DENSITIES AND BIOMASSES OF SOME UNGULATE POPULATIONS IN EASTERN CONGO AND RWANDA, WITH NOTES ON POPULATION STRUCTURE AND LION/UNGULATE RATIOS

FRANÇOIS BOURLIÈRE

International Union for Conservation of Nature and Natural Resources

Morges (Vaud), Switzerland

The densities of natural populations of tropical ungulates—as well as their structure and dynamics—are so poorly known that it seems worthwhile to put on record here some figures obtained during the last five years by the *Institut des Parcs Nationaux du Congo* in three strict natural reserves of eastern Congo and Rwanda. These studies were initiated in 1957 with the aim of following the evolution of the mammalian populations in three different types of open environments free from any human intervention (with the exception of bush fires spreading from surrounding areas).

From 1958 to 1960 bi-monthly censuses of a 600 square kilometer sample area were regularly made in the central sector (Rwindi-Rutshuru plain) of the Albert National Park by C. Cornet d'Elzius, the park officer in charge of the Rwindi Camp. At the same time the park biologist, Dr. J. Verschuren, and I made regular counts on four line-transects situated in the same plain, together with a complete census of the hippopotamus population of the park (18,900). In the summer of 1959, O. Kint, the warden in charge of the north sector of the Albert Park at Mutsora, undertook three censuses of a 226 square kilometer sample area in the upper Semliki plain, north of Lake Edward. The census operations in the Albert Park were unfortunately interrupted at the time of Congo independence and have not yet been resumed.

In the Kagera National Park (Rwanda), J. Haezaert, the warden at Gabiro, made 31 counts, from August 1959 to June 1960, in a 4·3 square kilometer sampling area, between Lake Mihindi and Lake Gihinga.

In the Garamba National Park, A. Ory has finally succeeded in making two complete counts in March 1960 and March 1963 of the larger game species inhabiting the 4,800 square kilometers of the reserve.

Techniques

C. Cornet d'Elzius, O. Kint and A. Ory all used the same technique for counting the game in the open plains of the Albert and Garamba National Parks. Patrols of well-trained game guards "combed" the area to be censused on foot, walking parallel to each other at intervals usually of one kilometer. Any animal present within 500 yards on each side of the observers was

FIGURE 1. The Rwindi-Rutshuru plain, looking East from the Kabasha escarpment, December 1934. Photo G. F. de Witte, IPNCB.

FIGURE 2. The same plain, seen from the same place, October 1959. Photo J. Verschuren, IPNCB.

recorded and counted. Controls were repeatedly made by European observers to check the reliability of the results. Line transect counts by Dr. J. Verschuren, J. Haezaert and myself were made from a Land Rover driven at low speed; the width of the counting strip varied according to the "openness" of the environment, the height of the grass and the size of the animals. Further details on this technique can be found in Bourlière and Verschuren (1960).

Habitat types

Both the Rwindi-Rutshuru plain and the upper Semliki plain in the Albert National Park are short-grass savannas, now almost completely devoid of any tree. The annual precipitation averages 863·4 mm. at the Rwindi camp and the rains occur from April to June and from September to November. Even at the end of the rains the grass remains short, seldom exceeding 80 cm. in height. In November 1958, the plant biomass ranged from 3,000 Kg./ha. to 10,000 Kg./ha. (dry weight) in seven 100 m^2 quadrats where all the vegetation was clipped one centimeter above the ground. Such a short grass savanna apparently represents a regressive stage of the *Themeda-Heteropogon* savanna described by Lebrun (1947) in his pioneering study of the vegetation of the plain. In a quarter of a century of protection the tree savanna has changed into an almost treeless grassy plain, despite the restriction of bush fires. Such a drastic change is beautifully shown by the two pictures (Figs. 1 and 2) taken from the same point at a quarter of a century interval (1934 and 1959). The destruction of the trees is apparently due to the dramatic increase of the elephant (and buffalo) populations in this plain (Hubert 1959).

Hubert in 1947 estimated that no more than 150 elephants and 2,000 buffaloes lived in the 1,200 square kilometer plain south of Lake Edward in 1931, but Cornet d'Elzius counted 3,923 elephants and 24,054 buffaloes in the same area in 1959. Conversely, the numbers of topis and Uganda kobs at first declined sharply from 1931 to 1940, apparently as a consequence of the restriction of bush fires. They reached their lowest population levels in the forties (1,200 and 3,000 head respectively, in 1940), to increase again afterwards as the trees disappeared reaching totals of 4,798 topis and 9,571 kobs in 1959.

The vegetation of the central part of the Kagera National Park (Rwanda) is quite different to that of the Lake Edward open plains. Along the lakes and marshes of the upper Kagera river basin, most of the area in which Haezaert's line-transect was situated is covered by a tree-savanna where the dominant tree is *Acacia nefasia* (Lebrun 1955). The width of the counting strip had therefore to be restricted to 200 yards. The annual precipitation averages 785·1 mm. at Gabiro, with two rainy seasons, March to May and October to December.

In the Garamba National Park, the situation is again very different. Located in the Uelle district, the park is mainly covered by a savanna of tall grasses (*Loudetia arundinacea*, *Hyparrhenia* spp.), interspersed with some fire-resistant trees and bushes (de Saeger 1954). At the end of the rainy season these grasses reach a height of 2·5 meters, which makes any type of game count quite impossible. In December or January huge bush-fires coming from outside the park regularly burn the whole area. The annual precipitation averages 1,570·6 mm., with a single dry season extending from December to February. Contrary to what is the rule in the

Albert Park, some of the largest ungulates of the Garamba region—particularly the elephant—do not stay permanently in the park, and wander more or less regularly among the extensive savannas of the Congo-Sudan border.

Results

The results of these various game counts are given in Tables 1 to 4. Average standing-crop biomasses per square kilometer have been estimated by multiplying the number of individuals by the minimum adult weight of each species. Thus, over-estimation caused by attributing to the young the weight of an adult is more or less compensated for by the underestimation of the weight of most adult individuals.

Besides these figures on population density, Doctor J. Verschuren and I have obtained some data on the sex and age structures of the populations of ungulates living in the Rwindi-Rutshuru plain, south of Lake Edward, in the Albert Park, These data are summarised in Table 5, and further details can be found in our 1960 report. Suffice it to say here that in this area, just under the equator, any ungulate is able to reproduce at any month of the year. Topis alone show a definite calving season, dropping most of their young from January to May. The figures in Table 5 therefore represent averages based on counts made at different times of the year. The natality rate of the topi is based on our 1957 observations made after the end of the calving season.

Furthermore we attempted to estimate the mortality rate for one species, the elephant. All the skulls of the animals dying in the 600 square kilometers regularly censused every two months for two consecutive years were carefully collected. From 1 August 1958 to 31 July 1959, seven elephants were found dead, when the population of living individuals averaged 168 head (with a minimum of 110 in October 1958 and a maximum of 256 in May 1959). This means an overall mortality rate of the order of three per cent per year. Mortality is certainly higher in young elephants than among adults. From 1955 to 1957, 391 elephant tusks were found in the upper Semliki plains of the Albert National Park, among which 260 weighed less than 5 kilograms. This would indicate a mortality rate in young elephants almost twice as great as among older ones.

COMPARISONS WITH SOME OTHER AFRICAN ENVIRONMENTS

The Albert Park figure (Table 1) is of the same order of magnitude as that for Queen Elizabeth Park, its sister area on the eastern side of Lake Edward. In both cases a largely sedentary population succeeds in living all the year around at the ecotone between the Congo forest and the Kivu-West Uganda savannas. In both cases also, about three-fourths of the ungulate biomass is made up of only two slow-growing, late-maturing species of large dimensions, the elephant and the hippopotamus. Most of the ungulate biomass has therefore a slow population-turnover.

TABLE 1: AVERAGE POPULATION DENSITIES AND BIOMASSES OF THE 11 UNGULATE SPECIES LIVING IN THE 600 SQUARE KILOMETERS OF SHORT-GRASS SAVANNA, SOUTH OF LAKE EDWARD, CENSUSED BY C. CORNET D'ELZIUS AND J. VERSCHUREN (FOR THE HIPPOPOTAMUSE*)

Species	Minimum adult weight (Kg.)	Average counted in six bi-monthly censuses		Average density per square kilometer*		Average biomasses Kilograms per square kilometer*	
		1958	1959	1958	1959	1958	1959
Elephant	3,000	1,071	1,026	1·8	1·7	5,400	5,100
Hippopotamus ..	1,400	4,800	4,800	8	8	11,200	11,200
Buffalo	500	8,340	7,402	13·9	12·3	6,950	6,150
Topi	130	1,288	1,199	2·1	2·0	273	260
Waterbuck ..	150	753	760	1·25	1·26	187	195
Uganda kob ..	70	5,562	4,976	9·3	8·3	651	581
Reedbuck	40	84	61	0·14	0·10	5	4
Bushbuck	50	53	53	0·09	0·09	4	4
Grey duiker ..	10	?	?	?	?	?	?
Warthog	70	715	603	1·2	1·0	84	70
Giant forest hog ..	140	42	35	0·07	0·05	10	7
Totals ..		22,708	20,915	37·85	34·80	24,764	23,571

* To obtain the values per square mile, multiply this figure by 2·5.

TABLE 2: POPULATION DENSITIES AND BIOMASSES OF THE 7 UNGULATE SPECIES LIVING IN THE 226 SQUARE KILOMETERS OF SHORT-GRASS SAVANNA, NORTH OF LAKE EDWARD, CENSUSED BY O. KINT IN 1959 (HIPPOPOTAMUSES NOT INCLUDED)

Species	Actual counts made on:			Average density per square kilometer	Average biomasses Kg./sq. Km.
	28.V.1959	9.VII.1959	19.VII.1959		
Elephant ..	867	208	534	2·4	7,200
Buffalo ..	5,223	4,309	4,355	20·4	1,020
Waterbuck ..	960	519	597	3·1	465
Uganda kob ..	502	516	443	2·1	147
Reedbuck ..	33	11	6	0·1	4
Bushbuck ..	26	20	11	0·1	5
Warthog ..	353	249	279	1·3	91

TABLE 3: POPULATION DENSITIES AND BIOMASSES OF THE 12 UNGULATE SPECIES LIVING IN A SAMPLE AREA OF 4·3 SQUARE KILOMETERS IN THE CENTRAL PART OF THE KAGERA NATIONAL PARK, RWANDA. AVERAGE VALUES OF 31 LINE-TRANSECT COUNTS MADE BY J. HAEZAERT, FROM AUGUST 1959 TO AUGUST 1960

Species	Minimum adult weight in Kg.	Average density per square kilometer	Average biomasses kg./sq. Km.
Zebra	290	2·1	609
Eland	300	0·6	180
Roan antelope	250	0·1	25
Waterbuck	150	2·0	300
Impala	60	20·2	1,212
Reedbuck	40	0·3	12
Oribi	15	0·6	9
Buffalo	500	1·4	700
Topi	130	1·6	208
Bushbuck	50	0·1	5
Grey duiker	10	0·1	1
Warthog	70	0·9	63
Totals		30·0	3,324

TABLE 4: POPULATION DENSITIES AND BIOMASSES OF THE UNGULATES LIVING IN THE 4,800 SQUARE KILOMETERS OF THE GARAMBA NATIONAL PARK, CENSUSES BY A. ORY, 1960–1963

Species	Minimum adult weight in kg.	Number counted in 1960	Number counted in 1963	Densities in 1960	Densities in 1963	Biomasses (Kg./km²) in 1960	Biomasses (Kg./km²) in 1963
Elephant ..	3,000	9,983	5,694	2·07	1·18	6,210	3,540
White rhinoceros ..	2,000	1,190	1,202	0·25	0·25	500	500
Hippopotamus ..	1,400	?	168	?	0·03	?	42
Giraffe	1,200	616	426	0·13	0·09	156	108
Buffalo	500	?	4,677	?	0·97	?	485
Lelwell hartebeest	140	?	1,523	?	0·32	?	45
Waterbuck ..	150	?	1,202	?	0·25	?	37
Uganda kob ..	70	?	1,449	?	0·30	?	21
Warthog	70	?	611	?	0·13	?	9
9 other species, scarce or small-sized							
Totals ..		>11,789	>16,952	>2·45	>3·52	>6,886	>4,787

TABLE 5: SOME DATA ON THE POPULATION STRUCTURE AND DYNAMICS OF THE UNGULATES OF THE RWINDI-RUTSHURU PLAIN. FOR FURTHER DETAILS SEE BOURLIÈRE AND VERSCHUREN (1960)

Species	Sex-ratio: per cent of males in the population	Natality rate: per cent of young of the year in the total population	Fecundity rate: number of young of the year per 100 adult females
Elephant ..	±50	±9	
Hippopotamus ..	±50	<10·5	
Buffalo	45·7	7 to 10	
Waterbuck ..	30·5		13·4 to 21·3
Topi	35·7	21·2 to 31·2	
Uganda kob ..	37·1		9·1 to 11·3
Warthog ..	34·2	20·4	
Reedbuck ..	43·6		
Bushbuck ..	42·0		

TABLE 6: NUMBER OF SPECIES AND STANDING CROP BIOMASSES IN KG. PER SQUARE KILOMETER IN DIFFERENT AFRICAN HABITATS, BASED ON GROUND CENSUSES

Vegetation type	Number of ungulate species present	Biomasses in Kg./Km²	Area studied (Km²)	Year	Source
Western Sahara, stony desert	1–2	0·3–190	100	1955	Valverde (*in litt.*)
Western Sahara, sandy desert	1	4–17	400–1,700	1960	Monod (*in litt.*)
Masai steppe, Nairobi Nat. Park	18	2,180–8,257 (normal year)	28–4	1953–54	Petrides (1956)
Masai steppe, Nairobi Nat. Park	18	13,215 (prolonged drought)	116	1960–61	Ellis (*in litt.*)
Kenya Acacia savanna ..	?	14,000–20,000	±5,000	1959–61	Talbot (1963)
Tarangire Game Reserve, wooded savanna	22	3,200 (rainy season)	1,683	1958–61	Lamprey (1962)
Tarangire Game Reserve, wooded savanna	22	41,600 (dry season)	1,683	1958–61	Lamprey (1962)
Queen Elizabeth Nat. Park ..	11	18,800	1,670	1960	Bere (1960)
Ghana rain forest	3	5	250	1954	Collins (1959)
Aberdares mountain forest ..	8	>420	3,870	1961	Holloway (1962)

The standing crop biomass of the Garamba tall savanna is, on the contrary, much smaller. According to the year (and probably the time of the year) it fluctuates between 5,000 and 7,000 Kg./Km², according to the wanderings of the elephant troops. These figures are fairly close to figures calculated for East African savannas, but with a major qualitative difference. At Garamba most of the biomass is again made up of two large and long-lived species while, in East African plains, species weighing more than a ton represent no more than a minute proportion of the total biomass.

The Kagera figure on the contrary, falls well within the range of the biomasses found for other East African wooded savannas, with the bulk of the ungulate biomass represented by small or middle-sized species, with a rapid population turnover.

LION: UNGULATE RATIOS

Lamprey (1962) has already noticed the striking similarity between the ratio of the mean lion density to the mean herbivore density in the two Tanganyika areas where he had worked personally. In the Tarangire Game Reserve this ratio was 1 lion for 292 prey ungulates and in the Ngorongoro Crater 1 : 260. If one makes the same calculation in the Rwindi-Rutshuru plains and in the Kagera National Park sample area, where the lions have also been counted, one finds the following ratios:

Kagera Park, 1 lion to 300 prey ungulates.

Albert Park, 1 lion to 360 prey ungulates (elephants and hippos excluded).

Our figures and Lamprey's are therefore of the same order.

If one bears in mind the fact that the average annual kill per lion is estimated to range from 20 (Guggisberg 1961), 26 (Stevenson-Hamilton 1947), 35 (Talbot and Talbot 1963) to 36·5 prey-animals per year (Wright 1960), according to the observer and place, one comes to realise that the toll of lion-predation upon ungulate populations is by no means negligible.

SUMMARY

Data are given on the average population densities and standing-crop biomasses of the ungulate populations living in three Congo and Rwanda National Parks. In the north-eastern and eastern Congo savannas, the major part of the ungulate biomass is made up of slow-growing, long-lived species. There is therefore a slower population turnover in those habitats than in east-African savannas supporting lower biomasses but where population turnover is much more rapid.

Data are also given on the population structure and dynamics of some Albert Park ungulates, and on the lion/ungulates ratios.

REFERENCES

BERE, R. M. 1960. An outline survey of the status of the major mammal species (and the crocodile) in the Uganda National Parks in 1960. *Report and Accounts of the Trustees of the*

Uganda National Parks, for the year ended 30th June, 1960: 13–49.

BOURLIÈRE, F. and VERSCHUREN, J. 1960. *Introduction à l'écologie des Ongulés du Parc National Albert*. Bruxelles.

COLLINS, W. B. 1959. *The perpetual forest*. Philadelphia, New York. Lippincott.

GUGGISBERG, C. A. W. 1961. *Simba. The life of the lion*. Cape Town. Timmins.

HOLLOWAY, C. W. 1962. The effect of big game on forest management. *Thesis*. Commonwealth Forestry Institute, Oxford.

HUBERT, E. 1947. *La faune des grands Mammifères de la plaine Rwindi-Rutshuru (lac Edouard). Son évolution depuis sa protection totale*. Bruxelles.

HUBERT, E. 1959. *Rapport de Mission au Parc National Albert*, 1959. Bruxelles, IPNCB. (Mimeographed).

LAMPREY, H. P. 1962. A study of the ecology of the mammal population of a game reserve in the *Acacia* savanna of Tanganyika, with particular reference to animal numbers and biomasses. *Ph.D. thesis*, Oxford University.

LEBRUN, J. 1947. *La végétation de la plaine alluviale au sud du lac Edouard*. Bruxelles.

LEBRUN, J. 1955. *Equisse de la végétation du Parc National de la Kagera*. Exploration du Parc National de la Kagera, Mission J. Lebrun, fasc. 2, Bruxelles.

PETRIDES, G. A. 1956. Big game densities and range carrying capacities in East Africa. *Trans. Twenty-first North Amer. Wildlife Conference:* 525–37.

SAEGER, H. DE. 1954. *Exploration du Parc National de la Garamba*, fasc. 1. *Introduction*. Bruxelles.

STEVENSON-HAMILTON, J. 1947. *Wild life in South Africa*. London, Cassell.

TALBOT, L. M. 1963. Ecosystems and biological productivity. Savanna. *IUCN Ninth Technical Meeting, Nairobi*, 1963, RT 9./II./5.

TALBOT, L. M. and TALBOT, M. H. 1963. The Wildebeest in western Masailand, East Africa. *Wildlife Monographs*, No. 12.

VERSCHUREN, J. 1958. Ecologie et biologie des grands Mammifères (Primates, Carnivores, Ongulés). *Exploration du Parc National de la Garamba*, fasc. 9, Bruxelles.

WRIGHT, B. S. 1960. Predation on big game in East Africa. *J. Wildlife Manag.*, 24: 1–15.