Grass Foggage
Food for Fauna or Fuel for Fire or Both?

PETER HILL

P. O. Sweetwaters,
Pietermaritzburg, South Africa

INTRODUCTION

Evidence of the Role of Ungulates in the Development of Vegetation Communities in Africa and the Importance of the Wealth of Grass Species

Considering

1) The origin and history of the naturalized domestic livestock in Africa south of the Sahara (Colonial Office, 1957)
2) Their present distribution throughout many of the bioclimatic regions of the sub-continent
3) Their approximate population (100 million head each of cattle sheep and goats) (FAO., 1963)
4) The approximate area of land available to the grazer and grazer–browser of four million square miles
5) They are in general grazers or grazer–browsers

It can be said that naturalized domestic livestock, through fire and cultivation have played a significant role in the development of proclimax vegetation communities in Africa in which grass features to a greater or lesser extent. In this they have been aided to a locally varying extent by wild ungulates having similar, though wider food preferences. Furthermore, the importance of the wealth of grass species, their stability and their maintenance, to the fauna dependent on them, wild or domesticated, must be borne in mind by all those responsible for management.

FOOD FOR FAUNA

The Biotic Community—Selected Features, Functions, and Fullness

Food Preferences, Water Requirements, Conversion Efficiency, and Feeding Range of Wild Ungulates and Naturalized Livestock:— The savanna lands of East Africa supported, at least until the arrival of the white man, a fauna composed of up to about 30 species of wild ungulates with attendent populations of predators and scavengers.

Studies in East Africa (Talbot, 1962; Talbot and Talbot, 1963a, 1963b) have shown that each species of wild ungulate involved appears to have a yearlong preferred diet different from and complementary to the others. Some species of animals eat different classes of food. Giraffe, for example, feed largely on trees; black rhino feed largely on thicket; while wildebeest almost exclusively take grass. But within the different classes of food the diets are also complementary, either as to species of food plants eaten or to the stage of growth of a given plant. "Red grass" (*Themeda triandra*) is an example: although not eaten by some ungulates, it is the most important single item in the diet of wildebeest, topi, and zebra. Wildebeest choose fresh green leaves, zebra slightly more mature green plants, and topi dried leaves, stalks and dry inflorescence.

The composition of the plants making up each ungulate's diet varies greatly. The water requirements and drinking habits of a given ungulate species, like food habits, may vary from area to area and from season to season. Ungulates such as oryx, addax, gerenuk, and Grant's gazelle can survive for periods of several months with little or no free water, while other species such as wildebeest, buffalo

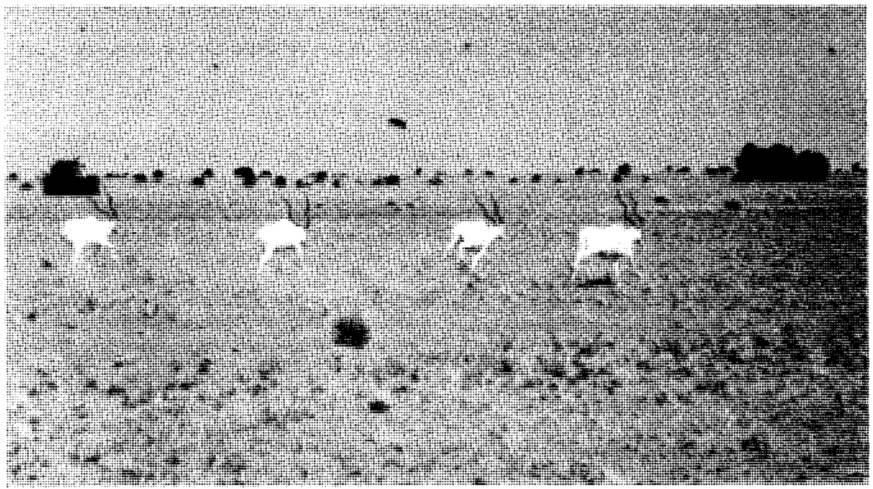

FIG. 1. Addax, N. Tchad, obtain their water requirements from plants. They do not drink surface water.

and zebra appear to require water frequently. There are many animals with intermediate water requirements. The species living under desert conditions have physiology and behaviour adapted to the rigorous environment, which include a digestive system that is extremely efficient in extracting and conserving moisture (Bolwig, 1958, 1959; Schmidt-Nielsen, 1959, 1964; Chew, 1961). Furthermore, many of the ungulate species in arid and sub-arid habitat may possess a mechanism whereby, under conditions of water and nutritional stress, ingested nitrogen could be re-cycled in the body rather than excreted in the urine, thus further saving water and enabling the animals to thrive on foods with an available protein content insufficient for survival in temperate-zone animals (Livingstone, 1961; Livingstone, Payne and Friend, 1962; Talbot and Talbot, 1963b; Payne, 1964).

Physiological studies of the Animal Husbandry Division of the East African Agriculture and Forestry Research Organization indicate that the physiology of the digestive tract also varies significantly from species to species. It appears that the distinctive diets of each of the wild ungulates represent not only foods that are preferred, but also food for which each species' digestive system is best adapted. The animals are capable of surviving on different or more limited food, but under such conditions they exhibit nutritional stress (Talbot and Talbot, 1963a, 1963b).

The ungulates of the East African savanna ecosystem may be divided into two broad groups; the resident mixed feeders and the migrant grazing animals. The nutritional requirements of the first group are satisfied by grazing and browsing yearlong within a relatively limited home range, while the nutritional requisites of the much larger latter group may be found at different places within the savanna ecosystem at different times of the year, depending on patterns of grazing, burning, and rainfall. Freedom of movement over a large area is therefore essential to maintain a high population of migrants on an optimum plane of nutrition.

Naturalized livestock, like wild animals, have well-defined and limited preferences in their food habits. But in East Africa, the preferences of cattle, sheep, donkeys, and to a large extent, goats, overlap (Heady, 1960; Talbot, 1960).

The result of the non-duplicating food preferences of the mixed wild ungulates is that much of the available vegetation can be used to support efficiently the biomass of mixed herbivores. Whereas, when domestic livestock graze, grass, and only a few species within that class, are the preferred forage. Shrub and tree leaf are taken, but are of seasonal importance. Cattle and sheep are predominantly grazers or grazer-browsers.

Standing Crop Biomass, Indigenous and Naturalized, of Certain Biotic Communities:—One result is that broadly equivalent savanna lands support a biomass of wild ungulates that is 2–15 times higher than that of domestic livestock (Talbot, et al., 1961).

Table I presents comparative biomass figures from East African savanna domestic livestock under tribal grazing and European ranches, and wild ungulates, with North American prairie (wild ungulates and domestic livestock) and deer.

Habitat:—1) Efficiency of use. Relative to the native wild ungulates, the naturalized livestock are very recent imports to African savannas. It would be expected that they would not be so well adapted to the savanna conditions as the indigenous wildlife, and

TABLE I. YEARLONG UNGULATE BIOMASS DATA FROM EAST AFRICAN SAVANNA AND NORTH AMERICA (TALBOT, 1963b)

Approximate Yearlong Biomass pounds/square mile	Approximate Size of Area square miles	Animals	Range Type	Location	Reference
70,000–100,000	about 2,000	Wild ungulates	Savanna ungrazed by domestic livestock	East Africa	Talbot & Talbot, 1963a
30,000+	10,000+	Wild ungulates & domestic livestock	Savanna (incl. tribal grazing land)	East Africa	Talbot & Talbot, 1963a
21,300–32,000	—	Cattle	Managed savanna (European ranches)	East Africa	Ledger, et al., 1961
26,700	—	Domestic livestock	Average of virgin long & short grass	Western U.S. United States	Watts, et al., 1936
14,000–20,000	—	Bison & associated wild ungulates	Prairie	United States	Bourliére, 1961; Petrides, 1956
19,700	1,126,500	Domestic livestock	Average of all virgin ranges	Western United States	Watts, et al., 1936
11,200–16,000	2	White-tailed deer	Woodland proper density	Michigan, United States	O'Roke and Hamerstrom, 1948
1,360	88,080	Mule deer (5 races)	Average all ranges	California, United States	Longhurst, et al., 1952

several lines of evidence indicate that this is the case. In terms of digestive efficiency (based on killing percentages and visceral weights), water requirements, growth rates and liveweight gains, age of maturity and reproduction, disease relationships, standing crops, and carrying capacity, the wild ungulates make more efficient use of the savanna rangelands than the domestic livestock (Talbot, et al., 1961). Stated another way, naturalized livestock cannot be substituted for the wild ungulates in the savanna ecosystem without significant loss of production of animal protein.

2) Over-use: Such fuller and more balanced utilization of habitat by wild ungulates than by domestic livestock does not mean that the former are incapable of over-utilization. On the contrary, there is ample evidence of slight to severe degradation of habitat by wild ungulates in the majority of established Parks and Reserves where wildlife is protected in Africa, South of the Sahara, from Senegal to Somalia and the Sudan to South Africa. (Examples of wildlife eruptions and die-offs are given elsewhere in this note, as are references to the die-off of domestic livestock).

3) Need for, and some problems of the control of ungulate populations. Pratt (1967) observed that as a result of grazing by zebra, wildebeest, kongoni, and gazelle, a burnt plot in the Nairobi National Park (forming part of an experiment on the control of *A. drepano lobium*) yielded about 50 percent of the dry matter of an adjoining unburnt plot. (One year following the burning treatment, both plots were fenced and dry matter yields taken one year after fencing). A parallel trial was conducted in the Machakos District, but here controlled grazing by cattle and goats replaced uncontrolled grazing by wildlife. Here the burnt area out yielded the unburnt by nearly 10 percent.

Pratt points out that the data add support to two general theses:

1) Wild life species do not necessarily have "better" grazing habits than cattle or goats. *Any species that is present in too great numbers, seasonally or continuously, is likely to damage the habitat.* And whereas domestic stock movements and populations are often too closely controlled, those of wild life are very difficult to control. Here it should be stated that important contributory problems to wild life population control are:

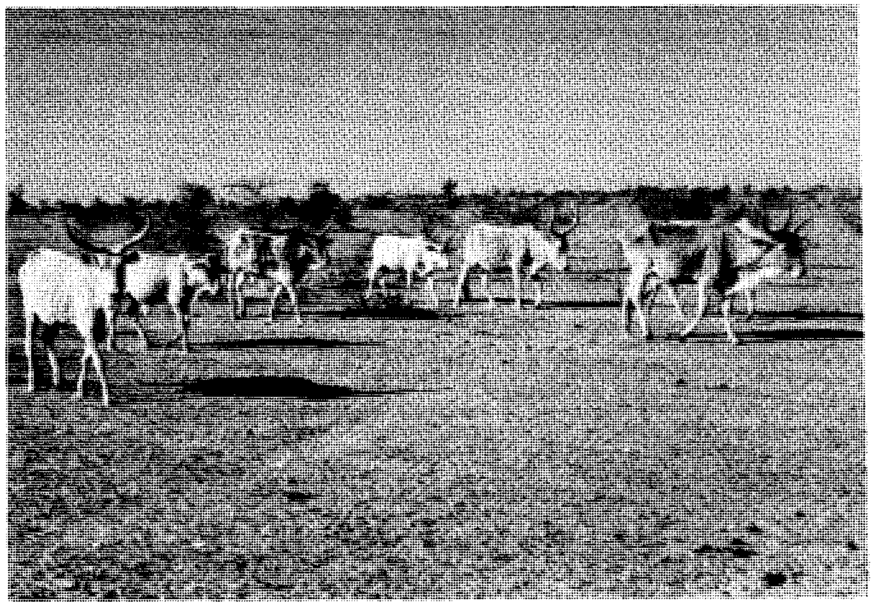

FIG. 2. Ferlo, Senegal. Overgrazing by Fulani cattle.

a) Wide differences in public opinion; the ultra protectionists; the true hunters who want to hunt tomorrow, and who therefore ensure that an adequate stock population is preserved; the selfish hunter who thinks only of his sport to-day; those who see wild life as a practicable form of land-use, including farmers; the true conservationist with responsibility for wildlife park or reserve, who accepts the fact that the area in his charge, however large, is not natural in the true sense because of boundaries, visitors, roads, motor cars and artificial water points, and that therefore there must be imbalance that must be controlled to an extent if the habitat is to be maintained in an acceptable state

b) the economic capture and utilization of wild products, especially wild protein

c) disease transmission factors

d) taboos

2) That grass (*Themeda trianda* dominant) is very sensitive to

misuse during the growing season following burning, and relatively small numbers of grazing animals can do disproportionate damage at this time.

Management Skill and Intensity Requirements of Different Ecosystem Usage:—It is true to say that wild species do not have "better" grazing habits than cattle or goats. But, as has already been said, for much of the great wooded savanna (Phillips, 1959) of the African tropics and hotter sub-tropics, a population of mixed species (grazers, browsers) of wild animals makes more efficient use of the habitat than do domestic livestock for the reasons given. Thus, where such a spectrum of wild ungulates exists, more of the vegetation growth of an area provides nutrition for the animal mass living on it than with naturalized livestock. This ensures a maximum conversion rate or energy flow within a given habitat. Where cattle, sheep, and goats graze and browse a similar area, a lesser part of the total vegetational growth provides preferred and efficient nutrition for the animals involved, much of the potential productivity is wasted, and a small part is disproportionately used. But the point already made is repeated, namely that mismanaged wildlife can over-use habitat as effectively as mismanaged livestock, or even more, as their usage is fuller!

Many species of game show a decided preference for young grass. So do domestic livestock. Obviously the extent to which any species of grass susceptible to intensive grazing, following early burning, will suffer depends on the intensity of grazing pressure. These factors must clearly form a part of any management plan whether this is for a farm, with naturalized livestock alone or in a managed wildlife area, or where multiple land-use, with naturalized and wild ungulates, is being followed. Moreover, it must be remembered that the concept of mutiple land use, originally loosely and generally applied, is now becoming more meaningful. In any ecosystem there will be a principal form of land use, dictated by ecological and other conditions. Thus, for example, though the major objective for a block of humid tropical forest would be sustained extraction of hardwood, management objectives would include, as part of forestry objectives, water conservation, and might include rational use of wild life, and even planned shifting cultivation. The usage emphasis, on the other hand, in a wooded savanna community such as *A. Senegalensis*, might be towards wild life assisted by harvest of gum.

Meaningful combinations of potential land-use virtually know no end, but must rely on the usual resources of men, machines, money, morale and method for implementation, of which dedicated men having the right basic training are essential. In this regard the training of foresters will, in certain cases, need to be expanded to include management of wild life and recreation areas.

It is important to record that facilities for the training of medium grade wild life personnel already exist at Mweka, Tanzania and Garoua, Cameroun, in English and French medium respectively, to serve Africa. This is a small but significant beginning, and it is hoped that the grounding in ecology is adequate.

Selected Evidence of the Importance, Actual and Potential, of the African Wildlife Resource as a Source of Protein

Cameroun:—A study conducted by the Cameroun Research Institute in which animal protein intake of representative sections of the populace, from both wild and domestic sources (excluding milk and fish) was obtained from detailed surveys undertaken in the densely populated area of Galompui and lightly populated Batouri.

The information obtained by the Cameroun authorities, the bare results of which are tabulated below (Table II), was the first of its kind in Africa. This indicates emphatically that wild animal protein does make a significant contribution to the total animal protein intake of a large sector of the populace having little other source of supply, and that it is still sought after even when rodents, small reptiles and insects only, are available, in addition to domestic meat. The data obtained, however, also clearly show the depleting effect of pressure of human population.

As one half of the population of Cameroun is located on nine-tenths of its surface at a density of 1.3 inhabitants per square mile, and whereas Batouri, with a density of five per square mile provided over fifteen pounds of wild meat per head of population, it is fair to assume that some ten thousand tons of wild meat per annum are consumed, if the survey data are applied. This wild, "free," depend-

Table II. Cameroun

Site	Representation of sample: Area in square miles	Representation of sample: Population	Population density per square mile	Animal protein intake in pound/head/annum: Domestic	Animal protein intake in pound/head/annum: Wild	Wild species consumed with estimate of occurence
Golompui	718	100,000	139	46.63	1.21	Buffalo, antelope spp., warthog, hare, rodents, guineafowl.
					0.96	Insects (termites), grasshoppers.
					Total 2.17	
Batouri[1] (1)	19,686	99,000	5	13.64	15.27 (2)	*Plentiful:* Maxwell's duiker, black-backed duiker, monkeys, chimpanzee, buffalo *Less frequent:* situtunga, kob, water buck, gorilla, drill *Fairly frequent:* Yellow-backed duiker, elephant, hippo-potamus *Rare:* Giant forest hog, colobus spp., bongo
					2.2	*Also eaten:* Civet genette, porcupine, cane rat, tortoise, snakes, snails, insects (caterpillars, larvae, etc.)
					Total 17.4	

[1]Note The province of Lom and Ladei was selected because of the wide range of vegetation encountered—Humid forest through broken forest to derived savanna—thus account for the range of animal species ecnountered.

[2]Note This is considered to be a minimum figure because survey staff were unable to accompany hunters who usually remained for long periods in their hunting grounds; no actual analysis of their diet could be made. Furthermore no analyses were conducted in the high forest during the peak of the rainy season due to difficulty of access. The team learned, for example, that eight gorilla were killed and eaten in the Bokindja district during the three heaviest rainfall months.

able, indispensable, substantial source of animal protein is large by any standard, and an integral part of the country's economy.

Tanzania:—From a study in both the Tarangire Game Reserve and the Masai Steppe in Tanzania, Lamprey (1963) estimated large mammal densities, biomass, and energy exchange by use of the transect system of game counting, including the use of a visibility profile, to determine the actual area covered, and, as a check on this technique, direct aerial counting and total counting on the ground.

The study area in the game reserve were three transect lines, each 8,000 yards long by approximately 200 yards wide, and each parallel to and 1,000 yards from the other. These lines were concentrated in an east-west direction at right angles to the River Tarangire which virtually bisected them. These sample areas traversed several vegetation zones, major species consisting of woody species of *Acacia*, *Commiphora*, *Combretum* and *Dalbergia*, generally termed acacia savanna, but described by Phillips (1959) as mild sub-arid wooded savanna.

The study area was very little disturbed by human activity and it is probable that the game population was near to its natural carrying capacity. No direct comparison between the densities observed and those of domestic livestock is available as records were not kept. Such a comparison would have limited value in any event. It is however, of considerable importance to have data indicating the order of size, both in numbers, but more especially in biomass, of communities of game mammals in Africa.

Results of the monthly transect averages over a period of four years are summarised below (Table III) and to the large mammal densities and biomass obtained, the meat yield, both in pounds weight per square mile and per acre, together with its cash value on a certain basis, have been added.

Botswana:—The outstanding point that emerges from these data obtained as a result of sustained meticulous observation and recording to a very high scientific standard, and the observed densities of Tinley (1965) in the newly declared Wildlife Reserve of Moremi in Botswana is that the "standing crop" (and thus protein availability) of wild animals, measured in terms of biomass, on the great African wooded savanna and related bioclimatic regions is, according to

TABLE III. TANZANIA. TRANSECT AREA DENSITIES FROM THE WEST AND EAST SIDES OF THE TARANGIRE RIVER IN NUMBER OF ANIMALS, THEIR BIOMASS AND THEIR POTENTIAL MEAT YIELD PER SQUARE MILE—AVERAGES FOR FOUR YEARS

	Animals per square mile		Biomass per square mile		Meat yield per square mile			
					10 percent basis		20 percent basis	
Species	West	East	West	East	West	East	West	East
Grant's Gazelle	1.17	0.02	140.40	2.40	7.02	0.12	14.04	0.24
Wildebeest	7.68	2.21	2734.10	786.80	136.70	39.34	273.41	78.68
Impala	74.78	27.31	7777.12	2840.24	388.86	142.01	777.71	284.02
Eland	1.08	0.71	1006.56	661.72	50.33	33.09	100.65	66.17
Giraffe	3.44	2.48	5504.00	3968.00	275.20	198.40	550.40	396.80
Zebra	28.11	20.50	17934.18	13079.10	896.70	653.95	1793.42	1307.90
Waterbuck	5.19	4.01	2283.60	1764.40	114.18	88.22	228.36	176.44
Warthog	2.99	2.49	466.44	388.44	23.32	19.42	46.64	38.84
Dikdik	3.92	4.13	47.04	49.56	2.35	2.48	4.70	4.96
Rhino	0.37	0.41	1110.00	1230.00	55.50	61.50	111.00	123.00
Buffalo	8.55	19.03	10260.00	22836.00	513.00	1141.80	1026.00	2283.60
Elephant	1.78	4.00	14240.00	32000.00	712.00	1600.00	1424.00	3200.00
Hartebeest	0.52	1.95	179.92	674.70	9.00	33.74	17.99	67.47
Lesser Kudu	0.18	0.75	41.40	172.50	2.07	8.63	4.14	17.25
	139.76	90.00	63724.76	80453.86	3186.23	4022.70	6372.46	8045.37
Meat value @ 1/– per pound					£159	£201	£319	£402
Meat yield in pounds per acre					4.98	6.28	9.95	12.56

known evidence, higher than is found on any other type of range, in equivalent bioclimatic conditions, in the world.

Botswana—Bushmen of the Central Kalahari Reserve:—Consideration must be given to the few, but nonetheless important populations of hunting-food gathering men. It is of special interest to note that whilst hunter food-gatherers âre to be found occupying every bio-climatic region, the largest and "purist" concentrations are to be found in the extremes: the Bushmen living under sub-desert conditions of the Kalahari and the Pygmies of the various and still extensive highly humid forest regions of West-Central Africa.

The Central Kalahari Reserve supports a self-contained community of plants and animals and is, in addition, the home of between three and five thousand Bushmen who have expressed the wish to continue to follow their present life of hunting-food gathering without interference or encroachment by other peoples. The features outlined make this situation unique, offering incomparable opportunities for research into floral, faunal and human ecology of an arid African biome; it must be stressed, however, that it is not intended to preserve the Bushmen of the reserve as museum curiosities and pristine primitives. They have the right of choice of the life they wish to follow; they have freedom of movement across the borders of the reserve; if they wish they may abandon their hunting life and align themselves with their own kith and kin outside: they have chosen to stay.

The Bushmen's place in the ecology of the reserve is as predator on all the ungulates, springhares, jackals, foxes, rodents, birds and insects which they hunt and eat; they compete with browsers and fruit eaters for edible food plants; and as hunters they are also rivals of the predators, both mammalian and avian.

In their utilization of bulbs and tubers, they are careful not to exploit an area completely, but always leave some plants intact as seed bearers for the next season. They are never wasteful in their hunting and kill only as much as they require. Their hunting methods, bow and poisoned arrow and the use of snares, involve a minimum of disturbance of the herd to which the hunted animal belongs. Their bows have a very short range, and arrows, for satisfactory results, have to be loosed from within 25 yards. The bow and arrow, unlike the firearm, is silent and the only disturbance is caused by the wounded animal and the fear-reaction it stimulates in the herd. In fact, the disturbance caused by a Bushman hunter is considerably less than that caused by a lion or leopard making a kill.

Although their diet is predominantly vegetable, meat not making up more than 40 percent of their total intake even at the peak of their hunting activity, Table IV gives a calculated average for the various species killed during the year by a band whose membership averaged eighty (Silberbauer, 1965). The band's territory extended over about 350 miles of mixed scrub, pans, plain, and low woodland typical of the southern region of the reserve.

Hunting drops off very sharply during the early months of the summer. This is because fresh poison is no longer available and the old stocks have either been exhausted or have lost their potency. Moreover, the weather is so hot and the available plant food so meagre that the men have little energy for such strenuous exertions.

From the evidence available Bushman hunting and food gathering is nowhere sufficiently intensive to cause any disruption of the ecological balance. On the contrary, it has been clearly established that when left to themselves, these people are an integral part of a fairly stable ecology. They have lived and hunted in their present areas for certainly a century, probably very much longer, and in that time had not reduced the game herds. As long as they continue to use their present methods of hunting and food-gathering, therefore, and are not subjected to outside interference, there is no reason why the present balance should not be maintained.

The vegetation of the whole reserve, while stable in the sense that it has been established for a long time, is extremely delicately poised. Burning is carried out about once every 3 years in any one band's territory with the stated purpose of clearing the ground of choking undergrowth which would otherwise interfere with the growth of melons and other useful vines. The season for burning coincides with the dry windy period of winter or early summer so that most burning is done a month or two before the onset of the rains. The fires take off the dead growth of the previous season's grass but seldom do more than singe the perennial shrubs. Greater damage is attributable to fire in the woodland areas and although the bald

Table IV. Botswana, Number of Animals Killed by One Band of Bushmen in One Year and Assessed Meat Intake per Head

Species	J	F	M	A	M	J	Month J	A	S	O	N	D	Tot	Estimated minimum meat available in pounds[1]
Giraffe	1	—	—	—	—	—	—	—	—	—	—	—	1	800
Kudu	—	1	—	1	1	—	—	—	—	—	—	1	4	1,400
Eland	2	1	—	1	3	1	—	—	—	—	—	1	9	4,194
Gemsbok	2	4	2	1	—	4	3	4	—	—	—	3	23	6,440
Hartebeest	—	—	2	1	2	2	2	1	—	—	—	1	11	1,903
Wildebeest	1	—	3	2	—	2	2	1	—	—	—	1	12	2,136
Springbok	4	2	6	6	4	6	2	4	—	—	—	1	35	1,050
Duiker	5	4	3	7	2	3	1	2	12	10	12	4	65	1,040
Steenbok	3	4	3	6	8	2	4	2	8	10	15	3	68	680
Springhare	30	24	28	30	26	22	20	4	3	—	8	32	227	454
Porcupine	—	—	1	—	1	—	—	—	—	—	—	—	2	8
Warthog	—	—	—	—	1	—	—	—	—	—	—	—	1	78
Fox	—	—	—	—	4	—	3	1	3	2	1	4	18	90
Jackal	—	—	—	2	—	—	1	2	2	3	4	—	14	210
Rodents	20	30	30	30	40	20	20	15	15	15	30	30	295	60[2]
Birds	18	22	13	15	6	12	3	12	16	16	20	8	161	10[2]
Tortoises	90	90	80	40	—	—	—	—	—	—	50	90	440	—
Snakes	6	3	—	8	10	8	2	—	—	—	6	4	47	47[2]
Ants (pints)	1	1	1	—	—	—	—	—	—	—	1	1	5	10
Termites (pints)	8	4	—	—	—	—	—	—	—	—	—	4	16	32
														20,642 = 258 pound/head/ annum

[1] These figures are minimal as the Bushmen eats all the meat save that surrounding the arrow, together with most of the soft organs and blood.

[2] Low estimates have been used because no breakdown into species was given in the work cited (Silberbauer, 1965).

patches thus formed would take a long time to heal were several successive years of drought combined with fires to occur, it should be remembered that the Bushmen would not then burn for he would have no need to do so.

The grass is, however, easily trodden out and has a low resistance to over-frequent burning. The trees are only partially resistant to severe drought and extreme cold; both of these if prolonged and combined with excessive burning, could alter the environment within a very short time.

Although this balance is being maintained because man is such an integral part of the ecology, his superior intelligence enables him to know that he must use the assets rationally in order to survive in this bioclimate where the balance is very delicate indeed.

Comparison of Domestic and Game Meat Availability and Consumption in Certain African Territories:—To obtain an impression of the order of magnitude at a glance, the country-wide data described in this note and obtained elsewhere, are presented in Table V. Incomplete though they are, it may be assumed that availability and consumption of wild protein is greater than the amounts shown by the more intensive surveys.

Rise and Fall of Populations—Man and Other Mammals

It is certain that eruptions and die-offs of a variety of Africa's wild populations have occurred in cycles, of lengths according to species down the millennia. A major factor which now inhibits the continuance of natural cycles is the increase of humans. In some localities this increase is large and rapid. In areas of low human density, and suitable habitat, wild ungulate eruptions continue. Of the larger ungulates, the principal species affected are the elephant, buffalo, wildebeest and zebra.

Elephant Populations:—1) Tsavo National Park: Examples of the dimensions of selected elephant populations (some of these being over-populations), to be found in Africa to-day are as follows. In Kenya's Tsavo National Park of 8,000 square miles, containing the biggest elephant and black rhinoceros populations in Africa, with an elephant population of over 20,000 or 2.5/square mile (Glover, 1970). The total ecological unit, in fact extends over some 17,000

TABLE V. COMPARISON OF DOMESTIC AND GAME MEAT AVAILABILITY AND CONSUMPTION IN CERTAIN AFRICAN TERRITORIES

Country	Population in 000's	Production of domestic meat in 000's of tons	Consumption of domestic meat per head of population in pounds	Game Meat Availability		
				total in 000's of tons	Per head of population in pounds	Percent of domestic meat consumption
Cameroun	3,180	26.48	17.6	10.00	6.3	35.8
Kenya	6,401	167.32	55.0	2.90	0.9	1.6
Zambia	2,860	20.38	15.4	1.19	0.83	5.4
Uganda	6,437	73.79	24.2	5.88	1.82	7.5
Rhodesia	2,360	65.79	61.5	7.07	3.00	4.9
Dahomey	1,680	10.73	13.0	2.16	1.61	12.3
Upper Volta	3,340	10.31	6.6	6.90	4.10	62.1
Congo (Kins.)	13,700	28.14	6.6	13.34	1.91	28.9

Note: Meat availability for Zambia and Uganda does not include that taken by local hunters and, in the case of Kenya, only includes losses to poacher of species such as elephant, rhino, giraffe and larger antelope.

FIG. 3. Queen Elizabeth National Park, Uganda. Cropping an over population of Hippo. Meat was sold fresh to local inhabitants.

FIG. 4. Galana Game Area, Kenya. Elephant meat being sun-dried.

square miles and probably contains about 25,000 head of elephant (Laws, 1970). This is about double the recommended stocking rate on a yearlong basis of one elephant per square mile (Glover, 1963). The vegetation over much of the park for the past 50 or 60 years, and until a decade or two ago, consisted of dense commiphora-acacia mixed woodland. However, during the last 20 years, much of this woodland has been cleared by elephant or fire; this community having been thinned or destroyed over very large areas and replaced by grassland. An upward trend in the annual rainfall, combined with the elephants' destruction of commiphora and other trees, has brought a new vegetation pattern with higher carrying capacity than existed twenty years ago. More "plains game", oryx, zebra, eland, kongoni, buffalo, are appearing (Glover, 1970).

2) Murchison Falls National Park: In Uganda's Murchison Falls National Park, totalling 1,500 square miles: 7,000 to 9,000 elephants. Admittedly rainfall is 40 to 50 inches per annum (as against that

Fig. 5. Tsavo National Park, Kenya. Typical use of Commiphora.

of the Tsavo region of 12 inches with great variation (1942, 2.46 inches, 1943, 5.31 inches) but even so, Buechner, et al. (1963) stated that "numbers must be regulated to avoid damage to the vegetation and the future welfare of the population of elephants". Petrides and Swank (1958) generalized in the same way, saying "contradictory as it may seem, it is our belief that wild lands to-day will often require management in order to preserve their wilderness character."

3) Kruger National Park: In South Africa's Kruger National Park, an elephant cropping programme has been initiated. (Other species such as zebra, buffalo, impala, wildebeest, hippo, and giraffe are being, or will be controlled).

4) Republique Centrafricane: In the Central African Republic some 550 elephant are killed annually on licence alone.

5) Uganda: In Uganda the known minimum elephant mortality between 1927–1959 is reflected in Table VI (Buss and Brooks, 1963). The estimated 1959 elephant population in Uganda is reflected in Table VII (op. cit.).

6) Luangwa, Zambia: In the Luangwa Province of Zambia, the average number of elephant taken annually on control between 1947 and 1953 was 318. The contribution of meat to the entire population of 2,900,000 people thus amounted to one half pound per head (Hill, unpublished data). In 1963 there was certainly an overpopulation of elephant and buffalo. According to Riney, *Colophospermum mopane*, generally very heavily pollarded over large patches, is actually maintaining itself and even spreading despite the heavy use to which it is subjected. It cannot therefore be regarded as a weak link in the habitat complex for buffalo and elephant. Observations in the valley and from records by Bullock indicate that lack of adequate perennial grass cover at the end of the dry season is the most critical factor. Die-offs of buffalo have been recorded in recent years and more of these can be confidently expected, unless drastic culling measures are instituted (Riney and Hill, 1967).

7) Botswana: In 1962, Botswana held the largest concentrations of plains game occurring in Africa (Riney and Hill, 1967). There was then abundant evidence of very large scale mortality, especially of wildebeest, buffalo and elephant in recent years. 40,000 wildebeest were estimated to have died in 1959 (one trading store alone dealt

TABLE VI. KNOWN MINIMUM ELEPHANT MORTALITY IN UGANDA 1927–1959

Years	Numbers shot as trophies[1]	Numbers shot on control	Elephants found dead[2] Outside of Nat. Parks	Inside of Nat. Parks	Totals
1927	169	604	184		957
1928	227	657	281		1,165
1929	211	1,033	170		1,414
1930	97	892	135		1,124
1931	105	1,211	130		1,446
1932	143	1,210	179		1,532
1933	75	1,308	150		1,605
1934	100	1,603	292		1,995
1935	159	1,546	149		1,854
1936	296	1,626	133		2,055
1937	337	1,519	128		1,984
1938	331	1,053	103		1,487
1939	267	1,008	149		1,424
1940	226	1,219	133		1,578
1941	183	1,040	97		1,320
1942	169	980	59		1,208
1943	170	855	133		1,188
1944	280	971	147		1,398
1945	266	1,301	92		1,659
1946	287	853	76		1,216
1947	379	737	52		1,168
1948	441	970	135		1,546
1949	383	774	121		1,278
1950	533	781	81		1,395
1951	589	723	103		1,415
1952	263	477	92		832
1953	205	660	90		955
1954	206	696	66		968
1955	207	681	168	47	1,103
1956	258	865	106	69	1,298
1957	244	892	69	80	1,285
1958	219	1,119	76	76	1,490
1959	259	1,494	104	188	2,045
	8,284	33,460	4,183	460	46,387

[1] Excludes 145 elephants shot in 1925–1926.
[2] Based on number of tusks found, and corrected for single-tusked (0.35) and tuskless (0.01) elephants (Brooks and Buss, 1961).

TABLE VII. ESTIMATED 1959 ELEPHANT POPULATION IN UGANDA

Districts	Numbers
North Bunyoro	12,000
South Bunyoro	630
Toro	2,500
Mubende-Mengo	600
South Masaka	70
Ankole-Kigezi	2,300
Nugishu (Mt. Elgon)	50
South Busoga	150
Karamoja	200
Acholi	4,000
West Nile (transient Sudan population)	1,000
TOTAL	23,500

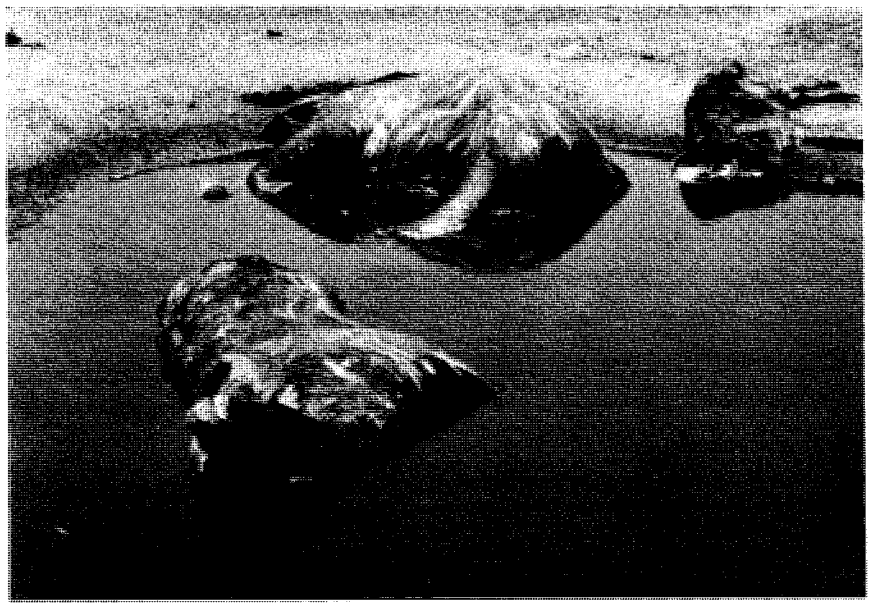

FIG. 6. Nata River, Botswana. Die-off of elephant and buffalo. Note animals are untouched by scavengers.

with 19,000 skins brought in by Bushmen). During a brief visit to the Nata River area and a few weeks afterwards, many elephant died (probably 50–100), together with several thousand buffalo and wildebeest, all in the vicinity or edges of water holes with water. The condition of all game seen was poor to deplorably poor. For two whole days of our visit we smelt dead animals and carcases were so plentiful that the majority were untouched by predators. This was a small part (48 square miles) of an area where, within living memory, the river used to flow at the end of the dry season and supported crocodile and hippo.

Food Conversion and Feeding Values

Food Conversion Efficiency Differences between Ungulate Species and Breeds:—There are considerable differences in conversion efficiency between breeds of ruminant naturalized livestock. Whilst one breed of cattle may be able to maintain body weight under a given dry-season vegetation condition, another will lose condition fast. Generally speaking most wild ungulates are superior to naturalized stock in their better ability of converting rough (high fibre, low protein) grass into animal protein. Thus, although browser-grazers may obtain their crude protein requirements from browse of adequate crude protein content, and are therefore to an extent more independent of standing dry grass, grazers-browsers and, to a lesser extent, grazers must have access to standing dry grass during the dry season.

Crude Protein Seasonal Variation In Tropical and Sub-Tropical Grasses:—Generally speaking there is a pronounced seasonal variation in the crude protein content of tropical and sub-tropical grasses. Rose Innes, Lansbury, and Mabey (1962) working on the Accra Plains in Ghana, found that crude protein forms about 10 percent of the dry matter in the early rainy season grass growth (dominant grasses, species of *Andropogon*, *Vetevaria*, *Brachiaria*, *Schizachyrium*, and *Monocymbium*) but falls to three percent during the dry season. Darling (1960) has provided data from Zambia showing an even wider variation (Table VIII).

TABLE VIII. PERCENTAGES OF CRUDE PROTEIN IN DAMBO GRASSLAND FROM ZAMBIA OVER A PERIOD OF ONE YEAR

	Month	Crude Protein		Month	Crude Protein
	November	3.35		May	2.20
	December	11.01		June	2.10
RAIN	January	6.13	DRY	July	1.08
40.3	February	5.15	SEASON	August	0.86
Inches	March	4.16		September	0.68
	April	4.50		October	0.64

Crude Protein Content of Leaves of Some Shrubs and Trees:— In many types of vegetation, ranging from broken forest to wooded grassland, naturalized livestock maintain bodyweight by browsing leaves of shrubs with an adequate crude protein content. Rose Innes and Mabey (1962) found that shrubs such as species of *Baphia*, *Capparis*, and *Griffonia* contain an average of 22, 19, and 15 percent respectively of crude protein. But this is not everywhere so. Limiting factors such as tsetse fly and water may preclude the keeping of naturalized livestock.

Role of Rumen Bacteria:—It has long been known that simple nitrogenous compounds can be converted, more or less completely, into protein by bacteria in the paunch of ruminants, during the fermentation which takes place normally in digestion.

A Function of Urea:—It is known that when urea is added to a ration low in protein, but with sufficient starch, the bacteria rapidly convert the urea more or less completely into protein, which can then be used by the ruminant. The conversion of urea into protein is poor when urea is added to hay alone, without any concentrates (Morrison, 1954). Down the centuries farm husbandry has experienced many changes in treatment of soil, plant and animal, all towards the achievement of greater productivity per unit area.

Substantial increases in yield were achieved between 1850 and World War II as a result of plant and animal breeding; from application of inorganic fertilizer; supplementary water; and by control of weed plants, fungi, and insects.

The past 25 years have seen a sharp increase in the use of pesticides; of these herbicides are supplementing and even replacing cultural methods of weed control.

The ultimate outcome of such a sustained treatment is a matter for conjecture, but as the ultimate test laboratory is the species at the end of the food chain, a similar development to that caused by chlorinated hydrocarbons cannot be ruled out. It is hoped that we have learned something from our mistakes and that a severe curtailment of this practice will occur

The urea-based ruminant lick is a valuable aid to veld utilization and has securely established itself in this regard. Like all management "tools" however, it needs to be used selectively if imbalance is to be avoided.

It must be remembered that the prime factor responsible for the development of the majority of grassland associations is fire. If this is excluded due to total, sustained use of grass by ruminants, woody vegetation will increase and grass productivity will fall, possibly even until a thicket stage, with little or no grass, is reached.

Too great a reliance on and use of this management "tool" will

FIG. 7. Luangwa Valley, Zambia. Many wild species require dry grass during the dry season.

lead to veld deterioration, to erosion, and to disaster, as reports already indicate (Phillips, personal communication).

Urea Excretion and Re-Cycling:—Reference has already been made to work which has demonstrated that urea excretion in camels and other livestock is reduced with reduction of crude protein in the ration, and deprivation of water. It may be assumed that many of the wild ungulate species in arid and semi-arid habitats possess these mechanisms. With tolerance to many disease-causing protozoa such as trypanosomes, they are able, not only to survive, but thrive on habitats wholly unfavourable for naturalized livestock.

The Importance of Grass Foggage:—The importance of grass foggage, the principal fuel for fire, for many ungulates, domestic and wild, for the duration of the dry season is thus clearly apparent. The importance of burning policies which incorporate this need is, therefore also apparent.

PETER HILL

FUEL FOR FIRE

Burning Policies for Woodlands, Open Woodland and Open Shrubland

Needs of:—1) The Forester: When considering indigenous forest of mixed species the ideal policy for the forester is to achieve complete protection of the forest reserve in his charge, thereby promoting rapid development towards a climax. In practice, it is virtually impossible to maintain complete protection, if for no other reason than the occurrence of fires caused by lightning. As the volume of combustible material accumulates, the effects of accidental fire on protected woody vegetation are catastrophic. Thus, for the forester, the only practical course is to accept the lesser of two evils and to burn early in the dry season (Ramsey and Rose Innes, 1963; Phillips, 1965).

2) The Pastoralist: Although the spread of woody vegetation reduces grass cover by introducing new environmental conditions, including increased competition, it does not follow that vigour of all perennial grass species is lowered to the point of perennials giving way to annuals. On the other hand, Ramsey and Rose Innes show (op. cit.) that in the northern Guinea Savanna (mild sub-arid to arid wooded savanna), *Andropogon gayanus*, the most valuable species to the cattle grazier, is encouraged by early rather than late dry-season burning.

Where a pronounced dry season occurs there are two factors that determine grass growth, soil temperature and soil moisture. Of the two, soil temperature is a better limiting factor, as at least whatsoever burning treatment occurs, there is no strain on grass roots as long as soil temperature remains too low to stimulate growth. There are many reasons for burning veld advanced by farmers, administrators, planners and others all of which are well known. They bear reiteration if only because we seem always to forget lessons previously learned. New government administrations too often take little or no heed of what their predecessors learned: whilst the young consider they know far more than their elders.

a) Early or mid-season burning may cause a reduction in tick and other stock disease transmitting insect populations, but this is temporary and populations will return rapidly to normal, in the absence of other controls.

b) The farmer who claims he needs palatable green grazing from a summer or rainy season grass should first look to his summer food conservation effort and his stocking density, because it will be in these directions that the fault will lie. If we were only able to evaluate quality food produced under natural conditions and lost or wasted altogether in quantity and quality, we would have much food for thought.

c) Autumn burning in sour veld, even where soil moisture is adequate, is a bad practice because food transfer from leaf to root is taking place, plant vigour is reduced for several seasons, and veld is grazed short and exposed to erosion by wind. Very much the same applies to winter or spring burning where there is inadequate soil moisture. Erosion by wind or sheet erosion from a first high intensity fall of spring rain can be very severe indeed.

d) Removal of foggage and, in the process, control of certain veld plants is a reasonable justification for burning. This may be done by burning or mowing or both but, in either case, only after one to two inches of rain has fallen.

e) One cannot generalize about burning, but for naturalized livestock the effort should be to manage carefully during the summer, with adequate resting periods; to rest sour veld but graze sweet veld during the winter period, and to graze in spring after adequate rain, (irrigated planted pasture is not considered here).

3) A group of wild ungulate species comprising browsers, browser/grazers, grazer/browsers and grazers: What is a good forest policy and what may be a sound component of pastoral policy in that a grass species of value to the grazier is encouraged, is not, however, of necessity, good wild life policy. For the grazer, the benefit from a post-burn flush of grass is of a temporary nature (this aside from any long term effect on the vegetation itself). Although certain species of ungulates may show preference for selected young, palatable grass species with high protein flush, a period of stress follows extensive early burning.

It is of significance that, until 1962, the majority of national parks, forest reserves, and other areas where wild life received protection

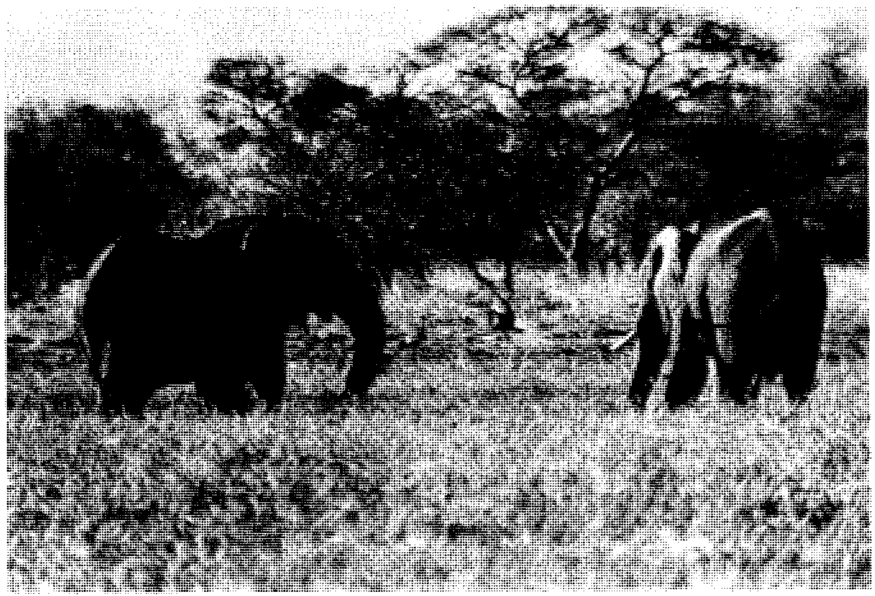

FIG. 8. Zakouma National Park. Tchad Elephant taking grass in seasonally inundated swamp.

in West and West Central Africa, were administered by Government Forest Departments in both the former British and French territories. Where burning was undertaken, the policy was almost entirely one of early burning. This logical forest policy was extended, by forestry personnel, into areas where the timber aspect of land under their jurisdiction was not the principal forest product. The results of this have tended to favour browsing species as against grazers.

Mention must be made here of species such as kob, damaliscus, reedbuck, waterbuck and species showing preference for low-lying areas. Many of these are seasonally inundated and, because of this and impeded drainage, support very few shrubs or trees. Soils are often of heavy texture. Here we find fire-tolerant sour veld that retains sufficient moisture to ensure growth throughout the dry season. Vast areas of this kind of habitat are to be found throughout Africa,

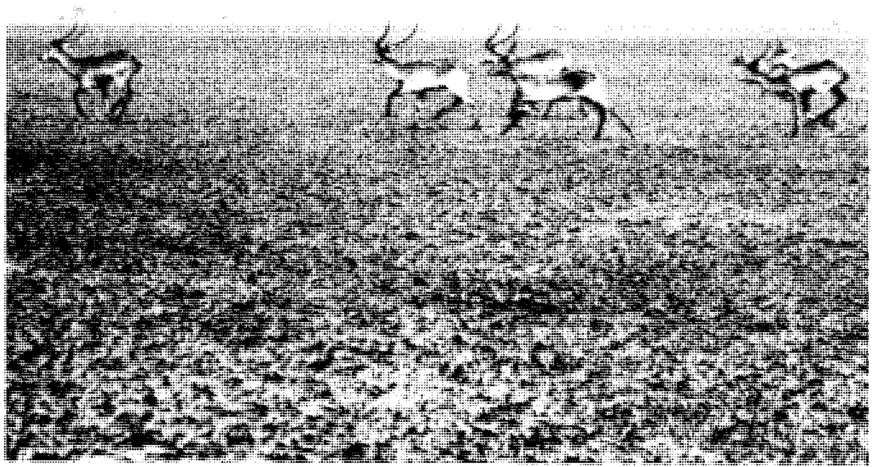

FIG. 9. Kafue Flats, Zambia. Red lechwe on burned riverland verges.

with a general usage pattern of burning early in the dry season; with restricted growth until onset of rains; pasturage par excellence for ungulates; inundation during the rainy season, with little usage. This results, broadly speaking, in a long spell of use (about six months) and a long spell of disuse (about six months). Even before inundation occurs, with heavy soils, the majority of wild and naturalized animals appear to avoid heavy textured soils when these are wet, probably because of difficulty in walking and the "clodding" of the heavy clay on animals' feet (Talbot, 1961; and Talbot and Talbot, 1963a). The high density of species such as kob and damaliscus, predominantly grazers is explained by this particular situation which is favoured by early burning.

The Importance and the Role of Standing Dry Grass During the Dry Season:—Some wild animals suffer severely as the dry season progresses because various species of standing dry grass, that form an essential part of their diet, are unavailable. Whilst certain wild animals can migrate and sometimes obtain their requirements elsewhere,

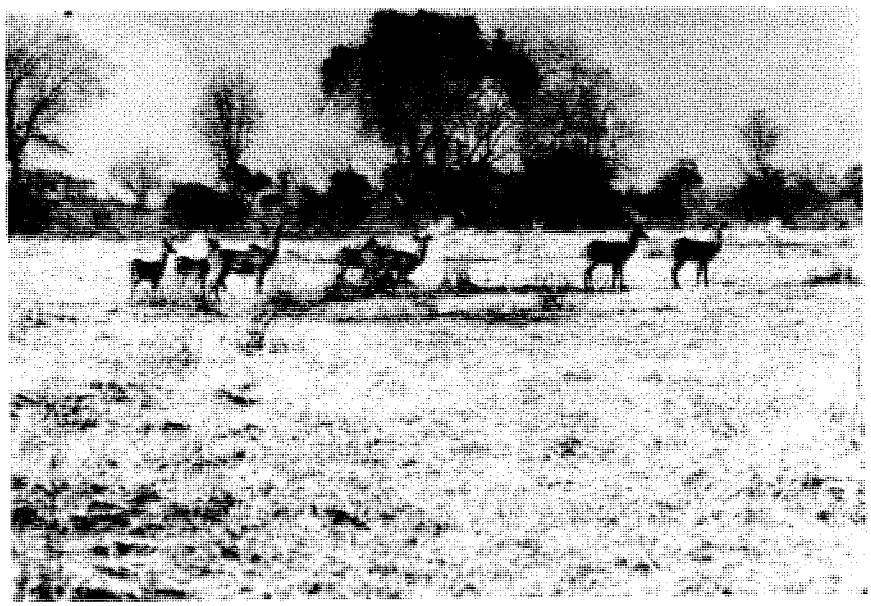

FIG. 10. Luangwa Valley, Zambia. Puku.

others have a restricted home range and they cannot. Such species may be eliminated completely as a result of such a policy.

Some Considerations:—When considering burning policy for national parks, game reserves, and equivalent areas—whether to burn, when to burn, how best to burn, how often to burn—there are two basic policies applicable. Either to attempt to perpetuate the original habitats by following the traditional pattern of firing, under which the local biota evolved, or, by skilful manipulation of burning patterns based on ecological understanding and research, to improve the carrying capacity of the habitat and satisfy the requirements of those species that the habitat can support, thereby directing total energy flow through the best usage channels.

Where the latter policy is decided upon, a number of factors should be borne in mind, amongst which are the following, which are not listed in any order of priority:

1) Tourists pay for the pleasure of seeing animals. Thus, selected,

representative areas of road verge, vlei, and viewing points must be burned in predetermined rotation, as soon as conditions permit.

2) Where funds are available it may well be possible to use a tractor and heavy duty rotary slasher, as an alternative method. Slashing, however, is not necessarily better than burning, for its effect is different.

3) To assist this part of the policy, and where natural water is not available, artificial water points may be provided. Water may be turned on and off to comply with the policy.

4) Many species need access to an adequacy of dry standing grass throughout the dry season. Thus, selected areas will require protection from fire until the end of the dry season.

5) It has been found that for dairy cows, the provision of high protein, palatable, lush pasturage alone depresses butter fat content and that, to give their maximum potential, cows must have yearlong access to good quality hay. In all probability all ruminants react in the same way with a depression of weight increment occurring under the described conditions. Whatever the case may be, it would be wise to manage range and wild life areas to provide both adequate and well-distributed stretches of dry-standing grass, sweet or sour. Such a distribution would certainly have occurred as part of the natural development of vegetation prior to man's interference.

6) Many species need young seedling browse. Early burning annually or possibly every second or even more years will ensure this.

7) Where any faunal area abuts on an area where control of fire is not possible, then a wide enough break must be subjected to constant early burning policy to give the major internal policy a chance to succeed.

8) Whatsoever burning policy is desirable, to achieve optimum ecological response, the garment must be cut according to the cloth. Under the best possible plantation and range conditions of management, with men and machines of the right calibre, runaway fires occur, and where combustible material has accumulated, severe, long term habitat damage may occur similar to that of a large dam wall breach. The damage may indeed be permanent. Plan to do only what management resources will permit.

Phillips (1965) summarized the more significant effects of fire upon biotic communities in the bioclimatic regions, emphasizing that for certain effects such as fire upon animal associates, little was yet known.

In certain parts of Africa we now have national parks, game reserves and other areas incorporating key communities, where flora and fauna are given protection of different kinds. We also have in some cases, approved burning policies which incorporate treatments directed to help the fauna concerned. We have men of different capacities, devoted to their job, and many machines and methods of work. Herein lie unique opportunities for using the patterns that have been outlined and develop these.

To select a specific vegetation community in a national park, and obtain detailed data on the effects of various seasons of burning, together with effects on pasturage, forestry potential and animal associates would be valuable work indeed! So many aspects of veld management can only be studied in our parks and reserves. The potential importance therefore, of these as check areas against which different forms of annual land-usage may be measured, cannot be overemphasized. Where such an approach is adopted, a control treatment would be logical. Thus the setting aside of a representative area within a park from which all forms of management and human interference are withheld as far as possible, should always be given serious consideration.

Fuel Shortage—Causes and Effects:—Excessive naturalized livestock populations used to be controlled in very much the same way as those of wild life, a species increases numerically until a stage is reached when the habitat is overtaxed. A drought year, or a series of drought years, sometimes combined with disease, causes a die-off.

Rinderpest was probably introduced into Africa in the middle of the 19th century with imported cattle. The pandemic which swept the continent began during the Italian campaign in Somalia about 1887 and within 10 years had spread as far as the Cape. That particular outbreak was said to have accounted for more than four million head of cattle in Southern Africa alone. Referring to the heavy mortality in Masailand (the Masai lost the greater portion of their herds), Lord Lugard stated in 1893, that "never before in the memory of man, or by the voice of tradition, have cattle died in such numbers; never before has the wild game suffered." Many wild species were affected, the principal ones being buffalo, eland, wart-hog, giraffe, kudu, roan, and bushbuck; wildebeest also succombed (Simon, 1962).

Although livestock losses continue to occur (about 100,000 head of cattle died in Masailand in 1960) they are now less frequent and severe, due largely to international veterinary control. However, medicines are no substitute for food, and if animal populations are allowed to increase beyond the capacity of the habitat—and they still are on a large scale and over a wide area in Africa south of the Sahara—then large scale losses will recur.

Fortunately, over much of the great wooded savanna, water is only available seasonally, and thus livestock and game are compelled to migrate for months at a time allowing vegetation some respite. The danger here is the establishment of perennial water from boreholes assuring animals of year-long residence. A typical example of many encountered during an FAO/IUCN mission that covered much of Africa south of the Sahara was found in the Ferlo region of Senegal. Since time immemorial, livestock had been compelled to retreat to the vicinity of the Senegal river for the dry season, but borehole pumps installed to transect the region now permit livestock to be resident, with the result that severe habitat degradation has occurred.

Overgrazing, therefore, produces inadequate combustible fuel, unless special treatment be given. Thus, to provide an area with perennial water, may prevent fire from being possible where live-stock control is inadequate.

Fire is the simplest, cheapest, most practicable tool we have at our disposal for manipulating habitat, and it is therefore important that our management permits an adequacy of combustible material to provide the quantity of fire for the control we require.

Traditional Practices:—"One of the errors of commission, it will be remembered, is the ignoring of traditional approaches and methods. To this is added the omission to test fully the possible sub-stitute therefor." (Phillips, 1959).

Although the theme of this note centres around grass foggage, this is a component of the ecosystem to which it belongs and therefore

FIG. 11. Kajiado, Kenya. Severe degradation of habitat around artificial water point.

can only be considered in that light. As is well known, the range of association between woody vegetation and grass is seemingly endless, and accounts to a large extent for the wealth of the associated fauna.

In the long list of forest products, the importance of the rich variety of browse in the diet of fauna, wild and naturalized has been emphasized. Three other aspects of forest and savanna vegetation have a direct bearing on our discussion, and are referred to here:

1) The major leguminous component of vegetation in Africa is the tree. We are still searching for palatable perennial legumes of the clover type that could be seeded and succeed in our managed veld. The role of leguminous trees in refurbishing of soil nitrogen is thus a vital one, particularly for shifting cultivation.

2) The widespread practice of shifting cultivation (clearing land by selective slashing of branches and woody shrubs and scuffling out of grass, growing crops, abandoning land, clearing new land, or re-

clearing abandoned land after a fallow period) is generally dependent upon fire, the mixed material being burned when dry enough. (The merits and demerits of the practice as such are well covered in the literature. (Phillips, 1959, 1961, 1964a, 1965, 1970a)).

The value of trees and shrubs as soil rejuvenators is widely recognized by peasant cultivators. "Clear felling" is very rarely practised; trees are severed 3 to 4 feet from the ground and are thus established for the fallow period.

Although many tree species are highly tolerant of fire and thus can accommodate any burning policy, the needs of the cultivator must be born in mind when formulating burning policy because shifting cultivation has always been, and still is widely suited ecologically and socio-economically, to the simple needs of man and the potentialities of the environment. It bears strong resemblance to nomadism, and, to a lesser extent, transhumance.

3) The physical soil protection ensured by living root systems of trees and shrubs is of paramount importance. According to Phillips (1970a), there is a steady cumulative and frightening deterioration of the ecosystems of Africa, particularly within the sub-arid to desert regions. The threat to man, livestock, wild animals, vegetation, soils and superficial water resources is accelerating as population pressures (of man and his livestock) increase. Unless remedial measures are taken now, by the administrations responsible, the deterioration will be very severe to severe in these regions by A.D. 2000.

In many areas the deterioration has reached a stage of disturbance of the surface soils to a point where restoration of the original vegetative condition is no longer possible and, under the widespread conditions' of mismanagement, this deterioration development curve is steepening.

Serious though the situation is, both in stage and scale, solutions rarely lie in abandoning or destroying traditional practices (Watterson and Hill, 1965). Let all those concerned preserve the best that there is in the ecosystems of the vast fragmentary terrain of Africa, south of the Sahara. Simultaneously, an endeavour must be made to improve these ecosystems through sound management by local administrations and their people, with help, where necessary, from international and other sources (Phillips, 1970a).

FIG. 12. Mandara Mountains, N. Cameroun. Bench terracing done entirely by hand by the Podoko and Matakam peoples.

SUMMARY

Climax grassland is restricted in dimension and location in Africa.

Almost invariably grassland occurs with trees and shrubs in association with some form of forest, woodland, or thicket community. These plant communities range from humid forest to arid wooded savanna conditions and support a wealth of mammal species.

The communities were developed and are being maintained or modified by lightning fire, indigenous (wild) animals, and by man via his use of fire, axe, cultivation and his naturalized livestock.

To emphasize the complexity of these communities reference is made to specific features such as food preferences of the wealth of associated fauna, both wild and naturalized, and to their water requirements, conversion efficiency and feeding range, and to the protein resource these mammals represent.

Examples of some large elephant populations are given to illustrate the adaptability of this species even under restricted circumstances and how it can survive and even thrive under the diverse plant community changes for which it is often largely responsible. Certain it is that the elephant has played a significant role in the basic development of vegetation.

As grass is the principal source of tinder and basic fuel for fire, the importance of ensuring an adequacy of grass for fire, an essential factor in the development and maintenance of biotic communities other than those appertaining to extremes of wetness and dryness, is clear.

The crude protein content of grass rises and falls very quickly. Many mammals require grass at different stages of protein, fibre and digestibility, and indeed are able to utilize grass for their sustenance at these stages. The importance of yearlong grass availability to wild and naturalized ungulates is thus apparent. In this connexion it should be remembered that, under certain circumstances, wild ungulates are over-using vegetation more effectively than cattle and goats.

The need for conservation and management of our ecosystems has always existed but with present population trends it has now become an urgent necessity because of the extent of pollution and of the steady, cumulative, and frightening deterioration of those ecosystems within the drier regions. The threat to man, livestock, wild animals, vegetation, soils, and superficial water supplies by the year 2,000 is large. Unless remedial measures are taken now, the deterioration will be very severe to severe in these drier regions. In the sandy areas, the deterioration may lead to so great a disturbance of the surface soils that restoration of the original vegetative condition will be impossible (Phillips, 1970a).

Bachilele Proverb:—

Iboka Landeng nte:—ka la lokwa hin o
manu
di kela BUH!
ka la lokwa hin o nenge
di kela PKSSH!

A bundle stuck in a tree:—if it falls on
the ground it goes BUMP!
if it falls on the
grass it falls softly!
Thanks for the grass—and the fire that
made it possible!

LITERATURE CITED

Anderson, G. D. & Talbot, L. M. 1965. Soil factors affecting the distribution of the grassland types and their utilization by wild animals on the Serengeti Plains, Tanganyika. J. Ecol. 53:1.

Bolwig, N. 1958. Aspects of animal ecology in the Kalahari. Koedoe no. 1:115–135.

———. 1959. Further observations on the physiological and behavioral characteristics of small animals in the southern Kalahari. Koedoe. no. 2:70–76.

Buechner, H. K., Buss, I. O., Longhurst, W. M., and Brooks, A. C. 1963. Numbers and migration of elephants in the Murchison Falls National Park, Uganda. J. Wildl. Mgmt. 25(27):36–53.

Buss, I. O. 1961. Some observations on food habits and behaviour of the African elephant. J. Wildl. Mgmt. 25:131–148.

Buss, I. O. and Brooks, A. C. 1963. Observations on number mortality and reproduction of elephants in Uganda, Publ., IUCN., New Series, no. 1:117–122.

Chew, R. M. 1961. Water metabolism of desert inhabiting vertebrates. Biol. Rev., 36: 1–31.

Colonial Advisory Council of Agriculture, Animal Health & Forestry. 1957. The indigenous cattle of the British dependent territories in Africa (with material on certain other African countries) H.M.S.O. London.

Conservation of Nature and Natural Resources in Modern African States. 1963. Report of a symposium organized by CCTA and IUCN and held under the auspices of FAO and UNESCO at Arusha, Tanzania. IUCN Morges, Switzerland.

Darling, F. F. 1960. Wild life in an African territory. London: Oxford University Press.

F.A.O., 1963. Production yearbook. Vol. 17.

Glover, J. 1963. The elephant problem at Tsavo. East Africa Wildl. J. 1:30-39.

Glover, P. E. 1970. The Tsavo and the elephants. Oryx. 10, No. 6.

Heady, H. F. 1960. Range management in East Africa. Nairobi: Government Printer. 125 pp.

Hill, P. R. 1966. Whole Management: the conservation challenge posed by areas protected for wildlife. African Wildl. Vol. 20 (1).

Lamprey, H. F. 1963. The survey and assessment of wild animals and their habitat in Tanganyika. Publ. IUCN New Series no. 1. 1:219–222.

Laws, R. M. 1970. The Tsavo research project. Oryx 10, 6.

Livingston, H. G. 1961. Metabolic stress and nitrogen excretion. *In* conference on land management problems in areas containing game: Lake Manyara, Tanganyika. (Mimeo).

Livingston, H. G. Payne, W. J. A., and Friend, M. T. 1962. Urea excretion in ruminants. Nature, (London), 194:1057–1058.

Morrison, F. B. Feeds and Feeding 21st ed. The Morrison Publishing Company Ithaca, New York. 1954.

Payne, W. J. A. 1964. Specific problems of semi-arid environments.
Petrides, G. A. and Swank, W. G. 1958. Management of the big game resource in Uganda, East Africa. Trans. N. Amer. Wildl. Conf., 23:461–477.
Phillips, J. 1959. Agriculture and ecology in Africa. London. Faber. 424 pp.
———. 1961. The development of agriculture and forestry in the tropics: patterns, problems and promise. Faber & Faber, London.
———. 1964. The impact of man on the tropical environment-shifting cultivation. Proc. 9th Tech. Meet., IUCN., Nairobi. Morges Switzerland. Publ. IUCN.
———. 1965. Fire—master and servant; its influence in the bioclimatic regions of Trans-Saharan Africa. Proc. Fire Ecology Conf. Tall Timbers, no. 4, pp. 7–109.
———. 1967. The interrelations among vegetation, land-treatment and wildlife—with emphasis on forest and savanna ecosystems. Typescript.
———. 1970a. Africa South of the Sahara. In, Arid Lands in Transition. America Assoc. Adv. Sci.
———. 1970b. Features in the identification of some commoner physiognomic types to be seen in the south, south-eastern, south-western and central Africa. Typescript.
Pratt, D. J. 1960. A note on the overgrazing of burned grassland by wildlife. East Africa Wildl. J.
Ramsey, J. M. and Rose–Innes, R. 1963. Some quantitative observations on the effects of fire on the guinea savanna vegetation of northern Ghana over a period of eleven years. African Soils, 8 (1): 41–85.
Riney, T. and Hill, P. 1967. Conservation and management of African wildlife: English speaking country reports. FAO ROME.
Schmidt–Nielsen, K. 1959. The physiology of the camel. Sci. Amer, 201 (6): 140–151.
Schmidt–Nielsen, K. 1964. Desert animals. Oxford Clarenden Press, 277 pp.
Simon, N. 1962. Between the sunlight and the thunder–the wildlife of Kenya. Collins, London.
Talbot, L. M. 1961. Preliminary observations on the population dynamics of the wildebeest in Narok District, Kenya. East Africa Agric. For. J., 2:108–116.
———. 1962: Food preferences of some East African wild ungulates. East African Agric. For. J. 2:131–138.
———. 1963a. Comparison of the efficiency of wild animals and domestic livestock in utilization of East African rangelands. Publ. IUCN New Series, no. 1. 328–335.
———. 1963b. The biological productivity of the savanna ecosystem. Proc. 9th Tech. Meet IUCN., Nairobi. Morges, Switzerland. Publ. IUCN New Series (in press).
Talbot, L. M., Ledger, H. P., and Payne, W. J. A. 1962. The possibility of using wild animals for animal production in the semiarid tropics of East Africa VIIIth Int Cong. Anim. Prod. (Hamburg 1961), III (Final Rep.) 205–210.
Watterson, G. G. and Hill, P. R. 1965. Traditional resource conservation practices in Africa. Typescript.