into adjacent Terminalia savanna, while Monotes woodlands appear to be expanding more rapidly in both Terminalia savanna and Isoberlinia woodlands. Contrary to the conclusion drawn by Silans (1958) for other central African savannas, the Isoberlinis-Monotes woodlands of Bouba Ndjida have evidently resulted from the invasion of Monotes into established Isoberlinia woodlands.

The fringing forests would expand and grow more dense in the absence of fire, but present annual fires are preventing this, and together with

erosion are reducing the size of these forests in several areas. The extensive zones of shallow, stony soils and very low grass and tree densities are a continuous result of erosion and the harmful effects of fire.

The grasses of the park are in poor condition and their overall basal cover appears to be diminishing. This is probably due to strong competition from woody plant species and to early dry-season fires, which do more direct damage to perennial grasses than to trees and shrubs.

In summary it can be said that, given the history of the area and an annual regime of uncontrolled bush fires, former agricultural fields have become shrub, tree and woodland savanna, and the following trends are presently occurring: the phenologies of the Terminalia laxiflora and Combretum glutinosum tree and shrub savannas are being maintained, although the woody component of these savannas is increasing; the Isoberlinia and Monotes woodlands are expanding; the fringing forests are decreasing in size; and the perennial grasses are diminishing in both number and vigor.

Growth of perennial grasses

After the fires of December and January, 1974-75 had passed, enclosures two meters on a side were built on six different sites to prevent larger antelope from grazing the enclosed new shoots of grass. The object was to document the growth rate and availability of grasses after the bush fires, a time when wildlife habitat is drastically changed, and to evaluate wildlife utilization of the pasture. Poles at least 10 cm in diameter and two meters long were cut from small trees to form the sides of the plots.

Five exclosures were built on sites which had burned during December, and one was built in an area burned at the end of January. Four plots were in Terminalia laxiflora savanna and two plots were in Isoberlinia doka wooded savanna. None of the structures were destroyed by elephants or other animals during the five month study period. Each month the mean height of the five longest blades of several marked perennial grass tussocks both within and outside the plots were measured.

As can be seen from Figure 3, grass growth during the dry season in areas where fires have burned all surface parts of perennial grasses was, in general, very slow. The first new shoots usually appeared five to eight days after the fire, and growth was rapid during the following month. As ambient temperatures increased, and relative humidities and available water in the soil decreased, growth slowed markedly and many blades of grass wilted and died. This is represented by the "negative growth" during February and March in Figure 3, and occurred in both protected and unprotected plots. More leaf blades wilted during this period than were replaced by new shoots. April growth was also minimal until the first few light showers arrived, marking the end of the dry season and the start of a period of rapid grass growth.

On the site which was burned in late January, excellent growth resulted until mid-March. Other areas which burned during the dry season were also characterized by vigorous grass growth which started several days after the fire and invariably slowed after a few weeks. This indicates that the time of burn does not make a difference in the initial regrowth of burned grass tussocks during the dry season. They grow vigorously until available soil moisture is exhausted, and then display very little growth until the rains arrive and restore moisture to the soil and air.

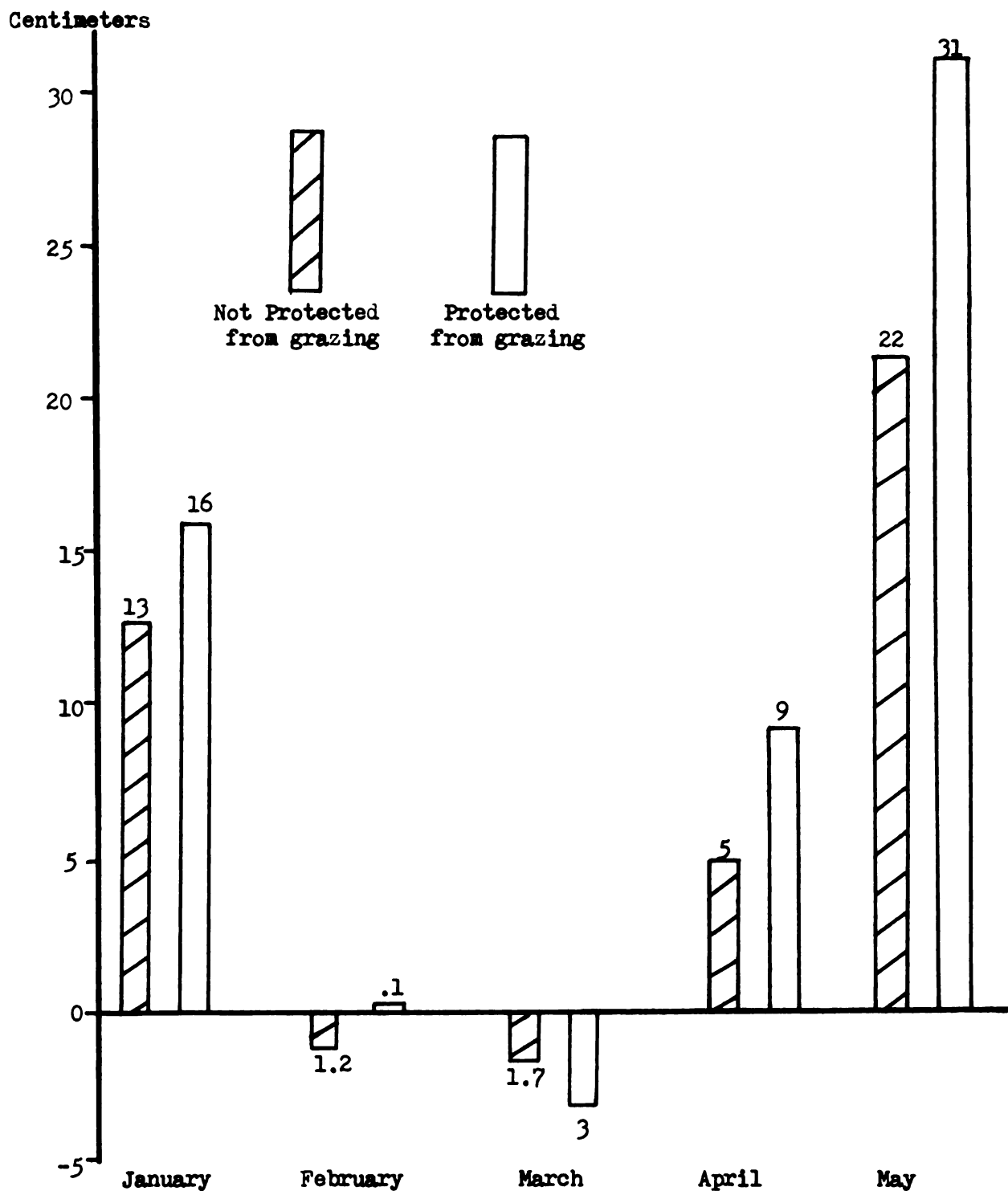


Figure 3. Monthly growth(cm) of perennial grasses, protected and non-protected from grazing, in areas of Bouba Ndjida N. P. which were burned during the month of December, 1974.

Unprotected grasses were actually grazed to a greater extent than is shown in Figure 3, because grazing stimulates more active growth. Total grass production in unprotected plots during January, April and May was greater than that in the protected plots. This production is concealed in Figure 3 by ongoing grazing during each month on the unprotected sites.

VALUE AND USE AS WILDLIFE HABITAT

General considerations

Any evaluation of the vegetation as wildlife habitat must take into consideration the changes in the phenology and structure of the vegetation during the year. The perennial grasses in Bouba Ndjida N.P. mature by October and November, while different species of trees and shrubs come into leaf, flower and fruit at different times of the year, sometimes over a period of several months, sometimes during just a few weeks. To a very large extent the dry season fires determine the quality and quantity of food available to wildlife.

Since several species of grazing antelopes and buffalo form a very high percentage of herbivore numbers in Bouba Ndjida, it is obvious that the perennial grasses form the base of the wildlife diet, and as such are the most valuable park resource. After fruiting (usually September through November), these plants start to transfer food and water reserves from their leaves and stems to their roots. During this process the percentage of protein in the leaves and stems decreases, while the percentage of cellulose increases. Herbage during the dry season is therefore both low in nutrients and poor in digestibility (DeLeeuw, 1976; Gaston, 1972).

Most of these grasses, however, are burned by park personnel in December and January to improve wildlife viewing. In addition to improving visibility, these fires stimulate growth of perennial grasses, which would otherwise remain dormant until March or April. Although the amount of forage produced by each tussock is small, it is of

tremendous importance to the wildlife of the park, since the majority of the park's wildlife species are dependent directly or indirectly on such growth. In its absence, that is in the absence of fire, dry, coarse perennial grasses form the only pasture for wildlife until late March, at which time the first new shoots were observed to appear from unburned tussocks. Thus by the end of January much of the park is carpeted with a nutritious, if thin, pasture of young grass shoots which all herbivores eagerly use. Not by coincidence, December, January and February are the peak calving months for most herbivores. The fresh grass growth provides an excellent diet for female antelopes during their last month(s) of pregnancy and ensuing months of milk production.

Poor grass growth has been shown to occur between February and the start of the rainy season in areas that are burned during December and early January. This is estimated to be the case for 75% of the park's surface. Following the first rains in April, and especially with the more substantial rains of May, grass growth increases dramatically. Not everywhere, however, is this true. Storms pass very locally during April and May, dropping rain on some areas of the park several weeks ahead of other areas. As a result grass growth varies greatly from region to region during the month of May. Some annual grasses become available to the park's herbivores during June, July and August. Thus the soil, climate and annual early fires of Bouba Ndjida combine to produce highly palatable perennial grasses from January to about August, by which time these tufted grasses have grown coarse and much less preferred by most herbivores. Although the quality of grasses may be poorer after August, the very high primary production of these and other plants provide herbivores with the necessary forage to maintain satisfactory diets.

The trees and shrubs in the park generally follow a similar growth cycle as that of the perennial grasses. They are highly resistant to the annual fires which essentially burn only grasses, dead trees and very small woody plant. Even small trees less than one meter tall often survive the intense heat generated by rush fires. This heat does kill the leaves of all but the tallest trees, and browsers are forced to search elsewhere for forage. After a few weeks, usually in January new leaves appear on most trees. This growth continues during the remainder of the dry season. The chiefly browsing herbivores have the best browsing conditions at this time as the new leaves and twigs are more nutritious in the growth period. In areas where fires do not pass, most trees and shrubs replace their leaves gradually during the second half of the dry season (Feb.-Apr.). The majority of trees produce flowers and fruits during the dry season, although there is a great deal of variation between species.

No attempt was made to study the feeding behavior and food preferences of the wildlife of the park. Nevertheless, from general observations and animal distribution studies it was possible to evaluate wildlife use of different park habitats. The relative value of each vegetation type as wildlife habitat, and wildlife use of each type is summarized as follows.

Terminalia laxiflora wooded savanna

This vegetation type is characterized by very large production of a variety of tree and shrub species, most of which are under three meters in height and thus readily available to all browsers. Many species of grass are heavily used by grazers and also by browsers, especially during the dry season when new shoots appear. From the point of view of

forage production, the diversity and abundance of browse and pasture in this vegetation type, as well as its size and juxtaposition with other vegetation types throughout the park, make it the most important vegetation type to the majority of wildlife species.

This wooded savanna is the principal habitat of the following ungulate species: oribi, Ourebia ourebi*; Grimm's duiker, Sylvicapra grimmia; reedbuck, Redunca redunca; hartebeest, Alcelaphus buselaphus; roan antelope, Hippotragus equinus; waterbuck, Kobus ellipsiprymn; warthog, Phacochoerus aethiopicus; buffalo, Symeros caffer; and giraffe, Giraffa camelopardalis. Elephant, Loxodonta africana; hippopotamus, Hippopotamus amphibius; and patas monkey, Cercopithecus patas also rely largely upon forage of this vegetation type. Although eland, Taurotragus derbianus; and lion, Panthera leo; and most other carnivores do not seem to prefer one specific vegetation type over another, they are most commonly seen in the T. laxiflora wooded savanna because it is the largest vegetation type.

Terminalia macroptera tree savanna

Because this vegetation type covers a very small fraction of the park surface it is relatively unimportant to wildlife. However, good grass production together with the higher moisture of these areas combine to provide the best pastures of the park, and herbage which remains unburned for a longer time than that of other vegetation types. Grazers use these areas intensively, especially during the dry season.

Combretum glutinosum shrub savanna

This shrub savanna provides abundant browse, but grass production

* The authorities for the scientific names of mammals are given in Appendix 2

is low due to poor soils. Rhinoceros, Diceros bicornis, and roan apparently prefer this vegetation type over all others, possibly because of some soil factor, or the abundance of the trees Combretum glutinosum and Gardinia aqualla, both of which are browsed considerably by wildlife.

Anogeissus leiocarpus fringing forest

This vegetation type is very important to all wildlife species because almost all dry season water is found in the streams of the fringing forests. These forests also provide abundant cover and considerable browse. Grass production and value is insignificant, except in sandy riverbeds where Chloris robusta is often common and heavily grazed by waterbuck and buffalo in particular. The often dense cover and the tall trees of this vegetation type make it the principal habitat of red-flanked duiker, Cephalophus rufilatus; bushbuck, Tragelaphus scriptus; guereza, Colobus guereza; and tantalus monkey, Ceropithecus tantalus. These species spend much of their time foraging for food in savanna adjacent to fringing forests. Hippopotamus spend the daytime resting in large pools of rivers, and elephants take advantage of the browse and shade provided by the fringing forests. These forests are the principal habitat of leopard, Panthera pardus, and are often frequented by lions. Isoberlinia doka and Monotes derstingee woodland savannas

The three vegetation types dominated by one or both of these tree species are of moderate value to wildlife. Their soils are sandier and drier than the Terminalia savannas and grass production is not as good. Browse abundance and variety are low. Isoberlinia doka provides abundant shade during the early dry season when little other shade is available to wildlife. It is also a browse species preferred by eland. Oribi, reedbuck, Grimm's duiker, hartebeest, roan and eland are the

species most commonly observed in these woodland savannas.

Mountain vegetation

The mountain vegetation provides wildlife with excellent cover and abundant browse. However, the grass cover is usually very low, the slopes are steep, and water is not usually available. It is the principal habitat of baboons, Papio anubis, and rock hyrax, Procavia capensis, and supports several tatalus populations. Roan, Grimm's duiker and oribi are occasionally found on the slopes of park mountains.

Fire

Most of Bouba Ndjida N.P. is burned each year between November and March. Presently policy is to burn the savanna along the roads when grasses become dry enough to burn completely, thereby greatly improving the visibility for wildlife-viewing tourists. This is during December and early January, and coincides with the annual opening of roads in the park. The fires are set by game guards and other park workers who also trek to places away from roads during February and March to burn areas that have not yet burned. This, supposedly, is to prevent wildlife from hiding in thick cover far from the road, where they cannot be seen by tourists. Travellers frequently set fires along a public road which passes through the park between Vamba and Djibao. Poachers set fires and then attempt to kill fleeing wildlife. Fires set outside the park to improve hunting, cattle grazing and foot transportation sometimes spread to the park.

The fires may travel rapidly or very slowly, for long or very short distances. The amount of fuel, dryness of grasses, strength of prevailing winds, time of day, and the presence of streams or roads all affect the speed and intensity of a given fire. Many fires smoulder

during the cool nights of December and January only to be blown to life again the following day. The direction of winds may change, thus changing the direction a fire travels.

Once a fire has started, there is nothing that park personnel can presently do to affect the fire. They are uncontrollable. Nevertheless, whether or not to burn, where to burn, and the time of year and time of day to burn all can and should be controlled to some extent. This is discussed further under Recommendations.

The changes effected by the bush fires on the park and its wildlife are great. From a savanna of two to three meter tall grasses, which are difficult to even walk through, it is reduced to a more open savanna of no grasses (above ground level), scorched trees and shrubs and a thin layer of ashes which covers otherwise exposed soils. No forage is available to wildlife until grass shoots and new leaves appear one to three weeks later.

Fortunately the whole park does not burn at the same time, but areas exceeding 100 sq km are sometimes burned entirely during only one or two days. About 90% of the park's surface is estimated to burn each year from scores of individual fires.

FAUNA

General

Bouba Ndjida N.P. has long been known as one of the richest wildlife areas in Cameroon, but little was known of its wildlife populations. A major goal of the study was to determine the exact status of the various wildlife species in the park. Specifically, information on relative and absolute densities, distribution, reproduction, and movements of the wildlife was needed so that future park management could be based upon a sound foundation of knowledge of the park's wildlife.

Methods

To determine the distribution and relative density of major wildlife species, and to initiate a wildlife monitoring program, several transects were systematically walked and driven once a month for five months during the dry season of 1975. The transects were established in different areas of the park and included portions of most habitat types (Figure 4). Each month a Land Rover pick-up truck was driven at a speed of 20 km per hour along the three road transects. Two observers standing in the rear of the vehicle searched for animals on both sides of the road. When animals were observed, information on species, numbers, herd sex and age structure, surrounding habitat and behavior was noted. Similar information was collected while walking the three foot transects. All transects were driven or walked during the first of the month, between 6:30 and 10:30 hours.

Both road and foot transects were chosen to obtain data and to

Length of Transects

Vehicle Transects

- 1 33 km
- 2 30 km
- 3 35 km

Foot Transects

- 4 10 km
- 5 5 km
- 6 4.5 km

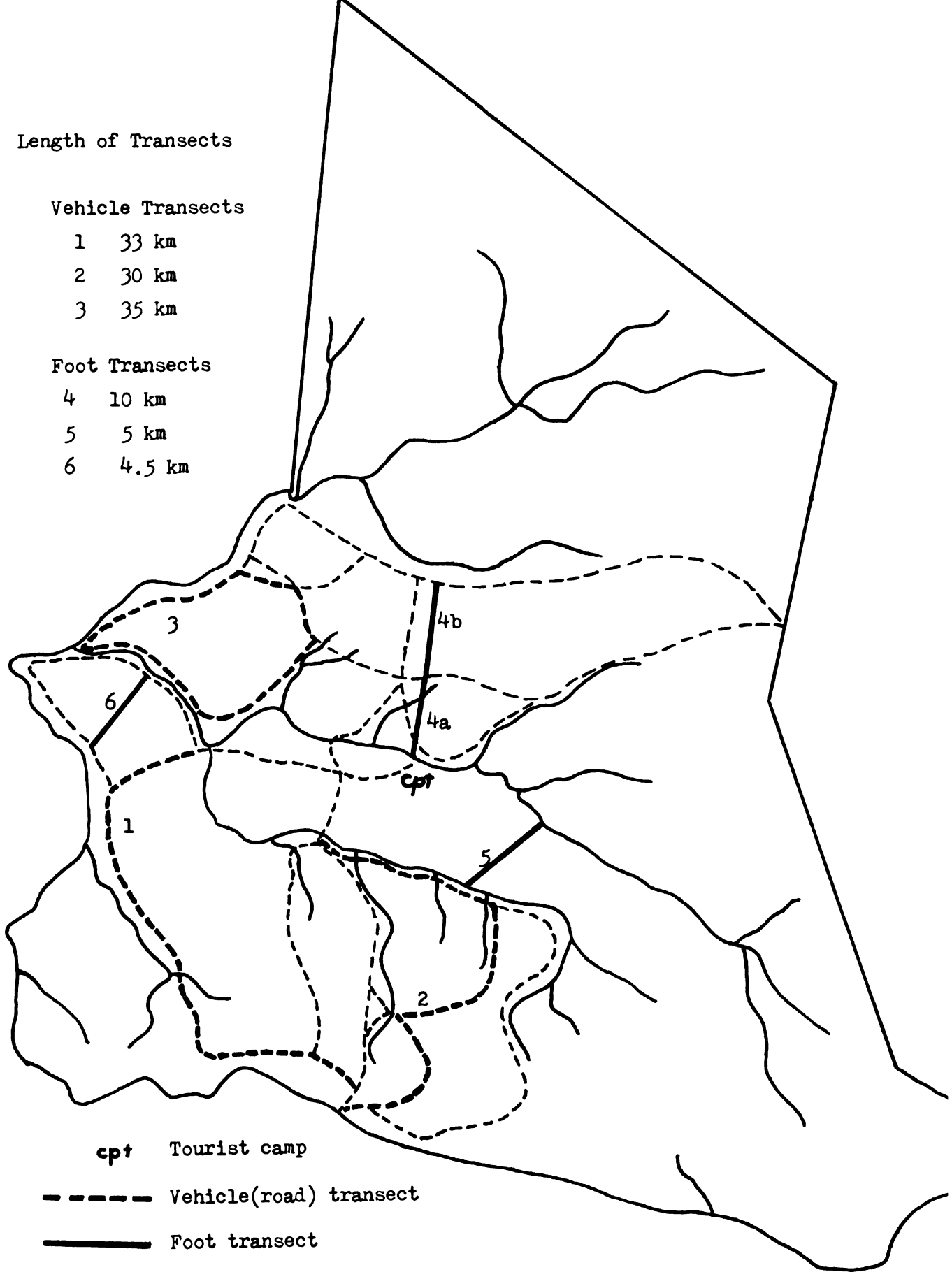


Figure 4. Permanent transects established in Bouba Ndjida N. P. to monitor animal populations.

monitor wildlife because it was obvious that not enough information on the park's wildlife could be gathered from foot transects alone. Also, the roads of Bouba Ndjida are well distributed through much of the park, making vehicle monitoring representative of the park as a whole. Foot transects also served to measure the difference in the number of animals seen while walking and while riding in a vehicle - invaluable information for interpreting the results of the monitoring. The primary objective of the transects was to establish fixed, standardized transects can be driven and walked under similar conditions and at similar times of the year and day for many years to come. This will allow a quantitative assessment of any changes in the condition, distribution, and relative abundance of wildlife populations in the future.

The densities of the most abundant species of wildlife were determined both by employing a road strip census method, and from information gained from the monthly monitoring (Lavieren and Bosch, 1977). Basically the methods consists of measuring with a rangefinder the distance from the observer to the point where an animal(s) disappears in the wooded savanna. The average of the distances measured for many herds and individuals of a given species is multiplied by two and assumed to be the effective stripwidth within which all individuals of that species are seen. This value is multiplied by the length of the road transects to give the total area covered. Dividing the total number of animals of a given species which are seen, by the total area covered, gives the density of that species.

Evaluations of the abundance of less common species, and additional information on the distribution, reproduction and behavior of wildlife

were based on observations made while doing transects and during additional studies carried out in the park. Many areas away from roads were visited on foot to determine the extent of wildlife use and distribution in such areas. Several salt licks were regularly visited to determine to what extent they are used by wildlife.

SPECIES LISTS

Mammals

The mammals known to occur in Bouba Ndjida N.P. are listed in Appendix 2. Five additional species are assumed to inhabit the park, and may even be quite common, but were not observed during the course of the study because of their nocturnal behavior. They are: ratel, Mellivora capensis (Schreber); cape clawless otter, Aonyx capensis (Schinz); spotted necked otter, Lutra macaulicollis, Lichtenstein; giant ground pangolin, Manis gigantea, Illiger; and giant rat, Cricetomys gambianus Waterhouse.

Individuals of four other species possibly, but doubtfully, extend into the park during certain periods of the year: cheetah, Acinonyx jubatus (Schreber); striped hyaena, Hyaena hyaena (Linn.); pale fox, Vulpes pallida (Cretzschman); and red river hog, Potamochoerus porcus (Linn.).

Upon closer investigation several different species of small rodents and bats could easily be added to the park mammal list.

Birds

Although no special study was made of the bird life of Bouba Ndjida, notes were kept of birds observed during the expert's travels and activities in the park. Appendix 3 lists 135 species which were identified in the park. Many more species either inhabit the park permanently or migrate through the park, but are difficult to identify, or, because of their secretive behavior, are rarely seen.

Bouba Ndjida has neither large bird populations nor a great variety of birds. The number of species associated with water is especially low since the park offers few suitable resting or feeding places for such species.

Guinea fowl (Numbida meleagris) and bush fowl (Francolinus spp.) are the only species which are regularly hunted in areas around the park, but both sport and traditional hunting pressure on these hearty birds is light. Regretably, bustards are the target of many hunters, and observations of these spectacular birds have been rare.

Reptiles

Crocodiles, (Crocodulus niloticus) (Laurenti). occur in some rivers of Bouba Ndjida, but the park does not provide good crocodile habitat. They are persecuted by poachers, and the remaining population is represented principally by small, one to two meter long, crocodiles. Tourists never see these interesting reptiles and only one was seen by the expert during three dry seasons.

The varana, Varanus niloticus, is very common along most streams of the park.

Fish

Many species of fish are found in the streams and rivers of the park. The Niger perch, Lates niloticus (Linn.), and the tigerfish, Hydrocynus vittatus (Linn.), are the most characteristic large species. Sport fishing for these species can be very good in Mayos Lidi and Vamba. The fish in several rivers, especially in M. Lidi, are exploited by local park personnel and by poachers who enter the park illegally. They use nets to trap all species and sizes of fish, primarily during the dry season.

Distribution

The general distribution of the most common ungulate species, both in different areas of the park and during different months, can be compared quantitatively in Tables 5 and 6 and Figures 5 and 6. Standardizing all transect observations by expressing them as the number of animals of a given species seen per linear kilometer of a defined vehicle or foot transect travelled, allows a direct and valid comparison to be made of the relative abundance of a given species in different areas of the park and at different times of the year.

The visibility of animals was similar in all transects, that is no transect was considered "more open" or "more wooded" than another. Likewise the visibility did not change greatly during the January to June study period. Best visibility was in February, and although the vegetation in June was denser, the green grass at that time provided a good background for observing animals, and visibility was not much less than during previous months.

Only six of the seven most common ungulate species are considered in Tables 5 and 6. The seventh, buffalo, were observed much less frequently and usually in large herds. Such data did not therefore lend itself to comparisons of the number seen per linear km in space and in time. Data from five additional ungulate species are included in Figures 5 and 6: eland, red-flanked duiker, waterbuck, korrigum, and bushbuck. As can be seen, the addition of these five species represented a relatively small increase in the mean number of ungulates seen while conducting the transects. The difference in Transect 4a (Figure 5) is caused mainly by the abundance of waterbuck in that region, while the differences during March and April foot transects (Figure 6)

Table 5. Number of animals of six ungulate species seen per kilometer travelled in a vehicle and on foot along six transects in different regions of Bouba Ndjida N.P. Mean of five runs of each transect done between January and June, 1975.

Species	Vehicle		Transects		Foot		Transects		
	1	3	3	Mean	4a	4b	5	6	
Oribi	.53	.32	.62	.50	.96	.64	.44	1.10	.75
Reedbuck	.09	.27	.33	.23	.20	.44	.52	2.20	.75
Hartebeest	.23	1.33	.59	.69	.24	1.80	2.48	2.65	1.69
Roan antelope	.13	.05	.14	.11	.04	.60	.00	1.00	.37
Grimm's duiker	.04	.05	.12	.07	.16	.32	.12	.30	.22
Warthog	.05	.03	.18	.09	.00	.00	.16	.20	.04
Mean for six species	1.07	2.05	1.98	1.69	1.60	3.80	3.72	7.45	3.82

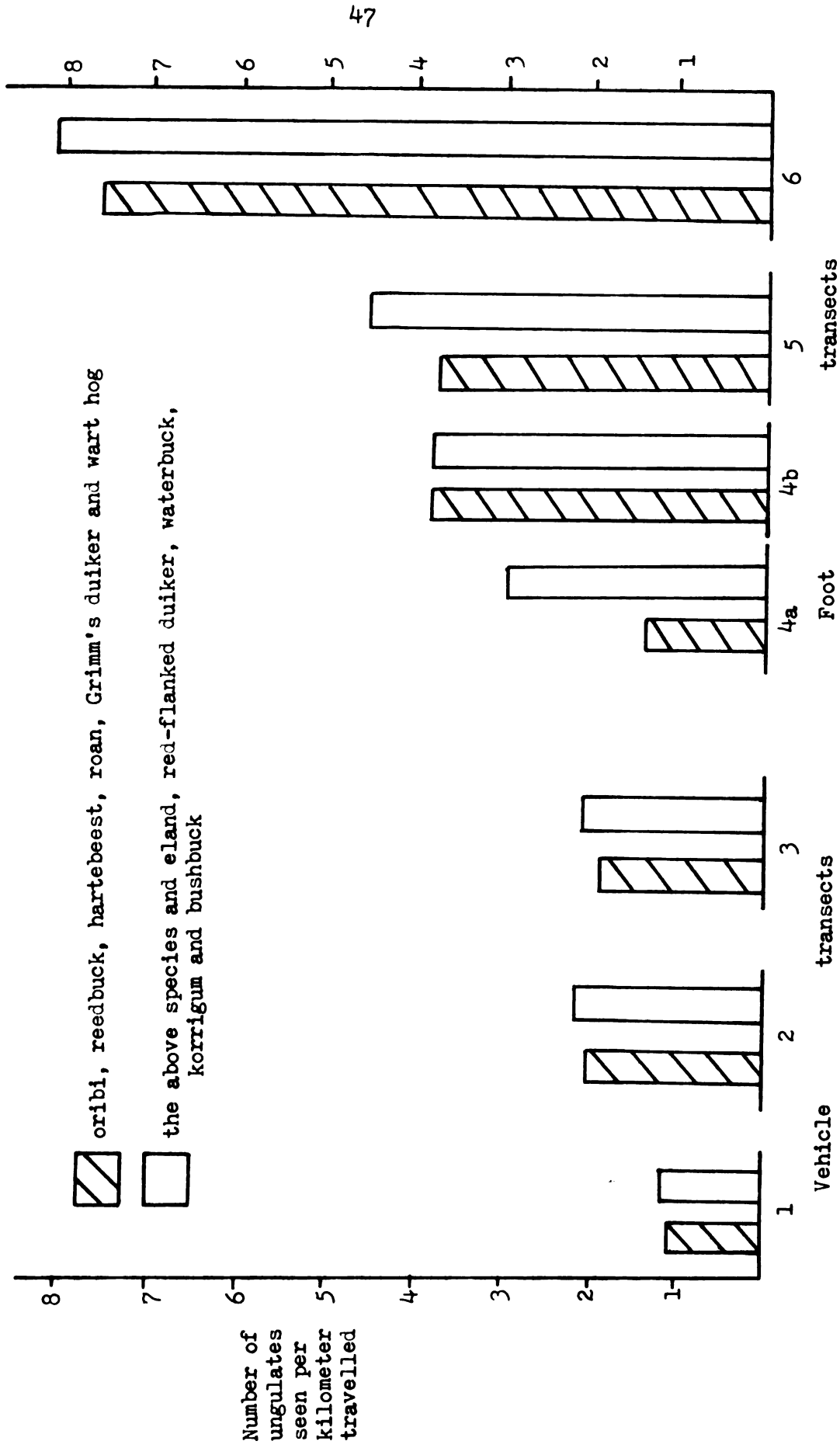


Figure 5. Number of ungulates seen per kilometer travelled in a vehicle and on foot along six transects in different regions of Bouba Ndjida N. P. Mean of five runs of each transect done between January and June, 1975.

Table 6. Number of animals of six ungulate species seen per kilometer traveled in a vehicle and on foot in Boubu Ndjida N.P. during five consecutive months. Mean of three vehicle transects and three foot transects done each month.

Species	Vehicle			Transects			Foot			Transects		
	Jan.	Feb.	Mar.	Apr.	May	Jan.	Feb.	Mar.	Apr.	May	June	
Oribi	.61	.62	.39	.44	.42	.86	1.03	.67	.56	.72	.72	
Reedbuck	.11	.34	.19	.16	.26	.29	.56	.82	1.44	.67	.67	
Hartebeest	.40	.87	.76	.49	.96	3.26	2.21	1.18	1.59	.62	.62	
Roan antelope	.10	.13	.04	.03	.23	.00	1.54	.26	.05	.00	.00	
Grimm's duiker	.02	.09	.14	.06	.04	.11	.10	.41	.26	.21	.21	
Warthog	.08	.17	.08	.09	.02	.00	.17	.00	.15	.05	.05	
Mean of six species	1.32	2.22	1.60	1.27	1.93	4.52	5.61	3.34	4.05	2.27	2.27	

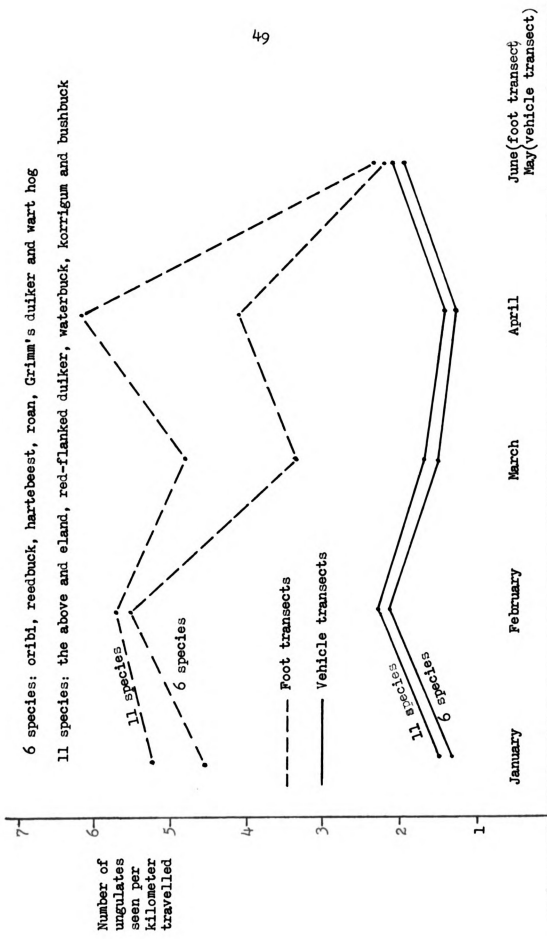


Figure 6. Number of ungulates seen per kilometer travelled in a vehicle and on foot in Bouba Ndjida N. P. during five different months. Mean of three vehicle transects and three foot transects done each month.

represent water buck and two herds of eland.

Obvious from these data is the fact that many more animals are seen per linear km. during the foot transects than during the vehicle transects. Only Transect 1 was located in markedly poorer habitat (less available water and poorer solid and resulting pasture); the other five transects were similar in habitat quality for the 11 species considered. The reason why more animals are seen while walking is thought to be a combination of two factors: the slower pace of movement of the observer allowed more thorough searching for animals and caused fewer animals to flee, and much less noise made by the (walking) observer than by a vehicle resulted in fewer animals fleeing before being counted.

There are considerably fewer ungulates in the area of Transect 1 than where the other two vehicle transects are located (Table 5). This is due to poorer pasture and water supply in the southeast corner of the park during the dry season. The two species which are known to be more tolerant of such conditions - oribi and roan antelope - are indeed as abundant along Transect 1 as elsewhere in the park. Transect 2 is characterized by excellent water availability, better pastures on heavier clay soils and as larger variety of habitat types. Hartebeest populations in this area are very high relative to other regions of the park, and roan numbers are markedly low, reflecting a difference in habitat preference of these two species, the first being chiefly a grazer, and the second chiefly a browser. The region of Transect 3 is more heterogenous in soil and habitat types and supports comparatively average populations of a larger variety of ungulate species.

The foot transects are all located in fairly good habitat with

good water availability. The low ungulate densities along Transect 4a reflect the disturbing influence of man on the wildlife. It is located near the visitor lodge and two roads which are used considerably by tourists and workers, and the habitat is not poorer than that of Transect 4b. All six common ungulate species are considerably more abundant in the region of Transect 6 because it is characterized by a large diversity of habitats with good browse and pasture, and good water supplies. The abundance of reedbuck along Transect 6 is due, in part at least, to the presence of considerable tall grasses in the region which remained unburned during the dry season of 1974-75. Such grasses are preferred and used heavily by reedbuck for cover.

Ungulate distribution between January and June shows some distinct patterns (Figure 6). There is a significant increase in the number of animals seen from January to February due to the regrowth of grasses burned (chiefly along roads) during December and early January. This regrowth forms a nutritious pasture during the months of January and February, attracting grazers from interior regions which have not yet been burned. After such regions are burned in late January, February and March, the regrowth there attracts animals back to those areas. This, combined with higher ambient temperatures in March, which make wildlife less active, resulted in fewer animals being seen during the March counts.

April vehicle counts again reflected the relatively poor grazing conditions near the roads, while the number of animals seen during counts made on foot increased significantly, possibly because of better pasture in such regions after late fires of February and March had passed. The pasture along the roads improved with the first rains in April and more animals were seen while doing the vehicle transects in May. June foot

transects observations decreased considerably from those of April, since by June rain showers had produced good pasture throughout the park, and animals were more evenly distributed. Most animals are more widely dispersed through the park during the rainy season, when water resources are excellent everywhere.

Densities

A detailed description of the results of census methods employed by the expert and other personnel of the Garoua Wildlife College is presented elsewhere by Lavieren and Bosch (1977). Population estimates for all larger species of wildlife are listed in Table 7.

Table 7. Population estimates of the large species of mammals in Boubu Ndjida National Park, 1976.

<u>Species</u>	<u>Total population</u>	<u>Species</u>	<u>Total population</u>
Oribi	11,736	Giraffe	75-150
Reedbuck	5,663	Hippopotamus	0-10
Hartebeest	6,988	Rhinoceros	25-50
Roan antelope	4,356	Elephant	150-300
Warthog	2,196	Lion	50-100
Grimm's duiker	5,400	Leopard	20-25
Waterbuck	1,383	Hunting dog	40-80
Buffalo	1,500-2,000	Sp. Hyaena	20-40
Giant eland	800-1,100	Baboon	1000-1500
Bushbuck	700-1,000	Tantalus monkey	150-250
Red-flanked duiked	1,000-1,5000	Patas monkey	150-350
Korrigum	100-200	Guereza	75-125
Kob	0-20		

Estimates for the first seven species are based on the results of numerous separate censuses. The remaining estimates are based on information gained while conducting the censuses and the monthly monitoring counts, and from observations made in performing other activities in the park during the past three years.

In one respect the estimates for the first seven species should be considered underestimates, as they are based only on animals actually seen during foot and vehicle censused. Although an attempt was made to measure the number of unobserved animals during the vehicle censuses by comparing such data with that of foot censuses, it must be accepted that some individuals are always overlooked. In another respect, however, some estimates may be overestimates, since the amount of human disturbance (poaching) and its negative effect on wildlife along the northern and eastern park boundaries has not been fully evaluated. In any case it can be assumed that the densities of many species in these areas are lower than in better protected regions of the park.

Species descriptions

This section includes the following information (if known) of the major species of wildlife in the park: density, distribution, group size and structure, reproduction data, and predation.

Oribi

The oribi population is the largest antelope population in the park, and is distributed rather uniformly throughout the park in most vegetation types. They prefer more open areas of the park, visiting the fringing forests only to water, and only rarely venturing on mountain slopes. They are primarily grazers, but readily browse on new leaf shoots during the dry season. The relatively high population of oribi

in Bouba Ndjida is probably due to an excellent water availability, and a tree and shrub savanna which provides both good pasture and abundant browse within reach of these small antelope. A fire policy which maintains the present savanna form would assure very good oribi habitat in the future.

Oribi almost always occur singly, in pairs or in a group of three. Of 260 observations made primarily during 1975, the following group were recorded:

Group size	1	2	3	4	5	7
Number of observations	80	101	69	7	2	1
% of observations	31	39	26	3	1	-

Of 395 adults classified by sex in 1975, 45% were males and 55% were females. Adults represented 89% of total observations, while 3% were classified as juveniles, and 8% classified as calves (n: 527 animals). Juveniles and calves were sometimes difficult to distinguish, and the true calf population is probably underrepresented by these figures, since the young rest concealed much of the time during their first few months of life. Young were observed between December and June and the peak calving season appears to be March through May. Calving most likely occurs throughout the year, but dense vegetation during the rainy season limits the number of observations of all animals, especially those of smaller and younger animals. The only instance of mating behavior observed was during early February.

No evidence was found of predation upon oribi since scavengers eat much, and remains of such small animals deteriorate very fast during the humid rainy seasons. Hunting dog and leopard are the main predators of oribi, and smaller cats and birds of prey probably kill a

considerable number of young calves.

Reedbuck

The reedbuck population is difficult to estimate because of the irregular distribution of this species, but rests between 3,000 and 6,000. They are significantly more abundant in the central part of the park where water supplies are better, and more grass cover remains unburned during the dry season. They are particularly abundant in the Terminalia laxiflora savannas along the three large rivers of the park: Mayos Lidi, Vamba and Dopsa.

If the present succesional trend toward a more wooded savanna is allowed to continue, good reedbuck habitat and the reedbuck population will diminish. Since they are almost entirely grazers, they would benefit from any improvement in the quality of park pastures.

Observations of 147 reedbuck groups revealed that reedbuck also are usually found singly or in pairs. The distribution of group size was as follows:

<u>Group size</u>	1	2	3	4	5	6
<u>Number of observations</u>	65	54	20	4	2	2
<u>% of observations</u>	44	37	14	3	1	1

Of 185 adults classified in 1975, 40% were males and 60% females, a ratio which may reflect a behavioral difference between the sexes, or preferential predation upon males. Of 241 individuals classified according to their age, 81% were adults, 5% were juveniles and 14% were calves. An equal portion of new-born were seen in the population from December through June, indicating that no specific calving period exists.

As with oribi, the difference between yearling and calf reedbuck is sometimes difficult to distinguish.

Little evidence of predation upon reedbuck was found, but leopard and hunting dog are most likely their chief predators. Poachers take advantage of the reedbuck's preference for riverine areas as two reedbucks were seen with snares on their neck and leg respectively.

Hartebeest

Hartebeest are probably the second most common antelope in Bouba Ndjida and like reedbuck, prefer the central part of the park where grazing is better and water is abundant. Nevertheless, they are well represented throughout the park, especially in T. laxiflora and T. macroptera and Isoperlinia doka savannas. Because of their size and herding behavior, they give an impression of being the most abundant antelope in the park. These grazers rely heavily on the perennial grass regrowth during the dry season, and a controlled burning program could improve the pasture for this species.

Observations of 1334 individuals occurring singly and in 155 herds revealed the following herd size distributions:

<u>Herd size</u>	1	2-5	6-10	11-15	16-20	21-30
<u>Number of observations</u>	36	67	41	26	15	6
<u>% of observations</u>	19	35	21	14	8	3

The adult population was marked by a very high female population - 69%, while males made up only 31% (n:434). Sex determination is more difficult among hartebeest since both sexes carry horns, but horns of males are markedly heavier than those of females. Only rarely did this characteristic fail in accurately indicating the sex of an adult.

Adults, yearlings and calves composed respectively 60%, 18% and 22% of hartebeest so classified during 1975 (n:1077). Immature hartebeest larger than one half the size of adults were classified as yearlings while those smaller were classified as calves. Calving takes

place throughout the year, but the peak calving period occurs in January and February when high proportions of very young calves were observed.

Hartebeest are very gregarious although several males often form bachelor herds of up to 12 individuals. Lone individuals observed were mainly medium-sized males. Typical mixed herds were comprised of an adult male, 3-5 females, 2-3 yearlings and 2-4 calves. The male defends a territory and jealously guards his harem. Males were often seen defecating at specific points to mark their territory. Territorial and mating behavior were at their peak during March and April. A single female was often observed guarding a nursery group of calves a short distance away from the main herd, while the rest of the herd grazed. Waterbuck, roan antelope and eland were occasionally seen in association with hartebeest.

The hartebeest population in the park seems to be in a healthy condition, and has a high birth rate. Impressions gained over three years indicate the population is expanding. Hartebeest are however, a favorite prey of lions in the park, and numerous hartebeest remains were found during the study. Most of them were of adults, and many of adult males apparently in the prime of life. Hunting dogs also prey upon hartebeest, but lions undoubtedly account for most predation on hartebeest. Poachers are also fond of these antelopes - their camps complete with meat-drying racks and littered with antelope remains were found in the park.

Roan Antelope

A good population of roan is also found in the park. These large antelope are more or less evenly distributed throughout the park and are

well adapted to the pastures and browse conditions available in Bouba Ndjida. Primarily grazers, they nevertheless take considerable browse, especially the leaves and twigs of Gardinia aqualla. They are quite common in the Combretum vegetation type, but also prefer the open and wooded savannas of Terminalia and Isoberlinia.

Roan are usually seen in small herds of 3-9 animals but one males often search out females during the mating season. Observations of 393 roan revealed group distribution as follows:

<u>Group size</u>	1	2-5	6-10	11-15	16-17
<u>Number of observations</u>	37	15	16	11	2
<u>% of observations</u>	46	18	20	14	2

Females were also preponderant among roan adults - 31% were males and 69% females (n:115). Of 298 roan classified by age in 1975, 58% were adults, 18% were yearlings and 24% were calves. December and January were the peak calving month, but calving apparently takes place over much or all the year. Mating behavior was observed twice, during April and May.

Roan are preyed upon by lion and hunting dog, and several kills were found, mostly of adult roan. Remains of young animals often deteriorate completely, but the bones of large animals may remain several years.

Warthog

Warthog are not abundant in the park but are commonly seen in most areas. They are most abundant in the better-watered central portion of the park south of Hoseres Vaimba and Doui. They feed mainly on mat forming stoloniferous grasses, tubers and roots, and prefer areas where they can wallow. The tufted tall grasses of Bouba Ndjida do not provide

good warthog habitat.

They occur alone or in small groups of one or two adults accompanied by up to five juveniles and piglets. The mean group size was 3.0, and the largest group encountered was 8.

Of 103 warthogs classified by age 49% were adults, 10% were considered juveniles, and 41% were young less than half the size of an adult. Piglets were seen from December to June and breeding undoubtedly takes place throughout the year. The mean litter size of the piglets observed was 2.64. Warthog are preyed upon chiefly by lions and leopards.

Grimm's duiker

Grimm's duiker are very numerous in Bouba Ndjida and occur commonly in all vegetation types except on the mountains of the park. They are chiefly browsers, taking advantage of the browse provided by the Terminalia, Combretum and Isoberlinia savannas.

These duikers almost always occur singly; only twice were two seen together. Only one young was observed (during March) as they are kept concealed by the female. Breeding most likely, takes place throughout the year. They are preyed upon by leopard and hunting dog, and the young are exposed to predation by lesser carnivores and by birds of prey.

Waterbuck

Waterbuck are common in the park in certain areas along the major rivers. During the dry season they rarely range farther than three kilometers from Mayos Godi, Lidi, Nangari, Vaimba, Senaroua, Senabou and the lower stretches of Bidjou. During the rainy season they extend their range to the M. Dopsa drainage system and small streams throughout the park. The Terminalia savannas bordering Mayos Lidi and Vaimba are the

best waterbuck habitat in the park.

They are primarily grazers which eagerly feed on grasses and sedges in riverbeds, and the regrowth of perennial grasses after the fire season. Waterbuck drink often and usually stay within one kilometer of a river during the dry season. They frequently sleep on sandy riverbeds or streambanks during the dry season.

Of 68 observations of different groups, the following distribution of sizes was seen:

<u>Group size</u>	1	2	3	4	5-10	11-20
<u>Number of observations</u>	16	17	12	7	10	6
<u>% of observations</u>	23	25	18	10	15	9

The largest group was an all-male group of various ages numbering 20. Another herd comprised 1 adult male and 13 females, almost all adults. Of 116 adults classified by sex, 32% were males and 68% were females. Differentiation by age revealed 63% adults, 19% yearlings and 18% calves.

Yearlings and calves usually accompanied adult females, but occasionally a mature male would take control of a herd. Several all-bachelor herds were observed, as were numerous single adult males. Sometimes only subadults and calves were encountered in a herd. The population seems to be healthy and is probably expanding.

Young were born throughout the dry season and a year-round breeding season is assumed. Waterbuck are common prey of lions, while hunting dogs, leopards and poachers no doubt also kill some. Several skulls were found during the course of the study.

Buffalo

Buffalo are common in the park, but their shyness and tendency to

herd into large groups made encounters with them fairly sporadic. They are more abundant in the southern half of the park than in the northern half, and are particularly common along Mayo Dopsa and its tributaries.

Of 23 observations, the following herd size distributions were noted:

<u>Group size</u>	1-10	11-20	21-30	31-40	41-50	65-80
<u>Number of observations</u>	12	1	4	3	1	1

Herds over a hundred individuals probably occur occasionally. The larger groups were always mixed - mostly females, subadults and young, and a few bulls. Small groups often composed several bulls.

Because of their shyness, accurate aging of herds was difficult, but several calves were always present in the larger groups. The population seems healthy and is probably expanding.

Buffalo require water each day and prefer dense grass vegetation for resting and ruminating. They are chiefly grazers although they sometimes browse new growth during the dry season, notably Gardinia aqualla. They obtain necessary roughage in their diet by grazing the perennial grasses both when these grasses are moist and growing, and when they are dry and coarse. Extensive burning of the park limits the amount of good dry season habitat for buffalo.

The majority of buffalo in Bouba Ndjida are solid reddish-brown, and only about 10% are all black. A considerable proportion of the population are black on the head, neck and shoulders and reddish-brown on the body. The color of a buffalo is no indicator of the sex or age of the animal.

Several remains of buffalo were found in the park, and once a pride of lions was frightened from a buffalo kill they had made the night before. With hartebeest, buffalo are the favorite prey of lions and several hundred are probably killed each year by these carnivores.

Eland

The eland population in Bouba Ndjida is probably the largest remaining population in Cameroon and could be significantly larger than a thousand animals. They are well distributed through the park but appear more abundant in the regions between Mayos Bidjou and Dopsa, and around Gigidge. Both regions have an abundance of Isoberlinia doka, which is very commonly browsed by eland. The especially abundant browse around Gigidge is provided by Isoberlinia which sprouted from root suckers after small scale agriculture was abandoned in the area several years ago. The abundant and widely dispersed Isoberlinia woodlands, and the tree and shrub savannas of the park provide these browsers with abundant forage throughout the park. They do graze leaves of new grass during the dry season.

Of 76 observations made by the author and by tourists during the study, most groups included fewer than ten animals. The breakdown was as follows:

<u>Group size</u>	1	2	3-10	11-20	21-30	31-40	50-100
<u>Number of observations</u>	14	13	18	10	9	5	7

Three eland males were once seen with a larger herd of hartebeest. Herds of 1-4 animals were always all adult males. Larger herds included individuals of all age classes. Because of their extreme shyness very little data was obtained on age structure, but of four herds analyzed, 29% were calves (n:82). Young were seen during March and June, indicating

calving period between January and April, although it is possibly continuous through the year. The number of young in mixed herds indicates a healthy birthrate and good potential for population increase. However, eland tolerate contact with man very poorly, and must have large, undisturbed tracts of land to maintain a high population level. For this reason these huge and impressive antelopes will always be a species which is only sporadically seen in the park.

Lions are the only predators of adult eland. Several remains of eland were found during the study.

Bushbuck

Bushbuck are commonly seen along all fringing forests of the park. They rarely range farther than a kilometer from dense vegetation but normally browse and graze in more open savanna as well as on streamside vegetation. They most frequently are seen alone and occur in pairs of adult male and female, or female and young. Observations of females far outnumbered those of males but relatively few observations were made of these shy antelope. Age ratios indicate a good reproductive rate. Of a sample made in 1975, 70% were adults, 4% were juveniles and 26% were calves (n:53). Immature animals larger than one half adult size were classed as juveniles, and those smaller than one half adult size as calves. New-born calves were seen each month between December and June.

Primarily a browser, bushbuck find good feeding conditions in the fringing forest and shrub savanna of Bouba Ndjida. To a lesser extent they do graze the grasses and sedges of riverbeds and the dry season regrowth of perennial grasses in adjacent savannas. They are timid antelopes which prefer dense vegetation for security. Annual early

bush fires are presently reducing their habitat, while a controlled fire policy could improve bushbuck habitat.

Bushbuck are preyed upon by leopards, and are also favorite prey of poachers, who set snares for them. Such snares often cause crippling injuries and lingering deaths which are not recovered by poachers.

Red-flanked duiker

Red-flanked duiker are also common along fringing forests and other areas where there is thick streamside vegetation. They are very shy antelope but are readily observable if one waits patiently along almost any fringing forest. Most observations were of a single animal, although occasionally two adults were seen feeding together. No young were seen but they are kept hidden carefully by the female.

Both a grazer and browser, this duiker would also benefit from a fire policy which better protected its habitat.

Duiker are preyed upon by leopards and are also exposed to predation by smaller cats and birds of prey.

Korrigum

Korrigum are uncommon in Bouba Ndjida but are reportedly abundant south of the park near Mayo Rey, and there may be some movement of these antelope between the two regions. These grazers prefer short grass pasture and flood plains, which explains their rarity in Bouba Ndjida. All animals seen were in the central part of the park.

The average size of seven groups seen during the study was 5.1. Of 36 animals, 25 were adults, 6 were yearlings and 5 were calves. Calves were seen February, March and May. Korrigum were once seen with hartebeest and once with roan antelope.

Korrigum number will probably never greatly increase in the park,

due to poor habitat and keen competition from other antelope. They are undoubtedly preyed on by lion.

Kob

Six kob antelope were introduced to Bouba Ndjida several years ago. Two observations were made during the study of lone kob in the company of waterbuck. A reliable report also noted a female and young in 1975.

Kob are abundant in similar habitat in the Benoue N.P., but the critical factor why they do not occur naturally in Bouba Ndjida seems to be the presence of a permanently flowing, large river in the former park, and the absence of such a river in Bouba Ndjida. Kob will not become established in Bouba Ndjida because they cannot compete with waterbuck, which occupy and use the habitat preferred by kob.

Giraffe are uncommon in the park, occurring at the southernmost limit of their range in Cameroon. They prefer the more open, Acacia savanna of the Sahelian zone. They occur mainly in the central part of the park, between Hosere Doui, Mayo Dopsa, and M. Nangari. They were frequently seen in eroded zones where Acacia hochii and Combretum spp. were. They have been seen browsing C. glutinosum and Daniellia oliveri.

Size distributions of 62 group observations were as follows:

<u>Group size</u>	1	2	3	4	5	6
<u>Number of observations</u>	22	14	9	7	7	3
<u>% of observations</u>	36	23	14	11	11	5

Young were seen in February and June. The giraffe populations is permanent in the park and is probably increasing.

The remains of one adult were found in the center of the park. Lions may kill young giraffe, but adults have few enemies except poachers

armed with guns.

Hippopotamus

Hippopotamus enter the park only during the rainy season when water levels of rivers have risen and large pools are formed. There is usually a small herd at the confluence of M. Bidjou and M. Godi between August and November, and their tracks have been seen along Mayos Lidi and Vaimba. After November, they move downstream out of the park, since dry season pools are too small to offer enough security to these mammals.

Strictly grazers, they find good grazing conditions on the perennial grass in the park.

Rhinoceros

In Cameroon, rhinoceros are at their northernmost and westernmost range in Africa. Only isolated populations remain in areas of little human disturbance, or where they are provided protection (notably Faro Reserve, and Benoue and Bouba Ndjida National Parks), and Bouba Ndjida is the only area where they are regularly seen. The total population in the park is probably between 30 and 40 animals, and some undoubtedly live permanently in the region west of the park. Almost all rhinoceros observed in the park have been seen between Gigidje and Mayo Vaimba, in the north western part of the park. Some rhinoceros have been seen along Mayos Bidjou, Lidi and Dopsa, and near the southern entrance to the park. They are especially common on both sides of Mayo Vaimba where hydromorphic soils rest on micaschists. This area is also characterized by rocky, hilly country, Combretum and Terminalia shrub savannas, near-continuous fringing forests and close proximity to permanently flowing water - the only such area in the park with this combination of factors.

Forty-four observations of rhinoceros made by the author and tourists revealed the following group size distribution:

<u>Group size</u>	1	2	3	4	5
<u>Number of observations</u>	21	19	1	2	1
<u>% of observations</u>	48	43	2	5	2

Several observations included calves and subadults.

Rhinoceros are almost entirely browsers and feeding on a variety of savanna and fringing forest plants. Only one rhinoceros browsing observation was made, that was of Butyrospermum paradoxum. They have essentially no predators except man, and given adequate protection and minimal disturbance should maintain their present population in the park. Reduced fire damage to fringing forests would undoubtedly improve rhinoceros habitat.

Elephant

Elephant are not abundant in the park, although they apparently have increased their numbers there over the past two decades. This probably reflects the increased activity of man in areas around the park, which can be expected to continue. They are more abundant north of M. Lidi, and in the southwestern part of the park.

Herd compositions of 40 observations were as follows:

<u>Group size</u>	1	2	3	4-10	11-15	20-25
<u>Number of observations</u>	9	4	5	10	6	6

The large groups were composed of several age classes.

The savannas, woodlands, fringing forests and permanent water of Bouba Ndjida provide very good elephant habitat and it is puzzling why they are not more abundant. They both browse and graze and have been noted to strip bark from Prosopis africana and Lannea kerstingii.

Leaves and branches of the following trees are also eaten: Acacia seibiana, Maytenus senegalensis, Parinari curatellifolia, Piliostigma

thonningii and Isoberlinia doka.

Elephant move for considerable distances within and outside the park. With increased human activity on lands surrounding the park, net migration of elephant into the park can be expected to occur in the future.

Lion

Lions are the major predator species in Bouba Ndjida. They are fairly common and range throughout the park. Their roaring is often heard during nights of the dry season. Groups up to 13 individuals have been observed, but lone or paired animals are most common. The author and tourists made 67 observations during the past three years. The following group sizes were noted.

<u>Group size</u>	1	2	3	4	5	6	7	8	11	13
<u>Number of observations</u>	21	15	6	9	4	6	1	2	2	1

Groups of four or more invariably included several cubs and once one female was seen accompanied by seven cubs, most likely her own and those of another lioness. Lions are particularly fond of lying on the sandy tracks of the park shortly after nightfall, since the sand guards the heat of the day longer than does the adjacent savanna. They are often seen on the airfield near the visitor lodge and sometimes enter the camp itself.

With large and varied herbivore populations and good water availability, Bouba Ndjida provides excellent lion habitat. Preferred prey of lion in the park are buffalo and hartebeest, but a number of other species are also preyed upon.

Leopard

Some fringing forests and the mountains of Bouba Ndjida provide good habitat for leopard but observations of these chiefly nocturnal

carnivores are rare, and a population estimates is difficult to make. Six observations have been made during the past four years along Mayos Vaimba, Lidi and Nangari. Poachers persecute leopard since their skin is worth considerably money on the open market and are freely sold in Cameroon. The attempt to protect the leopard will not succeed until both killing them and selling their skin are prohibited, and law offenders are prosecuted rather than ignored. This species will probably continue to suffer from increased human activity in and near the park.

Hunting dog

Wild dog are not uncommon in the park, but they have a wide range, and observations have been sporadic. They hunt a certain locality for a few days or even several weeks, and then move on to another region. If they are hunting an area near roads they are often seen on the tracks at dusk.

During the past three years 19 observations were made of hunting dig, and the following group sizes were noted:

<u>Group size</u>	2	3	4	5	6-8	10	16	17
<u>Number of observations</u>	2	5	1	3	2	4	1	1

They were seen at dawn, dusk and during the day. No young were observed, but young are usually kept at the den site while adults hunt. A pack is usually active in the area near the tourist lodge each year during the dry season, and a den is suspected to be present.

Hunting dog may temporarily affect the distribution of some prey species in the area where they hunt. Waterbuck and hartebeest particularly were at times less commonly seen in areas that hunting dogs were known to occupy. Reedbuck, oribi and Grimm's duiker probably also form part of this predator's diet. Tall grass between August and December

may limit hunting dog abundance in the park, as they make hunting more difficult for the predator.

With lion and leopard, hunting dog are the chief predators of the park. Their role in the balance and maintenance of herbivore populations is an essential and important one, as they cull the weak and old individuals, and through constant predation maintain the reproductive vigor of prey populations.

The size of the hunting dog population, as well as those of leopard and lion, is directly proportional to abundance of available prey. Predators are not responsible for any decline in prey populations, but rather adjust their numbers accordingly through emigration, territorial behavior and changes in reproductive patterns.

Hyaena

There have been no recent observations of hyaenas in the park, but droppings and a lower jaw were found during the study and were assumed to be of the spotted, rather than the striped, hyaena. They are probably fairly common, but since they are chiefly nocturnal little information was obtained. Hyaena are scavengers but are also known to prey on several species of wildlife. The relative lack of bones and other remains of animals which have died or been killed is due to a large extent to hyaena scavenging. With the vultures, hyaena form an important component in natural life processes in the park.

Jackal

Jackals are known in the park by their dropping and their call. Mainly nocturnal, these predator-scavengers do not seem to be very abundant.

Serval

Serval are common in the park and were frequently seen along the road after dark. They feed on rodents, birds, lizards, hares, and probably new-born duiker and oribi.

Caracal

Only one observation was made of a caracal, that during the day in a recently burned area near water. They have a diet similar to serval, and probably occur throughout the park.

Baboon

Baboon are common around all rocky hills and mountains in the park and during the dry season are frequently seen along the major rivers of the park where water supplies are best. They spend much time along riverbanks foraging for food, grooming and resting.

Troops usually number 10 to 30 animals, although larger groups and lone males were sometimes seen. The young are born throughout the year. It is puzzling why baboons are not more abundant than they appear to be in Bouba Ndjida, but it could be due to a lack of tall trees suitable as sleeping sites, and close to water. They are preyed upon by both lion and leopard.

Tantalus monkey

Tantalus, or vervet, are much less common in the park than baboons, but the mountains and fringing forests do support several populations. They are almost always seen in fairly dense cover near water, but do range into savanna to forage for food. Several lone tantalus were seen and the largest group numbered nine.

In Bouba Ndjida tantalus are preyed upon by leopards, martial eagles and probably also smaller cats.

Patas monkey

Patas monkeys are common in the park. They were usually seen near Djibao and the tourist camp. These mainly terrestrial monkeys range over a large area and are less dependant upon water than are tantalus. Groups of 8 and 7 were seen, as well as several individual animals.

Guereza

Guereza are confined to the better developed fringing forests of the park. They are common along some sections of Mayos Vaimba and Lidi and also occur along Mayos Dopsa and Faro. Their home range seems to be confined to a few hundred meters of fringing forest and small areas of adjacent savanna. They are infrequently seen on the ground. The largest troop seen included ten animals, and young were often seen clinging to female guerezas. They are probably preyed upon by leopard, and since their hide is highly valued for decorative purposes, they also make inviting targets for poachers.

Habitat for all primates in the park would be improved with the expansion of existing fringing forests.

Rock hyrax

Rock hyrax are common on all mountains and rocky hills in Bouba Ndjida. They are especially abundant around Hosere Vaimba and Doui. Leopards and raptors, such as the martial eagle, are undoubtedly their chief predators.

Aardvark

No aardvark were seen during the study, but the uneaten remains of one was found near a den. Their dens are common throughout the park, indicating they are quite abundant. They are nocturnal, feed on termites

and ants, and are probably the occasional prey of lion and leopard.

RECOMMENDATIONS

Objectives

To wisely and successfully manage a national park for the mutual benefit of man, the wildlife and the environment, it is absolutely necessary to define why the park exists, and what the objectives of park management are. Only then can a work program of management and research be carried out to its best potential.

Fortunately, Bouba Ndjida N.P. has an outstanding wildlife population and does not suffer greatly from adverse effects of man. As the human population in the region increases, however, there will be increasing pressures on the park and its wildlife. As wildlife populations continue to diminish outside the few protected areas in North Cameroon, poachers will increasingly seek to kill wildlife in the park. With more people to feed, cattlemen may regard park pastures with envy. Or they may attempt to eliminate tse-tse flies from the region with insecticides. This would have an adverse effect upon park wildlife. Tourism will undoubtedly increase, and with it the necessity for more, and better park management.

The direction of further park development must be planned, since some management practices are not compatible with all management objectives. For example, extensive road construction in the park is not compatible with trying to increase the eland and rhinoceros herds, since these species do not tolerate much human activity. Attempts to protect the park and its wildlife and to enforce laws require more than just employing a few game guards. They must be trained, given authority, and actually get into the field to be effective.

Bouba Ndjida can be managed for several different purposes: to maintain and protect plants and wildlife as valuable natural resources, to provide recreation through game viewing to both international tourists and Cameroonian citizens, to serve as an educational and scientific area for students and researchers, and to provide a reservoir for intense traditional and sport hunting around the park.

Fortunately most of these objectives are somewhat compatible, and it is only necessary to establish the priority of each objective relative to the others in planning future development.

At present, the government manages Bouba Ndjida to protect the park's wildlife and other natural resources, and to attract international tourists. Given this general policy and considering the potential of the park for other purposes, general recommendations concerning the development of Bouba Ndjida are made on the following subjects: staffing, law enforcement, habitat management, game viewing, facilities, hunting in areas outside the park, and further research.

Staffing and Equipment

There is presently a critical shortage of even minimally trained Cameroonians to manage and protect the national parks. Staff presently in the parks receive quite substandard material support, and virtually neglect the parks during the rainy seasons. None of the parks have a budget with which to operate.

Bouba Ndjida should have a conservator and two subordinates to assist him in wildlife and habitat management, law enforcement, and road construction and maintenance - all with training the equivalent to that of the superior level of the Garoua College of Wildlife Management, if not higher. They should be responsible for the overall functioning of

the park - game guard patrols and anti-poaching activities, implementation of a controlled burning program. construction and maintenance of park roads, improvement of game viewing, assessing the effects of man and fire on park wildlife populations and vegetation, and gathering additional information to facilitate better management and inaugurate educational services to visitors.

At least 15 game guards are required to adequately patrol the park and also act as guides to visitors. It is they who finally assure the protection of the park's wildlife, and keep watch over changing conditions and animal distribution in all areas on the park.

At least 10 laborers should be employed permanently to build bridges and drifts, maintain roads, build fire breaks and assist with other fire control activities.

The three senior staff should live permanently in the park, at the tourist camp. The present policy of living in the park only six months of the year during the dry season results in almost total neglect of the park during the rainy season when much necessary work can be done. Game guards should be posted to the visitor camp, Vaimba, Djibao, Mandingrin, Djanendi, Koum, Landou and "Chez Babassara" either permanently or on a rotating basis so that all areas of the park are patrolled on a continuous and regular basis throughout the year.

The final effectiveness of park personnel in protecting and developing the park will depend on three things: The enthusiasm of the staff in their work; the quality of supervision and support the staff receives from officials in Yaounde and Garoua and the park conservator; and the amount of authority the staff has in enforcing the law and effectuating park management. An ambitious recruiting campaign should

be of first priority in further park development. Efforts should be directed to recruiting only those who are genuinely interested in the protection and development of Cameroon's wildlife and national parks. Accordingly, salaries and living conditions must be improved if better candidates are to be attracted and expected to improve existing management in the park.

The absolute minimum vehicle equipment necessary for park development are: a grader, a truck to transport rocks and other heavy materials, two camionnettes and a Land Rover. This equipment can and should be used the year around, and be based at park headquarters at the tourist camp. Naturally the maintenance of such equipment must be provided for.

A separate budget for each park in Cameroon would facilitate the administration and implementation of park management. Bouba Ndjida presently receives money, equipment and other material sporadically, which makes park planning and functioning quite difficult.

Enforcement

To protect the park and its Wildlife, the existing game laws must be enforced. Presently there are too few game guards for adequate surveillance, and more importantly, they spend little time actually patrolling the park. During the dry season they quite commonly guide sport hunters in the hunting zones around the park, a practice which is not entirely surprising if they are inadequately supervised and irregularly paid.

Regular, closely supervised patrolling of the park and its borders is the only way to reduce poaching in the park. Each game guard should have a weekly work program, coordinated by the conservator or senior staff, which outlines the portion of the park he must patrol. Detailed

weekly reports should be submitted by game guards, containing the following information: patrol routes; evidence of poaching; condition, distribution and numbers of animals seen; condition of the vegetation; availability of water; the passage of bush fires; and other information which would be of use in managing the park.

To be effective in discouraging poaching it is absolutely essential that park employees, as well as those of the Forestry Department, be given the authority and necessary high level support to enforce the game laws. A special effort must be made to stop the illegal hunting of wildlife by government civil servants - notably gendarmes, Forestry Department employees and even national park employees. Until such poaching is diminished through active, government supported surveillance and prosecution, wildlife and park management will continue to be only marginally effective, and efforts to instill the general population with an anti-poaching sentiment will be quite fruitless.

Habitat Management and Fire Control

Aside from preventing poaching, there is little that wildlife managers can do to directly influence wildlife populations in areas such as Bouba Ndjida N.P. What is usually meant by wildlife management is the attempt to provide optimum living conditions, and especially good habitat, for wildlife. Even in trying to improve wildlife habitat in an area like Bouba Ndjida there are relatively few practices which man can employ successfully. One, however, can be an extremely effective and useful tool - the proper use of fire. The carefully planned use of fire gives man the opportunity to influence the succession and quality of the vegetation (the habitat), and therefore also influence the condition and abundance of wildlife, albeit usually over a considerable

time period.

As has been noted, the natural succession of park vegetation is toward a more densely wooded tree savanna. At present, repeated early dry season fires burn throughout the park, doing more damage to perennial grasses than to woody vegetation. The continuation of such a practice would result in the further reduction in quality and quantity of park pastures, increased erosion, and an increase in fire-tolerant woody trees and shrubs, which would grow beyond the reach of several species of browsing antelopes. In addition, many woody species of the fringing forests are fire-tender. that is, they are very susceptible to damage caused by repeated annual fires. Such fires not only prevent the expansion of fringing forests, but actually reduce the size of them by directly killing fire-tender tree species and providing optimum conditions for erosion along stream and river banks.

The fire policy in Bouba Ndjida should be, first of all, to prevent the setting of fires in the park by anyone, except those park personnel who are charged with effecting the burning program. Signs banning the setting of unauthorized fires should be placed at park entrances and at the visitor camp. The conservator alone must have the responsibility of implementing the burning program. Whether or not to burn, where to burn, and the time of season and time of day to burn should all be planned before the dry season begins.

Once started, fires cannot presently be controlled in Bouba Ndjida N.P., but the conservator can use some basic information to assist him in planning fires in the park and in keeping them as small as possible. Fires do not usually cross the major streams and rivers in the park. They do, however, almost always cross the roads in the park since the

roads are only about four meters wide. There is usually more wind at noon and early afternoon than in late afternoon. Fires should accordingly be set late in the day to prevent strong, wind-carried conflagrations which can travel extremely fast. Fires set late in the day are also sometimes suppressed the same night by cool night temperatures.

If Bouba Ndjida is to be managed for wildlife viewing, it is obvious that the tall grasses in at least a substantial part of the park must be burned during December and January to permit visitors to see the animals. It is also obvious however, that such annual burning of the park is, on the whole, detrimental to the vegetation (especially the grasses) and wildlife in the park. The park must be protected from continued degradation caused by fire. Fringing forests especially must be protected from fire as much as possible. Care should be taken never to purposefully burn fringing forests and to never burn areas where fires and erosion have severely degraded the vegetation. Such areas include extensive zones along both banks of Mayo Lidi from the visitor camp to Mayo Bidjou.

It is recommended that the park be burned to provide for as wide a diversity of habitats as possible and at the same time prevent burning practices which are obviously detrimental to the vegetation.

The park should be divided into blocks which are bordered both by rivers, which can act as natural firebreaks, and roads, which can be widened to also act as firebreaks. Some such blocks, perhaps 20% of the park's surface, should be totally protected from fire to provide areas where natural vegetal succession can continue. These areas should include both Terminalia and Combretum savanna and Isoberlinia savanna woodlands. Other areas should be burned in December and January, only

once every two years, while other blocks should be designated for such burning only once every three years. This would have the effect of providing a substantial area for wildlife viewing and at the same time reduce damage to park vegetation. Burning is valuable at three to four year intervals in making available nutrients which are otherwise held unavailable in the leaf and stem litter of previous years growth. The result of such rotational burning on the begetation of Bouba Ndjida would be to improve the quality and quantity of both woody plants and grasses, and therefore improve wildlife habitat. Fewer burned areas would also tend to concentrate animals which graze the grass regrowth on such areas, thus providing better game viewing.

In other areas an attempt should be made to improve the pasture and reduce the woody component of the savanna vegetation. This can be done by protecting an area from fire until the first rain shower of April that indicates the start of the rainy season. At this time the dry grass growth of the previous rainy season provides excellent fuel for a very hot fire. Such resulting fires do not harm grass plants because the living parts of the plant at that time are the roots and some leaves which have just recently started to grow. Grass growth would recommence unabated soon after, with the start of the rainy season. Many woody plants, especially those less than 4 to 5 meters tall, would be killed by the intense heat generated by such fires, and the general result would be a grass savanna with considerably fewer trees and shrubs.

To provide more effective firebreaks, trees should be removed on either side of park roads, and the roads should be widened.

It is realized that such an attempt at controlling fires in the park is very difficult and can never be carried out exactly as planned.

The cooperation of all park users is essential, and more park employees will be needed to effect such a policy.

Wildlife Viewing

Wildlife viewing is presently possible in the park from late December until early May. During the rest of the year park roads are not maintained and vehicle travel is impossible. This is unfortunate because one of the best periods to visit the park is during May, June and July, when grasses are less than a meter tall and the weather is quite pleasant.

In addition to controlling poaching in the park, increasing the number of trained park employees, and developing a controlled burning program, it is essential that much more emphasis be given to road maintenance and construction. Of high priority is the construction of a track to the visitor camp which could be used throughout the year. Such a road has been shown to be feasible. It would enter the park on the southern park boundary about 10 km west of Djarendi, and lead generally north and then north-west between Mayos Lidi and Dopsa. Because it would not traverse any watercourses, road damage caused by rainstorms would be minimal. Access to the visitor camp during the rainy season would permit the following: better provisionment of the camp and park employees living there, more opportunity to carry out road maintenance and park management programs, better anti-poaching surveillance, and a prolongation of the tourist season in the park.

All existing park roads can be improved to minimize damage done by rainwater runoff. Because roads are cut with a grader, water usually collects and often flows on the roads, causing erosion damage. To prevent this, wherever roads descend toward a river or stream several

trenches should be dug on each side of the road to divert water off the road. Such simple and effective preventive maintenance is the most basic of park management practices.

At the scores of stream crossings in the park drifts should be built or culverts installed. For small crossings drifts can be built of rocks held in place by strong wire mesh or fencing, as has been done at three stream crossings in the park. At some crossings it may be best to build rock and cement drifts. Both types of drifts allow firm passage for vehicles, while at the same time permitting streams to flow over the permanent foundations.

At the larger stream and river crossings simple bridges should be built by installing culverts, which allow water to flow under the road. The number and size of culverts needed depends on the width and flow of the stream or river. If such drifts and culverts are built and installed correctly they will last for many years and demand relatively little maintenance. The present policy of hiring and operating a grader for several months each year to reopen over 300 km of roads is far more expensive and wasteful of vehicles, manpower and time. With proper stream crossing construction, all park roads could be opened in a few weeks, rather than three months. Such construction can and should be carried out throughout the year.

The existing entrance fee to the national parks of Cameroon is 2000 F CFA per park. This allows a person to enter the park at any time during the tourist season. There is no lower rate for those who wish to visit the park for only a few days or just one day. A family of four visiting the park for only two days, for example, must pay 800 R, and if they wish to visit other parks they must pay the same amount at each

park. This discourages many people from visiting the parks, and many others visit only one park during the tourist season. Since the other national parks are much closer to the main tourist routes of North Cameroon, tourists prefer to visit those parks, and Bouba Ndjida receives relatively few visitors.

The tourists are the guests of the national parks, and the two-day visitor should not be obliged to pay the same entrance fee as the visitor who returns to the park several times during the tourist season. A more equitable and profitable system of entrance regulation would be to offer three different rates: one for those who wish to visit a park for four consecutive days or less, another for those who wish to visit the park more than one time during the tourist season, and a third which would allow the visitor to visit all five national parks at any time during the tourist season. Suggested entrance fees for such a system are as follows:

4-day permit per park	1500 F
Seasonal permit per park	2500 F
Seasonal permit for all parks	5000 F

Such rates would encourage more new tourists to visit the parks and also encourage present park-goers to visit the parks more often.

The present system of signalization in Bouba Ndjida N.P. should be continued and improved. It is essential that all intersections in the park be plainly marked. Without signalization a park forfeits its right to collect entrance fees from visitors. Signs placed at entrances and at the visitor camp should explain the rules and conditions of park visitation. Emphasis should be placed on the exclusive authority of park personnel to set fires, and the intersection of descending from vehicles

when animals are spotted. Wildlife, especially the more timid species such as eland, rhinoceros and elephant, will become more habituated to vehicles, and therefore provide better wildlife viewing, only if visitors remain in their vehicles.

Guides who are familiar with the park should be available to accompany visitors who come for wildlife viewing. With good road signalization however, it is not necessary to insist that tourists be accompanied by guides. Tourists are the guests of the park and should not be treated as potential criminals.

Facilities

The present visitor facilities in Bouba Ndjida N.P. are very good. The camp has eight "boukarous" with 32 beds, showers, electricity, and restaurant, and gasoline is available. The camp is open from December through April. It can presently serve many more tourists since it is filled to capacity only during the Christmas, New Years and Easter holidays. As park visitation and development grows the camp will have to be expanded.

There is lodging for the park conservator at the camp but only semi-permanent housing for game guards and other park employees. An attempt should be made to provide better lodging for them and at the same time prevent an expansion of the village adjacent to the visitor camp. A village and associated domestic animals and surrounding agricultural fields in the center of the park is not what the visitors to Bouba Ndjida N.P. come to see. Future construction should be carefully planned to keep such developments to an absolute minimum.

With additional staffing, an information and education boukarou could be built and maintained at the visitor camp. This would be used

to acquaint visitors with Bouba Ndjida and the animals found there, and to encourage them to actively participate in protecting and conserving the wildlife of Cameroon.

A meteorological station should be established and maintained at park headquarters, since basic information on temperatures, rainfall, wind direction and relative humidities in the park are lacking.

Hunting in Areas Adjacent to the Park

Bouba Ndjida N.P. is surrounded on the east, south, and west by four zones which are managed for sport hunting each year between December and June. These zones include an area equal to the size of the park, just over 2000 sq. km. Each year the Forestry Department allows a limited number of animals to be harvested according to a quota which is established for each zone. The quotas are based on the relative demand by hunters and former quotas, rather than on any knowledge of the actual sizes of animal populations in the zones. When the quota for a given species is reached, hunting for that species is supposed to cease. Table 8 outlines the quotas allowed in the four zones during the 1974-75 hunting season, which has been typical of the past several years.

Table 8. Hunting quotas for four hunting zones surrounding Bouba Ndjida N.P., 1974-75. Figures given are the combined quotas for Zones 10, 11, 12 and 23.

<u>Species</u>	<u>Allowable harvest</u>	<u>Species</u>	<u>Allowable harvest</u>
Eland	15	Reedbuck	14
Buffalo	28	Korrigum	5
Hartebeest	25	Kob	6
Roan antelope	19	Elephant	3
Waterbuck	15	Hippopotamus	2
Bushbuck	13	Lion	2

In general, the reported annual kill is near the allowed quota, although there are many exceptions. In Zone 11, during the 1974-75 hunting season for example, more than twice the quota of waterbuck, roan, hartebeest, elephant and reedbuck were killed; and the quotas for buffalo and bushbuck were also exceeded. In addition to the reported kill, there is an unknown number of animals killed and wounded which are not reported. Without proper censusing and analysis of the population structures on the wildlife in the hunting zones, it is impossible to say for certain that the present quotas represent the annual surplus of adult males (the huntable animals), or if too many animals are presently being harvested. Overharvesting mature male animals would result in a younger population structure and relatively few older animals. Hunters would then be dissatisfied with the relative lack of trophy-sized animals.

Judging from the age and sex ratios and sizes of the wildlife populations in the park, and considering the quality of habitat in the hunting zones, it appears that eland and waterbuck quotas should be reduced, and that hartebeest and roan antelope quotas may also be too high. One thing is certain: human influence in general, and poaching in particular, will continue to increase in these zones during the coming decades, and wildlife populations will diminish from their present numbers. It is imperative that such disturbances be kept to a minimum, since the hunting zones perform a valuable function in acting as buffer zones for the national park. If the zones were available for cultivation and the grazing of domestic cattle, the national park would be affected, as the hunting zones now are, by increased violations of poaching, woodcutting and grazing practices.

Since there is some movement of animals between the park and the hunting zones, hunting does have an effect of the wildlife of the park. Animals which are actively hunted in a region will never acclimatize to people, even those in vehicles, like those which are completely protected. The wildlife of Bouba Ndjida will therefore never be as undisturbed by animal-viewers as those in many other parks in Africa, around which hunting is prohibited. Bouba Ndjida will always be a park where the visitor is not sure of how many animals he will see, or for how long they may remain in sight, but for just these reasons, in addition to the large diversity of species in the park, the park is always surprising and inviting to wildlife viewers.

While hunting in the zones around the park has relatively little effect on park wildlife, and brings in much revenue in the form of license fees, trophy taxes and reservation and lodging expenses to hunters, it is the management of the hunting, and especially the behavior of some hunters which leave much to be desired and sometimes adversely affect the functioning of the park.

There are presently too few guides to accompany hunters in the zones around the park. Park personnel are therefore sometimes forced to guide hunters, and in other instances unqualified personnel guide the hunters. Hunting is presently managed around the park by both the Forestry Department and personnel of the General Tourism Commission, including both the park conservator and manager of the visitor camp. This has resulted in much confusion, dissatisfied clients, and lost revenue for the government.

Clearly defined responsibility for the supervision of hunting must be made. An employee of the Forestry Department should be posted to

the park headquarters during the hunting season and be responsible for the supervision of all activities in the hunting zones. He must work in conjunction with the manager of the visitor camp, since reservations for hunting zones and lodging facilities must be coordinated. Regular radio contact with Garoua is absolutely essential, and a new two-way radio should be installed to replace the existing one which is in poor condition. Three to five qualified guides should be available to hunters during the hunting season.

Since the visitor camp in Bouba Ndjida is the only facility in the region which offers full lodging and restaurant facilities, it is used by most hunters who hunt in the zones around the park. Although not as numerous as tourists who come to see the animals of the park, the hunters stay for longer periods of time and spend more money than do wildlife-viewing tourists. Many are very good hunters, but others, through their ignorance and arrogant attitudes, often diminish the enjoyment of wildlife-viewing tourists and give all hunters a bad reputation.

Many hunters, even some who have hunted before in Africa, cannot even identify the antelopes which they have come to hunt. It is obvious that such hunters have no respect for such animal species, and are hunting only to satisfy some inner depravity. Because some hunters cannot (or will not) identify male from female antelopes, several females are mistakenly killed each year. The interdiction of hunting in the portions of the hunting zones within one kilometer of the park boundary is commonly violated, and sport hunters have even been known to kill animals within the park. Such practices, in addition to being illegal, affect the quality of animal viewing in the park.

A cardinal sin of any hunter is to leave the carcass of an animal

in the bush after it has been killed. Yet hunters around Bouba Ndjida commonly leave much, and sometimes most, of the carcass in spite of the fact that there are enough porters or nearby villagers to take full advantage of such potential food. Of course the horns are always carried from the bush as "trophies" of the hunt.

Sometimes the carcasses of animals killed by sport hunters are taken to the visitor camp where they are skinned and butchered. The skulls are cleaned in the waters of Mayo Lidi, immediately adjacent to the visitor's boukarous. Most tourists are understandably upset when they see such practices carried out within a visitor camp in the middle of a national park. After all, most park visitors come to the park, and pay an entrance fee, to see and sometimes photograph live animals in their natural environment.

There is no reason why such negative aspects of hunting cannot be controlled in a better way, or why such obvious hunting violations cannot be prevented to a greater extent.

No license should be issued to hunters who cannot identify the animal for which they apply to hunt. Such simple screening can be easily done when hunting permits are issued. Hunting violations can only be detected and prosecuted by competent field personnel, of which there are presently too few. Guides should be given training and have complete understanding of the hunting regulations and rules of the national park. The cleaning of animals killed by hunters should be done in the field as much as possible, and away from the visitor camp in all cases. Both hunters and tourists who wish to see the park and its animals have rights and responsibilities which must be respected, if the park is to be managed in the best interests of the wildlife and the visitors.

Research

The effort to gather information on the relative abundance, and distribution of the wildlife of Bouba Ndjida N.P. should be of high priority. Such surveillance should continue by utilizing the six foot and vehicle transects established during the course of this study. By living permanently in the park the conservator and his staff can monitor the transects each month of the year, and establish new transects in other areas. Information thus gained will be invaluable in planning future management and interpretive programs for the park.

A program of controlled burning should be established as outlined in the section on fire control. This program is of prime importance in providing good wildlife habitat, which will determine the absolute and relative abundance of various wildlife species in the park in the future.

Additional studies should be made on how different wildlife species use the habitat in Bouba Ndjida. In particular, investigations of the food habitats of the more important species should be initiated.

All information of the more impressive and less abundant wildlife species - rhinoceros, eland, elephant, buffalo and lion - should be documented. As more important management and research goals are attained, detailed studies of these species can be undertaken in the park.

LITURATURE CITED

LITERATURE CITED

- Aubreville, A. 1950. Flore Forestiere Soudano-Guineenne. Societe d'Editions Geographique, Maritimes et Coloniales, Paris.
- Brabent, P. 1972. Notice explicative de la carte pedologique de reconnaissance a 1/2000,000. ORSTOM, Centre de Yaounde, Cameroun.
- Brabant, P. 1976. Personal letter dated 21 February, 1976. Centre pluridiscipline de ONAREST, Yaounde, Cameroon.
- Cottam, G. and J. T. Curtis. 1956. The use of distance measures in phytosociological sampling. Ecology 37(3):451-460.
- Flizot, P. 1962. Les reserves de faune du Cameroun. Chambre de l'Agriculture, de l'Elevage, des Eaux et Forets et des Chasses du Cameroun. 27p.
- Flizot, P. 1970. Etude sur la situation des parcs nationaux, de reserves et de la chasse dans le Nord Cameroun. Rapport au Service des Eaux et Forets, Cameroun. 25p.
- Gaston, A. 1972. Rapport annuel, 1972. Laboratoire de Recherches Veterinaires de Farcha (Tchad).
- Geerling, C. 1973. The vegetation of Yankari Game Reserve: its utilization and condition. Bulletin 3. Department of Forestry, University of Ibadan, Nigeria.
- Genieux, M. undated1 In: Atlas of Cameroon. ORSTOM, Centre de Yaounde.
- Hopkins, B. 1974. Forest and Savanna. Heinemann, Ibadan and London.
- Hutchinson, J. and J. Dalziel. 1954-1972. Flora of West Tropical Africa. 3 volumns. Crown Agents for Overseas Governments, London.
- Keay, R. W. J. 1959. Vegetation map of Africa. Oxford University Press.
- Lavieren, L. P. van and M. S. Bosch. 1977. Evaluation des densites de grands mammiferes dans le Parc National de Bouba Ndjida, Cameroun. La Terre et la Vie, 31 (1):3-32.
- Leeuw, P. N. de. 1975. Species preference of domestic ruminants grazing Nigerian savanna. Proceedings of the Ibadan-Garoua International Symposium on Wildlife Management in Savanna Woodlands, 23-25 Sept., 1975, Ibadan, Nigeria. (in press)
- Letouzey, R. 1968. Etude Phytogeographique du Cameroun. Editions Paul Lechevalier, Paris.
- Martin, D. and P. Segalen. 1966. Notice explicative de la carte pedologique du Cameroun orientale. ORSTOM, Centre de Yaounde.

- Meester, J. and H. W. Setzer. 1972. The mammals of Africa: an identification manual. Smithsonian Institution Press, Washington, D. C.
- Ramsay, J. and R. Rose Innes. 1963. Some quantitative observations on the effects of fire of the Guinea Savanna vegetation of northern Ghana over a period of eleven years. *African Soils* 8:41-85
- Riney, T. 1963. A rapid field technique and its application in describing conservation status and trends in semi-arid pastoral areas. *African Soils* 8(2): 159-258.
- Rose Innis, R. 1972. Fire in West African vegetation. Proceedings of the annual Tall Timbers Fire Ecology Conference, 1971, 11:147-173.
- Silons, R. 1958. Les Savanes de l'Afrique Central. Editions Paul Lechevalier, Paris.
- Taze, Y. 1973. Contribution a l'etude de la frequentation des salines et au comptage et la localisation des animaux dans le P.N. de Bouba Ndjida. Typewritten report to the College of Wildlife Management, Garoua, Cameroon.
- White, C. M. N. 1960-1965. Check list of African birds, 5 volumes. Government Printer, Lusaka, Zambia.

APPENDIX A

APPENDIX A

The plants of Bouba Ndjida National Park.

The following plants have been identified in Bouba Ndjida N. P.
The nomenclature is that of Hutchinson and Dalziel (1954-1972).

Mr. C. Geerling assisted with the identification of many species, and Mr. P. Wit identified several grasses. Many plant specimens are in the herbarium of the College of Wildlife Management, Garoua, Cameroon.

Each species is classified as being present (-), or abundant (+) in one or more of eight different habitat types. The difference between habitats are based on the amount of shade, the depth and quality of soils and the availability of water.

The numbers correspond to the following habitats:

- 1 Shrub savanna
- 2 Woodland savanna
- 3 Mountain
- 4 Bowal (ironstone plateau)
- 5 Erosion zone
- 6 Fringing forest
- 7 Aquatic environment
- 8 Sandy riverbed

Monocotyledons

Habitat types

	1	2	3	4	5	6	7	8
Agavaceae								
<u>Sansevieria liberica</u> Ger & Labr			+			-		
Alismataceae								
<u>Burnatia enneandra</u> M. Micheli				-			-	
Amaryllidaceae								
<u>Pancratium hirtum</u> A. Chev				-				

	Habitat types							
	1	2	3	4	5	6	7	8
Aponogetonaceae								
<u>Aponogenton vallisnerioides</u> Bak.				-			-	
Araceae								
<u>Stylochiton lancifolius</u> Koyschy & Peyr						-		
Commelinaceae								
<u>Aneilema lanceolatum</u> Benth.			-				-	
<u>Cyanotis luanta</u> Benth.			-				-	
Cyperaceae								
<u>Scripus jacobii</u> C.E.C. Fischer				-			-	
<u>Scleria</u> sp.							-	
Dioscoreaceae								
<u>Dioscorea abyssinica</u> Hochst. ex Kunth.	-							
Graminae								
<u>Andropogon gayanus</u> Kunth var squamulatus (Hochst) Stapf	+	+	+	-	-	+		
<u>A. pseudopricus</u> Stapf				-	-			
<u>A. schirensis</u> Hochst. ex A. Rich	-							
<u>Aristada kerstingii</u> Pilger					-			
<u>Beckeropsis uniseta</u> (Nees) K. Schum	-	+				+		
<u>Chloris robusta</u> Stapf						-	-	+
<u>Ctenium</u> sp.				-				
<u>Cymbopogon giganteus</u> Chiov.	-					-		
<u>Digitaria</u> spp.					-			
<u>Diheteropogon amplexans</u> var <u>catagensis</u> (Chiov.) W. D. Clayton	+	-	-	-	-			

	Habitat types							
	1	2	3	4	5	6	7	8
Zingiberaceae								
<u>Costus spectabilis</u> (Fenzl.) K. Schum.							-	
<u>Kaempferia aethiopica</u> (Schweinf.) Solms-Laub.		-						
<u>Diotyledones</u>								
Amaranthaceae								
<u>Achyranthus aspera</u> Linn.		-						
Celastraceae								
<u>Maytenus senegalensis</u> (Lam.)Exell	+	-		-	-			
Cochlospermaceae								
<u>Cochlospermum planchonii</u> Hook.	+							
<u>C. tinctorium</u> A. Rich.	+							
Combretaceae								
<u>Anogeissus leiocarpus</u> (DC.) Guill. & Perr.	+	+	+	-	-	+		
<u>Combretum ghasalense</u> Engl. & Diels	+	-		-	+			
<u>C. glutinosum</u> Perr. ex DC.	+	-		+	-	-		
<u>C. hypopilinum</u> Diels		-				+		
<u>C. molle</u> R. Br. ex G. Don	-	-				-		
<u>C. nigricans</u> var. <u>elliottii</u> (Engl & Diels) Aubrev.						-		
<u>C. paniculatum</u> Vent						-		
<u>C. sericeum</u> G. Don				-				
<u>Terminalia avicenoides</u> Guill. & Perr.	-							

Habitat types

	1	2	3	4	5	6	7	8
<u>T. brownii</u> Fres.			-					
<u>T. laxiflora</u> Engl.	+	+	-	-	-	-		
<u>T. macroptera</u> Guill. & Perr.	+							
Convolvulaceae								
<u>Ipomoea blepharophylla</u> Hallier f.		-						
Dipterocarpaceae								
<u>Monotes kerstingii</u> Gilg	-	+		+				
Ebenaceae								
<u>Diospyros mespiliformis</u> Hochst. ex A. DC.		-	-				+	
Euphorbiaceae								
<u>Antidesma venosum</u> Tul.	-							
<u>Bridelia scleronura</u> Mull. Arg.	-							
<u>Hymenocardia acida</u> Tul.	-			-				
<u>Phyllanthus muellerianus</u> (O. Ktze) Exell			-					
Hypericaceae								
<u>Psorospermum densipunctatum</u> Engl.	-							
Loganiaceae								
<u>Strychnos spinosa</u> Lam.	-		-		-			
Malvaceae								
<u>Hibiscus</u> sp.						-		
<u>Wissadula amplissins</u> var <u>rostrata</u> (Schum. & Thonn.) R.E. Fries			-			+		

Habitat type

	1	2	3	4	5	6	7	8
Melastomataceae								
<u>Dissotis rotundifolia</u> (Sm.) Triana	-						-	
<u>D.</u> sp.	-							
Meliaceae								
<u>Khaya senegalensis</u> (Desr.) A. Juss.						-		
<u>Pseudocedrela kotschyi</u> (Schweinf.) Harms	+	-					-	
<u>Trichilia roka</u> (Forsk.) Chiov.				-				
Mimosaceae								
<u>Acacia ataxacantha</u> DC.						+		
<u>A. hockii</u> DeWild.	-				+			
<u>A. macrothyrsa</u> Harms	-				-			
<u>A. sieberiana</u> DC.					-	-		
<u>Albizia coriaria</u> Welw. ex Oliv.	-							
<u>Entada africana</u> Guill. & Perr.			-					
<u>Mimosa pigra</u> Linn.							-	-
<u>Parkia clappertoniana</u> Keay	-					-		
<u>Prosopis africana</u> (Guill, & Perr.) Taub.	-	-			+	-		
Moraceae								
<u>Ficus abutilifolia</u> (Miq.) Miq.			+					
<u>F. glumosa</u> var. <u>glaberrima</u> Martelli	-							
<u>F. platyphylla</u> Del.				-				

	Habitat type							
	1	2	3	4	5	6	7	8
<u>F. sp.</u>	-		-					
Myrtaceae								
<u>Syzygium guineense</u> (Willd.) DC.						+	-	-
Ochnaceae								
<u>Lophira lanceolata</u> Van Teigh. ex Keay	-			-				
<u>Ochna afzelii</u> R. Br. ex Oliv.				-				
Olacaceae								
<u>Ximimia americana</u> Linn.	-	+					-	
Opiliaceae								
<u>Opilia celtidifolia</u> (Guill. & Perr.) Endl. ex Walp.	-		-					
Oxalidaceae								
<u>Biophytum petersianum</u> Klotzsch				-				
Papilionaceae								
<u>Polygonum salicifolium</u> Brouss. ex Willd.							-	-
Proteaceae								
<u>Protea elliotii</u> Ch. H. Wright var <u>elliotii</u>	+							
Rhamnaceae								
<u>Ziziphus mauritiana</u> Lam.						-		
<u>Z. mucronata</u> Willd.						-		
Rosaceae								
<u>Parinari curatellifloia</u> Planch. ex Benth.	-			-		-		
<u>P. macrophylla</u> Sabine						-		

	Habitat types							
	1	2	3	4	5	6	7	8
Rubiaceae								
<u>Adina microcephala</u> (Del.) Hiern						+	-	-
<u>Borreria octodon</u> Hepper	-							
<u>Crossopteryx febrifuga</u> (Afzel. ex G. Don) Benth	+	-						
<u>Feretia apodanthera</u> Del.						-		
<u>Gardinia aqualla</u> Stapf & Hutch.	+	+		-		-		
<u>G. ternifolia</u> Schum & Thonn.						-		
<u>Mitragyna inermis</u> (Willd.) O. Ktz.							-	-
<u>Morelia senegalensis</u> A. Rich. ex DC.							-	-
<u>Nauclea latifolia</u> Sm.	-		-				-	
<u>Polysphaeria arbuscula</u> K. Schum.							+	
Rutaceae								
<u>Teclea sudanica</u> A. Chev.			+				-	
Salicaceae								
<u>Salix ledermannii</u> O. v. Seem.						-	+	+
Sapindaceae								
<u>Allophyllus africanus</u> P. Beauv.	-					-	-	-
<u>Aphania senegalensis</u> (Juss. ex Poir) Radlk			-					
<u>Paullinia pinnata</u> Linn.		-				-		
Sapotaceae								
<u>Butyrospermum paradoxum</u> subsp. <u>parkii</u> (G. Don) Hepper	-		-					
<u>Malacantha alnifolia</u> (Bak.) Pierre			+			-		

	Habitat type							
	1	2	3	4	5	6	7	8
Scrophulariaceae								
<u>Dopatrium macranthum</u> Oliv.				-			-	
<u>Striga asiatica</u> (Linn.) O. Ketz.								
Sphenocleaceae								
<u>Sphenoclea dalzielii</u> N.E. Br.				-			-	
Sterculiaceae								
<u>Melochia corchorifolia</u> Linn.				-				
<u>Sterculia setigera</u> Del			-					
Tiliaceae								
<u>Grewia flavesens</u> Juss.	-							
<u>G. mollis</u> Juss.	-				-			
Umbelliferae								
<u>Steganotaenia araliacea</u> Hochst.			-					
Verbenaceae								
<u>Lippia rugosa</u> A. Chev.			-					
<u>Stachytarpheta angustifolia</u> (Mill.) Vahl								-
<u>Vitex doniana</u> Sweet				-		-		
<u>V. simplicifolia</u> Oliv.	-		-	-				

APPENDIX B

APPENDIX B

The mammals of Bouba Ndjida National Park

The following mammal species have been identified in Bouba Ndjida N.P. The systematic order and nomenclature are those of Meester and Setzer (1972).

INSECTIVORA

Erinaceus albiventris Wagner. Four-toed hedgehog

PRIMATES

Papio anubis J. B. Fischer. Olive baboon

Cercopithecus tantalus Ogilby Tantalus monkey

Galago senegalensis (E. Geoffroy). . . . Lesser galago

Colobus guereza Ruppell. Guereza

LAGOMORPHA

Lepus sp. Hare

RODENTIA

Hysterix cristata (Linnaeus). Porcupine

Taterillus sp. Gerbil

Thryonomys swinderianus (Temminck). . . Cane rat

Xerus erythropus (E. Geoffroy). Geoffroy's ground squirrel

Helioscirus gambianus (Ogilby). Gambian sun squirrel

CARNIVORA

Canis sp. Jackel

Lycaon pictus (Temminck). Hunting dog

Ictonyx striatus (Perry). Zorilla

Viverra civetta (Schreber). Civet

Genetta spp. Genets

<u>Ichneumaia albicauda</u> (G. Cuvier).	White-tailed mongoose
<u>Herpestes ichneumon</u> (Linnaeus).	Egyptian mongoose
<u>Crocuta</u> or <u>Hyaena</u>	Hyaena
<u>Panthera leo</u> (Linnaeus).	Lion
<u>Panthera pardus</u> (Linnaeus).	Leopard
<u>Felis serval</u> Schreber.	Serval
<u>Felis caracal</u> Schreber	Caracal
TUBULIDENTATA	
<u>Orycteropus afer</u> (Pallas).	Aardvark
PROBOSCIDEA	
<u>Loxodonta africana</u> (Blumenbach).	African elephant
HYRACOIDEA	
<u>Procavia ruficeps</u> (Hemprich & Ehrenberg).	Western dassie
PERISSODACTYLA	
<u>Diceros bicornis</u> (Linnaeus).	Black rhinoceros
ARTIODACTYLA	
<u>Phacochoerus aethiopicus</u> (Pallas).	Wart hog
<u>Hippopotamus amphibius</u> (Linnaeus).	Hippopotamus
<u>Giraffa camelopardalis</u> (Linnaeus).	Giraffe
<u>Syncerus caffer</u> (Sparmann).	African buffalo
<u>Tragelaphus scriptus</u> Pallas.	Bushbuck
<u>Taurotragus derbianus</u> (Gray).	Giant eland
<u>Sylvicapra grimmia</u> (Linnaeus).	Grimm's duiker
<u>Cephalophus rufilatus</u> Gray	Red-flanked duiker
<u>Redunca redunca</u> (Pallas).	Reedbuck
<u>Kobus ellipsiprymnus</u> (Ogilby).	Waterbuck

<u>Kobus kobus</u> (Erxleben).Kob
<u>Hippotragus equinus</u> (Desmarest).	Roan antelope
<u>Alcelaphus buselaphus</u> (Pallas).Hartebeest
<u>Damaliscus lunatus</u> (Burchill).	Korrigum
<u>Ourebia ourebi</u> (Zimmermann)Oribi

APPENDIX C

APPENDIX C

The birds of Bouba Ndjida National Park

The following species of birds have been identified in Bouba Ndjida N. P. The systematic order and nomenclature are those of White (1965).

PHALACROCORACIDAE

Phalacrocorax africanus. African cormorant

ARDEIDAE

Ixobrychus sturmi. Dwarf bittern

Ardeola ralloides Squaco heron

Ardeola ibis. Cattle egret

Butorides striatus Green-backed heron

Egretta alba Great white egret

Egretta garzetta Little egret

Ardea cinerea. Gryn heron

Ardea melanocephala Black-headed heron

Ardea purpurea Purple heron

SCOPIDAE

Scopus umbretta Hammerkop

CICONIDAE

Ciconia ciconia White stork

Ciconia nigra Black stork

Ciconia abdimii Abdim's stork

Ciconia episcopus Woolly-necked stork

Ephippiorhynchus senegalensis Saddle-billed stork

Leptoptilus crumeniferus Marabou stork

THRESKIORNITHIDAE

Threskiornia aethiopica.Scared ibis

Bostrychia hagedash Hadada

ANATIDAE

Plectropterus gambensis.Spur-winged goose

ACCIPTRIDAE

Aegyptius tracheliotus Lappet-faced vulture

Trigonoceps occipitalis White-headed vulture

Gyps ruppellii Ruppell's griffon vulture

Gyps bengalensis White-backed vulture

Neophron monachus Hooded vulture

Circus macrourus Pale harrier

Polybroides radiatus Harrier-hawk

Terathopius ecaudatus Bateleur

Circaetus cinerascens Banded harrier-hawk

Accipiter ovampensisOvambo sparrow-hawk

Melierax metabatesDark chanting goshawk

Melierax gabar Gabar goshawk

Kaupifalco monogrammicus Lizzard buzzard

Bustastur rufipennisGrasshopper buzzard

Buteo auguarealis. Red-necked buzzard

Lophaetus occipitalis Long-crested hawk-eagle

Polemaetus bellicosus Martial eagle

Hieraetus spilogaster African hawk-eagle

Aquila rapaxTawny eagle

Aquila wahlbergiWahlberg's eagle

Haliaetus vocifer Fish eagle

<u>Milvus migrans</u>	Black kite
FALCONIDAE	
<u>Falco ardosiaceus</u>	Gray kestrel
<u>Falco alopex</u>	Fox kestrel
SAGITTARIDAE	
<u>Sagittarius serpentarius</u>	Secretary bird
PHASIANIDAE	
<u>Francolinus streptophorus</u>	Ring-necked francolin
<u>Francolinus bicalaratus</u>	Double-spurred francolin
<u>Coturnix</u> sp.	Quail
<u>Ptilopachus petrosus</u>	Stone partridge
<u>Numida meleagris</u>	Guinea fowl
OTIDAE	
<u>Neotis denhami</u>	Denham's bustard
<u>Eupodotis melanogaster</u>	Black-bellied bustard
BURHINIDAE	
<u>Burhinus senegalensis</u>	Senegal thickknee
<u>Burhinus capensis</u>	Spotted thickknee
CHARADRIIDAE	
<u>Vanellus spinosus</u>	Spur-winged plover
<u>Vanellus albiceps</u>	White-headed plover
<u>Vanellus sengallus</u>	Wattled plover
<u>Charadrius hiaticula</u>	Ringed plover
<u>Charadrius tricollaris</u>	Three-banded plover
<u>Charadrius forbesi</u>	Forbes' plover
<u>Numenius phaeopus</u>	Curlew
<u>Tringa glareola</u>	Wood sandpiper

- Tringa ocropus Green sandpiper
- Tringa hypoleucos Common sandpiper
- GLAREOLIDAE
- Cursorius chalcopterus Violet-tipped courser
- Pluvianus aegyptius Egyptain plover
- PTEROCLIDIDAE
- Pterocles quadricinctus Four-banded sandgrouse
- COLUMBIDAE
- Streptopelia turtur Turtle dove
- Streptopelia semitorquata Red-eyed dove
- Streptopelia vinacea Vinaceous dove
- Stigmatopelia senegalensis Laughing dove
- Oena capensis Namaqua dove
- Turtur afer Blue-spotted wood dove
- Turtur abyssinicus Black billed blue-spotted
wood dove
- Treron waalia Bruce's green pigeon
- PSITTACIDAE
- Poicephalus senegalus Yellow-bellied parrot
- Psittacula drameri Rose-ringed parrakeet
- MUSOPHAGIDAE
- Tauraco leucolophus White-crested turaco
- Musophaga violacea Violet turaco
- Crinifer piscator Gray plantain-eater
- CUCULIDAE
- Cuculus canorus Cuckoo
- Centropus senegalensis Senegal cuckoo

STRIGIDAE

- Otus scops African scops owl
Otus leucotis White-faced scops owl
Scotopelia peli Fishing owl

CAPRIMULGIDAE

- Macrodipteryx longipennis Standard-winged nightjar

ALCEDINIDAE

- Ceryle maxima Giant kingfisher
Ceryle rudis Pied kingfisher
Alcedo cristata Malachite kingfisher
Halcyon leucocephala Grey-headed kingfisher

MEROPIDAE

- Merops superciliosus Blue-cheeked bee-eater
Merops nubicus Southern carmine bee-eater
Merops pusillus Little bee-eater
Merops bulocki Red-throated bee-eater

CORACIIDAE

- Coracias abyssinica Abyssinian roller
Eurystomus glaucurus Broad-billed roller

UPUPIDAE

- Upupa epops European hoopoe
Phoeniculus purpureus Green wood-hoopoe

BUCEROTIDAE

- Tockus nasatus Gray hornbill
Tockus erythrorhynchus Red-billed hornbill
Bucorvus abyssinicus Abyssinian ground hornbill

CAPITONIDAE

Lybidus dubius Bearded barbet

INCICATORIDAE

Indicator indicator Black-throated honey-guide

PICIDAE

Campethera punctuligera Fine-spotted woodpecker

Mesopicos goertae Gray woodpecker

ALAUDIDAE

Mirafrā rufocinnamomea Flappet lark

Eremopterix leucotis Chestnut-backed sparrow-lark

HIRUNDINIDAE

Hirundo smithii Wire-tailed swallow

Hirundo daurica Red-rumped swallow

Hirundo abyssinica Striped swallow

MOTACILLIDAE

Motacilla flava Yellow wagtail

LANIIDAE

Dryoscopus gambensis Gambian puff-back shrike

Laniarius barbarus Scarlet-breasted barbary
shrike

Malaconotus sulfureopectus Sulfur-breasted bush shrike

ORIOOLIDAE

Oriolus auratus African golden oriole

DICRURIDAE

Dicrurus adsimilis Drongo

STURNIDAE

Lamprotornis caudatus Long-tailed glossy starling

Buphagus africanus Yellow-billed oxpecker

CORVIDAE

Ptilostomus afer Piapiac

CAMPEPHAGIDAE

Campephaga phoenica Red-shouldered cuckoo-shrike

PYCNONOTIADAE

Pycnonotus barbatus Common garden bulbul

MUSCICAPIDAE

Myrmecocichla albifrons White-fronted black chat

Cossypha niveicapilla Snowy-crowned robin-chat

Turdoides plebeja Sudan brown babbler

Hypergerus atriceps Oriole babbler

Myioparus plumbeus Gray tit-babbler

Melaenornis edoliodes Black flycatcher

Platysteira cyanea Wattle-eye flycatcher

Trochocercus longicauda Blue flycatcher

Terpsiphone viridis Paradise flycatcher

SALPORNITHIDAE

Salpornis spilonota Spotted creeper

NECTARINIIDAE

Anthreptes platura Pygmy long-tailed sunbird

Nectarinia senegalensis Scarlet-chested sunbird

EMBERIZIDIDAE

Emberiza flaviventris Golden-breasted bunting

Emberiza forbesi Nigerian little bunting

Eberiza tahapisi Cimmanon-breasted rock
bunting

FRINGILLIDAE

Serinus mozambicus Yellow-fronted canary

PLOCEIDAE

Quelea quelea Red-billed quelea

Euplectes hordeaceus Black-winged bishop

Euplectes macrourus Yellow-mantled wydah

Vidua chalybeata Senegal indigo bird

Vidua orientalis Broad-tailed paradise wydah

Estrilda melpoda Orange-cheeked waxbill

Estrilda bengala Red-cheeked cordon-bleu

Lagonosticta senegala Red-billed fire finch

MICHIGAN STATE UNIVERSITY LIBRARIES



3 1293 03196 1950