THESIS

This is to certify that the

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HABITAT PREFERENCES AND ASPECTS OF
GENERAL ECOLOGY OF THE SENEGAL KOB
IN KAINJI LAKE NATIONAL PARK, NIGERIA

presented by

Olufemi Abiodun Sodeinde

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Geo A Petrides

Major professor

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HABITAT PREFERENCES AND ASPECTS OF GENERAL ECOLOGY OF THE SENEGAL KOB IN KAINJI LAKE NATIONAL PARK, NIGERIA

By

Olufemi Abiodun Sodeinde

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ABSTRACT

HABITAT PREFERENCES AND ASPECTS OF GENERAL ECOLOGY OF THE SENEGAL KOB IN KAINJI LAKE NATIONAL PARK, NIGERIA

By

Olufemi Abiodun Sodeinde

Senegal kobs (Adenota k. kob) in the Kainji Lake National Park, Nigeria were studied between October 1982 and February 1983 with the objective of determining their population densities and habitat preferences. The effects of fire on kob feeding ecology and habitat were also appraised.

Kobs in the Park occurred mostly in female herds or in harems and averaged a density of 7.46 ± 1.87 per km^2 in the Oli Valley. Density of this animal varied along individual tracks in the valley mainly in relation to the proportions of 3 major vegetation types evaluated as habitat. Based on daytime use of these vegetation types by kobs versus their availability in the valley, the Terminalia macroptera savanna was preferred as habitat over the Burkea africana-Terminalia avicennoides savanna woodland and open grasslands. Fire, through its effect on forage vigor and visibility, seemed to influence kob movements and feeding ecology by attracting kobs to burned areas.

ACKNOWLEDGEMENT

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This study would not have been possible without the permission granted me to conduct it at the Kainji Lake National Park. On this score my gratitude goes to the Controller of the Park, Mr. J. S. Ibeun, colleagues at the Park and my field assistants, Messrs. Fojuloye, Yusuf and Jimi. I am particularly grateful to the Kainji Lake Research Institute, New Bussa for granting me the use of their facilities; and to Dr. J. Ayeni and other members of the Wildlife and Range Division for their helpful suggestions on conduct of the study. I am also appreciative of the assistance given me by the School of Wildlife Management, New Bussa.

I gratefully acknowledge the support of the Federal Department of Forestry who through the Federal Ministry of Agriculture, sponsored me for this program. I wish to

thank our families the Sodeindes and Ojos for their love and support and my wife Toyin, for her support and for typing drafts of this report. My son, Femi Jr. also deserves special mention for his "priceless contributions".

Final thanks goes to Susan Hazard for typing the final copy of the thesis.

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INTRODUCTION

The Senegal kob (Adenota k. kob Erxleben), a member of the bovid sub-family Reduncinae, is the most abundant medium-sized antelope at the Kainji Lake National Park (KLNP), Nigeria. The adult male possesses thick, strongly ringed horns with S-shaped double curvatures (Figure 1). The female is similar but is hornless and smaller in size.

In Nigeria, kobs occur in the Derived, Guinea and Sudan savanna regions (Figure 2). Apart from the KLNP, kobs in reserves are also present in the Upper Ogun (Henshaw 1970, Ayeni 1976) and Kwiambana (Ajayi et al. 1981) Game Reserves. Not much is known about the population of this species in these and other reserves in the country.

Currently, interest is being generated in the domestication and possible harvesting of this species in areas outside reserves. The Wildlife Divisions of both the Kainji Lake Research Institute and the Federal Department of Forestry have prepared research proposals concerning kob domestication. These call for detailed studies of the ecology of this species.

The present study examined habitat use and preference of the Senegal kob, along with some aspects of its

Figure 1. An adult male Senegal kob (Adenota kob kob Erxleben) in an open wooded grassland at the Kainji Lake National Park, Nigeria.

Figure 2. Map showing generalized distribution of kobs in Nigeria (after Dorst and Dandelot 1970).

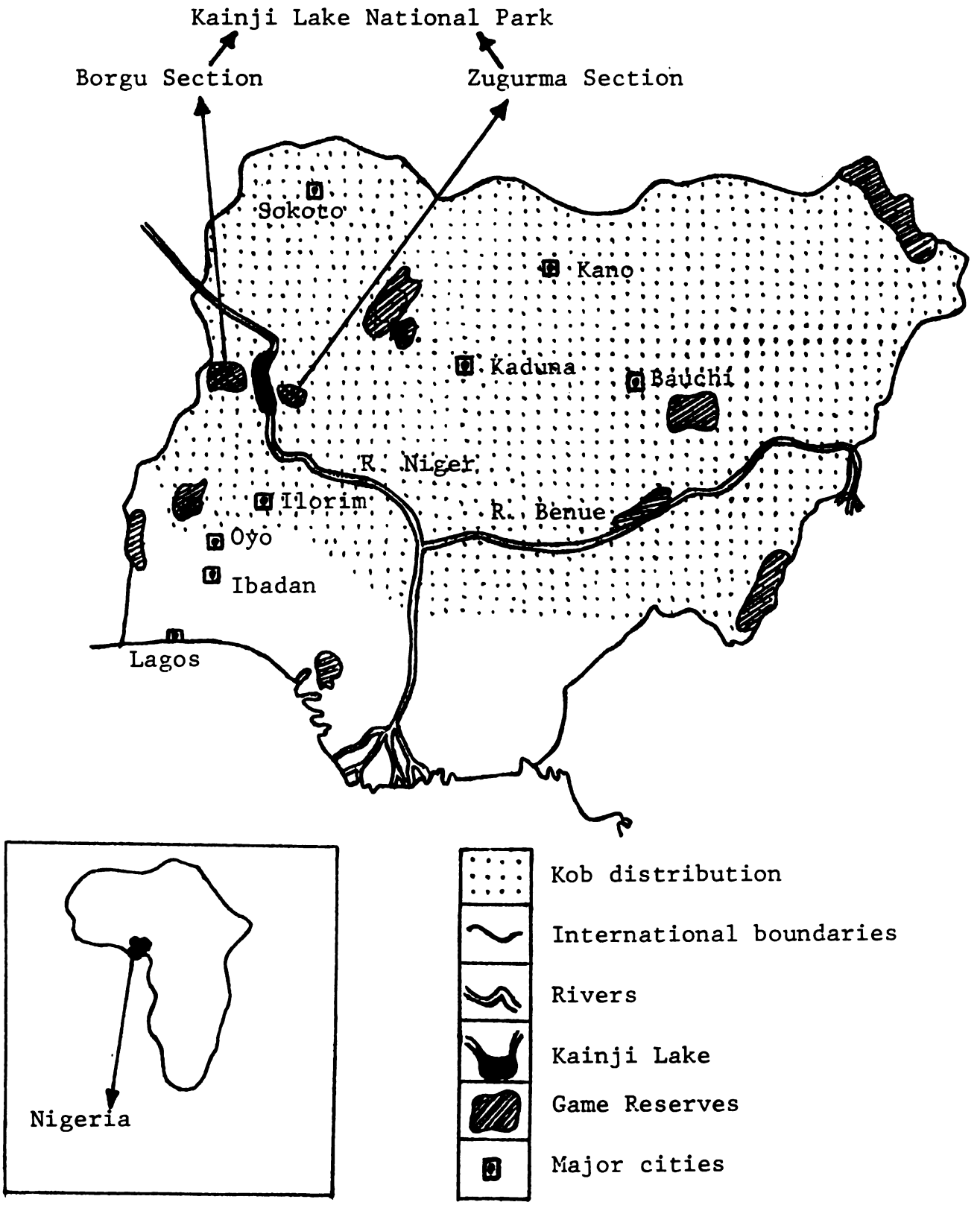
Kainji Lake National Park
Borgu Section
Zugurma Section
Sokoto
Kano
Kaduna
Bauchi
R. Niger
Ilorim
R. Benue
Oyo
Ibadan
Lagos
Nigeria
Kob distribution
International boundaries
Rivers
Kainji Lake
Game Reserves
Major cities

Figure 2.

feeding ecology, in the Borgu Section of the KLNP. Preliminary observations of kob population ecology, highlighting its herd structure, age distribution, sex ratio, social organization and population density also were conducted. The study was carried out between October 1982 and February 1983.

Literature Review

Most available information on the kob is derived from work on the East African subspecies, the Uganda kob (*A. k. thomasi*). Territorial behavior in this form was described by Buechner (1961, 1963, 1972), Buechner and Buechner (1971), Buechner and Roth (1974) and Leuthold (1966a). Male Uganda kobs defend fixed, nearly-circular territories 10 to 15m in diameter within an area of concentrated activities about 200m in diameter. The entire unit constitutes a territorial breeding ground which females enter throughout the year for the purpose of mating.

Leuthold (1966b) conducted experiments with the Uganda kob and found that both its degree of attachment to territorial grounds, and its homing tendencies were strong. Other studies showed that mating in the Uganda kob occurs throughout the year (Buechner 1961, Buechner and Schloeth 1965, Morrison 1971) with only short intervals between parturition and subsequent conceptions.

In West Africa, information has been collected on the Senegal kob as part of general ecological surveys

(Child 1974, Milligan 1978, Koster 1981). These reports indicate that West African kobs prefer open savanna habitats along perennial sources of water. Herds and harems headed by a male are commonly formed. Females generally outnumber males in the kob population.

Geerling and Bokdam (1971) appraised kob habitats, sociability and sex ratios. Gilbert (unpublished, 1982) also completed field work on the kob at the Comoe National Park in Ivory Coast, where he reported densities of the animal to be high in the open savannas. Henshaw (1970) analyzed kob habitats and WanZie (1978) commented on the ecology and behavior of the West African subspecies.

These studies indicate that the West African race of kob may exhibit territoriality which is not as pronounced as that of its East African counterpart. Territories may be more widely-spaced and matings less frequent.

STUDY AREA

Brief History, Location and Access

The Kainji Lake National Park is made up of the former Borgu and Zugurma Game Reserves in Kwara and Niger States, respectively. It is Nigeria's only declared national park. Established in 1976, the park was managed by the Federal Department of Forestry from 1976 to 1979 when the Kainji National Park Decree (now an Act) was signed into law. The Kainji National Park Law empowered a Board of Management with the overall management of the park under the Federal Ministry of Agriculture.

This study was carried out in the Borgu section of the park (Figure 3), hereafter referred to as the study area, or simply the 'park'. The section occupies an area of about 3924 km^2 between latitudes 9^o 45' N and 10^o 23' N and longitudes 3^o 40' E and 4^o 32' E. It is bounded on the east by the Lake Kainji and on the west by the international border with Benin. Vegetatively, it lies within the Guinea savanna zone.

The main access to the park is by the Wawa - Agwara road, with the entrance 18 kms from Wawa. Wawa is connected to New Bussa, 16 kms east, by an asphalt road.

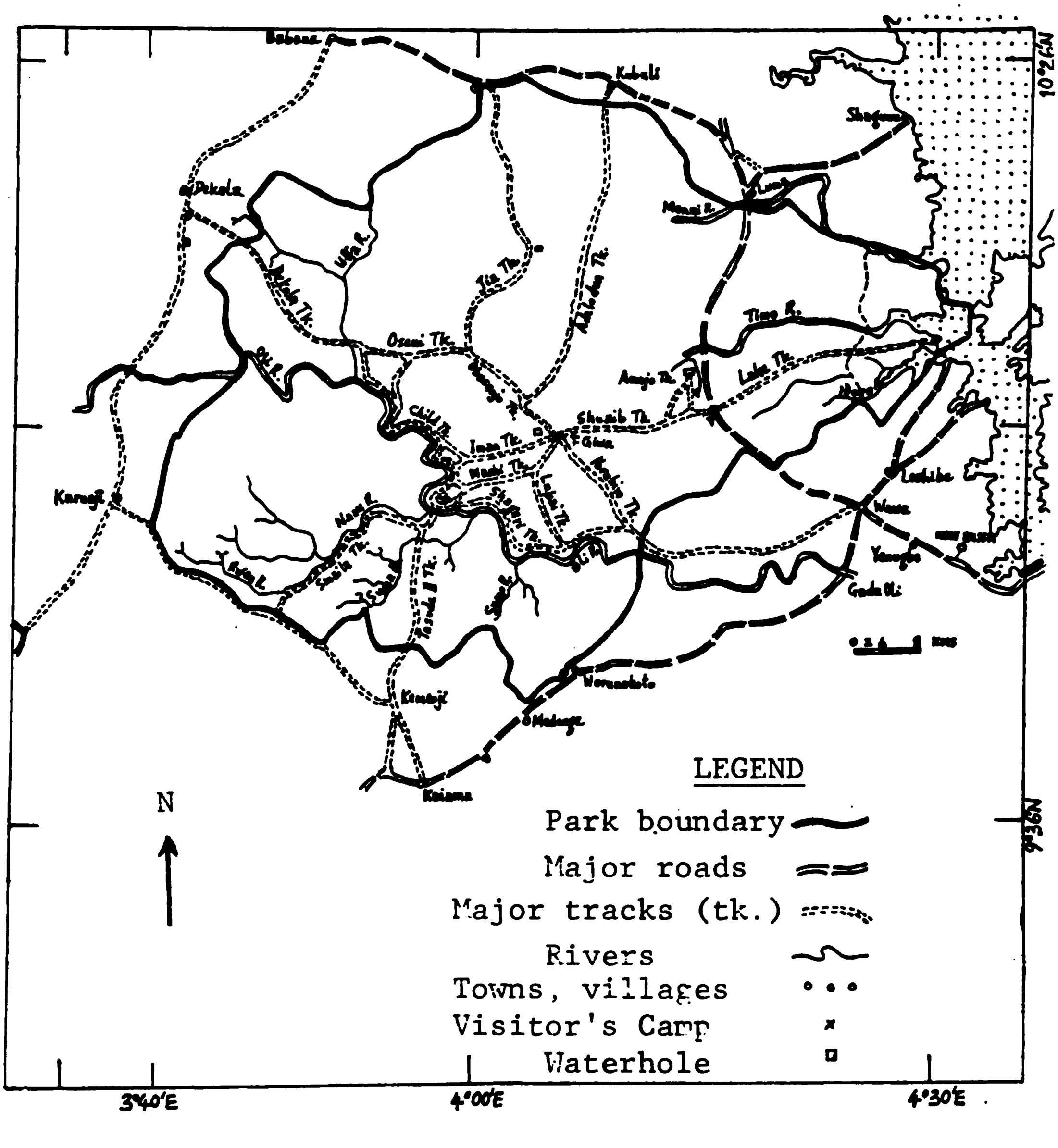

Figure 3. Generalized map of the Borgu Section of Kainji Lake National Park, Nigeria. This section comprised the study area.

Topography, Drainage and Hydrology

The terrain is gently undulating, rising from ca. 155m above sea level at Kainji Lake to ca. 380m in the northwest corner, most of the area lying between 250 and 325m (Geerling 1976).

There are 2 main drainage systems. The western part is drained by the Oli River and its tributaries which rise in Benin and drain into the artificial Kainji Lake. The eastern part is drained by the Doro, Timo and Menai rivers which enter Lake Kainji above its dam.

Though no watercourse flows throughout the dry season, good waterholes are retained by the Oli, Menai, Uffa and Nanu rivers and some smaller watercourses (Child 1974).

Geology and Soils

Intrusions of porphyritic granite have been identified in areas of the park. There is also a large occurrence of metasediments phyllite being the dominant. Bands of quartz and quartzite occur especially in the east (Child 1974).

Upper slopes generally have fairly deep soils, except where there are rock outcrops. Soils in the middle and lower slopes normally are shallow. Deeper valley soils are formed through colluvial and alluvial accumulations of materials (Child 1974). Soils vary in texture from sandy loam to clay loam and are slightly acidic to neutral (pH 6.1-7.3). Soil acidity irregularly increases with depth

(Milligan 1978). The organic content of soils in the area is low with nitrogen and carbon often being limiting (MAB 1981).

Climate

The rainy season ranges from 150 to 200 days. Rains fall between April and October with a peak in July, August and September, while the dry season lasts from November to April (Ajayi and Hall 1979). Total annual rainfall for 1982 was 1010mm, with monthly rainfall ranging from 5.7mm in March to 217.9mm in September (Figure 4). The precipitation-evaporation ratio normally ranges from 0.30 to 0.66.

Relative humidity is at its lowest in the months of December to February peaking in the rainy season at 68 to 78 percent (Figure 4). Relatively low humidities for the months of December, January and February are due to the influence of the dry northerly harmattan winds (Child 1974).

Though temperature was not recorded locally in 1982, the average mean temperature for the study area varied from 24^{o}C in September to 35^{o}C in April (Figure 5).

Vegetation

The park's vegetation has been well studied (Ajayi and Hall 1979). Geerling (1976) reported that the following 8 vegetation types were present (Figure 6):

Figure 4. Rainfall (histogram) and relative humidity (line-graph) for 1982 and early 1983 in the Borgu Section of Kainji Lake National Park (from School of Wildlife Management, New Bussa).

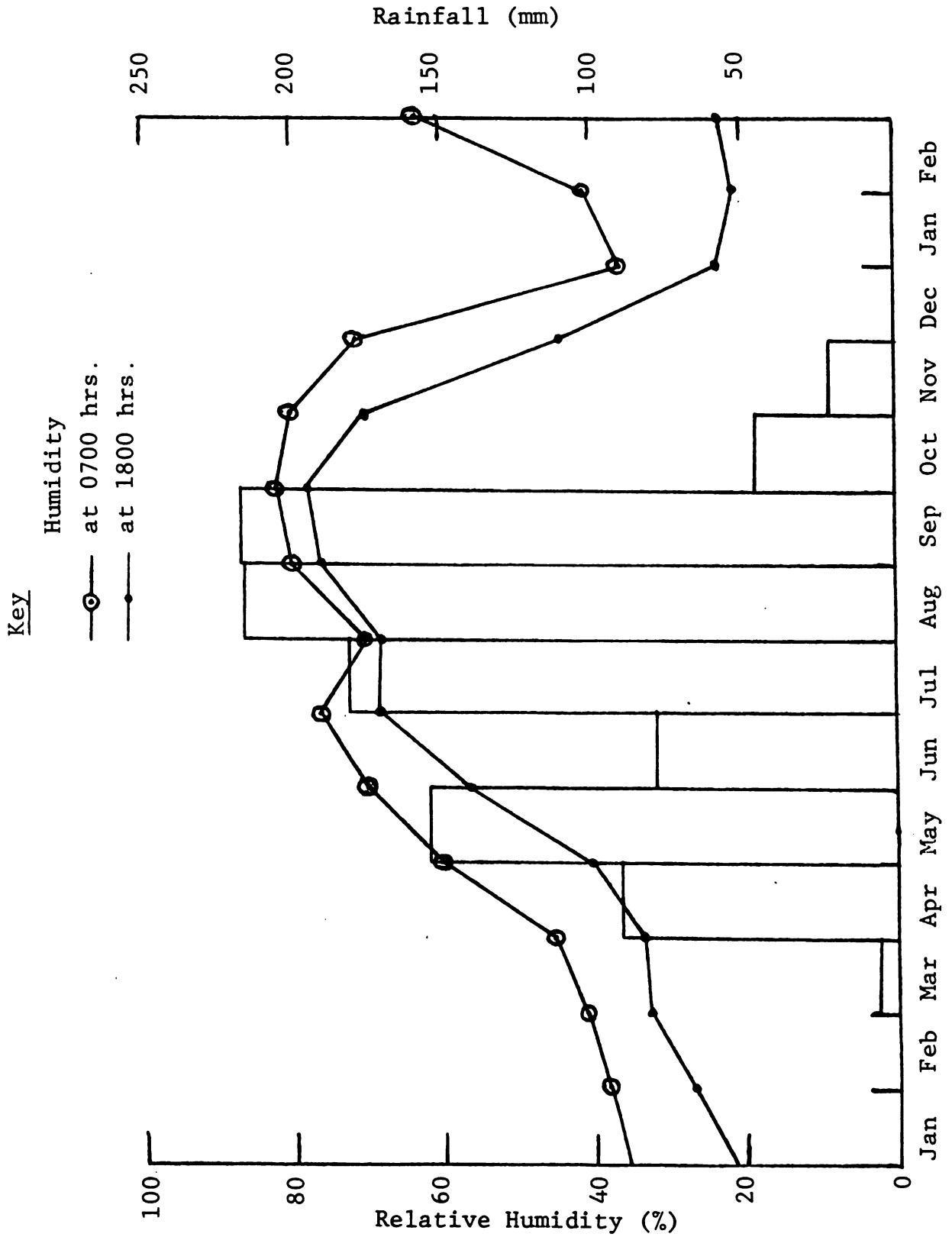
Rainfall (mm)
250
200
150
100
50
Key
Humidity
at 0700 hrs.
at 1800 hrs.
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb
100
80
60
40
20
0
Relative Humidity (%)

Figure 4.

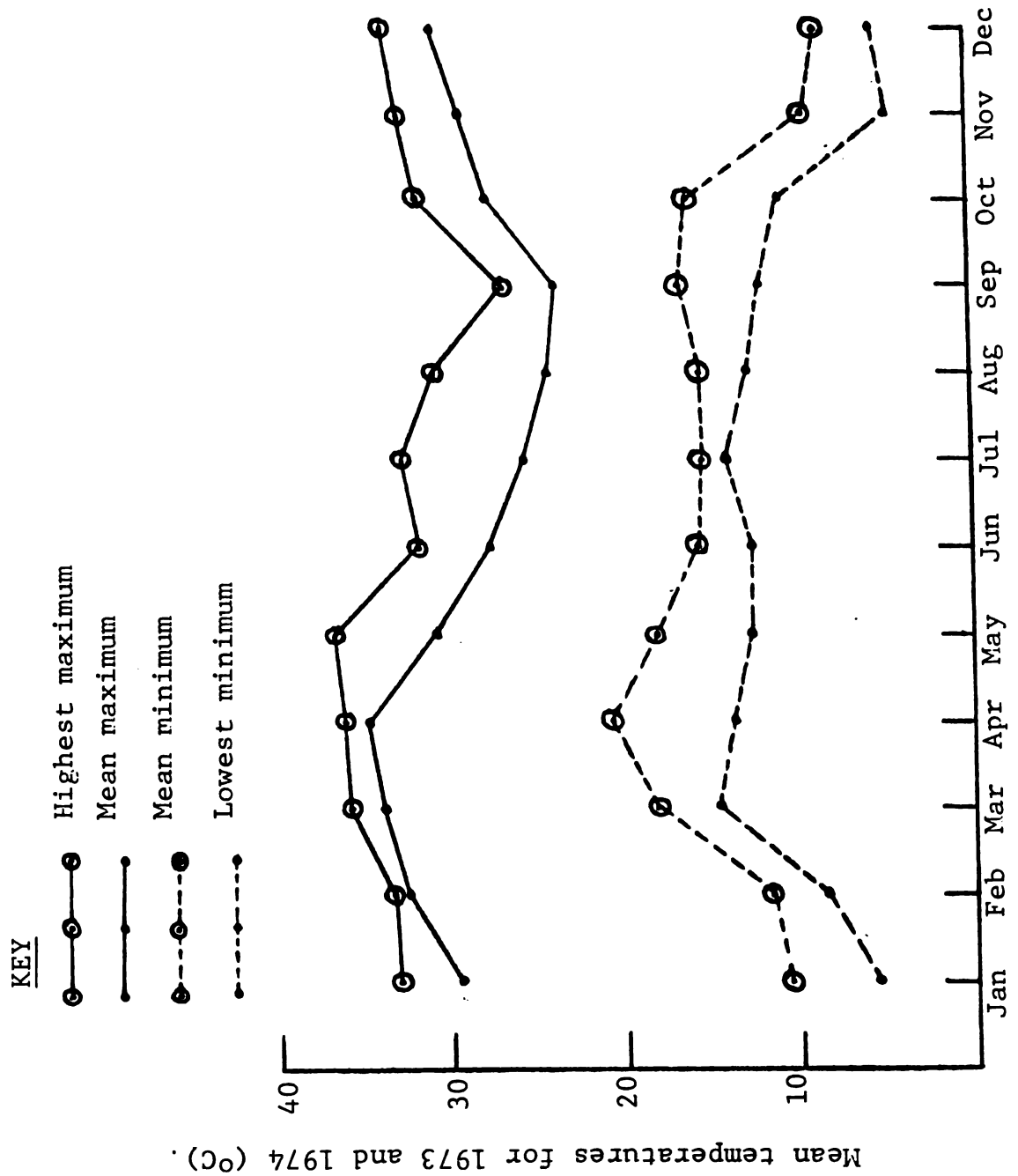

Figure 5. Temperature levels in the Borgu Section of Kainji Lake National Park (from Ayeni 1980).

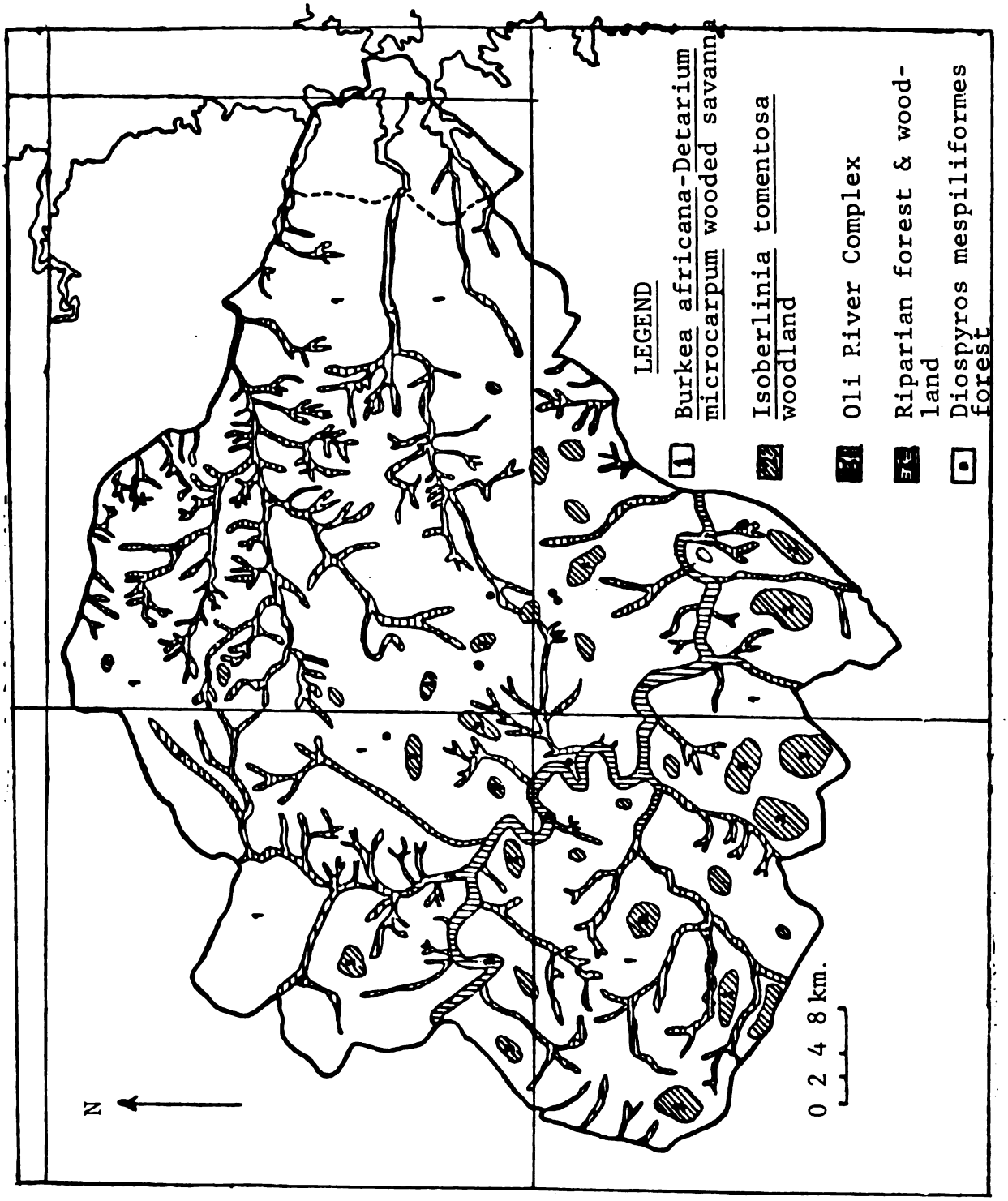

Figure 6. Generalized vegetation map of the study area showing some vegetation types. Kainji Lake N. Park, Nigeria (from Child (1974)).

Burkea Africana-Terminalia avicennoides Group

This is the prevalent woodland vegetation, covering 70 percent of the total park area. Five sub-types have been identified which grade into each other, but are not sharply differentiated. The group is equivalent to Child's (1974) B. africana-Detarium microcarpum vegetation type. Principal trees and woody shrubs in the group aside from the 3 dominant members are species of Combretum, Afzelia africana, Butrospermum paradoxum, Maytenus senegalensis and Gardenia ternifolia. Common grasses are several members of the genera Andropogon and Hyparrhenia, most of which are perennials. Forbs present include species of Borreria, Indigophera and Cochlospermum.

Oli Complex

Along the Oli river and the lower reaches of the Uffa and Nanu rivers, a series of vegetation zones are distinguishable between the river bed and the Burkea-T. avicennoides savanna woodland:

a) Riverbed and sandbanks with Rotula aquatica and Mimosa pigra as common woody shrubs and riparian forest strip with Cola laurifolia and Irvingia smithii as common trees.

b) Levee woodland consisting of such trees as Anogeissus leiocarpus, Daniellia oliveri, and Terminalia

glauscenses and with Andropogon tectorum as the prevalent grass.

c) Low, seasonally-inundated areas of open savanna grasslands with Mitragyna inermis as the typical tree species and with the woody shrubs Combretum hypopilium and Diospyros mespiliformis.

d) Savanna woodland of low trees and shrubs on the lower slopes which grades into the Burkea-T. avicennoides savanna.

Open Valleys

On low-lying, seasonally-inundated soils, scattered shrubs and trees mainly of termitaria occur. The upper valleys of rivers are often covered with Terminalia macroptera tree savanna. Pseudocedrela kotschyi, Mitragyna inermis, and Daniellia oliveri also are characteristic trees. Common grasses in these valleys are Andropogon perligulatus, A. pseudapricus, Hyparrhenia rufa, H. glabriscula and H. cyanescens, with Echinochloa spp. and Oryza barthii in moister situations.

Riparian Forest and Woodland

Fringing trees and shrubs are associated with temporary watercourses. Common species are Diospyros mespiliformes, Kigelia africana, Daniellia oliveri, Syzygium senegalensis and Vitex doniana.

Other Vegetation Types

The other form of Geerling's vegetation types include the Diospyros mespiliformis forest in scattered localities in the central part of the park, Isoberlinia tomentosa - Monotes kerstingii woodlands, and Acacia savanna woodland over an extensive area in the northeast of the park.

In this study, Geerling's "open valley vegetation type was separated into two categories according to their dominants (1) Daniellia oliveri - Mitragyna inermis and (2) Terminalia macroptera. All references to the open wooded grassland beyond apply to the Daniellia - Mitragyna category.

Fauna

The fauna is typical of the well-watered Sudano-Guinean savanna (Child 1974). The most common mammals in the park are the roan antelope (Hippotragus equinus), western hartebeest (Alcelaphus buselaphus), and Senegal kob (A. k. kob). The baboon (Papio anubis) is the most abundant primate. The lion (Panthera leo) which occurs in a large area of the park is the most often sighted carnivore , and the hippopotamus (Hippotamus amphibius) is common in deep pools of the Oli river. The buffalo (Syncerus caffer) is widely seen near areas with permanent water especially in the dry season. The African elephant (Loxodonta africana), although present, was rarely seen during the study.

The ground hornbill (Bucorvus abyssinicus) and the common guinea-fowl (Numida meleagris) are frequently seen in the dry season. The Nile crocodile (Crocodilus niloticus), although an endangered species in Nigeria, and the Nile monitor lizard (Varanus niloticus) are resident reptiles. Checklists of mammals, birds, reptiles and fish in the park have been prepared by Child (1974).

MATERIALS AND METHODS

Following the procedure of other studies conducted in the study area (Child 1974, Ayeni 1980, Milligan 1982), 2 broad strata based on habitat differences were recognized for the purpose of transect counts. These were (1) the Oli valley which is the area within 3 km on each side of the Oli river covering an estimated 375 km^2, and (2) the upland savanna regions which are the areas away from the Oli valley with an approximate coverage of 3300 km^2. The Oli valley constituted the "intensive study area" (Figure 7). Otherwise the 3 major vegetation types in the valley were evaluated as habitats for kobs, each vegetation type being considered as a habitat type after Geerling (1976). These were the T. macroptera tree savanna (Figures 8 and 9), the Burkea-T. avicennoides savanna woodland (Figure 10) and the Daniellia-Mitragyna grassland (Figure 11). The latter type occupied the upper reaches of watercourses including the Oli river. Tree densities and girth sizes were determined for each vegetation type from mean plant-to-point distances and dbh of sampled trees, using the point centered quarter method (Cottam and Curtis 1956). Information on these was obtained from ten points which were

Figure 7. Study area with tracks censused in the Oli valley (the "intensive study area" ▬▬) and the upland area (═══). Kainji Lake National Park, Nigeria, 1982-83.

● depicts beginning or end of transect

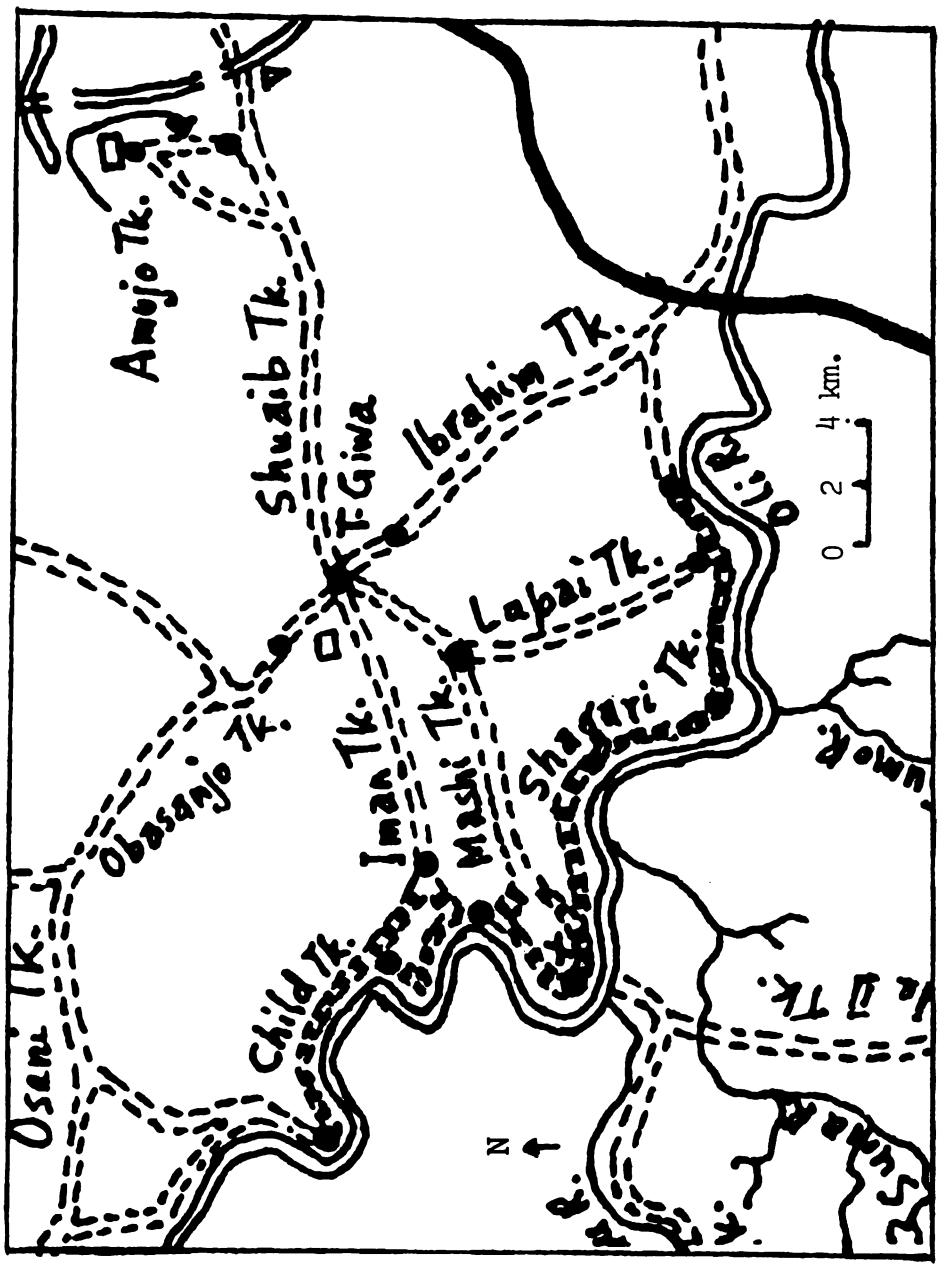

Figure 7.

Figure 8. The T. macroptera-Hyparrhenia rufa savanna in the Oli Valley, unburned. Kainji Lake National Park, December 1982.

Figure 9. T. macroptera savanna in the Oli Valley, late burned. Kainji Lake National Park, January 1983.

Figure 10. Burkea africana-T. avicennoides savanna woodland, on an upland site, unburned. Kainji Lake National Park, Nigeria. January 1983.

Figure 11. Open wooded grassland in the Oli Valley after December burn. Kainji Lake National Park, Nigeria. January 1983.

randomly located on selected areas representative of each vegetation type.

Aspects of Kob Population Ecology

i) Kob visibility distances for censusing

Visibility of kobs in the 3 major vegetation types in the Oli valley was measured prior to and again after early burning using full-size cut-out models of the animal. In each vegetation type 2 assistants, each with an identical model, moved in opposite directions from the road until the models were no longer visible from the original location. The distances from the observer to these points were recorded as kob visibility distances. The means of these distances in burned areas of each vegetation type were used as average visibility limits for kobs (Hirst 1969), because most kob observations were made on vegetation of this status. The lowest mean kob visibility distance recorded for any vegetation type was used to designate one half of a minimum strip-width for censusing kobs in all vegetation types. Kobs counted beyond this distance, where the vegetation was more open, were excluded from all density determinations. This approach was taken in order to minimize the possible effects which visibility biases may have on kobs seen and counted in each type.

ii) Strip-censuses of kobs

Portions of vehicle tracks in the Oli valley and upland savanna regions were established as transects to serve in appraising the effects of distance from the Oli river and habitat differences on kob distribution. Roads in

parks usually are planned to bring visitors to areas of animal concentrations, so sample counts along such roads may not be representative of the whole park. Transects located away from roads in the study area, however, were difficult to establish because of difficult terrain. With the exception of the Child and Shagari tracks which were associated with the Oli River (Milligan et al. 1982), roads in the study area were located away from major streams and were rather randomly distributed (Figure 3).

Kobs were counted along the following tracks which were established so that they could serve as a standard for later comparisons. Six transects were in the uplands:

i) Lapai, 13 km long; extending from the Shagari to Mashi tracks

ii) Ibrahim-obasanjo, the 4 km and 3 km portions of Obasanjo and Ibrahim tracks nearest the T. Giwa junction, comprising a 7 km transect

iii) Iman, 11 km long, from the Child track to T. Giwa junction

iv) Amujo, 7 km from the Shuaib tract to the T. Zomo waterhole

v) Hussain Mashi Proper, 13 km running from the Visitor Camp to the junction of the Lapai-Mashi tracks

vi) H. Mashi Extension, 7 km from the Lapai-Mashi junction to the T. Giwa junction.

In the Oli Valley, transects were fixed on the following tracks:

vii) Shagari Proper, covering the distance from the Visitor's Camp to kilometer 11

viii) Shagari Extension, continuing from kilometer 11 to 20

ix) Gilbert Child Proper, extending 10 km upstream from the Visitor's Camp

x) G. Child Detour, from kilometer 10 to kilometer 22 and

xi) G. Child Extension from kilometer 22 to 32.

Generally counts along roads were conducted from just after sunrise (0630-1130 hrs) and prior to sunset (1500-1900 hrs). Two observers and driver participated, each viewing one side of the track from the top of a vehicle which cruised at about 25 km per hour. When kobs were sighted, the vehicle was stopped and the transect name, time, vegetation type, burn status, kob numbers by sex and age, sighting distances and activity when first seen and after 1 minute were recorded. Counts along each road were repeated at least 7 times except for the Lapai, Amujo and the Shagari Extension which were censused less because of poor motorable conditions. Binoculars were used to facilitate sexing and aging of kobs in the field.

The number of kobs on each route was tallied and densities estimated for sampled strips, using the minimum

strip-width determined from visibility measurements. Strip-widths derived from mean sighting distances for kobs counted along transects were lower than those derived from mean visibility distances, but were used to estimate densities for comparison with the visibility method estimates. Densities so derived were not further used in the report. The number of kobs counted along the valley tracks was pooled in estimating kob densities in the Oli valley. A kob biomass estimate for the Oli valley was based on a mean weight of 70 kg per animal as employed by Child (1974).

iii). Herd composition

Solitary animals and kobs in groups were encountered during transect surveys. A group was defined as any collection of animals showing coordinated activity. Where distances between group members were less than 50m, the sighting distance to the most numerous cluster was measured. Animals separated from their neighbors by more than 50m were classed as a different grazing group (Underwood 1982). It was assumed that all kobs were equally visible, irrespective of size, sex or age.

Sex and age categories were identified as follows:

Males: adults: horns generally S-shaped, body coat brightly colored;

" sub-adults: horns bow-shaped;

" juveniles: horns spike-like, about 1½ times ear length;

Females: adults: smaller than male, lacking horns

" sub-adults: slightly smaller than adults, hair coarse and reddish brown in color

" juveniles: same body size as juvenile males, no horns

Unsexed juveniles and neonates : juveniles and neonates which were too small to be sexed in the field.

Kob associations were categorized as follows:

i) solitary kobs by sex and/or age;

ii) couple - one male and one female usually adults;

iii) male herd - combinations of juveniles and/or adult males, females absent;

iv) female herd - 1 or more adult females with or without sub-adult and juvenile females, adult males absent;

v) harem - 1 adult male with more than one female with or without juveniles.

Some of the males actually accompanying females in harems might have been missed during counts so that the proportion of female herds could have been overestimated. Herd observations for November and December were pooled for determination of monthly mean herd sizes.

Fire and Burning Regimes

In the study area, fire has been used in management mainly: (1) to reduce areas of coarse grasses thereby inducing an early flush of fresh grass, (2) to enhance

visibility for game-viewing, (3) to reduce the amount of combustible litter, and (4) to control tsetse fly populations (KLNP 1982). To achieve these objectives during the 1982/83 viewing season (November - June), vegetation along the major tracks and elsewhere in the park was burned either in November 1982 or in late January and February 1983. This represented the early- and late-burn regimes. Fires were generally started from the edges of tracks and were set such that a mosaic of burned and unburned areas were left. The effects of burns on habitat use and feeding ecology of kobs were appraised.

Habitat Use by Kobs

Kobs were observed mostly in the daytime with occasional observations in the early hours of the night. Habitat preference is therefore based mainly on daytime use of vegetation types by kobs.

The area of each vegetation type in the Oli valley within the censused strip-width was estimated from aerial maps and ground reconnaissances. The number of kobs counted in the valley as compared with the respective areas sampled in each vegetation type was used to investigate habitat preference, employing the technique of Neu et al. (1974). Because the average density per trip was low, the numbers of kobs seen on all transect counts were pooled in determining habitat preferences in the Oli valley. The chi-square procedure was used to test the null hypothesis of

proportional use of vegetation types by kobs, confidence limits for the proportion of kobs in each vegetation type were calculated. Preferred habitats were those which contained proportionately more kobs than the areas of available habitat would justify. Neutral habitats were those used in proportion to their availability. Neglected and avoided habitats were used less than their availability in the study area would indicate (after Petrides 1975).

Cover Use and Feeding Ecology

The types of cover utilized by kobs for resting, hiding and feeding were recorded in burned and unburned areas. Kob activity, including a preliminary review of feeding habits was observed, employing the scan sampling technique (Altmann 1974) as used by Spinage (1968) and Clough and Hassam (1970). Plants which kobs were observed to feed upon were collected and identified. Independent observations by foot and by vehicle were carried out along the river and at selected water-holes to determine if there was a periodicity of water use.

The forage on ranges heavily occupied by kobs was investigated together with the short-term effects of burning. The density of grasses in each vegetation type was estimated by counting the grasses present in ten 1m x 1m quadrats located randomly in each type. The proportion of grass shoots grazed was noted to determine the intensity of grazing by kobs and other herbivores during the dry season.

Heights and crown widths of 20 randomly-chosen individual plants of 2 range-indicator genera, Andropogon and Hyparrhenia, were measured on selected ranges of each vegetation type in order to determine the effect of burning on the vigor of forage available for feeding. Grass heights were measured as the distance from the base of the grass tussock to the tip of the longest blade. Where grasses occurred in clumps, and the bases of adjoining plants of the same species were separated by less than 1cm, the diameter of the aggregated plants was taken as the crown width. Only new growths were measured. With respect to burn status, vegetation of areas in which kob observations were made was classified either as (1) burned with little or no regeneration of woody and herbaceous components, (2) burned with regeneration, or (3) unburned. Student's t-test (Steel and Torrie 1980), was employed to test the statistical significance of differences in mean tussock sizes determined between individuals from early- and late-burned areas.

RESULTS

Aspects of Kob Population Ecology

Kob population and biomass densities

A total of 1148 kobs were encountered during repeated trips over censused tracks. Out of this number only 3 animals were seen in the upland savanna region covered during the survey, the rest were in the Oli Valley. The kobs observed in the upland area were within 5 km of the valley, along the Mashi and Iman tracks which presented a gradient of increasing distance from the Oli River as the upland area was approached. This finding corroborates reports from other studies (Child 1974, Ayeni 1980, Milligan et al. 1982) that kobs are restricted to the Oli Valley. Most kobs seen were within 100m of the transect roads as also reported for censused kobs in Ivory Coast (Geerling and Bokdam 1971, Gilbert 1983, pers. comm.). Geerling and Bokdam (1971) attributed this trend to a possible attraction of kobs to open areas since they are species of the open savanna, and road sides tend to be cleared before other areas by fires. In the Oli Valley although, this animal was observed near the park roads in the 3 vegetation types including burned open-savanna and grasslands. The mean

kob visibility distance of 143m in the Burkea-T. avicennoides woodland was the lowest in the 3 vegetation types and it was used to set the visibility limit for censusing.

Kob densities along different tracks of the Oli Valley varied from 2.73 to 11.36 kobs per km^2 in the Shagari Proper and the G. Child Proper tracks, respectively (Table 1a), indicating a wide variation in density along the valley. Based on pooled individual track estimates, a mean density of 7.46 kobs per km^2 was determined for the Oli valley. Density estimates derived from strip widths based on mean sighting distances are always higher than those derived from the wider strip widths using mean visibility distances (Table 1b). The estimates based on sighting distances given here are for comparisons with other studies (Ayeni 1980, Milligan et al. 1982) and were not used for any other determinations in this study.

As kobs were restricted mainly to that valley, extrapolation of density estimates to the whole park area cannot be made. The population density determined for the 375 km^2 area of the Oli Valley, using the mean density for the area, was 2798 kobs (Table 2). The use of different censusing procedures in previous studies carried out in the area makes comparisons difficult. The mean kob density derived from mean visibility distance was higher than the 1971/1972 estimate of Child (1974) who used the same (Hirst 1969) visibility method, but was lower than the

Table 1. Densities of kobs based on areas censused monthly along sections of the Oli Valley. Kainji Lake National Park, Nigeria.

A*.

Tracks	G. Child Proper	G. Child Detour	G. Child Extension	Shagari Proper	Whole Oli Valley
Area censused (km^2)	2.86	3.43	4.29	3.15	13.73
Total kob numbers	325	224	193	69	811
Mean density $\pm$ 2 S.E. per km^2	11.36 $\pm$ 1.14	9.32 $\pm$ 0.65	6.41 $\pm$ 1.44	2.73 $\pm$ 0.79	7.46 $\pm$ 1.87

*a minimum strip-width of 286m (=2 x mean visibility distance for kobs used cut-out silhouettes) was used for density estimates

B**.

Tracks	G. Child Proper	G. Child Detour	G. Child Extension	Shagari Proper	Whole Oli Valley
Mean sighting distance (m.)	78	95	93	55	68
Area censused (km^2)	1.56	1.90	1.86	1.10	6.49
Total kob numbers	369	281	219	69	938
Mean density $\pm$ 2 S.E. per km^2	25.12 $\pm$ 4.12	22.92 $\pm$ 2.40	16.52 $\pm$ 1.98	7.75 $\pm$ 0.89	17.34 $\pm$ 3.73
No. of trips per track***	10	7	7	8	8

**Strip-widths (based on mean sighting distance (observer to animal) x 2) were used for density estimations

*** for both A and B.

Table 2. Population density estimates for the Senegal kob in the Oli valley for 1983 and previous censuses at the Kainji Lake National Park, Nigeria.

	Ayeni (1980) Ground Survey	Milligan et al. (1982) Ground/ Air Surv.	Child (1974) Ground Survey	This study (1983) Ground Survey
Density estimate (nos. per km^2)	11.03	10.36 (ground)	5.67	7.46
Population estimate	-	236* (air)	2126*	2798*
Mean biomass density (kg per km^2)	-	-	467	522

*Based on the 375 km^2 area of the Oli valley

(Mean unit weight for biomass estimation = 70 kg per kob, from Child (1974))

estimates of Ayeni (1980) and Milligan et al. (1982) whose estimates were determined from mean sighting distances. Density estimates derived from mean sighting distances were always greater than those using the method of these latter 2 authors. Depending on the prevalent vegetation and habitat condition during the other censuses, this may be an indication that kob density has somewhat increased over the 1971/1972 level reported by Child (1974). The use of density estimates for restricted kob areas to determine mean kob biomasses for whole areas of other West African parks makes comparisons difficult. The estimate of 49.9 kg per km^2 for the Kainji study area was higher, however, than the 36.4 and 15.9 kg per km^2 estimates for the Comoe Park, Ivory Coast (Geerling and Bokdam 1971) and Park W, Niger (Koster 1981). Based on a mean weight of 70 kg per kob, mean biomass of the kob population of the Oli valley as calculated in this study was 522 kg/km^2.

Herd composition

Sex and age ratios are important in judging the welfare of animal populations (Downing 1980). In the study area the sex ratio of 19.9 males to 80.1 females in censused adult kobs was markedly unbalanced. Adult sex ratios fluctuated between months (Figure 12a). The tendency of males to be territorial and thus often alone as observed during intensive study of selected kob groups, may have resulted in some males being missed during counts. The proportion

Figure 12. Sex and age ratios of the Senegal kob based on dry season monthly censuses in Kainji Lake National Park, Nigeria, November 1982-February 1983.

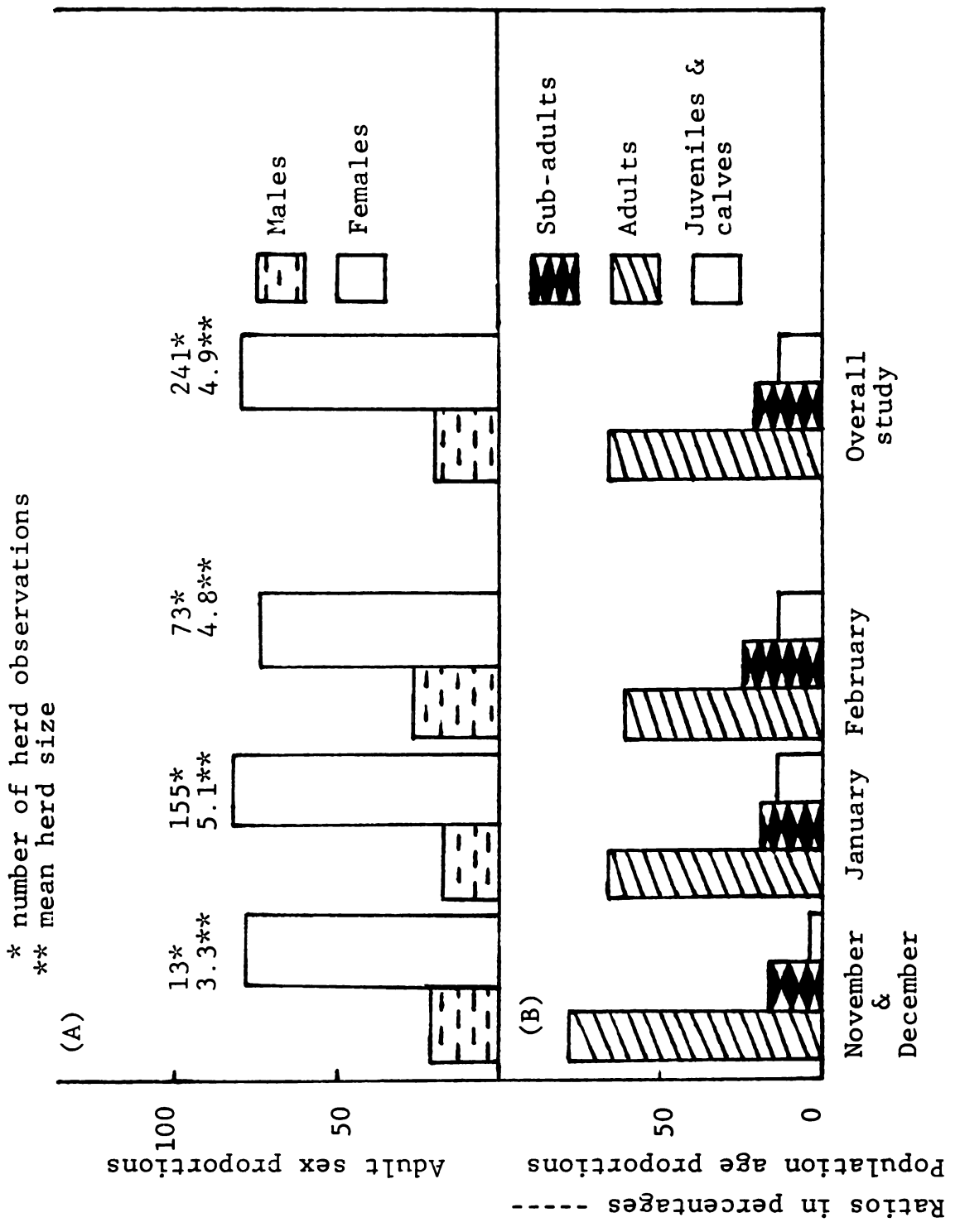
* number of herd observations
** mean herd size
(A)
13*
3.3**
155*
5.1**
73*
4.8**
241*
4.9**
Males
Females
Adult sex proportions
100
50
(B)
Sub-adults
Adults
Juveniles & calves
Population age proportions
Ratios in percentages -----
50
0
November & December
January
February
Overall study

Figure 12.

of adult females seen decreased in February, perhaps because of females leaving their groups to calve during this time of the year as reported by Child (1974) and Koster (1981).

In other parts of West Africa, male to female ratios for kobs were 42.4 : 57.6 in Ivory Coast (Geerling and Bokdam 1971), 43.5 : 56.6 in the Cameroons (Wanzie 1978) and 28 : 72 in Niger (Koster 1981). With the exception of the Niger figure, these ratios were more balanced than in the Kainji Lake National Park kob population. The reason is unknown.

Juvenile/adult ratios are a measure of the natality and rearing success of a population (Downing 1980 : 249). The dry season ratio of juveniles to adult kobs in the study area was 20.8 to 100 (Figure 12b). The ratio did not much differ from the ratios of 18.4 : 100 in Benoue National Park, Cameroons (Wanzie 1978) and 22.3 to 100 in Comoe National Park, Ivory Coast (Geerling and Bokdam 1971). These figures derived from dry season censuses approximately represent annual recruitment rates. As reported in other studies (Buechner 1963, Leuthold 1966a, Koster 1981), no significant difference was found between the monthly herd sizes of 3·3, 5·1 and 4·8 kobs per group for November and December (pooled), January and February, respectively (1-way analysis of variance $P > 0.10$).

Social organization of kobs

Of the 241 observations of kobs made during the study 19.1 percent were of solitary males. Solitary females and juveniles made up 5 percent of observations. Among groups, female herds were the most common type encountered, constituting 50.6 percent of total observations. Harems constituted 15.8 percent of all sightings and were the second most important herd type. Unlike other West African parks (Geerling and Bokdam 1971, Wanzie 1978), male herds in the park appeared to be unimportant.

Habitat Use and Preferences

About 74 percent of the total area censused within the established visibility limit in the Oli Valley was Burkea-T. avicennoides woodland (Table 3). T. macroptera savanna constituted only about 6 percent of the total area censused for kob, and the open wooded grasslands were 20 percent. The proportions of each vegetation type within the censused strip-width differed along transect roads in the Oli Valley, but approximately represent their true proportions in that area as judged by their distribution on the vegetation map of the Oli Valley. Densities of trees in the savanna were lower than in the woodland (Table 4).

Goodness-of-fit comparisons made regarding daytime use of (1) Burkea-T. avicennoides woodland, (2) T. macroptera savanna and (3) the open wooded grasslands

Table 3. Areas of each vegetation type censused within established visibility limits along named Oli river valley transects (expressed in km^2). Kainji Lake National Park, Nigeria. 1982-83.

Vegetation type	G. Child Proper	G. Child Detour	G. Child Extension	Shagari	Totals per vegetation type	% of total area
Burkea-T. avicennoides woodland	1.564	2.850	3.230	2.504	10.148	73.91
Open wooded grasslands	0.764	0.515	0.944	0.583	2.806	20.44
T. macroptera savanna	0.532	0.065	0.116	0.063	0.776	5.65
Totals per track	2.860	3.430	4.290	3.150	13.730	100.00

Table 4. Density and relative distribution of size classes of woody plants in each of 3 vegetation types of the study area. Kainji Lake National Park, Nigeria. 1982-1983.

Vegetation type	No. of sampled woody plants by dbh classes (cm) 0 - 10	10+ - 20	20+ - 30	30	dbh range (cm)	Mean dbh (cm)	Density per hectare (± S.E.)
Burkea-T. avicennoides savanna woodland	71	12	5	-	3.30-26.0	6.64	1147 ± 278.5
Terminalia macroptera savanna	8	6	9	9	3.0-74.0	24.91	49 ± 15.4
Oli River Complex (Levee vegetation)	78	5	1	4	3.0-80.0	6.75	268 ± 55

*Determined for each vegetation type from 10 sample points using the point-centered quarter method (Cottam and Curtis 1956).

as habitat by kobs in the Oli Valley, showed that kob use was not proportional to the availability of these habitat types (all chi-square values were significant, $P < 0.05$ with 2df). Of the three vegetation types, kobs showed a clear preference for the T. macroptera savanna as habitat in the Oli Valley (Figure 13), to which this type was confined. The open wooded grasslands were relatively less preferred by kobs presumably because unit areas of this type were too small in size. The Burkea-T. avicennoides woodland received the most sparse daytime use even though its proportion was the highest in the valley. Fifty-three percent of 58 solitary kobs were observed in this woodland type, out of which 43 percent were males. The remaining 47 percent were observed in the wooded grasslands.

The T. macroptera savanna was also preferred as habitat by kobs along each of the Oli Valley tracks except the Shagari Proper where it was nearly avoided (Figure 14). The areas of the T. macroptera savanna in both the G. Child Detour and Shagari Proper tracks were small but about equal. The T. macroptera savanna in the Child Detour was preferred despite its small area and the reason for the avoidance of the Shagari Proper tract of T. macroptera by kobs in that section is unknown.

The Burkea-T. avicennoides woodland was neglected in all sections, although kob use of the type was somewhat higher in the G. Child Extension and Shagari Proper sections.

Figure 13. Habitat preferences shown by kobs along the Oli valley as indicated by their total densities in vegetation types of known area. Kainji Lake National Park, Nigeria. 1982-83.

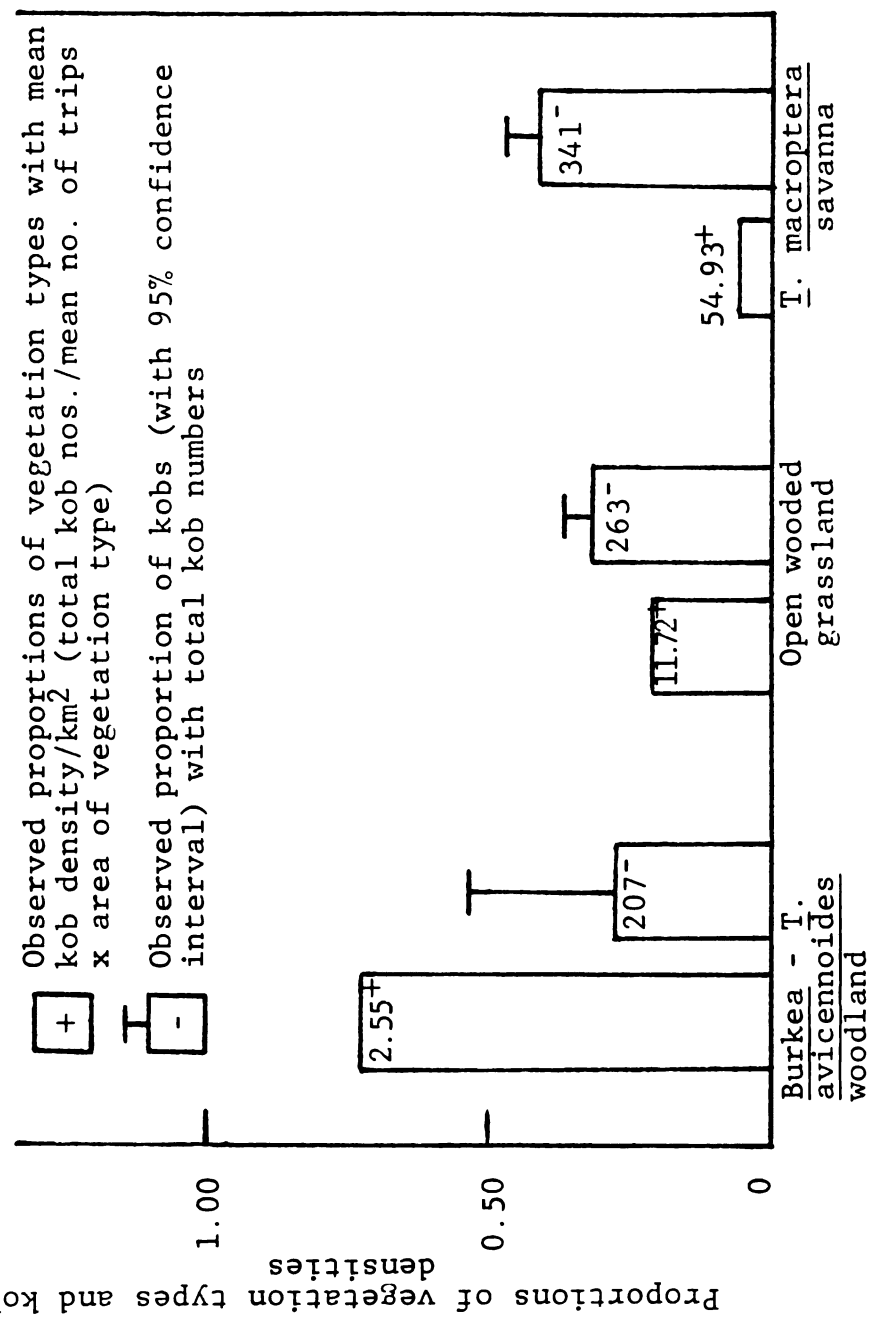
Observed proportions of vegetation types with mean kob density/km² (total kob nos./mean no. of trips x area of vegetation type)
Observed proportion of kobs (with 95% confidence interval) with total kob numbers
+
-
Proportions of vegetation types and kob densities
1.00
0.50
0
2.55+
207-
11.72+
263-
54.93+
341-
Burkea - T. avicennoides woodland
Open wooded grassland
T. macroptera savanna

Figure 13.

Figure 14. Habitat preferences shown by kobs in individual sections of the Oli valley as indicated by their total densities in vegetation types of known area. Kainji Lake National Park, Nigeria. 1982-83.

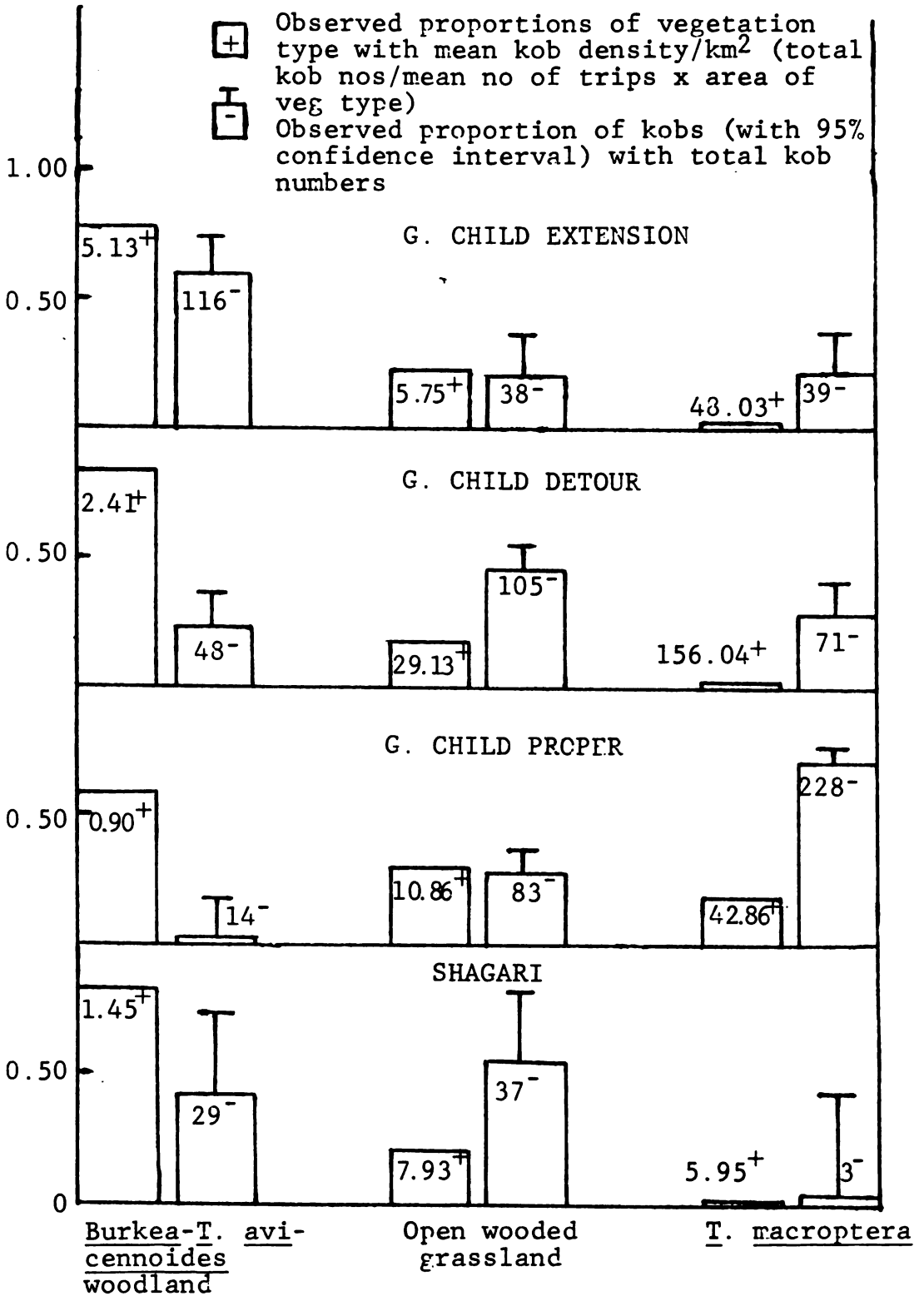
Observed proportions of vegetation type with mean kob density/km² (total kob nos/mean no of trips x area of veg type)
Observed proportion of kobs (with 95% confidence interval) with total kob numbers
1.00
0.50
G. CHILD EXTENSION
5.13+
116-
5.75+
38-
43.03+
39-
G. CHILD DETOUR
2.41+
48-
29.13+
105-
156.04+
71-
G. CHILD PROPER
0.90+
14-
10.86+
83-
42.86+
228-
SHAGARI
1.45+
29-
7.93+
37-
5.95+
3-
0
Burkea-T. avicennoides woodland
Open wooded grassland
T. macroptera

Figure 14.

In areas with relatively high proportions of T. macroptera savanna habitat, the open wooded grasslands were neglected by kobs, but were preferred over the Burkea-T. avicennoides woodland.

The few observations of kobs made at night (1900-1930 hrs) suggested that kobs might be making greater use of woodlands then, presumably more for bedding sites than for feeding opportunities. Woodlands furnished few foods for kobs in the dry season.

Cover Use and Feeding Ecology of Kobs

All 3 vegetation types were used for different activities by kobs. The availability of feeding and resting cover near feeding areas appeared to be important as shown by frequent observations of the animals in T. macroptera savanna areas, with adjacent shrubs such as Gardenia ternifolia and Maytenus senegalensis. In this regard, trees and occasionally shrubs in early-burned areas (Figure 15) retained greater foliage than those on late-burned areas (Figure 16). Thus they provided better shade for resting animals. During intensive feeding periods, patchily-burned areas with standing stalks of grasses which obscured feeding animals from view where dense, were used frequently. In the T. macroptera savanna and open wooded grasslands, trees present on the range such as Tamarindus indica and Diospyros mespiliformis, both associated with

Figure 15. Burkea T. avicennoides woodland in the Oli Valley 4 weeks after an early (November) burn. Kainji Lake National Park, Nigeria. 1982-83.

Figure 16. Burkea T. avicennoides woodland in the Oli Valley showing less foliage on trees and shrubs 4 weeks after a late (January) burn. Kainji Lake National Park, Nigeria. 1982-83. (Note solitary male in background.)

termitaria, were utilized as hiding and resting cover (Figure 17). Kobs were never seen to rest in open grassy area; the animals laid near the bases of trees or shrubs presumably for shade. Trees and shrubs in the Burkea-T. avicennoides and the Oli levee woodlands were frequently utilized as hiding or escape cover (Figure 18) and occasionally for resting.

Observations in the preferred T. macroptera savanna before early fires were set revealed areas grazed low by the hippopotamus, as indicated by grazing patterns and footprints. Pellets and footmarks of kobs were identified in such areas. This was taken as a possibility that the area was attractive to kobs because of regenerating stubble induced by hippo feeding. Plant species grazed by the hippopotamus there were, Panicum paucinode, Schizachyrium schweinfurthii and species of Hyparrhenia and Andropogon.

Investigation of kob behavior and feeding habits at selected pools along the Oli River showed that drinking was mixed with light feeding in all cases. A surfeit of pools along the river made it difficult to encounter kobs for observation there. Few observations were made, however from blinds along the riverside. Two kob herds and a solitary young male kob were seen between 1300 and 1400 hours on different locations and days. Sedges utilized as food along riverbeds and riverbanks were Mariscus alternifolius and Axonopus compressus. Forbs such as Portulaca grandifolia, Dyschoriste perrottetii and Polygonum spp. also were grazed.

Figure 17. Kobs and male waterbuck under Anogeissus - Tamarindus tree-clumps on termitaria, after recent late burn in the Oli Valley. Kainji Lake National Park, Nigeria. January 1983.

Figure 18. Young kob staying behind a T. avicennoides tree near the Shagari Proper track.

Effects of fire on kob feeding ecology

Burned areas along the Oli Valley were seen to be occupied by kobs within 2 to 3 days following cessation of burning, possibly because of the more open nature of such areas. Although the areas of burned and unburned vegetation in the Oli Valley was undetermined, the approximate ratio, judged by the rate of encounter of such areas along tracks was 2 burned to 1 unburned for all vegetation types. More kob herds or solitary kobs were observed in burned areas with new growth of grass and other herbaceous vegetation than in the burned areas without regeneration of vegetation (Figure 19). This may be due to the greater moisture or improved nutritional quality in the areas.

The burning regimes implemented during the 1982/83 viewing season had an effect on new plant growth available for feeding in the dry season. On the short term grasses on ranges burned early in the dry season produced new growth of better vigor than those burned late (all t-tests significant at $P < 0.05$) as indicated by sizes attained by species of Andropogon and Hyparrhenia 4 weeks after the respective ranges were early- or late-burned (Figure 20). The representative species measured in the vegetation types were A. perligulatus and H. rufa in the T. macroptera and open wooded grasslands, and H. smithiana and A. gayanus in the Burkea-T. avicennoides woodland.

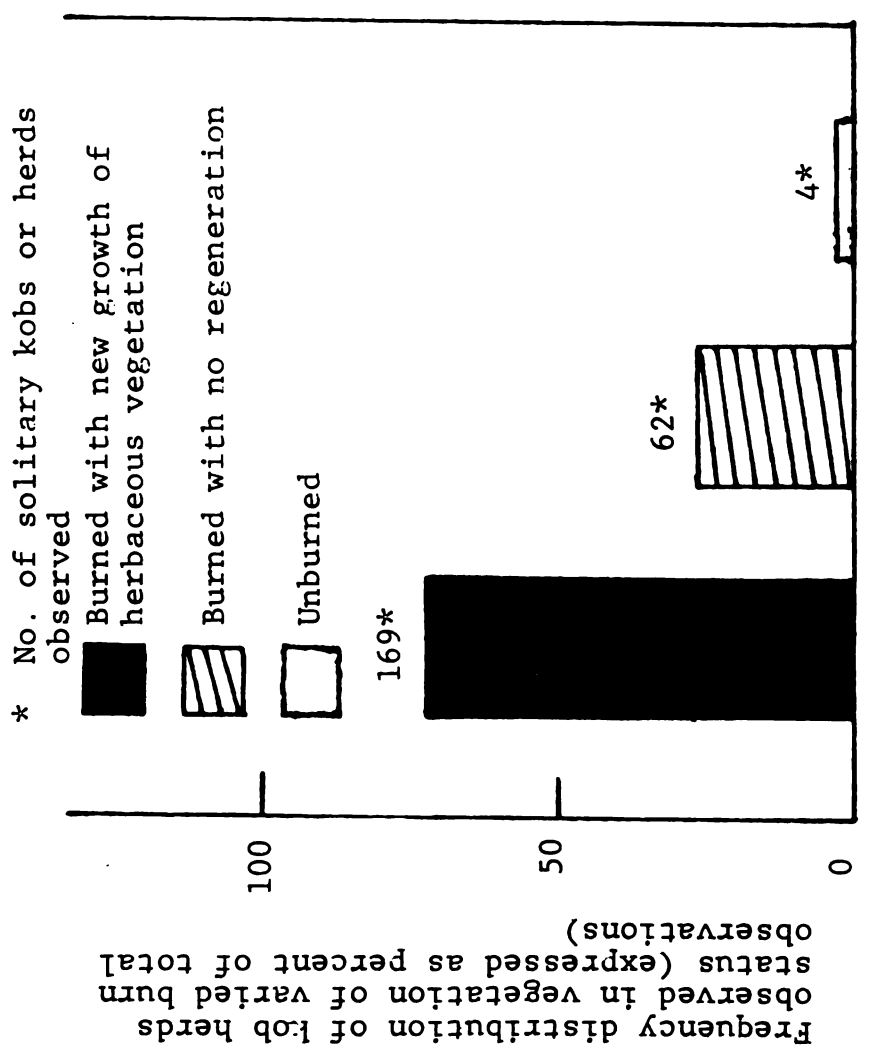

Figure 19. Observations of kobs in vegetation with varied burn status along tracks censused during surveys in the study area. Kainji Lake National Park, Nigeria. 1982-83.

Figure 20. Comparative sizes and SE attained by 20 individuals of named species of Andropogon and Hyparrhenia 4 weeks after early and late burns, in 3 vegetation types of the Oli valley. Kainji Lake National Park, Nigeria. 1982-83.

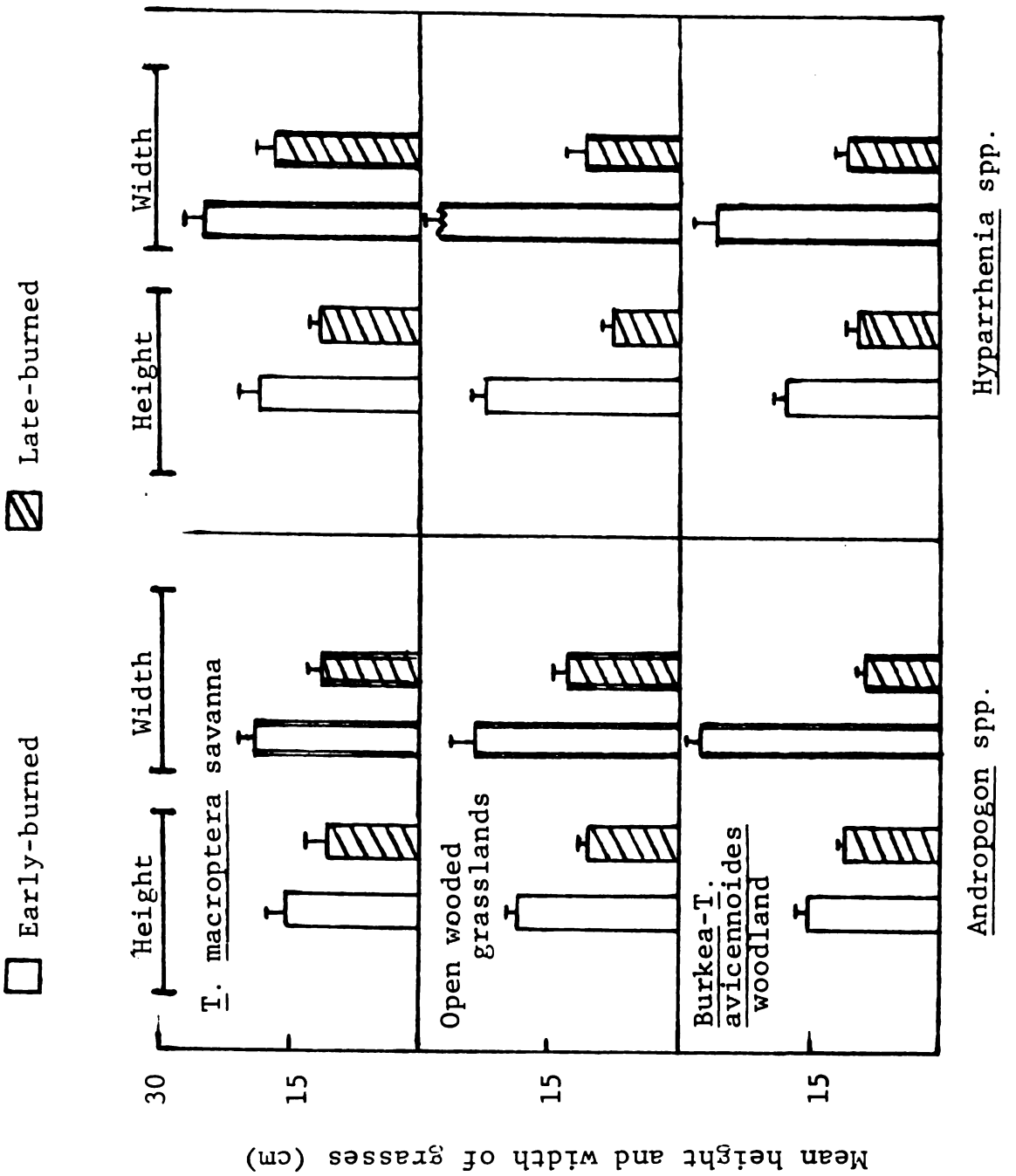
Early-burned
Late-burned
Height
Width
Height
Width
T. macroptera savanna
Open wooded grasslands
Burkea-T. avicennoides woodland
Andropogon spp.
Hyparrhenia spp.
30
15
15
15
Mean height and width of grasses (cm)

Figure 20.

Under the late-burn, Hyparrhenia spp. appeared to be most vigorous in the T. macroptera savanna.

These green post-burn flushes of grass were eaten by kobs up to the mid-dry season. Kobs were observed to feed primarily in the T. macroptera savanna and open wooded grasslands in which the highest grass densities were recorded (Table 5). Utilization of grasses was high in the savanna and wooded grasslands but low in other types. Previously-grazed grasses in the T. macroptera savanna were utilized repeatedly sometimes leaving the soil bare and compacted and occasionally eroded in some areas. Grass flushes utilized included the perennials Andropogon gayanus, A. perligulatus, Hyparrhenia rufa, H. cyanescens, Schizachyrium spp. and the annual Loudetia simplex. Soil lick areas of erosion gullies and/or abandoned termitaria as described by Child (1974) were seen only on the T. macroptera savanna.

Use of Kob Habitats by Other Species

The baboon was the most often seen animal in the T. macroptera savanna and open wooded grasslands. Ungulates sighted were the red-flanked duiker, bushbuck, buffalo and reedbuck. The roan antelope was seen browsing on shrubs in the Burkea-T. avicennoides woodland in the Oli valley. The Western hartebeest and waterbuck also were observed feeding on the grasslands alongside kobs.

Table 5. Mean densities and utilization of grass tussocks in ten 1m x 1m plots located on selected ranges used by kobs in the study area. Kainji Lake National Park, Nigeria. 1982-83.

Vegetation type	Mean tussock density + SE	Percentage of tussocks utilized	Distance from territory core (m.)
Burkea-T. avicennoides woodland	6.5 ± 0.74	73.7	150 - 300
Burkea-T. avicennoides woodland	15.2 ± 2.62	28.6	**
Open wooded grassland	21.1 ± 2.54	100	100 - 150
Terminalia macroptera savanna	21.6 ± 3.13	100	100 - 200
Terminalia macroptera savanna	28.1 ± 2.32	88.5	50 - 100

*Sampled after early burning was implemented

**Area not associated with any kob groups

DISCUSSION

Kob Densities and Distribution

While intermediate to densities elsewhere in West Africa (Koster 1981, Geerling and Bokdam 1971, Wanzie 1978), kobs in the study area were not as abundant as their counterparts in East Africa. There in parks and reserves, they range from 40 to 45 kobs per km^2 (Buechner 1961, Leuthold 1966a). Differences in the proportions of grasslands in East and West African parks may be the main factor responsible for the disparity in densities. Differences in local conditions and censusing methods also may be important. The lower number of kobs recorded per km^2 in Park W, Niger (Koster 1981), where savanna grasslands are scarce, may be indicative of the effect of the main factor.

The 3 divisions of the G. Child track upstream from the Visitor's Camp had higher kob densities and were observed to have received heavier visitor traffic during December 1982 to January 1983. Downstream along the Shagari track where kob density was lower, visitor traffic was relatively lighter. Possibly, frequent human presence deters daytime predator- and/or poacher-activity and leads

to the movement of kobs to safer often-frequented areas. There is further need, however, to determine with greater certainty the factors responsible for the uneven distribution of kobs in the Oli valley, especially in the dry season.

Within the study area, game poaching has been identified as the greatest factor limiting increase in the population of most wildlife species (Child 1974, Ayeni 1980). There probably was a reduction in the number of poachers entering the park in 1982, since there were more severe anti-poaching laws in effect and fewer arrests were made then (KLNP 1982) than in earlier years (Ayeni 1980 : 107). Cumulative fines from convictions for offenses committed between 1972 and 1975 ending was ₦ 2373.50k (₦ 1.00 = $1.40) whereas, fines for 1982 alone totalled ₦ 4600.00. In view of the reduced number of arrests, the stiffer penalties awarded for offenses in the new K.L. National Park Law must have been responsible for the increase in accrued fines. Kob population density may have increased as a result of such protection.

Effects of Vegetation and Habitat Types on Kob Distribution and Productivity

Like the Uganda kob (Buechner 1961, Leuthold 1966a), the Senegal kob in the study area preferred areas of short grass, good visibility in most directions and proximity to water and soil licks. In West Africa, these features are

present on grass plains and open wooded grasslands located near perennial streams (Geerling and Bokdam 1971, Wanzie 1978, Child 1974). The Terminalia macroptera tree savanna providing these features was preferred as kob habitat. Relatively high kob densities occurred only in those Oli Valley sections with high proportions of this habitat type.

Grass production was highest in the T. macroptera type as reported also by Afolayan (1978, 1979), followed by the open wooded grasslands. Being primarily grazers (Dorst and Dandelot 1970, Child 1974, Koster 1981), kobs made use of these 2 types for feeding almost to the exclusion of the woodlands. Good visibility and low tree density in the T. macroptera type and wooded grasslands is vital to kobs whose anti-predator strategy is to take flight when predators are sighted (Jarman 1974). Apart from individual tracts of wooded grasslands being smaller than those of T. macroptera type in area, the reasons for neglect of the former type are not known. The avoidance of the T. macroptera savanna tract in the Shagari section is an indication that other factors other than availability of good feeding sites may sometimes be important. Differences in microclimate between areas which may impact the vegetative community on the sites need to be investigated.

Woodlands seem to constitute marginal kob habitat in West Africa. As in the study area where kob densities in woodlands were low, in Park W, Niger where kobs inhabit

open shrubland and woodland areas (Koster 1981) the average kob density is one of the lowest anywhere. The low production of herbaceous vegetation (Afolayan 1978) and the poor visibility caused by high densities of trees may be the most important reasons for its avoidance by West African kobs. Although the relative use by kob of each vegetation type is known, it is important to determine the proportion of these vegetation types in the kob's daily range. This will furnish more information on the specific habitat requirements of this animal. In this regard, night observations should be made in the 3 vegetation types with the aim of determining their use by kobs during that period.

Effects of Fire on Kob Movements and Feeding Ecology

During the dry season, burned areas offered kobs good forage and clear visibility. Relatively few of these animals were seen in unburned areas in any of the 3 vegetation types then. Fire seemed, therefore, to be an important factor governing the distribution of this species.

In all vegetation types, soil moisture decreases with advancement of the dry season, although the soil at 1m depth does not reach wilting point until March (MAB 1981 : 30). Presumably the vigor of new herbaceous growth would decrease with the reduction in soil moisture. In any case, it seemed evident that herbaceous vegetation on early-burned ranges was of better vigor than those on late-burned areas as shown by the bigger sizes attained by individuals

of the perennial grass species studied on the former ranges. A taller and more robust growth of vegetation on early-burned ranges in northeastern Ghana also was reported by Brookman-Amissah et al. (1980). A greater water-retention capacity in the T. macroptera savanna than in other types is believed to be most probably responsible for the greater productivity of grasses under the 2 burning regimes in that type (Afolayan 1978).

Although, Brookman-Amissah et al. (1980) and Afolayan (1978) reported changes in density of woody vegetation due to treatment with fire, changes in herbaceous species' composition were not well documented. Until results of long-term effects of fire on the park's vegetative community are known, it is suggested that fire treatments be applied with caution. Fire may also have a deleterious effect on vegetation, through removal of accumulated litter and old growth. The new growth induced by such fires are easily reached by grazing animals and may be subjected to excessive grazing in areas without restriction on grazing (Daubenmire 1968 : 233). This is the usual situation in game reserves and national parks. The tendency of animals to overgraze may be responsible for the erosion gullies seen on densely-occupied ranges in the KLNP T. macroptera savanna.

Sex Proportions of Kobs in Relation to Vegetation Types

Disparate sex ratios in social ungulates have been attributed to habitat quality (Krebs and Davies 1981,

Geist 1974), and social structure (Jarman 1974). Although female nutritional status (Verme 1983) and the time of mating (Verme and Ozoga 1981) have also been reported to have an effect on sex ratios in white-tailed deer, little is known about these relationships in the Senegal kob.

In areas with a great range of productivity, the limited supply of a high-quality habitat as typified by the T. macroptera savanna in the park, encourages ungulates to establish territoriality regimes based on food defense (Geist 1974). In kobs, the aggression of territorial males may drive other males to inferior habitats where, as reported by Jarman (1974 : 261), they may suffer relatively greater mortality than females. Male Uganda kobs show strong attachment to their territories while females move freely between male territories (Leuthold 1966b). If the same behavioral trait occurs in the Senegal kob it may explain why males are likely to suffer greater mortality than females, since abandonment of "poor" woodland territories by males may be rare. Thus, males in the woodland habitats will tend to occur solitarily since a great turnover of females to better territories will most likely take place. In the study area where the highest percentage of solitary males was encountered in the Burkea-T. avicennoides woodland, the adult sex ratio was biased in favor of females. An unbalanced sex ratio partial to female kobs in Comoe Park, Ivory Coast, was ascribed to

the possible greater risk to males of the solitary life (Geerling and Bokdam 1971). As in the Kainji study area, treeless regions in the Comoe Park savannas are restricted in supply (Gilbert 1983, pers. comm.). Though selective killing of bucks by poachers possibly because of their trophy and bigger size, could also bias the ratio, it seems unlikely that this occurs regularly throughout the range of the species. While other factors may occasionally be significant, it seems reasonable that habitat quality exerts a considerable influence on the social structure and hence the sex ratio of kobs. The disparate sex ratio for kobs in the Kainji study area is not much below the 20 males : 80 females that is considered normal for such antelopes by Jarman (1974).

Management Implications and Recommendations

Current park laws in the KLNP seem to be effective in curtailing poaching activities and should be continued. Kob trophies confiscated from poachers could be recorded to determine sex and age ratios of animals thus killed, and the effect of poaching on these ratios and kob productivity. The possible influence of vegetation type proportions on kob sex and age ratios should also be investigated.

Management objectives for kobs and other animals in the park is currently geared toward maintaining large

numbers of all species. The status of each species needs to be constantly appraised, however, to determine which kinds might need special attention from time to time, and area to area. For the kob, it is suggested that the stock of this species downstream along the Shagari track should be given increased attention due to their low density along that stretch.

From a viewpoint of managing wild animals for meat production in areas outside the reserves, wild animals could be domesticated since they have been shown to be better adapted than livestock to the natural environment (Talbot 1963). An option that has an immediate prospect for Nigeria should be ranching of suitable species which are presently wild (Saba 1979). This option may best involve the raising of wild animals on extensive marginal lands where they can be cropped periodically (Petrides 1963). For kobs, information on the social structure and habitat requirements is essential when deciding on the composition of the initial stock and the location of the project site.

As determined also by Ayeni (1980), Afolayan (1978, 1979) and Child (1974), the T. macroptera tree savanna constitutes the preferred range for kobs and many other large herbivores. It should therefore be rationally managed to ensure optimal forage production especially during the dry season when most forages are of poor

nutritional quality. Afolayan (1979) found productivity of grasses on T. macroptera areas, mown without burning early in the dry season, to be as high as in burned areas. Mowing was also reported to promote better infiltration of water thereby reducing erosion hazards (Daubenmire 1968 : 254-256). For these reasons, mowing should be implemented for some areas in the T. macroptera savanna as recommended by Child (1974). This is true especially for areas which are beginning to suffer some erosion yet may need to be burned to improve visibility. Although some recommendations on the use of fire in habitat management are available (Child 1974, Ayeni 1980, Afolayan 1977), research into the full and long-term effects of burning and grazing regimes on wildlife habitats should be continued. At least more exclosures which prevent grazing by ungulates and perhaps by other herbivores, should be constructed as to enable ready appraisals of the effects of grazing.

The major objective of management in national parks is to conserve and maintain the indigenous fauna and flora for educational, scientific and recreational purposes (KLNP 1982). To appraise the conservation status of the park's flora, the condition of the vegetation has to be frequently monitored. Changes in habitat conditions which might be detected ocularly could occur so gradually as to be overlooked. Permanent transects may be laid

in vegetation types to assess vegetation trends and condition quantitatively.

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