game would surely stray beyond the limits of its arbitrary boundary; and there, in the cultivation of civilisation, slowly lose out against a monopoly of human interests. Farmland "control" techniques, fighting against the opposite side with rifle, snare and poison, reducing game to the last of its numbers, would operate in the face of ruinous damage to its own side through steady destructive nocturnal invasions, so that each side would be simultaneously destroying the other.

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A COUNT OF THE LARGE MAMMALS OF THE LAKE MANYARA NATIONAL PARK: RESULTS AND DISCUSSION

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SUMMARY

1. The method of counting the large mammals in Lake Manyara National Park is described.
2. The results of the count are listed, and the biomass estimated.
3. It is suggested that the present population exceeds the carrying-capacity because elephant and buffalo are being made to enter and stay in the Park by increasing cultivation round the boundaries.
4. The rise in lake level has aggravated the position by cutting off another route of entry and exit.
5. The extinction of the plains game population is likewise attributed to the new lake level and increased cultivation.

INTRODUCTION

On 24th and 25th April, 1965 we counted the larger (i.e. impala (*Aepyceros melampus* Lichtenstein) size upwards) mammals of Lake Manyara National Park, Tanzania. The count was made with the use of a Piper Super Cub aircraft, and during the count we flew 3.40 hours at a cost of Shs. 250/-.

METHOD

Lake Manyara National Park covers some 30 square miles and lies between the western Rift Valley wall and Lake Manyara as a narrow strip rarely more than one mile wide. This attenuated shape and the flat land surface made the mechanics of flying the count simple. However, the vegetation in parts has an almost closed canopy, and over such parts we flew a very close flight pattern (100-200 yds.) at an altitude of 150 feet and a speed of 50 m.p.h. We flew across the long axis of the Park making alternating "U" and "P" turns at the escarpment and lake shore respectively. Using this flight pattern the observer counted out of one side throughout the flight, and experienced no difficulty in placing exactly the limit of counting on each strip (see Figure 1).

On 24th April all large mammals except buffalo (*Syncerus caffer* Sparrman) were counted by eye and located on a 1: 60,000 map. On 25th April all buffalo were counted, the smaller groups by eye, the larger ones from photographs taken obliquely from about 500 feet.

The methods used in this count illustrate how flexible aerial counting methods can be. The camera, the eye, and the aircraft offer means of counting a wide range of animals over an equally wide range of conditions (Turner and Watson, 1964, 1965; Watson, 1965). Even a partially closed canopy need not prevent aerial census of large animals.

RESULTS

The results are recorded below (Table 1); the position of the animals counted is shown in figure 2.

We consider that the figures for wildebeest, zebra and buffalo are within 5% of the actual total; for elephant and impala we expect our figure to be up to 10% low, and for giraffe and rhinoceros 25% low.

The biomass estimates in the table (p. 98) are derived from Lamprey's "adjusted averages" (Lamprey, 1962).

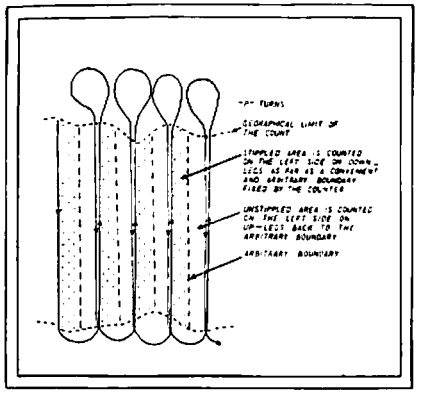

Figure 1
The flight pattern used for the count.

They do not take into account the possible counting error, and so true biomass figures will be slightly higher than those of the table.

DISCUSSION

The discussion of the implications of this census is confined to two major points; the very high biomass density of the Park and the imminent extinction of the plains-game population. We will demonstrate that both these problems have common roots.

BIOMASS DENSITY

The biomass density, in lbs. per square mile, for Lake Manyara National Park is 125,000 lbs. This figure exceeds any other published biomass density for wild animals in East Africa (Lamprey, 1964, Table 12). However, we are not in a position to say that 125,000 lbs. per square mile is the constant or year-round biomass density, nor can we state that the carrying-capacity of the Park is 3,748,500 lbs.

There is reliable evidence that movements of animals into and out of the Park took place in some numbers until quite recently (Morgan-Davies, 1959-1963). Over the last three years the rise in lake level, and the increase in settlement and cultivation at the northern and southern ends of the Park, have cut off the Park from the rest of the Masai Steppe with its mobile game populations (figure 2). The only routes of entry and exit now lie over the Rift Valley escarpment. It seems possible that the Lake Manyara game population is now effectively isolated from the much larger and mobile populations of the Masai steppe (of game and cattle), and therefore sheltered from the rinderpest epizootics which will occasionally occur in the Masai steppe, where the disease is probably enzootic (Plowright, 1963). Lamprey (1962) records the last rinderpest epizootic as being in 1959, when there was considerable mortality among buffalo in Lake Manyara. On that occasion the disease spread between Lake Manyara and the Tarangire Game Reserve, apparently being first recorded in Lake Manyara.

The escarpment presents no impassable physical barrier where it borders on Lake Manyara, and there are many well-worn game tracks. But above the escarpment human interests are encroaching rapidly towards the boundary of the Park, and undoubtedly even the Marang Forest Reserve is no longer the sanctuary that it was. We suggest that in part at least the very high biomass density recorded in this count is a result of the compression and confinement of the buffalo and elephant formerly occupying a larger range. As will be appreciated from figure 2 the route between the Marang Forest Reserve and the National Park is the only remaining safe exit point for elephant and buffalo.

Although there are no signs of excessive damage to trees by elephant a more critical survey is called for. But the low cover-values for the grassland and various types of erosion presently obvious in the Masasa region support the hypothesis that the present game population exceeds the carrying capacity of the Park.

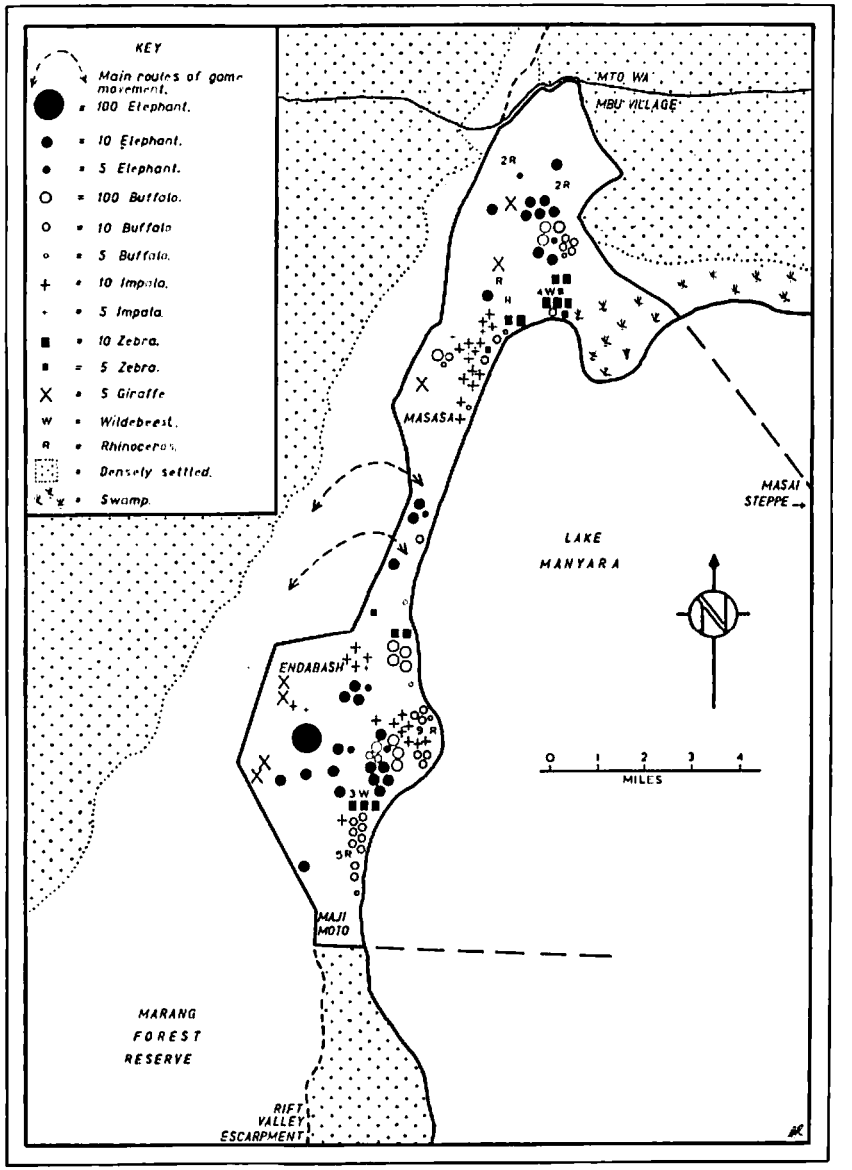

Figure 2
The position of the animals during the count.

TABLE 1

Animal	Numbers	Method	Biomass
Elephant (*Loxodonta africana* Blumenbach)	421	eye	1,900,000 lbs.
Buffalo (*Syncerus caffer* Sparrman)	1,507	1,339 photographs 168 eye	1,654,000 ,,
Zebra (*Equus burchelli* Gray)	115	eye	63,000 ,,
Impala (*Aepyceros melampus* Lichtenstein)	285	eye	31,500 ,,
Rhinoceros (*Diceros bicornis* Linnaeus)	20	eye	44,000 ,,
Giraffe (*Giraffa camelopardalis* Linnaeus)	31	eye	52,500 ,,
Wildebeest (*Connochaetes taurinus* Burchell)	7	eye	3,500 ,,
		Total Biomass	3,748,500 lbs.

The extinction of the resident plains-game population

Of plains game the census showed seven wildebeest and 115 zebra. As recently as 1961 there were about 700 wildebeest, and 400 zebra in the Park (Morgan-Davies, 1965). The course of the population of wildebeest towards extinction has been followed closely, and need not be discussed in detail here. It is sufficient to observe that the rise in lake level, which simultaneously eliminated more than half of the lake flats (the "plains habitat") and made an effective barrier to movements between the Manyara population and the Esimingor plains wildebeest, coupled with the increased cultivation on the northern and southern ends of the lake, is the "disaster" which has overtaken this small population of plains game.

Zebra, much less characteristic than wildebeest, may not become extinct at all, although their numbers are considerably reduced.

ACKNOWLEDGMENTS

The Director of Tanzania National Parks gave us permission to make this count. We appreciate the hospitality and kindness of Mr. J. Muhanga, Park Warden at Manyara, who invited us to do this work.

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A FIELD GUIDE TO THE REPRODUCTION OF THE GRANT'S ZEBRA AND GREVY'S ZEBRA

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INTRODUCTION

The reproductive cycles of the domestic horse and ass have been fairly well documented, but little is known about the reproduction of the wild species of Equidae in their natural environment (Asdell, 1964). The purpose of this paper is to outline the results of field work on the reproduction of the Grant's and the Grevy's zebra, which was undertaken as part of a comparative study of the reproductive physiology of some wild and domesticated equine animals. This will be published in detail elsewhere and the present work will be confined to a description of the most obvious changes in the appearance of the animal and the genital organs which characterise the different stages of the reproductive cycle.

1. GRANT'S ZEBRA *(E. burchelli böhmi)*

MATERIAL AND METHODS

The field work occupied the months of July-October, 1962, 1963 and 1964.

Post-mortem examinations were undertaken on 38 selected animals South of Maralal and three North of Isiolo. Body measurements were taken, incisor teeth drawn, mammary glands sectioned and genital organs and conceptus examined and weighed.

Material was fixed in Bouin's or 10% formol saline for histological examination and deep frozen for chemical analysis. Smears from the epididymis were stained with Eosin and Nigrosin for live : dead ratios of spermatozoa.

A further 17 animals were dart-immobilised using suxamethonium (six animals) or M.99 narcotic mixtures (11 animals) (King and Klingel, 1965); these included three lactating mares whose genital organs were examined by palpation per rectum.

Information on ageing was obtained from the appearance and dentition of ten captive or marked animals of known age, ranging from one week to 17 years.

RESULTS

Age determination

The size and appearance of the animal was found to be an accurate indication of age only during the first few weeks of life. During this period the young foal also provided a time scale by which the events in the reproduction of the dam could be measured. The growing animal was aged up to puberty by the eruptions of the temporary and permanent teeth. There was not enough information available to continue the time scale with reference to tooth table wear.

Appearance

The young foal at less than a week of age, had a short, thin body and long legs. The 2-3 cms. umbilical cord remnant was often present. The stripes were light brown in colour on the rump, body, forehead and nape of the neck, and much darker on the limbs and middle of the neck. The coat texture was fine and the hair length short (2-3 cms.) except for a mantle of long (5-9 cms.) upright hairs on the back and especially over the croup (Ansell, 1960). At about a month old the body had filled out a little, the dorsal mantle of hair was less obvious and the brown striping had darkened.

The weight of the new-born foal was 30-35 Kg. (see Fig. 3) and increased up to 50 Kg. at one month (Wackernagel,