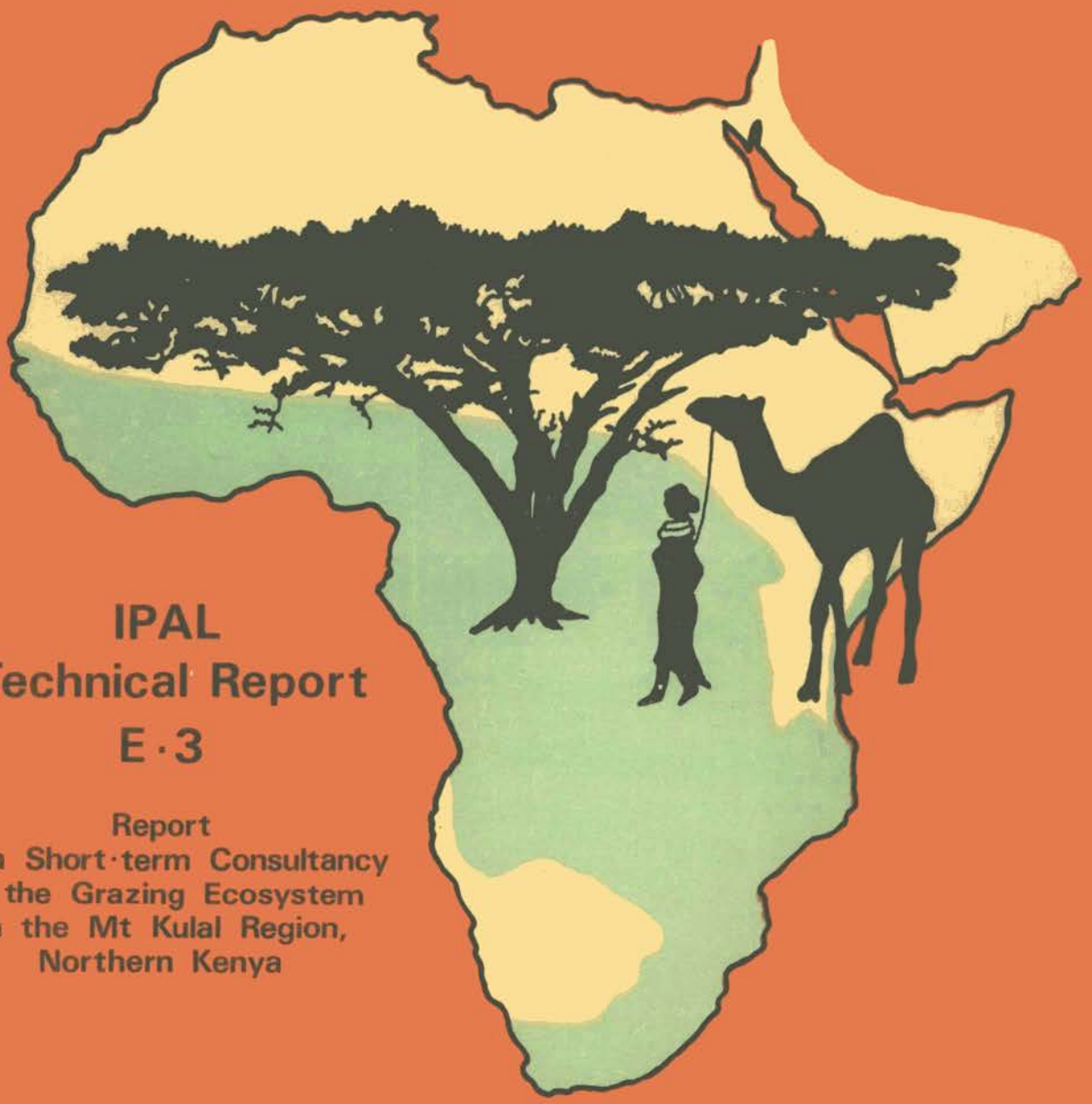
Unesco Programme on Man and the Biosphere (MAB)

United Nations Environment Programme (UNEP)

Integrated Project in Arid Lands (IPAL)



IPAL Technical Report E·3

Report of a Short·term Consultancy on the Grazing Ecosystem in the Mt Kulal Region, Northern Kenya

MAN AND THE BIOSPHERE PROGRAMME

Project 3: Impact of Human Activities and Land Use Practices on Grazing Lands

IPAL Technical Reports Number E - 3

REPORT OF A SHORT-TERM CONSULTANCY ON THE GRAZING ECOSYSTEM IN THE MT KULAL REGION, NORTHERN KENYA

by
Hunting Technical Services
J G Lewis

December 1977

UNEP-MAB Integrated Project in Arid Lands

Summary Introduction to IPAL and the Technical Report Series

The Integrated Project in Arid Lands (IPAL) was established jointly by UNEP and UNESCO in 1976 with the aim of finding direct solutions to the most urgent environmental problems associated with desert encroachment and ecological degradation of arid lands. It forms part of the operations under MAB Project 3, the Secretariat of which is jointly held by UNESCO and FAO, and also those of UNEP's Desertification Unit, established in response to the plan of Action adopted by the United Nations Conference on Desertification. It is an example of the type of pilot activity that UNEP and UNESCO, together with other ogrganisations and a number of governments, are trying to promote to provide the scientific base for the rehabilitation and rational development of arid and semi-arid zone ecosystems, ecosystems, through integrated programmes of research (including survey, observation and experimentation), training and demonstration.

During the early operational work of IPAL, a co-ordination unit was established in Nairobi and the initial field-work started in the arid zone of northern Kenya, where a field station has been constructed on the lower slopes of Mount Kulal and a working area demarcated between Lake Turkana and Marsabit Mountain. Work was started on several aspects of the ecology and experimental management, centred upon the interaction of pastoralists and their livestock with the soils and vegetation of the environment.

During the next two or three years (1979 - 1982), the investigations in progress will be extended and intensified. Initially, new activities within the IPAL project will be started in Tunisia, to be followed by other areas in the arid zones of Africa and the Near and Middle East.

This report is one of a series published by IPAL describing technical findings of the project and, where appropriate, giving management recommendations relating to the central problems of ecological and sociological degradation in the arid zone. The reports are divided into the following categories distinguished by the base colours of their covers:

A. general, introductory and historical: white.

B. climate and hydrology: blue.

C. geology, geomorphology and soils: brown.

D. vegetation: green.

E. livestock and other animal life: red.

F. social and anthropoligical: yellow.

PAGE NO.

TABLES

FIGURES

Summary

The results of a three month study of the grazing ecosystem are presented in this report.

In general the quality of the vegetation of the field layer is poor, but it is better in the highland areas than in the lowlands. This poor quality can be attributed to low rainfall, poor soils and locally heavy utilisation. Most of the rangeland is still capable of recovery if there is sufficient rain.

The productivity of the field layer is low and is considerably less than generally accepted estimates for production in arid areas.

Cattle are by far the most important grazing herbivore though the numbers of animals present vary during different seasons. Cattle concentrate around the highland areas, but they also make some use of the lowlands. Pastoralists living in the highlands use cattle for subsistence. Those living in the lowlands use cattle for investment purposes.

The ALP study area does not represent a self-contained grazing ecosystem and there is much movement of animals in and out of the area.

Much of the area is unsuitable for cattle production and long term management should be based on reducing the importance of these animals in the pastoral economy. Until this can be achieved it will be necessary to improve the marketing of cattle, which could be done with some success with government assistance.

Results from studies elsewhere in Kenya show that the domestication of oryx could increase the productivity of the grazing ecosystem.

Further long term study is required to describe in detail the ecology of the grazing ecosystem of the study area.

1. Introduction

1.1 UNESCO/UNEP ARID LANDS PROJECT (ALP) MT. KULAL

The field station at Mt. Kulal is the first of a proposed series of stations throughout the Sahelian Zone. These stations form part of the UNEP–MAB Integrated Project in Arid Lands (IPAL).

The objectives of the Project, which are given in detail in UNEP (1977), are basically to identify and describe the causes of ecological degredation and desert encroachment in the arid zone and to investigate and demonstrate suitable rehabilitation management procedures.

The Mt. Kulal field station, which formed part of Phase II of IPAL, was established in February, 1976. The present staffing of the station is:–

- 1 Senior Ecologist (studying browsing herbivores) – UNESCO
- 1 Woodland Ecologist – UNESCO
- 1 Administrator – UNESCO
- 1 Small Stock Ecologist – ODM

Proposals have also been submitted for funds for long–term studies on grazing ecosystems, ground layer vegetation, pastoralism and traditional livestock management. A number of short–term consultancies are also planned to cover the fields of meteorology, animal health, soils, remote sensing and other topics. Details of the results of the first year's work of the project are given in UNESCO (1977 b).

1.2 AIMS OF THE SHORT–TERM CONSULTANCY ON GRAZING ECOSYSTEMS

The aims of the short–term consultancy, as defined by the terms of reference, were:–

1. To assess the relative importance of the various components of the grazing ecosystem in the project area (e.g. grass/herb layer distribution and productivity, cattle numbers and distribution and wild grazing herbivores).

2. To assess the productivity of domestic grazing herbivores and the grass/herb layer. This shall include a review of local animal husbandry practices, grazing patterns, the importance of disease and the relationships between vegetation productivity and soil, land form and climate.

3. To determine the requirements of the people for the products of cattle and other grazing herbivores.

4. To investigate the present livestock marketing systems in the area and assess the potential for future development.

5. To integrate the findings of the survey with those of other studies in the project area with a view to establishing long term management procedures.

In view of the short-term nature of the consultancy it was not possible to collect extensive detailed ecological data. The study therefore took the form of a reconnaissance of the grazing ecosystem and was designed to analyse information which was already available and to identify areas which required more detailed collection of data. The intention of the study was to evaluate the relative importance of the grazing ecosystem and to determine any requirements for future studies.

Although technically a study of grazing ecosystems should confine itself to grass and grass consumers, the ecology of the study area is such that many of the traditional grass-consumers make considerable use of non-graminaceous plants. It has therefore been necessary to consider the total grass/herb layer of the vegetation and its relationship to the larger grazing herbivores. In this report the term field-layer will be used to describe the grass/herb complex which grows below the dwarf shrubs and trees, and which was the centre of the study.

1.3 METHODS OF STUDY

A number of different methods were used during the study, which took place during April, May and June 1977.

1.3.1 Review of the Literature

When compared with many other pastoral areas of East Africa there is little information available in the Literature on the ecology of the study area. The majority of the work done in the past has been by social anthropologists and human biologists. Such work, however, supplied valuable information on the management and husbandry of pastoral stock.

1.3.2 Discussion with Local People and Government Officials

Informal discussions were held with pastoralists from the different ethnic groups in the study area, with chiefs and councillors and with government officials at Marsabit and Nairobi.

1.3.3 Questionnaire

A questionnaire form (Appendix 1) was used to obtain information from pastoralists on the numbers, herd composition, mortality, production and management of their livestock.

There are a number of problems associated with the use of data collected in this manner. Many people are unwilling to reveal how many animals they own; as one chief pointed out, the method is the equivalent of a stranger demanding to know a person's income and the state of his bank balance. On a number of occasions deliberately misleading answers were given. This was especially true for information on mortality, where impossibly high figures were given. This was possibly done in the hope of obtaining some form of compensation. On the whole, however, the local people were extremely co-operative and this can be attributed to a large extent to the public relations work that has been done in the area by ALP personnel.

1.3.4 Direct Observation

A collection of almost 300 specimens of grasses and herbs was made during the study, one set of specimens was left at the field station at Mt. Kulal, the other was sent to the East African Herbarium at Nairobi for identification. This has not yet been completed.

A number of vegetation transects were made to describe characteristics of the vegetation of the field layer.

Herds of pastoralist livestock and wild grazing herbivores were counted and wherever possible information on age and sex composition was collected.

1.3.5 ALP Data

Considerable use was made of information already collected by ALP personnel. Much of this information is at present unpublished and acknowledgement is made wherever these data have been used in this report.

2. The Study Area

2.1 LOCATION

The study area, which covers approximately 20,000 km^2, is located in the west of Marsabit District in the Eastern Province of Kenya. It lies between 1°50′ and 3°30′ N and 36°10′ and 38°00′ E. To the west lies the eastern shore of Lake Turkana, while to the east is the Nairobi–Moyale road. The location and base map of the study area is shown in Figures 2.1 and 2.2.

Access from Nairobi is obtained either from the main Nairobi–Moyale road, or from Maralal along the road to Loiengalani passing through Baragoi and South Horr.

2.2 LAND FORM AND SOILS

The bulk of the study area is made up of a large central plain which is less than 700 m a.s.l. Around this central plain lie a number of volcanic hill masses; the Hurri Hills (1,310 m) to the north, Mt. Marsabit (1,836 m) to the east, Mt. Kulal (2,295 m) to the west. Mt. Nyiru and Ol Donyo Mara (over 2,000 m) to the south west are partly formed from basement material. To the west of Mt. Kulal lies Lake Turkana.

The main drainage lines originate in the hill masses and are mostly in the form of seasonal sand rivers which dry out in the open plains. Most of the land in the study area drains into the Chalbi Desert in the north of the area.

There are four major 'desert' plains; the Chalbi, the Koroli, the Hedad and the Kaisut.

The soils are derived either from the Precambrian Basement rocks or from more recent volcanic activity. It is estimated that the soils are roughly equally divided between these two parent types. The basaltic lavas from volcanic activity are found around the volcanic hills, while sedimentary deposits are found in the plains. The soils in the north of the Chalbi desert are saline and this area marks the site of a former lake.

Soil and geomorphological maps of the study area are currently being prepared by Dr. P.M. Sinda at Gatab.

2.3 CLIMATE

Due to the wide range of altitudes there is considerable variation in climate. Following the classification of ecological zones of Pratt et al. (1966) the highland areas are represented by Zone II (sub-humid). As the altitude decreases the zones change to IV (semi-arid), V (arid) and VI (very arid). The majority of the area falls within Zones V and VI.

Until the establishment of the Arid Lands Project at Mt. Kulal in 1976 the cover of rain gauges was very poor. Apart from the highland masses, the rainfall is low and erratic. Table 2.1 summarises data

Figure 2.1
Location of study area

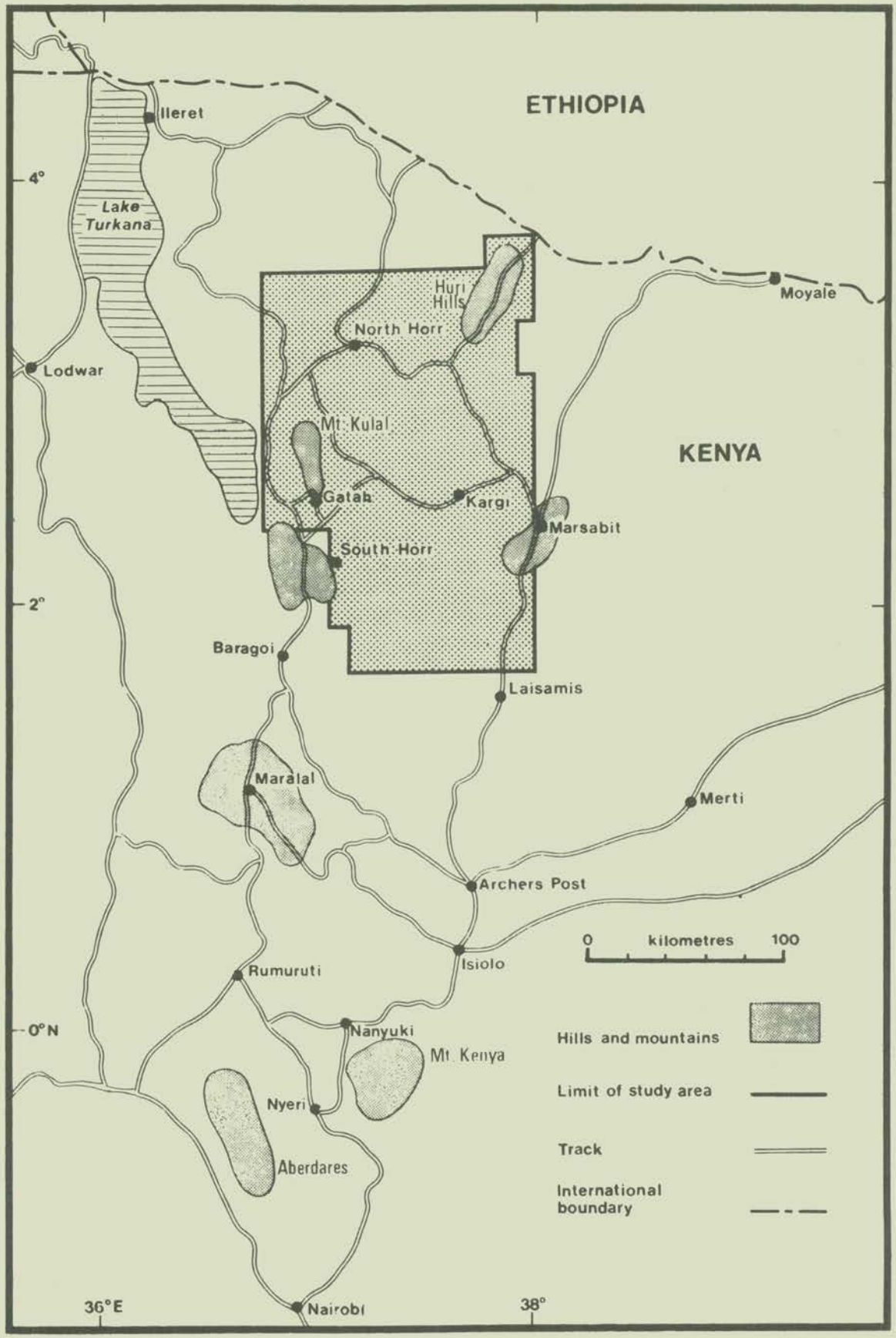
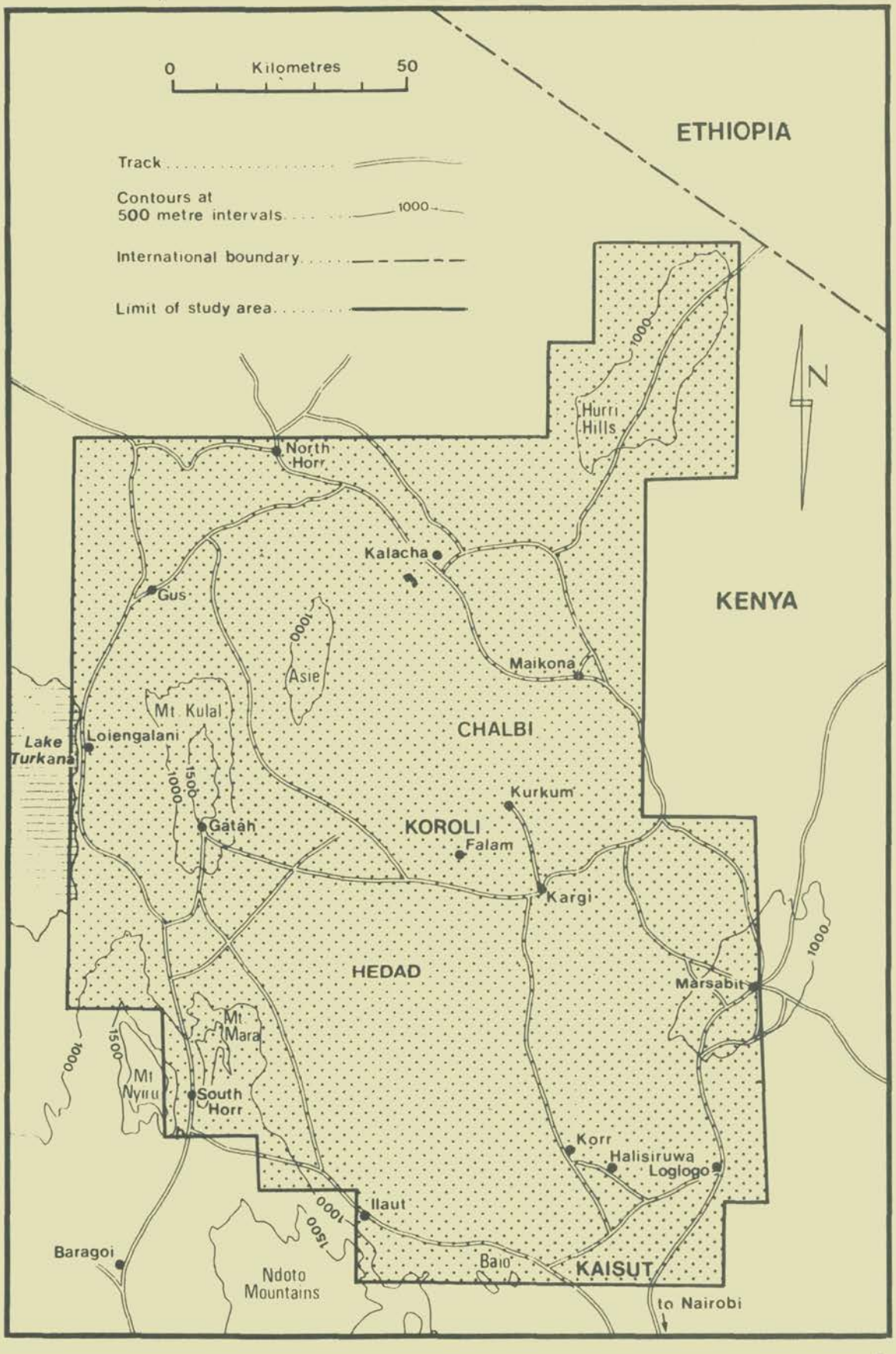


Figure 2.2
The study area



for one highland area, Gatab, (Mt. Kulal), and for three lowland areas, North Horr, Loiengalani and Maikona. The data for Loiengalani and Maikona are very limited.

Table 2.1 Summary of Rainfall Data in the Study Area – Mean Monthly Rainfall (mm)

Month	Station			
	Gatab[1]	North Horr[2]	Loiengalani[3]	Maikona[4]
January	36.7	10.5	0.0	5.9
February	39.7	6.0	3.2	0.0
March	40.3	23.1	1.7	68.7
April	125.3	34.3	23.4	34.0
May	88.3	11.2	14.8	4.6
June	13.5	0.2	0.0	0.0
July	11.8	3.4	9.6	1.5
August	2.2	4.5	0.9	0.0
September	2.7	0.1	0.0	0.0
October	58.0	12.3	0.0	0.0
November	151.5	38.0	2.4	0.0
December	27.0	28.7	0.0	0.0
Total	**597.0**	**172.3**	**56.0**	**114.7**

[1] 1967–77; [2] 1959–72; [3] 1974, 1975, part 1976; [4] 1974, 1975.

In general the main rainfall occurs in two seasons; March to May, during the S.E. monsoon, and October to December, during the N.E. monsoon. The rainfall in the lowland areas is highly variable and has been calculated to have a coefficient of variation of greater than 50 per cent (FAO, 1971). The rainfall during the first month of the present study (April, 1977) was exceptionally high and 437 mm were recorded at Gatab during this month.

Abnormally high rainfall occurred throughout the study area and produced good growth in the field layer. The study of grazing-ecosystems was therefore undertaken during a period of exceptionally favourable conditions for growth. Wherever possible allowance has been made for these atypical conditions when assessing the quality and productivity of the rangelands.

The potential evaporation is high and has been estimated at 2,620 mm p.a. (FAO, 1971). Table 2.2 shows a breakdown of the estimated monthly potential evaporation.

2.4 VEGETATION

A detailed description and map of the vegetation of the study area are currently being prepared by Dr. D. Herlocker, the UNESCO Woodland Ecologist, at Gatab. Information collected by Dr. Herlocker has been used in the following brief description of the vegetation area.

There is a marked relationship between vegetation type and altitude. The highland areas are characterised by upland evergreen forest in which *Juniperus* and *Olea* are the dominant tree genera. There is no *Juniperus* on Marsabit. The lower limit of the forest is approximately 2,000 metres a.s.l. Below the forest there is evergreen and semi-deciduous bushland, though there are also areas of upland perennial grass land. The important perennial grasses include *Themuda triandra, Panicum maximum, Cenchrus ciliaris, Chloris gayana, Digitaria spp., Hyparrhenia hirta, Pennisetum spp.* and *Eragrostis cilianensis*, which behaves as either a perennial or an annual, and is an important pioneer species in overgrazed areas. After heavy rains, such as those experienced during April, sedges of the genera *Cyperus* and *Mariscus* are also common in the field layer.

Table 2.2 Estimated Monthly Potential Evaporation (mm)

Month	Potential Evaporation
January	225 mm
February	220
March	235
April	205
May	220
June	210
July	210
August	215
September	225
October	230
November	210
December	215
Total	**2,620**

Source: FAO, 1971.

Lower down, approximately below the 1,000 m contour, bushland and dwarf shrubland are the major vegetation types. The bushland, which is found mainly on the sandy soils, are dominated by a canopy of *Acacia reficiens* with *Duesperma eremophilum* growing underneath. The dwarf shrubland is dominated by *Blepharis sp.*, which is mainly found on lava, and *Indigofera spinosa*, which occurs principally on sandy soils. Along drainage channels and on the old lake beds to the north of the Chalbi there is *Acacia tortilis* woodland.

At these lower altitudes grasses become very much less frequent. The relative proportion of annual grasses increases and for much of the year there is virtually no grass cover at all. *Aristida spp.* (especially *A. adscensionis*), *Chrysopogon aucheri*, *Cenchrus ciliaris*, *Leptothrium senegalensis*, *Dactyloctenium aegyptium*, *Sporobolus spp.*, *Tetrapogon spathaceus* and *Enneapogon spp.* are found. After the heavy rains of April there was a good germination of annuals, with *Aristida spp.* being particularly prominent, and good growth of perennials.

Sporobolus spicatus is a locally important perennial grass of certain lowland areas and is found along the shores of Lake Turkana and around the edge of the Chalbi Desert.

Further discussion of characteristics of the field layer is given in Chapter 3.

2.5 HUMAN POPULATION

The results of the 1969 National Census (Republic of Kenya, 1970) indicated that there was a population density in Marsabit District of approximately one person per km^2. This density is very much lower than the national average of 19 people per km^2. The survey also showed that 44 per cent of the population was under 16 years old.

The main ethnic groups in the study area are Rendille, Gabra, Boran and Samburu. Other groups such as Somali, El Molo and Turkana also use the area.

The Gabra and Boran are Galla people who originated in Southern Ethiopia, and the Boran still maintain links with that country. Anthropological studies of the Gabra and Boran have been made by Torry (1973) and Baxter (1954). Although coming from different ethnic sources the Rendille and Samburu have a number of affinities, which have been analysed by Spencer (1973). One group of Rendille, the

Ariaal, can almost be considered as intermediate between the two tribes. The Samburu have been studied by Spencer (1965) and a number of studies on the Rendille and Ariaal are at present under way (e.g. Grumm, 1977; Fratkin, 1977a, b). Although the mobility of all these groups is very high the Boran and Gabra tend to use the north and central parts of the study area, the Rendille the southern and western sections and the Samburu Mt. Kulal and the area south towards the South Horr Valley.

The Gabra and Rendille are basically camel keepers, though they also have cattle and small stock, while the Boran and Samburu are basically cattle keepers.

The areas used by each group are chosen for the location of suitable vegetation for each type of stock, as well as for water and security considerations.

2.6 GRAZING LIVESTOCK

The cattle are mainly humped zebu animals (*Bos indicus*) of the Northern Frontier District Boran type (Mason and Maule, 1960). There are, however, a number of small humped long horn cattle of the Humpless and Humped type described by Payne (1970). These animals are well adapted to utilise certain parts of the study area. A useful generalised summary of the adaptations of indigenous zebu cattle is given by Siefert (1975). The adaptations are given as:-

1. A high tolerance to heat and a relatively low consumption of water.
2. A capability to digest diets with a high content of crude fibre and low protein.
3. Tough muscle texture surrounded by relatively thick fasciae and little tendency to produce fat.
4. Low milk yield.
5. Good, but often unutilised, capability to produce meat.
6. Capability to travel long distances.
7. Seasonal oestrus and resistance to milking.
8. Resistance to some diseases, though susceptibility to other diseases.

The donkeys are typical to those used throughout East Africa.

2.7 WILDLIFE

The main species of wild grazing herbivores in the study area are Beisa Oryx (*Oryx beisa beisa*) and Grevy's zebra (*Equus grevyi*). Other wild herbivores include Dik Dik (*Rhynchotragus guentheri*) Gerenuk (*Litocranius walleri*), Grant's gazelle (*Gazella granti*), Reticulated giraffe (*Giraffa camelopardalis reticulata*), Rhinoceros (*Diceros bicornis*) and Elephant (*Loxodonta africana*). Lion (*Panthera Leo*), Leopard (*Panthera pardus*) and Cheetah (*Acinonyx jubatus*) also occur.

The numbers and ecology of oryx and zebra are discussed later in this report.

2.8 LAND TENURE

The majority of the land in the study area is County Council Trust Land. The exceptions to this are the County Council Forest Reserve at Mt. Kulal, National Forest Reserve at Marsabit and Ol Donyo Nyiru, and the Game Reserve at Marsabit.

3. The Vegetation of the Grazing Ecosystem

3.1 INTRODUCTION

In this chapter some quantitative and qualitative information on the field layer will be presented, and the vegetative resource of the grazing ecosystem discussed.

3.2 CHARACTERISTICS OF THE FIELD LAYER

3.2.1 Maintenance of Grass Lands

The dominant species of the field layer have been mentioned in the previous chapter.

Open grass lands cannot generally be considered to form a natural climax vegetation type in the study area. In the highland areas, where perennial grass lands are found, the grass lands are maintained by fire. If left unburnt for a sufficiently long time these grass lands would revert to upland evergreen forest or bushland. The fires are deliberately started by the pastoralists, not only to maintain the open grass lands, but also to kill ticks, encourage new growth and remove any dead and fibrous grass left from previous growing seasons. The need to remove dead and fibrous grass, however, is unlikely to occur very frequently due to the high stocking rates and vegetation offtake in the highland areas. For the same reason the use of fire as a method of controlling bush encroachment will become increasingly difficult as stocking rates and vegetation offtake increase. As the offtake increases so the grass standing crop will decrease and there will be less fuel for the fires. This situation is occurring around Gatab, on Mt. Kulal, where permanent water and health and education facilities have encouraged settlement. Although the high stocking rate in the vicinity of Gatab means that the standing crop of the field layer never gets to the stage where it could support a fire, there is no sign of bush encroachment. In this situation it is likely that the effect of heavy browsing by small stock is sufficient to prevent bush regeneration. Unpublished results of feeding observations on small stock by Mrs. Field at Gatab indicate that the diets of sheep and goats contain sufficient amounts of woody plants to prevent encroachment. One consequence of this method of bush control is that it tends to lead to the spread of unpalatable weeds. This can be seen further down the mountain from Gatab, where there are virtually pure stands of the unpalatable herb *Heliotropium spp.* covering large areas.

There is one exception to the point of perennial grass lands not being a natural climax type in the study area; this is in the case of *Sporobolus spicatus*. Although stands of *S. spicatus* do not cover very extensive areas, they do form small natural perennial grassed areas where they occur. The reason for this is probably the plant's ability to withstand high levels of salinity and alkalinity, (Edwards and Bogdan, 1951). The distribution of the plant, around the edge of the saline Chalbi desert and on the shores of the alkaline Lake Turkana, supports this suggestion.

3.2.2 Cover

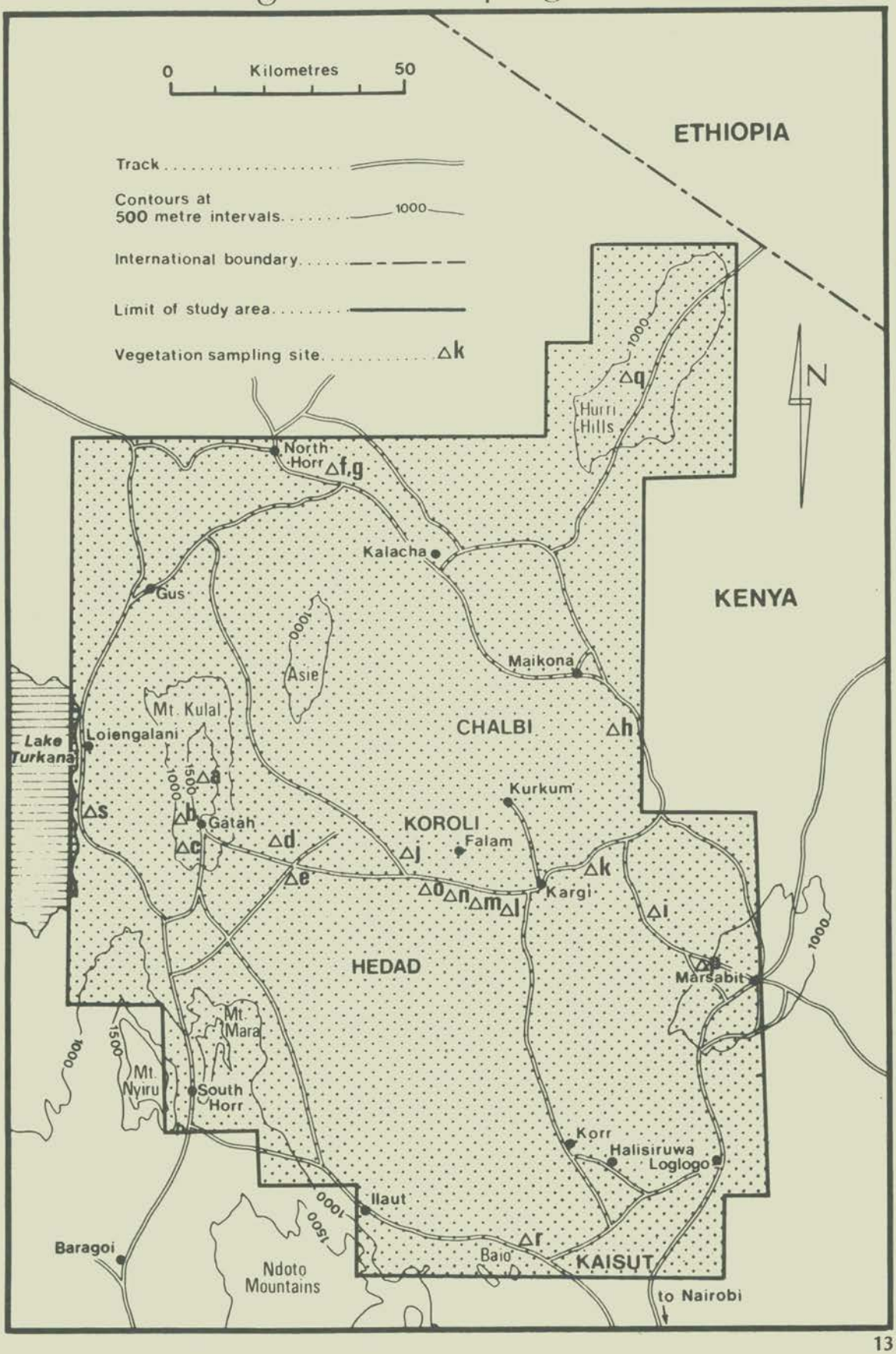
The results of transects to measure the foliar and ground cover are shown in Table 3.1. The approximate location of each site is shown in Figure 3.1. It should be remembered that due to abnormally

Table 3.1 Cover of Field Layer

Site [1]	[2]	Percentage Cover: Annual Grass	Perennial Grass	Total Grass	Woody Herb	Non-woody Herb	Total Herb	Other	Total Cover
A	f	2	39	41	1	16	17	2	60
	g	1	11	12	0	5	5	4	21
B	f	12	8	20	2	5	7	4	31
	g	8	6	14	0	3	3	3	20
C[3]	f	0/4	10/13	10/17	18/7	2/1	20/8	0/0	30/25
	g	0/1	4/6	4/7	2/2	1/2	3/4	0/0	7/11
D	f	1	0	1	9	8	17	1	19
	g	0	0	0	1	3	4	0	4
E	f	2	0	2	17	3	20	0	22
	g	1	0	1	4	0	4	0	5
F	f	1	2	3	22	2	24	0	27
	g	3	0	3	3	0	3	0	6
G	f	1	0	1	2	1	3	2	6
	g	0	0	0	0	1	1	3	4
H	f	33	0	33	0	4	4	0	37
	g	10	0	10	0	4	4	0	14
I	f	18	0	18	1	2	3	0	21
	g	8	0	8	1	0	1	0	9
J	f	44	6	50	2	3	5	0	55
	g	12	3	15	2	2	4	0	19
K	f	1	1	2	7	13	20	0	22
	g	0	0	0	3	4	7	0	7
L[4]	f	0	1	1	2	0	2	0	3
	g	0	1	1	1	0	1	0	2
M[4]	f	0	4	4	0	6	6	0	10*
	g	0	2	2	0	1	1	0	3
N[4]	f	0	2	2	20	7	27	0	29
	g	0	0	0	2	2	4	0	4
O[4]	f	5	5	10	8	17	25	0	35
	g	3	1	4	2	1	3	0	7
P	f	14	10	24	6	10	16	0	40
	g	4	9	13	0	5	5	0	18
Q	f	2	52	54	3	25	28	0	82
	g	0	22	22	0	8	8	0	30
R	f	3	1	4	8	6	14	0	18
	g	1	1	2	1	1	2	0	4
S	f	1	0	1	0	2	2	0	3
	g	0	0	0	0	1	1	0	1

[1] The Location of each site shown in Figure 3.1.
[2] f = foliar cover, g = ground cover.
[3] For site C (Luai) first figure for cover inside exclosure, second for cover outside.
[4] Sites L, M, N, O are 1, 2, 4 and 6 km west of Kargi.

Figure 3.1
Location of vegetation sampling sites



high rainfall these figures represent data for an exceptionally good wet season. Many parts of the area which, during the study, had good levels of cover are reported to be virtually bare during most years.

The selection of sites was not random. Areas were chosen which were either supporting grazing herbivores at the time of the study, or which appeared to have the potential for supporting grazing animals. Areas such as the Chalbi Desert, which is completely void of vegetation, were not included.

It can be seen from Table 3.1 that the total cover and composition of the field layer was highly variable. Total foliar cover varied from 3 to 82 per cent and total ground cover varied from 1 to 30 per cent; the mean foliar cover was 28.7 (±19.62) per cent and mean ground cover 9.8 (±7.91) per cent.

The cover in the highland areas was better than that in the lowland areas. Table 3.2 compares foliar and ground cover from five sites above and fourteen sites below the 1,000 metre contour. Mean foliar cover above 1,000 metres was 2.2 times greater than that below, and mean ground cover 3 times greater.

Depending on the area, herbs contributed between 9 and 93 per cent of the total foliar cover. On average herbs formed 55.0 (±29.26) of the field layer cover at the foliar level, of which 28.3 (±18.74) was made up of woody herbs. Grass contributed between 7 and 91 per cent of the total foliar cover, with a mean of 41.9 (±29.45) per cent, of which 19.7 (±21.57) per cent was made up of perennial grass. These figures show that less than half (43.5 per cent) of the total available foliar cover of the field layer was made up of perennial vegetation, the remainder being mainly ephemeral herbs and annual grasses.

Table 3.2 Difference in Total Cover Between Sites – Above and Below 1,000 m a.s.l. Contour

	Above 1,000 m		Below 1,000 m	
	Foliar	Ground	Foliar	Ground
No of Sites	5	5	14	14
Mean % cover	48.6	19.2	21.9	6.4
± SD	22.22	8.22	14.42	4.88
Coefficient of variation (%)	45.7	42.8	65.8	76.2

3.2.3 Inflorescence Production

Few of the lowland grasses are able to spread by the use of stolons, though *Sporobolus spicatus* spreads by rooting runners. The production of seeds is therefore important in the maintenance and regeneration of grass areas. An indication of the level of grass seed production was obtained by measuring inflorescence densities. Table 3.3 shows inflorescence densities for 10 sites.

Inflorescence densities varied from between 1.2 per m^2 to 971 per m^2. Although the variation between sites was large, the variation within sites was also large and all apart from three had coefficients of variation ($\frac{SD}{mean} \times 100$) which were greater than 100 per cent. The mean density of the ten sites was 131.5 (± 299.00) per m^2.

Many factors, such as utilisation, rainfall and soil, determine the level of inflorescence production. The mean figure obtained for the study area was similar to that obtained for inflorescence densities in Northern Ethiopia (129 per m^2; HTS 1976), an area of high average rainfall and heavier use. The effect of use on inflorescence production is discussed in the following section.

It is expected that, due to the abnormally high rainfall, the level of inflorescence production measured during the study was exceptionally high. Many areas, which were reported to have been

absolutely bare for the past eight years, were bearing a high density of inflorescences, mainly the annual *Aristida spp.* This indicated that these seeds can remain in the ground and viable for at least this length of time.

Table 3.3 Inflorescence Densities

Area	Density per m^2	± SD	Coefficient of variation %
South west slopes of Mt. Kulal	106.8	55.56	52.02
Lake Turkana shore	1.2	1.67	139.17
Balessa Kulal	30.3	40.06	132.21
Hedad, near Falam	971.2	220.34	22.69
1 km west of Kargi	2.4	5.38	224.17
2 km west of Kargi	7.2	8.32	115.56
4 km west of Kargi	20.0	23.58	117.90
6 km west of Kargi	144.4	112.60	77.98
4 km east of Kargi	5.2	9.48	182.31
Baio	26.2	35.91	137.06

3.2.4 Usage

The effect of usage of the vegetation of the field layer was investigated by measuring plant cover and grass inflorescence densities at increasing distances from Kargi, a permanent settlement which for many years has held a large number of stock. These parameters were measured at intervals of 1 km, 2 km, 4 km and 6 km west of Kargi; the results obtained are shown in Figure 3.2.

Inflorescence densities were low (20 per m^2 or less) until six kilometres from Kargi. They then increased to a value which was similar to the overall mean for the study area.

Ground cover, although slightly increasing with the distance from Kargi, was low and only slightly greater than the overall mean for the study area 6 km away from the settlement. Foliar cover increased more rapidly than ground cover and was above average four kilometres from Kargi.

During the period of study very few of the animals from Kargi were using the area to the west of the settlement; instead they were tending to use a laga to the east and an area to the south. The distance effect shown in Figure 3.2 was therefore mostly a result of previous years usage and the effect this had had on production since the heavy rain of April and May. Although the rain gauge at Falam, to the west of Kargi, recorded approximately 50 mm more rain than the one at Kargi during the period from March to May (C.R. Field, pers. comm.), it is unlikely that any rainfall gradient could account for these differences during a year of such ubiquitously heavy rainfall.

3.2.5 Period of Growth

Although no direct measurement was made, the period of growth of most species in the field layer was very short. By mid-May most of the rain had finished and the growth of plants was well under way. However, by the middle of June most plants had stopped active growth and the vegetation of the field layer was already starting to dry out. Rapid and vigorous growth as a result of rainfall is a well known characteristic of many plants which are adapted to arid environments. The speed with which the plants stopped growing and started to dry out, however, is thought to be a function of the high permeability of the sand and lava soils which predominate the study area and the high wind speeds coupled with high temperature.

3.2.6 The Effect of Shade

The effect of shade on the germination and subsequent growth of grass was very marked during the period of study. In many places with very little grass cover in open areas there would be good grass cover under bushes and trees. To a certain extent this may have been due to the protection from grazing given to grass growing under low, spiny trees such as *Acacia mellifera* and *Acacia reficiens*. The phenomenon was also observed under large, mature trees, such as *Acacia tortilis*, which offer no physical protection. It is therefore thought that the improved cover was primarily a result of the shade, and the consequent reduction in insolation and temperature.

This fact has been observed by Bille (1971) who has recorded increases in herbaceous production in shaded areas of the order of two and a half times that in unshaded areas.

3.3 PRODUCTION

3.3.1 Dry Matter Production

Long term measurements of primary production of both the field layer and browse plants are being undertaken by Dr. D. Herlocker of ALP. These measurements will form an essential part of the study of the ecology of the area. Until data from these studies are available it will be necessary to use information from the literature for estimates of primary productivity in the field layer.

Although primary production depends on many factors it is generally accepted that rainfall is the most important one. There is, however, a notable exception to this generalisation within the study area; the Chalbi Desert. This area produces no vegetation at all, although it receives water, not only from rain but also as the drainage basin for the entire study area. During the period of study there were large areas of standing water in the middle of the desert. The lack of productivity in this case is due to high soil salinity rather than low rainfall.

Generalised estimates for the relationships between rainfall and primary production have been given by Le Houérou and Hoste (no date) and Le Houérou (1972). The latter reference applies to North Africa, but is considered to be of relevance to the ALP study area. The relationships between mean annual rainfall and dry matter (DM) productions are shown in Figure 3.3.

Using the rainfall data given in Table 2.1 and the regression given by Le Houérou and Hoste (no date), it is estimated that primary production of the field layer in the lowland areas would generally be between 150 and 250 kg DM/ha/year. The condition of the rangeland probably lies between fair to mediocre and therefore the Le Houérou (1972) lines give lower estimates 50 to 100 kg DM/ha/year.

The rainfall in the highland areas is higher than in the lowlands. Using the Le Houérou and Hoste (no date) regression of $y = 42.17 + 1.03 x$ it is estimated that the average annual primary production would be approximately 660 kg DM/ha/year at Gatab.

It is readily acknowledged that these estimates of primary production are prone to many errors. As data from the direct measurement of primary production become available the validity of these estimates can be examined.

The ALP study area is subject to low and erratic rainfall and there is considerable variation between years, seasons and areas. Despite such variations an attempt has been made to estimate gross primary productivity during poor, normal and good years (Table 3.4). In this table the total study area has been broken down into 3 parts; Highland area, over 1,000 metres, the Chalbi desert and Lowland areas.

It should be remembered that during exceptionally bad years there will be virtually no rain at all and therefore no primary production.

Figure 3.2
Effect of use

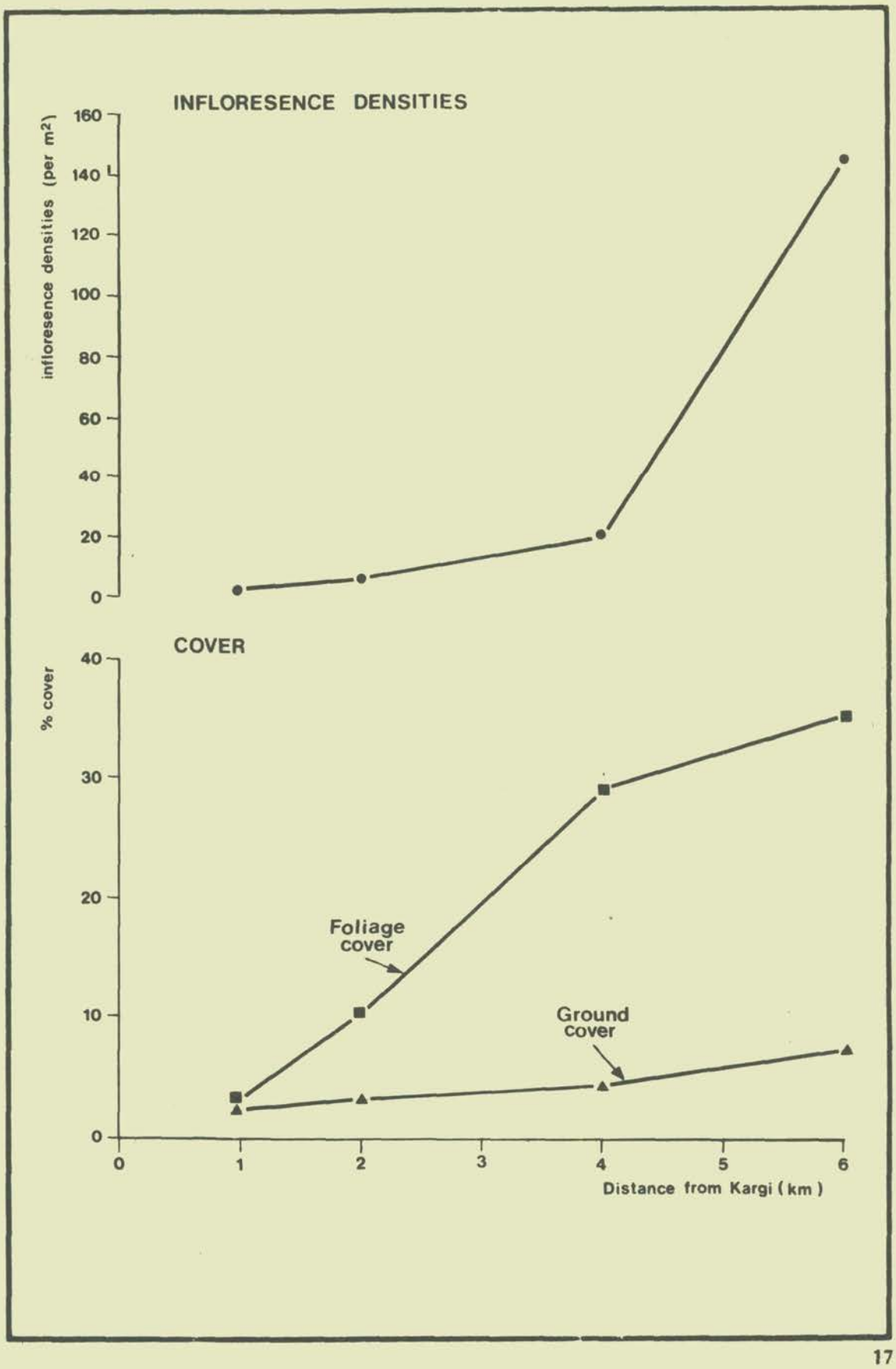


Table 3.4 Estimates of Annual Primary Production of the Field Layer for ALP Study Area for Poor, Normal and Good Rainfall Years

	Approx. Area		Poor Year		Normal Year		Good Year	
	km^2	%	Tonnes DM	%	Tonnes DM	%	Tonnes DM	%
Highland[1]	3,300	16	149,820	65	217,800	48	285,780	42
Lowland[2]	16,000	78	80,000	35	240,000	52	400,000	58
Chalbi	1,200	6	0	0	0	0	0	0
Total	**20,500**	**100**	**229,820**	**100**	**457,800**	**100**	**685,780**	**100**

[1] Production for highland areas based on Le Houérou and Hoste (no date). Assumed rainfall for poor, normal and good years 400 mm, 600 mm and 800 mm respectively.

[2] Production for lowland areas for poor, normal and good years assumed to be 50, 150, 250 kg/ha/year respectively.

Although comprising only 16 per cent of the total area, the highland areas are estimated to provide approximately 50 per cent of the total dry matter production of the field layer.

The relative contribution to total DM production from the highland areas is greater during poor years (65 per cent) than during good years (42 per cent). The rainfall in the highlands can be expected to be more reliable than that in the lowlands and the importance of highland production may therefore be even greater than indicated by these figures.

3.3.2 Total Digestible Nutrient (TDN) Production

As with the estimates of dry matter production, estimates of TDN production use generalised information from the literature which will need to be verified by experimental work. In estimating the production of Total Digestible Nutrients it has been assumed that TDN production (as a percentage of Dry Matter Production) from highland and lowland areas during poor, normal and good rainfall years is as follows:

	Poor Years	Normal Years	Good Years
Highland	35%	40%	45%
Lowland	30%	35%	40%

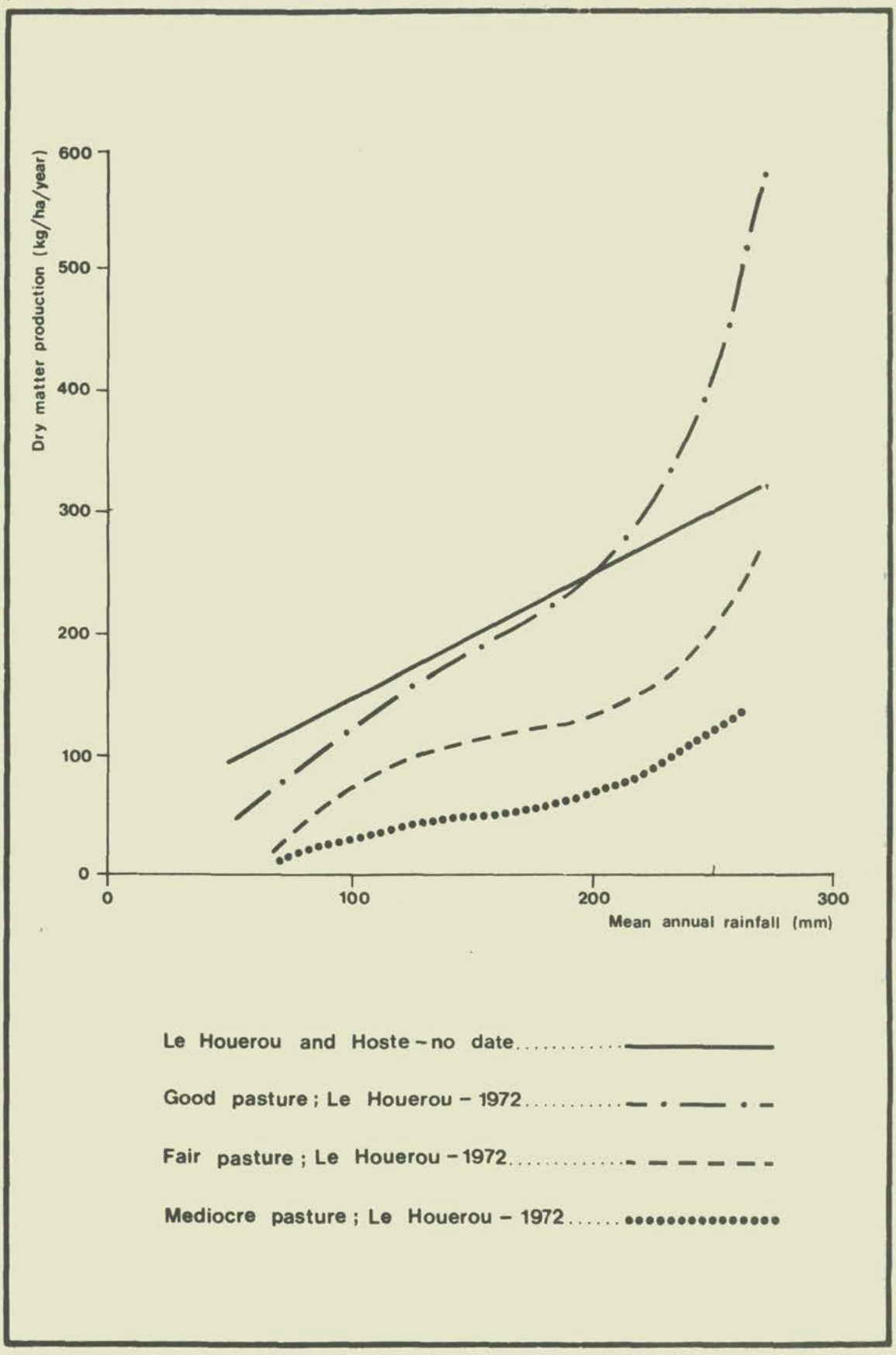
If these figures are applied to those for dry matter production (Table 3.4) an estimate of Total Digestible Nutrient production in the field layer can be obtained (Table 3.5).

Table 3.5 Estimates of Total Digestible Nutrient Production

	Poor Year			Normal Year			Good Year		
	Tonnes TDN	Tonnes /ha	%	Tonnes TDN	Tonnes /ha	%	Tonnes TDN	Tonnes /ha	%
Highland	52,500	0.16	68	87,120	0.26	51	128,600	0.39	45
Lowland	24,000	0.02	32	84,000	0.05	49	160,000	0.10	55
Total	**76,500**		**100**	171,120		**100**	**288,600**		**100**

The production of TDN in the field layer is estimated to be 2.2 times greater on a normal year than on a bad year and 3.8 times greater in a good year than a bad year.

Figure 3.3 Estimated dry matter production in relation to rainfall



3.4 ASSESSMENT OF RANGE QUALITY AND TRENDS

The state of the rangeland in the ALP Study Area is a product of the long and short-term effects of soil, climate and use. Like all natural systems, the ecology of the area is in a constant state of change and can be modified by short term alterations in these factors.

The period of the study of grazing ecosystems was one of high rainfall. The rangeland was therefore in as good a state as was possible, given the effects of soil, previous year's rainfall and use.

The vegetation in the herb layer of the lowland areas is characterised by ephemeral herbs and annual grasses. During the study these were relatively abundant, even on many areas of lava. During more normal years these are scarce, if present at all. It will be shown in the next chapter that the distribution of domestic grazing animals is determined by the distribution of water and therefore usage has a local effect on range quality. The local effect of usage has already been demonstrated in Section 3.2.4 of this chapter. Due to low rainfall the quality of lowland rangeland is poor as far as grazing animals are concerned, and around sources of permanent water this is further exacerbated by intensive use.

Due to greater rainfall the range quality in the highland areas is generally better than in the lowland areas. However, around sources of permanent water there is again heavy utilisation and the range is not nearly as productive as it could be. Although the ground cover is good, unpalatable weeds tend to replace good forage species.

One highland area, the Huri Hills, was found to be in very good condition; as good as any grass land in East Africa. There is very little permanent water on the hills and the area can only be used for a limited part of each year when rain water pools are full. It is also possible that the productivity of the field layer is stimulated, not only by rain, but also by water harvested by the plants from the mists which frequently cover the hills.

Signs of sheet and wind erosion were observed throughout the study area. Gully erosion was less frequent, probably due to the flatness of the land in the lowland areas. In certain areas, however, the heavy rainfall in early April had caused a number of new lagas to be formed and had cut deeply into existing ones and, in many cases, altered their course. Although the effects of good vegetative cover on increasing infiltration rates and reducing run-off are well documented, poor vegetative cover at the onset of the rains cannot entirely be blamed for this. The rains were so heavy that much of the soil in the area quickly reached field capacity and was unable to absorb any more water; the water was consequently forced to run off.

It is difficult to produce a reliable assessment of range quality from a short study during an exceptionally favourable period. It can be said, though, that despite any localised degradation which might have taken place during previous, less favourable, years the area still has the potential for recovery.

4. The Animals of the Grazing Ecosystem

4.1 INTRODUCTION

In this chapter the animal resource of the grazing ecosystem will be discussed in terms of numbers, distribution and estimated off-take in the field layer.

Having calculated the consumption of the field layer an attempt will be made to relate these data to those of production given in the previous chapter.

The information on numbers and distribution is based on data from the ALP aerial surveys.

The present study was primarily concerned with cattle, donkeys, oryx and zebra. Other species of stock, including camels, sheep, goats and a number of wild animals also make use of the field layer. These animals are the subject of independent long-term studies currently under way at ALP, and will not be discussed in detail in this report.

4.2 NUMBERS

The numbers of large herbivores have been counted using an aerial survey technique which is well established for East Africa (e.g. Norton–Griffiths, 1975). The area is counted on regular transects based on a 10 km grid and sampled at an intensity of 6 per cent. By June 1977 five counts had been completed; July and August 1976 and January, March and June 1977. The total areas counted during the surveys have varied. The July 1976 count covered only 14,600 km^2, leaving out the area south of Marsabit and the Huri Hills. The August 1976, January and March 1977 counts covered 19,300 km^2, which still excluded the Huri Hills. The June 1977 count covered 22,800 km^2 and included the Huri Hills and the northern part of the South Horr Valley. Results showing the numbers and densities of grazing herbivores are given in Table 4.1.

Cattle were by far the most common grazing herbivore and contributed between 86 and 99 per cent of the total grazing herbivore biomass. The biomass of each grazing species, expressed as a percentage of the total grazing herbivore biomass, is given in Table 4.2.

The relative proportions of donkeys, oryx and zebra varied in different counts; for three counts zebra were the second most numerous grazer and both oryx and donkeys were the second most important species for one count each. In none of these counts did any of these three species contribute more than 8 per cent of the total grazing herbivore biomass.

Comparative data in the densities of camels and small stock (sheep and goats) for the first two counts (July and August 1976) show that cattle, donkeys, oryx and zebra comprised 50.05 and 30.10 per cent of the total large herbivore biomass.

Table 4.1 Summary of Grazing Herbivore Numbers and Densities from ALP Aerial Counts

Species	July 1976			August 1976			January 1977			March 1977			June 1977		
	Estimated Pop.	Density /km²	Biomass kg/km²	Estimated Pop.	Density /km²	Biomass kg/km²	Estimated Pop.	Density /km²	Biomass kg/km²	Estimated Pop.	Density /km²	Biomass kg/km²	Estimated Pop.	Density /km²	Biomass kg/km²
Cattle	18,287	1.25	225.0	14,486	0.75	135.1	39,008	2.02	363.6	34,057	1.76	316.8	211,175	9.26	1,666.8
Donkeys	500	0.03	4.5	733	0.04	5.7	233	0.01	1.5	400	0.02	3.0	2,250	0.10	15.0
Oryx	2,917	0.20	20.0	1,217	0.06	6.3	1,650	0.09	9.0	483	0.03	3.0	917	0.04	4.0
Zebra	850	0.06	12.0	750	0.04	7.8	1,884	0.10	20.0	1,467	0.08	16.0	467	0.02	4.0
Total Biomass Density			**261.5**			154.9			394.1			**338.8**			**1,689.8**

Note: Mean liveweights used for biomass calculations were:-

Cattle	180 kg
Donkey	150 kg
Oryx	100 kg
Zebra	200 kg

Source:- ALP, unpublished data.

Table 4.2 Species Composition of Grazing Herbivore Biomass

Species	Per cent of Total Grazing Herbivore Biomass					
	July 76	August 76	January 77	March 77	June 77	Mean ± SD
Cattle	86.0	87.2	92.3	93.5	98.6	91.5 ± 5.09
Donkeys	1.7	3.7	0.4	0.9	0.9	1.5 ± 1.30
Oryx	7.6	4.1	2.3	0.9	0.2	3.0 ± 2.98
Zebra	4.6	5.0	5.1	4.7	0.2	3.9 ± 2.09

Although the relative proportions of grazing animals remained fairly constant during the counts, their absolute numbers and densities varied considerably. Due to changes in the area counted biomass densities rather than absolute numbers are more meaningful figures. The density of cattle was more than twelve times greater in June 1977 than in August 1976. Such large changes in densities over a relatively short space of time are the result of livestock movements rather than recruitment within a static population.

The changes in cattle densities appear to be related to changes in range condition; low densities are observed during dry periods and high densities during wet periods. These changes in densities and their relation to range condition are shown in Figure 4.1. Due to the high proportion of cattle in the total grazing herbivore biomass the total grazing herbivore biomass follows very closely the changes in cattle biomass.

For reasons which will be discussed later (Section 4.3.3) an average cattle density, calculated from the five aerial counts, is considered to have its limitations. Average densities for the other three species, however, were:–

Donkeys	5.9 ± 5.34 kg/km^2
Oryx	8.5 ± 6.85 kg/km^2
Zebra	12.8 ± 6.36 kg/km^2

These figures are concerned with the overall animal densities and imply an even distribution of animals throughout the area. This, in fact, was not the case; the distribution and local densities of grazing herbivores will be discussed in the following section (Section 4.3).

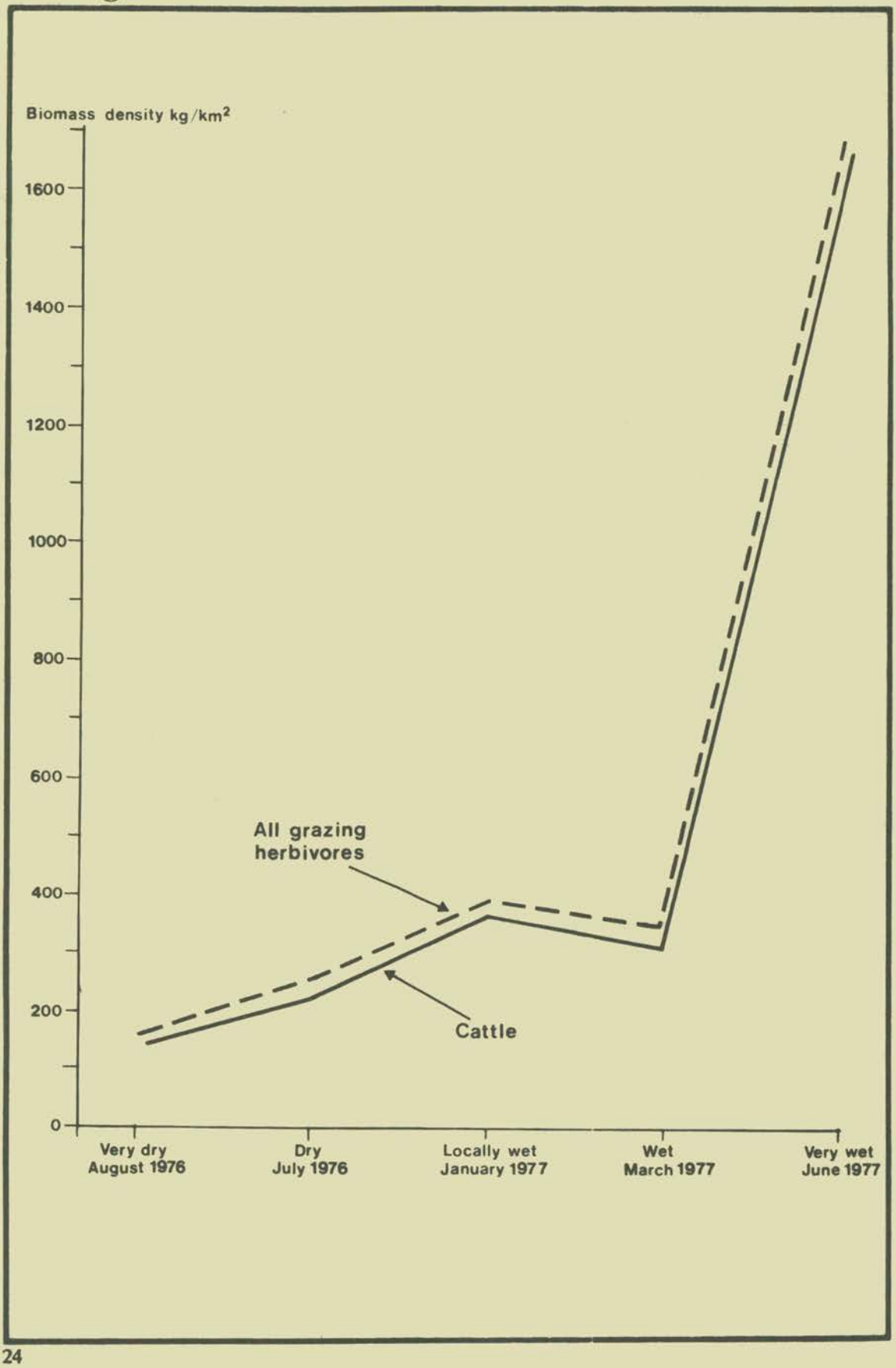
It is of interest to compare the cattle densities observed during the ALP survey flights with the results of livestock surveys undertaken for Marsabit District in previous years (Table 4.3).

Table 4.3 Changes in Cattle Densities in Marsabit District

Date	Estimated Biomass Density kg/km^2 [1]	Source
1963	527	Brown, 1963
1964	655	Spinks, 1964
1970	459	Watson, 1970
1971	331	FAO, 1971
1976/7	135 to 1667	Table 4.1
For ALP study area only	(Mean = 542 ± 635.7)	

[1] Biomass densities calculated using assumption that one beast weighs 180 kg.

Figure 4.1
Changes in biomass densities



The estimated biomass densities of cattle have varied considerably during the past thirteen years. Lower and higher values have been found during the one year of ALP surveys, but the mean value for the ALP study area is similar to that obtained for the whole of Marsabit district in 1963. Since 1964 the densities have declined, probably due to low rainfall. The drought in 1970–71 has been estimated to have caused between 25 to 35 per cent mortality in the District herd (FAO, 1971).

4.3 DISTRIBUTION

Distribution maps for the grazing herbivore species are given in Figures 4.3 to 4.5. These maps have been prepared using the raw data from the ALP survey flights and show the result of the 6 per cent sample rather than the total number of animals estimated to be in each block counted. Data from the count in January 1977, when range conditions were 'locally wet' have not been included. In order to facilitate the interpretation of these maps, the distribution of water and the greenness of the vegetation of the field layer have also been included for a very dry period and a very wet one (Figure 4.2). Due to the small scale of the maps used to show distribution no place names are given; these are given in Figure 2.2.

4.3.1 Water Distribution

During the dry season the main concentration of water is found at the shores of Lake Turkana. The rest of the water is mainly located around the periphery of the area and mostly comes from permanent springs and seepages, though there is permanent water at Kargi. During the wet season water is much more widely dispersed, though the area to the south and east of Mt. Kulal has little.

4.3.2 Greenness of Vegetation

As would be expected, there is considerable difference in distribution of the greenness of vegetation categories between the wet and dry seasons. Table 4.4 shows the relative proportion of the greenness categories for the two counts.

Table 4.4 Relative Proportion of Grass Greenness Categories

Category of Greenness		Per cent Wet	Dry
0	Very dry	3.0	84.1
1	Dry	25.5	14.6
2	Intermediate	41.4	1.3
3	Green	22.3	0.0
4	Very green	7.7	0.0

It can be seen that during the wet season only 3 per cent of the area was very dry, while during the dry season 84 per cent was very dry. During the wet season 30 per cent of the area was green or very green, while these two categories were not recorded during the dry season.

The maps for the distribution of greenness within the field layer during the dry season (Figure 4.2) show the only green area to be around Mt. Kulal. The rest, apart from the north west corner and the Lake edge, was very dry. In the wet season the situation is very different. Two highland masses, Mt. Kulal and the Huri Hills (which were not included in the dry season survey) were very green, while Mt. Marsabit, Mt. Mara and the Ndotos were all green. The only area in which the vegetation remained 'very dry' was the Chalbi where there was no vegetation at all, though there was standing water.

4.3.3 Distribution of Cattle

The distribution of cattle is shown in Figures 4.3a to 4.3.d. In general cattle are distributed around the periphery of the study area near sources of permanent water, the Lake edge, Mt. Kulal and Marsabit.

The count during the very wet period (Figure 4.3.d) showed a lot of cattle in the Huri Hills. Unlike other highland areas the Huri Hills have very little permanent water and are used only during the wet season.

Cattle usually avoid the dry lowland areas and throughout the year tend to concentrate in or around the highlands.

Although not clearly shown in the distribution maps, cattle do tend to move away from the highland areas during the rains, using the grass, which, due to lack of water during the dry season, can only be used when temporary rain-water pools are full. As soon as these pools dry up, however, they return to the permanent sources of water. At this time many animals move out of the study area altogether, going to the north east shores of Lake Turkana, north into Ethiopia and towards the wetter areas to the south.

Using the data for the numbers and distribution of cattle it can be seen that there are basically two distinct populations of cattle. Firstly there are those cattle which stay permanently in the study area and which are based around the highland areas: these are the animals which remain throughout the dry season. The second population is that which only comes into the study area during the wet season.

(a) Permanent Herd

The distributions of the permanent herd during the dry season can be seen in Figure 4.2.a (August 1976). The total estimated population of this herd is 14,500 animals (Table 4.1) and it has an overall biomass density of 135.1 kg/km^2. However, the area used by the permanent herd is very much less than the total study area and is estimated to be approximately 2,100 km^2 (the land over 1,000 m a.s.l. less the Huri Hills). This gives an effective biomass density of 1,242.9 kg/km^2 for the area actually used, nine times the overall biomass density and the equivalent of 6.9 180 kg animals per km^2.

(b) Temporary Herd

In June 1977 there were almost 200,000 more cattle than in August 1976. These animals represent the Temporary Herd and come in only when conditions are suitable. The actual numbers which enter the study area at any one time will depend on the conditions in other parts of their range as well as the condition within the area itself. As with the permanent herd, the temporary herd only makes use of part of the study area. If it is assumed that it used only half, though Figure 4.3.d suggests that it is even less than this, there would be an actual cattle biomass density of 3,105 kg/km^2. This represents a temporary animal density of 17.25 180 kg beasts per km^2. The density of the Temporary Herd for the whole study area would be 1,553 kg/km^2 or 8.6 180 kg beasts per km^2.

4.3.4 Distribution of Donkeys

No maps are given showing the distribution of donkeys. The distribution of these animals is very similar to that of cattle, though there is perhaps a relatively higher concentration of donkeys around the lake shore.

4.3.5 Distribution of Oryx

The distribution of oryx is shown in Figures 4.4.a to 4.4.d. Unlike cattle, oryx avoid the highland

Figure 4.2
Distribution of water and grass

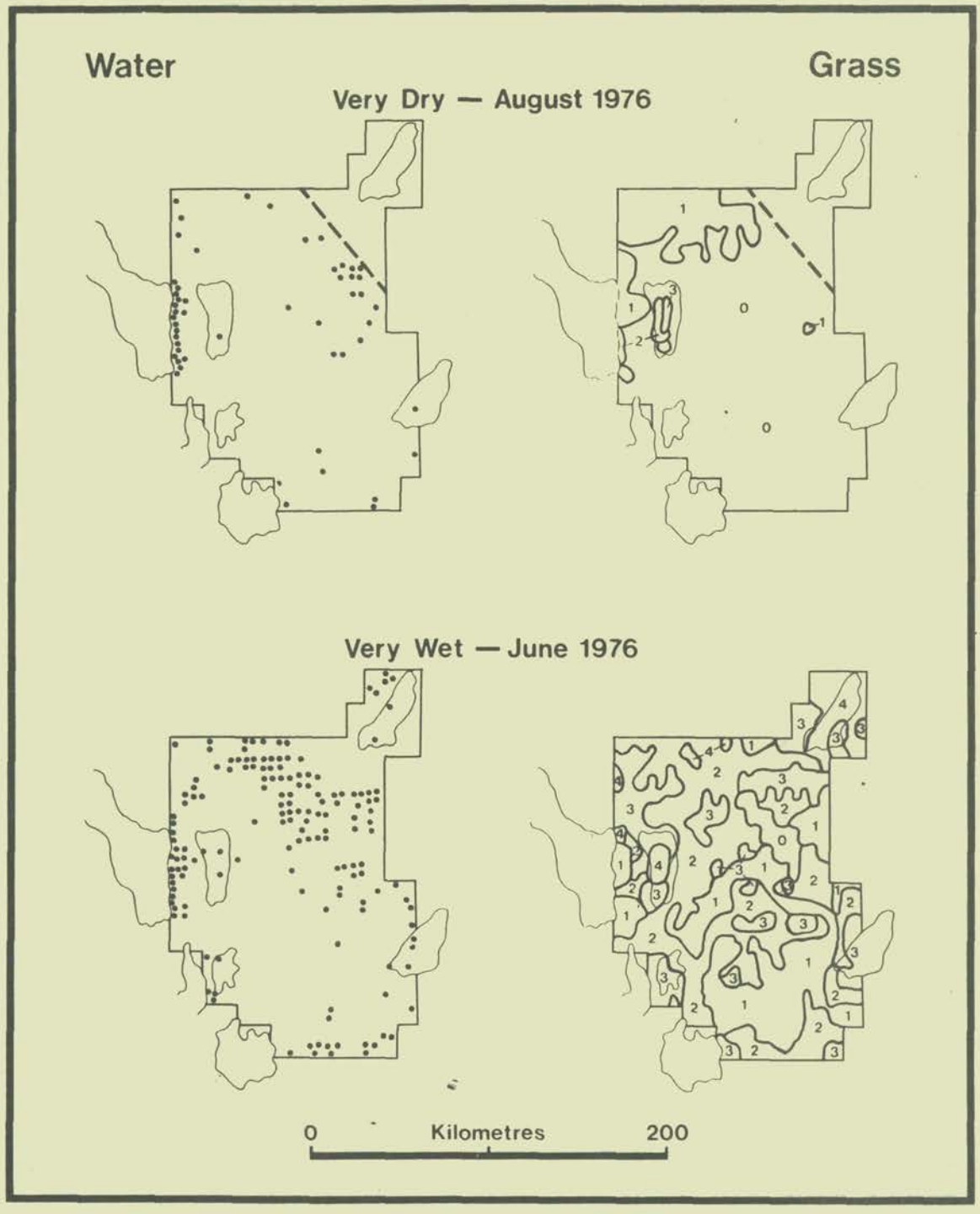


Figure 4.3
Distribution of cattle

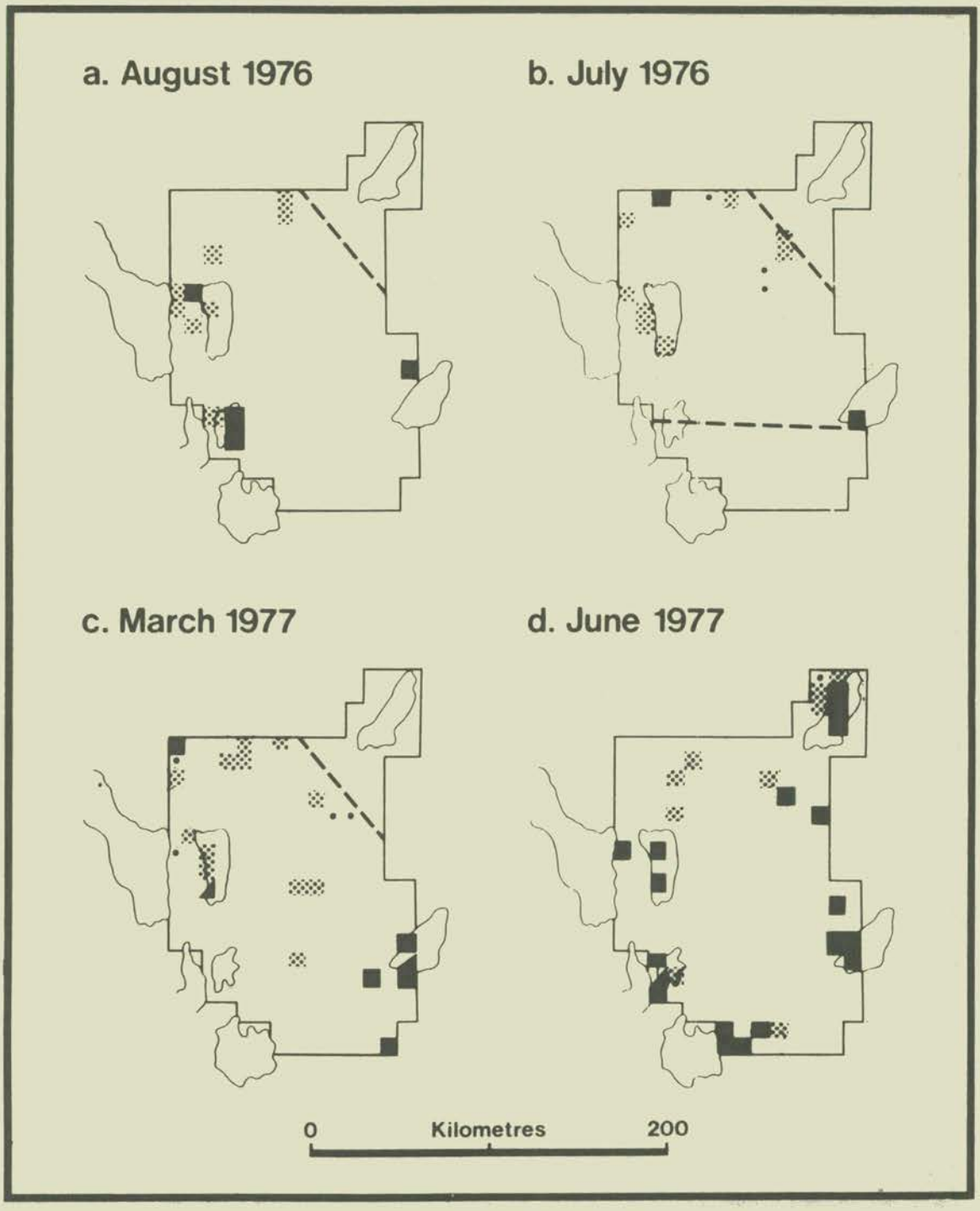
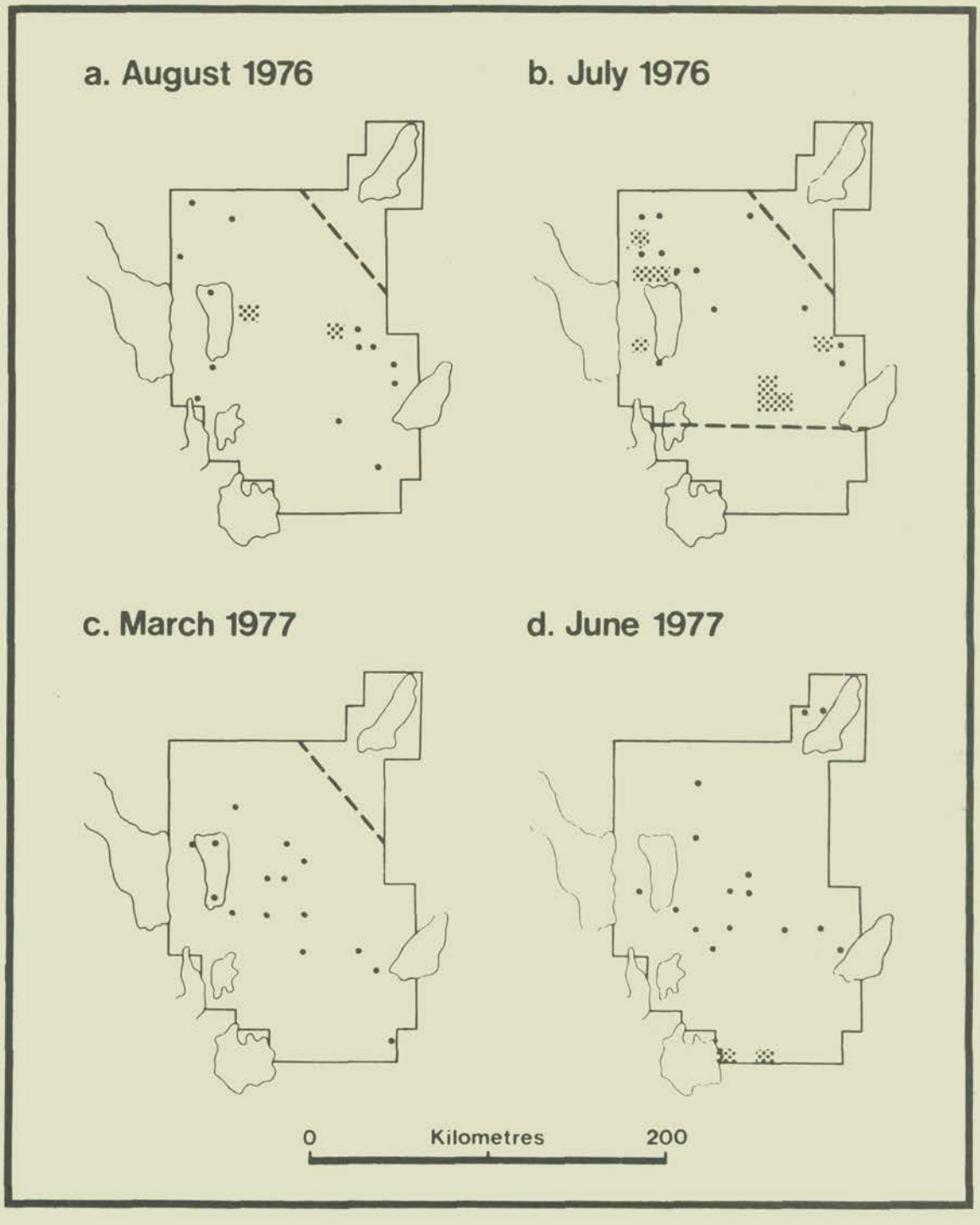


Figure 4.4
Distribution of oryx



areas and are widely distributed throughout the lowland part of the study area. Even in the dry season oryx are found far from water. There is a tendency for oryx to use the areas of lava during dry periods and to move onto the sandy soils after rain.

4.3.6 Distribution of Zebra

The distribution of zebra is shown in Figures 4.5a to 4.5d.

In the dry season zebra are usually found around the edge of the study area, but during the wet season they spread out into the central areas (Figure 4.5c).

4.3.7 Distribution of Grazing Animals in Relation to Water and Vegetation

The dependence of cattle on water is probably the primary factor in determining their distribution. There are, however, certain parts of the lowlands where permanent water is available but cattle densities are low, indicating that, as would be expected, poor grazing capacity also has an important effect.

The wild grazing animals do not appear to be so limited in their distribution. This is especially true for oryx whose distribution, even in the dry season, appears to be independent of free water.

Factors other than water and vegetation can determine the distribution of domestic stock. By far the most important other factor is security and areas are left unused for long periods due to the dangers of inter-tribal stock raiding and fighting.

4.4 VEGETATION OFFTAKE

In the previous chapter estimates of the rates of primary production in the field layer have been presented. In this section the potential offtake of vegetation by the grazing herbivores will be estimated. The four species of grazing herbivores being considered in this report are not the only mammals which use the vegetation of the field layer. Both camels and small stock, as well as other wild mammals, use the field layer to varying extents at certain times of the year.

Certain lowland areas were heavily infected by larvae of the Hawk moths *Agrius convululi, Celerio livornica, Basiothia nedea* and *Hippotion celerio* and by grass hoppers (Fam; *Acrididae*).There were also small outbreaks of two species of Armyworm in the area; *Spodoptera exempta* in a highland area around Gatab and *Spodoptera exigua* in lowland areas. Both these species are widely distributed throughout Africa, (and the world) and are economically important pests of both natural grass land and cultivated crops. *S. exempta*, unlike *S. exigua* tends to infest plants of the family *Gramineae* (Brown and Dewhurst, 1975). These insect pests were collected and identified by Mr. C.F. Dewhurst of the Desert Locust Control Organisation and his help is gratefully acknowledged.

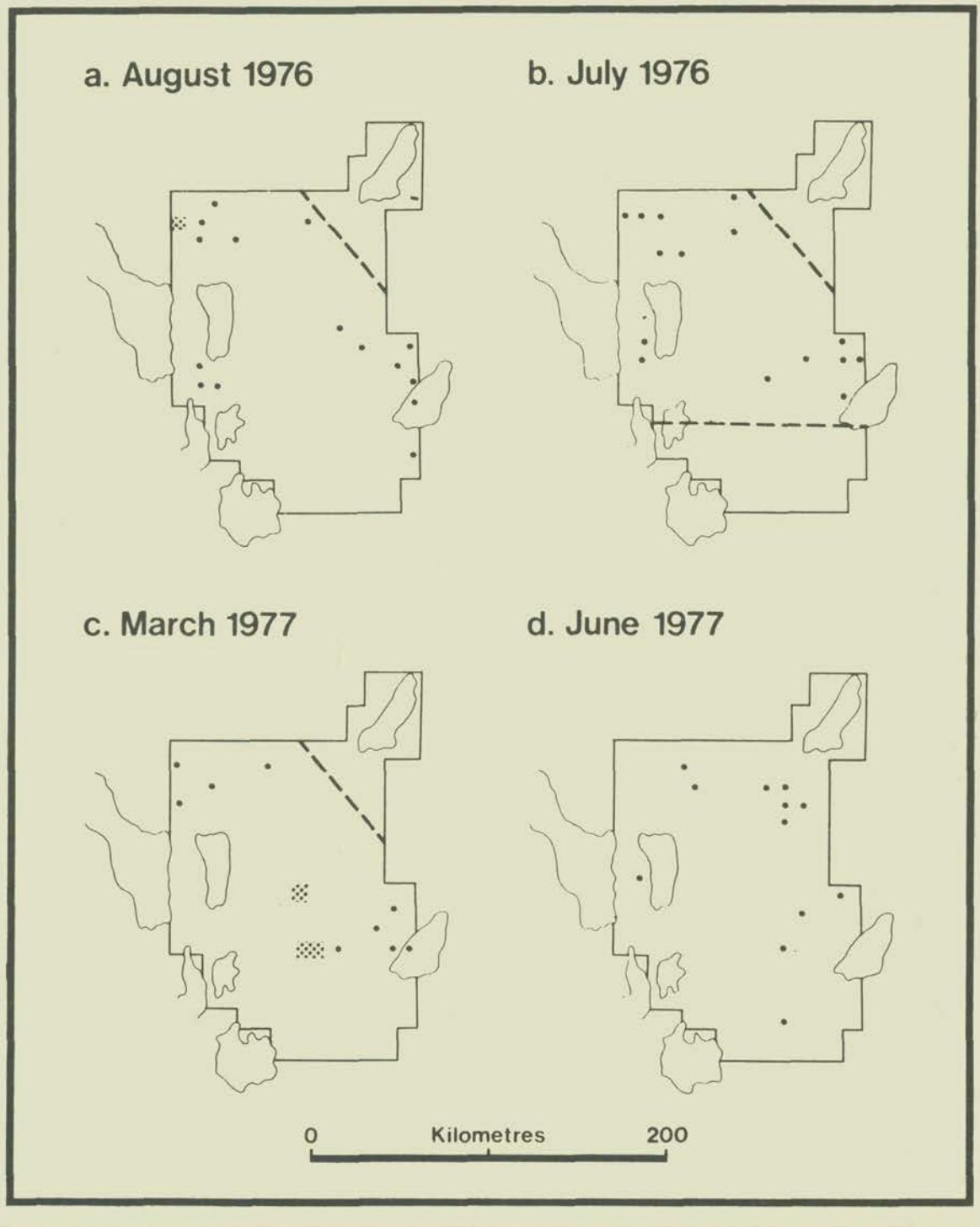
It is unlikely that during more normal rainfall years these insects are a serious pest of the field layer. Due to the heavy rains of April and May, however, infestations were locally heavy and had a considerable effect where they occurred.

4.4.1 Composition of Cattle Diet

Four sets of cattle feeding observations were undertaken during the study, the results of these observations are given in Table 4.5.

The majority of the food of cattle was perennial grass, annual grass was less frequently used. On average grass formed 83 per cent of the total intake. Herbs were considerably less important than grass, but non-woody, ephemeral herbs were more frequently taken than woody herbs. Sedges were not important,

Figure 4.5
Distribution of zebra



but at Kargi, where the animals were feeding in a wide, recently flooded laga, they comprised over 12 per cent of the diet.

Table 4.5 Summary of Cattle Food Intake Observations – Per cent

Area	Perennial Grass	Annual Grass	Woody Herb	Non-Woody Herb	Sedge
Gatab, Mt. Kulal	67.6	12.4	2.1	13.8	4.1
Luai, Mt. Kulal	88.1	2.4	2.4	7.1	0.0
Kargi	70.2	8.6	3.4	5.0	12.8
Huri Hills	73.3	10.7	0.0	16.0	0.0
Mean	**74.8**	**8.5**	**2.0**	**10.5**	**4.2**
± SD	**9.17**	**4.37**	**1.43**	**5.26**	**6.03**

These observations were undertaken at a time when grasses were relatively abundant in the field layer, especially in lowland areas. It is unfortunate that it was not possible to observe the feeding habits of cattle during the dry season, when very little grass would be available.

The bulk grazing technique of cattle can be damaging to the area they use, especially if grasses are only shallow rooted or the soil around the grass has been eroded away. In order to measure the effect of cattle grazing the number of times grass roots were removed when a mouthful of grass was taken was recorded (Table 4.6).

Table 4.6 Frequency of Grass Root Removal by Cattle Expressed as a Percentage of Total Grass Intake

Area	% Root Removal
Gatab	8.6
Luai	13.2
Kargi	8.6
Huri Hills	3.4
Mean	**8.4 ± 4.00**

The rate of root removal is very high and almost one bite in ten removes a rooted grass plant. The effect of this destructive grazing must be considerable, though whether this continues into the dry season is not known.

4.4.2 TDN Requirements

Field measurements of dry matter intake of unrestrained herbivores under field conditions is a complicated procedure and was beyond the scope of the present study. In order to obtain estimates of intake it has therefore been necessary to use generalised figures and it has been assumed that for all classes of animals intake is at the rate of 2.5 kg DM per 100 kg liveweight per day. If TDN was available at 40 per cent of dry matter this would make 1 kg TDN available per 100 kg liveweight per day, a low figure when compared to most published figures for TDN intake (Morrison, 1950), but one which was probably a reasonable estimate considering the conditions of the study area.

Estimates of the TDN requirements of the grazing herbivores are given in Table 4.7. The density data used in these calculations are given in Section 4.2 (donkeys, oryx and zebra) and Section 4.3.3 (cattle).

Table 4.7 Estimates of TDN Requirements of Grazing Herbivores

Species	Biomass Density kg/km²	TDN Required kg/km²/day	kg/km²/year
Cattle			
a. Permanent herd	135.1[1]	1.35	492.7
b. Temporary herd	1,553.0[1]	15.53	931.8[2]
Donkeys	5.9	0.06	21.9
Oryx	8.5	0.08	29.2
Zebra	12.0	0.12	43.8
Total including temporary and permanent herds			**1,519.4**
Total excluding temporary herds			**587.6**

[1] Biomass densities for cattle herds are for the entire study area.

[2] It is assumed that the temporary herd of 200,000 cattle use the study area for the equivalent of two months each year.

The TDN requirements of the grazing herbivores are estimated to be approximately 1.5 tonnes per km² if the temporary herd is included, but only 0.6 tonne per km² if it is not. These figures are equivalent to a requirement for the total study area of 34,200 tonnes, including the temporary herd and 13,680 excluding it. If the temporary herd of 200,000 animals were to stay for three months instead of two the TDN requirement would be increased to 45,260 tonnes. If it stayed for only one month the TDN requirements would be 24,000 tonnes.

The annual TDN requirements of the three minor species (donkeys, oryx and zebra) is estimated to be 2,160 tonnes.

4.5 RELATIONSHIP BETWEEN PRODUCTION AND OFFTAKE OF THE FIELD LAYER

A comparison between estimates of production and offtake in the field layer is given in Table 4.8.

Table 4.8 Comparison of Production and Offtake in the Field Layer

	Production Tonnes TDN	Offtake Tonnes TDN
Rainfall – Poor	76,800	
– Normal	171,120	
– Good	288,600	
Permanent herd*		13,680
Permanent herd + 60 days temporary herd		21,250
Permanent herd + 90 days temporary herd		45,260

* Defined as the permanent cattle herd, donkeys, oryx and zebra.

It can be seen that according to the theoretical calculations production exceeds offtake, even for poor years when the temporary herd spends three months in the study area.

There can be little doubt that this situation does not exist in reality, for if this was the case the study area would always be covered with vegetation. It is not.

Even allowing for errors in the basic assumptions used, the differences between production and offtake are very large – the estimate for production during poor years could be halved and the area would still theoretically be able to support the permanent herd and the temporary herd of 200,000 cattle for 60 days.

These calculations suggest that the carrying capacity of the field layer is always greater than the stocking rate. The state of the rangeland shows that this is not so and it is worthwhile considering some of the possible reasons for this.

(a) Rainfall and Production

It is not unusual for the area to go for many years with very little rain. During this time the grazing animals have to use the standing crop, which will go without any substantial boost of growth. At such times the range will become severely depleted and would need substantial rainfall, such as that of 1977, to recover.

It is likely that, due to this, productivity levels are in fact lower than those assumed in the model.

(b) Water

The dependence of cattle on water is another important factor and one which contributes to the apparently low stocking rate. Cattle need to be watered at least once every three days and the areas these animals use are therefore limited by the distribution of water. Due to this limitation a large proportion of the grass produced is 'out of reach' of cattle.

A further effect of water dependence is to concentrate cattle around sources of permanent water and to degrade the grazing. The productive potential of these important areas is therefore reduced.

(c) Errors in Animal Number Estimates

The concept of the permanent and temporary cattle herds comes from only one year's aerial survey data. The permanent herd has been defined as the smallest number of cattle counted in the area, but it may well be that there is only a very limited part of the year when there is only this number of cattle present. The very large figure used for the temporary herd (200,000 animals) allows for error in estimating the permanent herd size. The presence of the temporary herd for 60 days is the equivalent of 12 million extra cattle–days. This could be recalculated as adding an extra 16,500 cattle to the permanent herd and reducing the temporary herd's effect to 100,000 cattle for 60 days. The effective offtake figure remains the same.

(d) Other Use of the Field Layer

The use of the field layer by 'non-grazing' animals could account for a certain amount of the discrepancy between production and offtake. Camels and small stock use the herb layer as well as phytophagous insects: trampling by large herbivores would also reduce the amount of vegetation available in the field layer. It is the opinion of ALP personnel that, due to a frequent shortage of vegetation in the field layer, grazing animals must use perennial woody vegetation to a large degree.

4.6 CONCLUSION

It is apparent that the grazing ecosystem in the ALP study area does not conform to the generally

accepted assumptions which have been used to describe production and offtake in arid range areas. The theoretical model constructed to show the yield and consumption of the field layer did not 'work'. The differences suggest that the figures used for production are much too high, but they compare with other arid rangeland areas in Africa.

The grazing component of the total ecosystem of the study area is an important one and on occasions grazing animals form more than 50 per cent of the total herbivore biomass. In order to understand the dynamics of the grazing ecosystem it will be necessary to collect field data over several years and to break down the ecosystem into its component parts. Recommendations for such a study are given in Chapter 6.

5. Animal Husbandry, Production and Marketing

5.1 INTRODUCTION

In this chapter factors concerned with the management and productivity of domestic grazing herbivores are discussed.

The comments and data presented in this chapter are not intended to represent a comprehensive account; in order to achieve this a very much fuller and more detailed study would be required.

With the exception of a few mixed farmers on Marsabit and some very limited cultivation on Mt. Kulal and in the Huri Hills, nomadic pastoralism is the only method of food production in the study area. The methods of stock management are basically similar to those used by pastoral people throughout the arid and semi-arid parts of Africa.

Of the two domestic grazing animals, cattle and donkeys, the former were much more important, both numerically (Table 4.1) and from the point of view of food production. The attitude of the people towards donkeys was interesting and they were generally reluctant to talk about these animals. The reason for this appeared to be that, although they used donkeys, they considered these animals to be very inferior and did not think their management worth discussing.

Although there were many similarities in the management of cattle in the different parts of the study area, the role of these animals in the pastoral economy varied.

For Samburu and Boran, cattle are used as the base of their subsistence. The Rendille and Gabra base subsistence production on camels and small stock. Whether these differences are primarily due to the areas used by each group, or whether the type of stock used for subsistence determined the area used by each group, is difficult to determine. Such questions can only be resolved by historical research into the tribes' past and traditions (e.g. Sobania, 1977).

5.2 LOCAL ANIMAL HUSBANDRY

5.2.1 Donkeys

The care given to donkeys in the study area is minimal. Donkey owners mark their animals for identification, but having done that take very little further interest in them. Donkeys are not usually herded with other stock and are often left to fend for themselves. If an owner wishes to use his donkeys he frequently has to go and search for them in the bush. Losses through animals straying and being killed by predators are high but difficult to estimate.

Donkeys are allowed to mix with cattle and small stock, but not with camels. If camels are being milked and donkeys come into the manyatta they are chased out.

Despite the lack of interest shown by the people in donkeys, they are obviously locally important and useful animals. If people do not own camels, donkeys are the sole means of transporting water and moving camps. Even those who own camels admit that donkeys are useful for carrying water in areas which are too steep or stony for camels.

5.2.2 Cattle

The Samburu and Boran need cattle in their settlements to provide milk. Gabra and Rendille (with the exception of the Ariaal Rendille who keep both cattle and camels for subsistence) get their milk from other stock and therefore do not necessarily need to keep cattle near settlements. The result of this difference is that the cattle of Samburu and Boran are run in two herds, the milk herd and the dry herd. The milk herd, which stays in the settlement, is made up of lactating cows, their calves and a few bulls, while the dry herd is made up of dry cows, weaned young stock, immature and surplus males. The cattle of the Gabra and Rendille are usually run in one herd, away from the settlement, as a 'dry' herd, although this herd contains all classes of animals including those in milk.

The cattle of the Samburu and Boran are primarily subsistence animals, but are also used as an investment; the cattle of the Gabra and Rendille are primarily an investment which can be turned into cash whenever the need arises. Cattle are the most frequently used class of stock for investment purposes. This is a result of the marketing infrastructure and will be discussed in greater detail in Section 5.8.

Animal husbandry is based on traditional pastoral practices which have evolved as a result of the harsh conditions. On the whole, the people in the study area are good stockmen, as are most pastoral people in East Africa.

(a) Grazing Patterns

It has already been shown that there is considerable movement of cattle within and in and out of the study area (Sections 4.2 and 4.3). Movements of animals of the permanent herd are basically up and down the mountains: moving down to the lower parts of the mountains during the wet season and retreating up the mountains in the dry season.

Animals of the temporary herd move over much greater distances and are not confined to the study area, the distances covered in recent years are thought to be less than they used to be (Rainy, 1977). The recent decline on mobility is due to reduced security and the availability of relief food at certain population centres. This reduction in mobility represents a change from true nomadic pastoralism to transhumant pastoralism.

Cattle are usually let out of their night enclosures (boma) between 7.30 and 8.30 in the morning. The timing of this very much depends on the number of animals which need to be milked. Cattle are only milked after all the small stock have been milked, but before camels are milked. Cattle are returned to the bomas just after sunset.

The daily feeding pattern of cattle depends on the availability of food and water. At Kargi, for instance, as soon as cattle were let out they walked four kilometres to a laga to the east of the village where there was good grazing, hardly stopping to feed on the way. If water is far away the animals will have to spend a considerable portion of the day travelling to available water.

Although cattle are not generally grazed at night the animals in the Huri Hills are let out to graze at about 4 o'clock in the morning and then returned for milking at about 10 o'oclock. The reason for this was to allow the animals access to the heavy dew which came from the mists on the hills.

(b) Disease

Herdsmen are very quick to spot an animal which is ill, but seem to have only a limited number of courses of action to cure it. It was not possible to make a detailed inquiry into the number of different diseases that the people identify, but superficial inquiry suggested that it was only a limited number.

Ticks are recognised as being vectors, or causative agents, of disease and high tick concentrations will cause herdsmen to move their animals elsewhere. Tick grease is in high demand, though limited supply. The people do not remove ticks by hand from cattle which they suspect to be ill of a tick borne disease.

Swellings, bumps, growths, stiff joints and broken bones are all treated by burning, as are irritations of the skin and other wounds. It is believed by some people that bleeding a sick animal can help in its recovery. Semi-castration, the removal of only one testicle, is thought by some to give an animal resistance to disease.

(c) Animal Identification and Decoration

Each herdsman knows his animals by sight and has no need for any extra identification marks. In order to be able to prove ownership, however, animals are often marked by cuts in the skin and the ears.

Some cattle, notably steel-grey and dappled-grey ones, are occasionally extensively covered with cuts, lines, circles, dots and crosses. These marks, which were noticed more in Samburu cattle than in others, are made to improve the aesthetic beauty of a favourite animal.

(d) Restraint

In general the cattle in the study area are highly tractable and easy to handle.

Animals which are restless when being milked have their hind legs tied together above the hock during milking. Young bulls, when being castrated, are thrown and have their legs tied. The only other form of physical restraint observed for cattle was used on young calves which were being moved, with their dams, from one camp to another. These calves, which were big enough to walk rather than be carried by herdsmen, had their mouths tied shut with rope. This was to prevent them suckling. If they were able to suck they would lie down and sleep rather than keep up with the rest of the herd.

(e) Young Stock

The value of colostrum to newly born calves is recognised and calves are generally allowed free access to their dams for one or two days after birth. Subsequently, however, calves are penned or tied in the boma while their dams go out to graze and only allowed to suck during the morning and evening milking. At these times it is usual for the calf to be allowed to suck two quarters of the udder while the other two are milked for human use. Results from the questionnaire forms (Appendix 1) indicated that it was unusual for people to stop milking the dam if her calf started to loose condition. Competition with humans for milk is probably the main reason for calf mal-nutrition.

The age at which calves are released to graze varies, but the earliest is probably about one month. Young unweaned stock are usually herded away from their dams to prevent them from sucking ad lib. Young stock are also penned separately at night to keep them from their dams.

It appears that there is no active move to wean a calf from its dam and they continue to suck until the dam dries off prior to calving. This period can be as short as four months but as long as over a year.

(f) Castration

Castration is carried out by making a small incision in the scrotum and pulling out the testes. Newly castrated steers are left in the boma for 2 to 3 days after the operation. Informants say that this method does not cause any deaths due to subsequent infection.

Age at castration varies, but there appears to be a general preference for late castration at 3 or 4 years old.

Some positive reason for selecting which animals should be castrated and which should not was not always expressed. Some people, however, did select animals to be left entire, and this was usually based on the dam's milk production or the bull's size. One informant, at Gatab on Mt. Kulal, said that he selected for 'strength', which he defined as an ability to walk long distances and survive drought, rather than sheer size.

(g) Milking

Cattle are milked twice a day, in the morning and evening. If the cow is suckling a calf only two quarters are milked. The simultaneous milking and sucking may help to promote milk let down. If a cow is reluctant to let her milk down she is stimulated to do so by someone blowing into her vagina. This encourages the production of oxytocin and stimulates let down.

(h) Bleeding

All classes of adult stock are bled. Some pastoralists said that if an animal was ill it would not be bled, while others held the view that bleeding could help an ill animal. The method used is similar to that used throughout East Africa. A rope is tied tightly round the base of the animal's neck and its head and neck are bent to one side. The jugular vein soon stands out on the neck and a small arrow, with a thick piece of wood just behind the head to prevent deep penetration, is fired into the vein from a distance of about half a metre. If the aim is correct blood will immediately flow from the wound and is collected in a gourd. On the three occasions this was observed the arrow hit the vein at the first shot. This is not always the case, and sometimes a number of shots are required. As long as the head and neck are kept bent away from the side being bled the wound will give blood freely. Bleeding is stopped by the head and neck being straightened. Nothing is put on the wound to stop the bleeding and after the neck has been straightened there is only a very slight trickle of blood which soon stops.

The frequency with which animals are bled varies and to a large extent depends on the number of animals in a settlement or dry herd camp and the amount of milk available. Most people thought that an animal should not be bled more than once every three or four months.

After the blood has been collected it is stirred with a wooden stick and the clot is removed. It is usually mixed with milk, but is drunk by itself by young men.

(i) Water

During the period of study water was readily available and virtually all cattle were able to drink once a day, though did not necessarily do so. During the dry season, however, water and adjacent

grass become more difficult to find and cattle drink less frequently; as little as once every 3, or even 4, days.

In the Huri Hills herdsmen claimed that their cattle had gone for 60 days without drinking. There was a very large number of cattle in the Huris during the study and only limited water. It was said that by letting the animals out to graze very early in the morning they were able to get all the water they needed from the dew formed by the condensation of mist. It is quite exceptional for cattle to go this length of time without drinking free water and every effort was made to check this claim. About ten pastoralists from different parts of the Huris were asked how often their cattle had drunk since they had been up in the hills. All of them gave the reply of approximately 60 days - the length of time they had been there. Mr. Herbert Anderson, of the Africa Inland Mission, has been working in the Huri Hills for several years and has become interested in the possibility of 'fog harvesting' there. In the course of his investigations he has collected about 10 litres of water in four hours from a screen door; an indication of the amount of water in the mist which could be available. By the middle of June cattle were beginning to move off the hills as the amount of water gathered from the mists by grass was getting less and there was no permanent source for the animals.

(j) Salt

The value of feeding salt to livestock is appreciated by the pastoralists. Although salt is considered to be less important for cattle than camels, efforts are sometimes made to make salt available to cattle. There are a number of areas in the lowlands where salt is readily available. In the highland areas, however, where the main concentrations of cattle are found, salt supplies are limited. A few stock owners at both Mt. Kulal and Marsabit bring salt up the mountains for their animals.

Unlike camels, cattle are not specifically taken to areas where salt is available.

(k) Herding

It is said by a number of authors that man-power for herding is an important constraint in livestock management (e.g. Torry, 1973; Gwynne, 1977). It was not possible to investigate this during the short study, but it would appear that this is a management factor which deserves further attention. Cattle herding is usually undertaken by young men.

5.3 HERD SIZE AND STRUCTURE

A summary of the data collected on cattle herd size is given in Table 5.1.

Table 5.1 Mean Herd Size

	No. of Herds	Mean Head Size	± SD
Samburu	10	105.7	68.84
Rendille	3	45.3	13.65
Gabra	7	62.4	33.65
Boran	2	71.5	36.06
Over-all	**22**	**80.6**	**51.86**

The over-all average herd size was 80.6 animals; the smallest herd counted was 18 animals, the largest was 206. Although the sample was too small to justify statistical analysis it is of interest that the Samburu herds were in general larger than those of other groups. The percentage distribution of herd size is shown in Table 5.2.

Table 5.2 Percentage Distribution of Cattle Herd Size

Herd size	Less than 50	50 to 100	100 to 150	Greater than 150
Per cent	27.3	50.0	13.6	9.0

This information on herd size does not relate to the number of animals owned by one man, as cattle belonging to several owners may be herded together.

It was not possible to mouth large numbers of cattle in order to obtain information on the age structure of herds. In order to obtain information on herd structure the age of cattle was estimated, using only three age classes: calf, immature, adult. The approximate relation between these classes and age is:–

calf	– less than 1 year
immature	– 1 to 3 years
adult	– greater than 3 years

The structure of the cattle herds in the study area are shown in Table 5.3. Included in this table are figures given by FAO (1971) for the herd structure in Marsabit District six years ago.

Over sixty per cent of the cattle are adult, and over fifty per cent of the cattle are adult females. These are higher figures than those obtained by FAO (1971) (46 and 40 per cent). The proportion of calves in the herds (12.5 per cent) is only half that recorded in 1971.

The ratio of adult bulls to adult cows is 1 : 10.28. Although at first this might appear to be a low ratio, with a small number of cows to each bull, the risk of infertility and disease probably makes this a practical figure. A similar ratio (1 : 14) has been recorded for Baggara cattle in Southern Darfur (HTS, 1974). The ratio of immature bulls to heifers (1 : 3.33) is lower than for adult animals. This reflects the effect of late castration on the structure of the herd.

The ratio of adult females to calves is 1 : 4.26. This is very low indeed and indicates either very low fertility or high calf mortality: in practice both these factors are probably important.

5.4 GROWTH

No data on growth were collected during the study. Information collected by FAO (1971) showed that cows reach a mature weight of 280 kg at 4.5 years and that steers and bulls reach a mature weight of 360 kg at 6.7 years. The average weight for animals of different age classes is shown in Table 5.4.

The weights indicate a growth rate of less than 0.2 kg/beast/day between the eruption of the first and third incisor pairs.

5.5 MILK PRODUCTION AND BREEDING

Without extensive long term measurements, estimates of milk production in pastoral areas are difficult as there is considerable variation depending on individual differences, the stage of lactation and range conditions. Estimates based on milk yield measurements for human consumption show that about 1 litre per day is a normal production level (Torry, 1973; Fratkin, 1977): presumably this comes from only two quarters, the other two being used by the calf. Total daily production is therefore approximately two litres.

Table 5.3 Cattle Herd Structure

	Total No. Herds	Total No. Cattle	Calves	Immature				Adult			
				M	C	F	T	M	C	F	T
Samburu	10	1,054	106	37	38	145	220	56	77	595	728
%			10.1	3.5	3.6	13.8	20.9	5.3	7.3	56.4	69.1
Rendille	3	136	4	8	3	20	31	6	8	87	101
%			2.9	5.6	2.1	14.7	22.8	4.4	5.9	64.0	74.2
Gabra	7	437	89	16	21	60	97	25	37	189	251
%			20.4	3.7	4.8	13.7	22.2	5.7	8.8	43.2	57.4
Boran	2	150	23	12	7	18	37	5	10	75	90
%			15.3	8.0	4.7	12.0	24.7	3.3	6.7	50.0	60.0
Total	22	1,777	222	73	69	243	385	92	132	946	1,170
%			.5	4.1	3.9	.7	.7	5.2	7.4	.2	.8
FAO, 1971			24	10		20	30	6		40	46

M = Entire Male
C = Castrate
F = Female
T = Total

Table 5.4 Average Weight of Different Age Classes of Cattle (kgs)

Incisor Pairs	0	1	2	3	4
Age (months)	<24	24–30	31–36	37–42	<42
Female Wt.	120	160	195	216	245

Source: FAO (1971)

Observations of milk yields during the present study indicated that yields in the lowland areas were slightly higher than this and the people were obtaining about 0.75 litre at each milking. This would make 1.5 litres a day available from each cow and total daily milk production of 3.0 litres. In highland areas yields were higher than this and in one case, near Marsabit, some cows were yielding about 6 litres a day. These higher yield figures are the result of the exceptionally favourable range conditions and it is unlikely that this would be maintained throughout the year.

The length of lactation varies considerably and is dependent on range conditions. Lactations can be as short as 4 months and as long as 15 months. Cows dry off during the latter stages of pregnancy and are reported only to be served by bulls if range conditions are good. A long period without rain will increase the length of lactation as empty cows will keep in milk. Production levels during such times would be very low indeed. According to informants it is uncommon for cattle to dry off due to poor range conditions, though they do so during bad droughts.

Information collected from local herds in the study area showed that overall 14.6 per cent of the adult cows in the area were lactating. There was a difference between highland and lowland areas; in the highlands 10.63 per cent and in the lowlands 25.89 per cent were lactating. If the dry cows were not in milk due to being in the last months of pregnancy this would mean that 89 per cent of highland cows and 74 per cent of lowland cows were in calf. No pregnancy diagnoses were undertaken, but these figures represent extraordinarily high values for fertility for local cattle under such conditions and are unlikely to be correct. It is probable that an unknown number of these cows were dry for reasons other than pregnancy. On the other hand, there had been reasonably good rain in parts of the study area in November 1976 which would have stimulated many cows to oestrus. By May 1977 these animals would be about two months from calving.

Further detailed information is required on the breeding and reproductive physiology of the cattle in the study area. The results of this study suggest that oestrus is stimulated by environmental conditions and that cows will only take service from a bull when good grass is available. Assuming pregnancy lasts for about 280 days calves will be dropped in the middle of the next dry season, for the area has a bimodal rainfall pattern.

Extended lactation during poor conditions could be a mechanism to enhance calf survival, but must put a heavy strain on the dam. If cows only dry off when pregnant, stimulated by good conditions, it will mean that calves are weaned onto good grass. It should, however, be pointed out that during the latter part of extended lactations milk will only be a supplement to the calf's diet, as it will have started foraging for itself.

Under good conditions heifers have their first calf at 3 years old, but if conditions are bad this may be delayed until they are 4 years old.

5.6 COAT COLOUR

The percentage frequency of the different cattle coat colours are shown in Table 5.5. A sample of 574 cattle was used.

Table 5.5 Percentage Frequency of Cattle Coat Colour

Colour	Per cent
White	46.2
Black	9.9
Red	16.2
Dun	13.1
Other	14.6
	100.0

Most herdsmen did not think that there was any difference in the performance of animals of different coat colours and there was no selection for any particular colour. It was of interest, however, to find that some herdsmen had noticed that animals with light coloured coats, especially white, were able to withstand drought conditions better than dark coated animals. Furthermore, they also considered that dark coated animals grew faster than light animals when conditions were good. These observations show similar results to those obtained by Dr. D. Western and Dr. V. Finch (Pers. Comm.) who have been studying the effect of coat colour on the mortality and productivity of Maasai cattle in Kenya.

5.7 MORTALITY AND DISEASE

5.7.1 Mortality

The loss of cattle through drought and disease is at times very high. Calf mortality during the year prior to the study must have been high, for calves only made up 12.5 per cent of the total herd. FAO (1971) estimated that there was a drop in calf numbers of between 60 and 70 per cent after the 1970–71 drought, but figures for calf numbers for this period are twice as high as those for the present study.

Direct information on mortality was difficult to obtain from the people, but indirect questioning showed that during normal years between 30 and 50 per cent of new born calves might be expected to reach breeding age. On bad years the entire calf crop could be lost.

Adult mortality for the year previous to the study was about 7 per cent, a figure similar to the 9 per cent quoted by FAO (1971).

5.7.2 Disease

There is only one qualified veterinarian for the whole of Marsabit District. As this officer also has to act as the District Agricultural Officer the amount of veterinary work done in the study area is limited.

The livestock of the area suffer from a number of major diseases, which include Foot and Mouth, Anthrax, Blackquarter and Rinderpest. Trypanosomiasis is not a major problem in the study area, though the disease occurs in Marsabit District.

There are two Government vaccination teams in the district which vaccinate cattle against Rinderpest and Contagious Bovine Pleuro Pneumonia (CBPP). Although these vaccinations are compulsory many people are reluctant to have their cattle vaccinated.

Figures for the number of animals vaccinated in the district during the last three years are given in Table 5.6.

Table 5.6 Cattle Vaccination Figures for Marsabit District

Year	Rinderpest	CBPP
1974	35,115	29,512
1975	62,357	65,485
1976	89,800	70,900

Source: Republic of Kenya, 1976a.

Poor communications, bad roads, a mobile livestock population and lack of man-power and transport are considered to be the major constraints to veterinary work in the district.

There are no cattle dips within the study area, though there is a dip at Karate, just outside the area, near Marsabit.

The pastoralists are very keen to be able to purchase tick grease, and, in some cases, dip solution and hand sprays. Unfortunately these cannot be bought in Marsabit. This situation has been explained to personnel from a commercial manufacturer and distributor of veterinary products and a representative from this company will shortly visit Marabit with the aim of establishing the long term supply of tick grease, dip and other equipment.

Outbreaks of notifiable diseases cause quarantine restrictions to be imposed on stock in the district. Although such restrictions should, theoretically, prohibit the movement of animals they are not always effective. The control of movements of animals over such a large area is virtually impossible. All animals which are moved out of the district as commercial sales should have had Rinderpest, CBPP and Foot and Mouth vaccinations. Unfortunately, these conditions also are not always fulfilled.

5.8 SALES, CONSUMPTION, MARKETING AND STOCK ROUTES

5.8.1 Sales

Virtually all pastoralists interviewed said that they would be willing to sell cattle, providing the price was right. There was some reluctance among some Samburu, which was only to be expected as cattle are the subsistence base for these people.

The Gabra and Rendille, who are not primarily cattle keepers, keep cattle as an investment. The reason they chose cattle, rather than camels or small stock which are better adapted to the areas they live in, is that there is a better developed infrastructure for the sale of cattle than for other stock classes. In general pastoralists only sell cattle when they have a need to realise cash for some purpose, such as during drought to enable them to buy cereal, or at time of marriage to pay the bride price.

The results of this study showed that commercial sales during the previous year were at the rate of 3.0 per cent of the total herd. There were differences between tribes and sales. For instance the cattle-keeping Samburu were at 1.6 per cent, while for Gabra they were 5.2 per cent. Torry (1973) gives a lower rate of 2 per cent for Gabra commercial sales. These rates are similar to that given by FAO (1971) of 5.0 per cent. Fratkin (1977b) reports a higher rate of 11.4 per cent for the commercial cattle sales of the Ariaal Rendille.

Although it has been said that the infrastructure for selling cattle is better than for other classes of stock, it is still far from satisfactory. The majority of animals sold by pastoralists go to traders, who generally give very poor prices. Full grown animals in good condition are generally bought by traders for

between KShs. 300.00 to 400.00. Frequently pastoralists said that, although they are willing to sell animals, they would not sell them for these low prices and would point to full grown oxen of seven or eight years which they had kept rather than sell for a bad price.

Although the Livestock Marketing Division (LMD) of the Ministry of Agriculture occasionally holds auctions at Marsabit, these are infrequent. Individual stock owners are understandably reluctant to trek a few animals long distances to Marsabit for sale by auction.

5.8.2 Consumption

The rate of home consumption of cattle varied considerably between different owners. For the year before the present study the average consumption was 7.6 per cent, higher than the 3 per cent quoted by FAO (1971). Approximately 20 per cent of the animals slaughtered for home consumption were killed for ceremonial purposes. Rates of home consumption are reported to increase considerably during periods of drought when milk production levels are too low to feed the people and they have to slaughter animals to stay alive.

5.8.3 Marketing and Stock Routes

An increase in marketing cattle through the LMD is a method of sale which would be welcomed by the pastoralists. They feel that they receive a fairer price for their animals from LMD than if they sell to traders. The people would be willing to have their animals bought by weight over a weigh bridge.

LMD activity in the study area has been limited during the last few years, though they bought 4,553 cattle at an auction in Marsabit in February 1977 and have been active to the north around Moyale.

The method of communicating the intention of LMD to hold an auction, through the district administration, chiefs and sub-chiefs, is very effective and virtually all pastoralists had heard of the auction.

The livestock marketing systems in the study area, and in the whole of the country, are centred around cattle. There is some organised marketing of small stock, though on only a limited scale at present. There are no facilities for marketing camels.

There are two livestock holding grounds at Jaldessa, outside Marsabit. From Jaldessa animals are either trucked or trekked down the main road to the holding ground at Isiolo. From Isolo they can either be trucked straight to the Kenya Meat Commission slaughter house at Athi River or taken to the rail head at Nayuki.

The main constraints of livestock marketing are quarantine restrictions and the capacity of the holding grounds to keep animals while they are awaiting clearance to move south.

The present, though little used, system of LMD auctions being held at Marsabit has only a minimal effect in improving the price paid to the pastoralists and only those within easy reach of Marsabit benefit. The majority of the cattle sold at the February sales had probably been bought by traders from pastoralists in outlying areas and then moved by the traders to Marsabit for sale. If the activities of LMD are to have a real effect in increasing the price paid to the pastoralists, and therefore encourage commercial sales, it will be necessary for buyers to be much more mobile.

5.8.4 Hides

The majority of pastoralists use hides from cattle which have been slaughtered at home and do not sell them. In 1976 only 4,188 hides were officially sold in the whole of Marsabit District, though this

was over 1,000 more than the number sold the previous year (Republic of Kenya, 1976a). Over 70 per cent of these hides were good quality and graded at either Grades I or II; less than 10 per cent were given Grade IV.

At the main population centres, such as Gatab, the people have a knowledge of the value of frame drying hides, but only do so if they intend to sell them.

The practice of branding and cutting the skin of cattle would hinder any large scale development of the hide industry. Hides from such cattle would fetch low prices due to the poor grade they would get.

5.9 CONCLUSION

The general management and husbandry of cattle in the ALP study area is basically similar to that used in most of arid tropical Africa. The problems of production are also similar to many other pastoral areas, and it can be expected that the implementation of long term solutions will, similarly, be difficult.

There are, however, a great number of production, management and physiological characteristics of the cattle which warrant much closer investigation than was possible.

There is considerable potential for improving the management and marketing of cattle and ensuring the ecologically sound long term management of the vegetation, which forms the primary resource base of the area. Such improvements will need to be carefully planned and based on an integrated development approach which takes into account, not only the management of cattle, but all the other factors of the human, animal and vegetative environment.

6. Conclusions and Recommendations

6.1 THE PRESENT STATE OF THE GRAZING ECOSYSTEM

6.1.1 Ecology

The ALP study area in Marsabit District is not a self-contained, complete grazing ecosystem. Although there is a resident population of cattle which stays within the study area all year, its numbers are small and it probably contains less than 15,000 animals. A much larger number of cattle, approximately 200,000 animals, use the area only occasionally. These animals form part of a much larger ecosystem, of which the ALP study area is only one portion.

From both the ecological and economic points of view cattle are the most important grazing animals.

Although theoretical field-layer production estimates suggest that the area can support a much larger cattle population, practical experience shows that this is not so. For the majority of most years the field layer in lowland areas is reported to be virtually bare and the only really suitable forage for cattle is found in highland areas. Despite this, a number of cattle continue to use lowland areas, even during bad years, and must encroach on the woody vegetation used by browsing herbivores.

Lava boulders and high salinity soils, which together cover over 50 per cent of the area, do not support high levels of primary production. This is especially true for the shallow rooted plants which form the field layer. If these edaphic factors are coupled with low rainfall it is not surprising that the vegetation in the field layer is inadequate.

The main vegetative resource base of the grazing ecosystem is found on the highland masses around the periphery of the study area. Here there is higher rainfall and generally more productive soils. Unfortunately there is also over grazing and a consequent reduction in productivity.

In lowland areas the vegetation of the field layer around sources of permanent water is over-utilised and degraded. It should, however, be pointed out that many lowland areas which are not used at all by animals are also bare, due to low potential productivity rather than heavy utilisation.

6.1.2 Human Use of the Products of the Grazing Ecosystem

Although much of the area is basically unsuitable for grazing herbivores, and in particular cattle, these animals make an important contribution to the household economy of the pastoralists. A comparison of the numbers of different livestock classes which are available per person for three different tribes has been given by Fratkin (1977b) and is shown in Table 6.1.

Table 6.1 Ratio of Livestock to People for Three Groups

	Ariaal	Rendille	Samburu
Camels per person	1.85	2.6	0.02
Cattle per person	3.5	1.1	4.2
Small stock per person	10.0	7.2	3.5

Source: Fratkin, 1977b.

Apart from the Samburu, who do not make extensive use of lowland areas, the relative importance of cattle would appear to be greater than can be justified by the range conditions. The ratio of camels: small stock is 1:1.9:5.6 for the Ariaal and 1:0.4:2.8 for Rendille. No comparison has yet been made between the productivity of the field and browse layers, but it is unlikely that the relative productivity of the field layer is high enough to warrant such a ratio.

No detailed information on human consumption of the products of the grazing ecosystem was collected during the present study. The collection of such data requires long and careful observation and would form an essential part of a long term study of the grazing ecosystem. The pastoralists are the reason for the livestock being in the area and therefore the nutritional relationships between the people and their animals are, finally, as important as the relationships between livestock and vegetation. Recently a number of attempts have been made to define these relationships (e.g. Brown, 1971; Dahl and Hjort, 1976) but more information is required before these studies can be related to the situation in the ALP study area.

6.2 LIVESTOCK DEVELOPMENT

6.2.1 Range Management

The basic livestock development strategy for Marsabit District as outlined by FAO (1971), was to take the form of 'extensive range improvement incorporating grazing control, improved water supplies, marketing and transport facilities'. The whole strategy was based on the precondition that effective controls could be implemented. The fact that very few of the recommendations have been implemented is indicative of the problem of gaining effective control over stock numbers and grazing practices.

The District Development Plan (DDP) for the period from 1974–78 (Republic of Kenya, 1976a) presents less ambitious plans which are intended to improve animal health, water supplies and marketing systems; again, however, requiring effective control of grazing. The DDP plans involve an expenditure of a little over K£ 100,000 for the 1974–78 period, while the FAO plans envisaged a capital expenditure of some K£ 680,000 and annual recurrent cost of approximately K£ 100,000.

There can be little doubt that at present there is virtually no scope for commercial ranching enterprises within the study area. It is equally unlikely that it would be possible to establish viable group ranches in the near future.

The establishment of group ranches should, in theory, give people the responsibility and control of a clearly defined area and therefore induce them to manage the grazing resource more carefully than at present. However, in order for such a group ranch to be ecologically and economically viable it would have to be extremely large, perhaps at least half a million hectares, and would have to include a portion of highland as well as lowland grazing. The finance, organisation and internal co-operation required for such a venture would have to be on a very large scale. Experience from more productive parts of Kenya, where group ranches have been developed, suggests that such a venture in Marsabit District would, at present, be unlikely to succeed.

It is therefore likely that in the near future any development in the livestock sector will be centred around the present traditional, subsistence-orientated production systems. The social changes and economic demands which would result from any large scale market-orientated development would, at present, be too great and inappropriate.

The Range Management Division of the Ministry of Agriculture is undertaking some extension work in the district, informing pastoralists of the value of rotational block grazing. This work is done in preparation for the possible development of grazing blocks in the district at a future date.

6.2.2 Marketing

The management and development of cattle, the most important grazing herbivore and most marketable livestock species, should not be undertaken in isolation from other livestock species. In fact there are arguments which suggest that there are good reasons to recommend the development of non-bovine marketing as more important than cattle development and marketing. These reasons are based on the fact that, although there are many cattle in the study area, most of the rangeland is unsuitable for cattle production. Any further development of cattle marketing will reinforce the tendance of the pastoralists to invest surplus money in cattle rather than in camels or small stock, which are better adapted, and will therefore accelerate the rate of range degradation. A shift of emphasis from cattle to camels and small stock marketing would be in the interest of maintaining the productivity of the area.

The overall marketing strategy needs to be related to the district and national strategy, and this is centred around cattle. There are, however, plans by various agencies to investigate the possible development of camel and small stock marketing.

A shift in emphasis of the sort described here will inevitably take time. Until this happens, opportunities for increasing cattle sales should be developed.

It has already been stated that pastoralists would be willing to sell their animals if they could get a better price than that currently offered by traders. There is little doubt that government buyers would be able to offer improved prices and would encourage people to sell. It would, however, be necessary for buyers to move around the area and visit the outlying population centres in order to buy cattle. If such visits could be established on a regular basis the commercial offtake of cattle could be greatly increased. One problem which this system would create would be the handling of cattle once they had been bought. Although it would probably be necessary for the government to establish more holding grounds in the area, the ideal solution would be to move the cattle out as quickly as possible. Whether this could be done would depend on the current quarantine restrictions and the economics of trekking relatively small numbers of cattle.

6.2.3 Hides

The development of hides and skins marketing could do much to encourage the people towards appreciating the value of money. Simple drying frames could be erected in the main population centres, where commercial goods can be purchased, and the pastoralists encouraged to frame-dry hides and skins for sale. This is a form of development which is cheap and simple to implement. The extension work required would also be minimal.

6.2.4 Integration

As the management of the animals of the grazing ecosystem cannot be approached in isolation from the other herbivores, so the development of the livestock sector should not be attempted without considering other aspects of development.

From the point of view of livestock, especially cattle, the most important factor is water development. The location of boreholes and dams must be related to carrying capacity. The deleterious effect of creating permanent sources of water can be seen throughout the study area. Ideally some form of controlling the number of animals which use each water source needs to be found, but no such method has yet been effectively developed in pastoral Africa. An example of an attempt to overcome this problem is found in Huri Hills. Here water development is taking place around the base of the hills, away from the main grazing areas on the top (Anderson, 1977).

Many other aspects of life in the area, health, security, afforestation, roads and education are all related to the livestock sector and all could, and should, be brought into an overall plan.

Planning the future management of the ALP study area as a single geographical entity in isolation will be both difficult and impracticable. It has been shown that as far as cattle are concerned the area does not represent a self-contained ecosystem; this is likely to be so for other classes of stock as well. However, this is also true for the whole of Marsabit District. The difference between the ALP study area and Marsabit District is that the district represents one administrative unit, through which management might be implemented; the ALP study area does not have this advantage.

6.3 WILDLIFE

6.3.1 Tourism

When compared to other parts of Kenya the densities of wild grazing herbivores and other game animals are low. The potential for game viewing is therefore limited. However, the fact that the area includes two tourist centres, Loiengalani and Marsabit, means that a number of tourists use the area. The Ministry of Tourism and Wildlife has plans to develop the tourist industry in Northern Kenya, including the ALP study area.

Due to the recent ban on game hunting the contribution to the economy made by grazing herbivores in the area can be expected to be minimal.

6.3.2 Game Domestication

In a recent UNESCO–MAB publication it was stated that 'there is no current evidence to suggest that oryx could one day be domesticated in the same way as zebu cattle' (Gillet, 1975). Work which has been carried out at the Galana Game Ranch Research Project in south eastern Kenya has now shown that it is possible to domesticate and manage fringe-eared oryx (*O.b. callotis*) in the same way as zebu cattle. It has also been shown that in arid environments these animals can make better use of the available vegetation and water, and under such conditions are more productive than cattle (Field, 1975; King *et al*, 1975, 1977; King and Heath, 1976, Lewis, 1977).

There can be little doubt that oryx offer a considerable potential in the development of the ecologically sound use of the field layer. The domestication of beisa oryx in Marsabit District merits investigation and a practical trial.

6.4 LONG TERM MANAGEMENT

Much has been written in recent years about the long term management and development of arid areas, the problems facing pastoralists and the causes of desertisation (e.g. Sherbrooke and Paylore, 1973; UNESCO, 1975; Monod, 1975). It is generally accepted that there is no easy solution to the problems and that very often ill-conceived attempts to offer short term solutions do more harm than good (Baker, 1975).

The long term management of the grazing ecosystem is an integral part of overall management.

A summary of the long term problems facing the people and the environment in Marsabit District has been presented by Lamprey (1977). Although immediate problems, such as famine relief, are very real, the provision of relief food offers no solution to the underlying problem and does nothing to guarantee the nutritional stability of future generations.

The long term development of the grazing ecosystem must be based on the strategy of minimising the importance of cattle in the lowland areas and improving their management in the highland areas. This can only be done by increasing the attractiveness of investing in camels and small stock or, which is even more desirable, encouraging the development of more cash orientated economy and thereby reducing the need to have investments 'on the hoof'.

Any development of the grazing ecosystem and the livestock sector will be of little value without a control of the demands made upon the resources of the environment. This inevitably means a limit on livestock numbers and the size of the human population. An understanding of the relationships between the environmental resources and animals, and between animals and people is vital to the long term management of the area. This understanding can only come about by the sort of integrated studies proposed by the Arid Lands Project.

6.5 FURTHER STUDY OF THE GRAZING ECOSYSTEM

Despite the fact that much of the area is unsuitable for grazing herbivores these animals form an important part of the ecology of the study area. If the role of these animals is to be fully understood further study is required. Using the animals as the pivot the relationships between them and the vegetation and between them and the people need to be defined.

The terms of reference for a long term study of grazing ecology are given in Appendix II. A brief expansion of some of the more important points is given below.

6.5.1 Vegetation

The productivity of the vegetation is considerably less than that estimated using generalised assumptions. The reasons for this need careful investigation and an analysis of production in the different plant communities should be undertaken. The effect of utilisation on production also needs to be investigated, as some areas are heavily used and other areas only slightly used. The growth stage of the vegetation at the time of use could also be an important factor in determining subsequent productivity.

The effect of closure should be investigated with a view to establishing the most suitable time of year and the duration of closure. This would produce information which would be invaluable when planning rotational grazing.

The offtake of vegetation of the field layer will need careful measurement and should be undertaken on both an intensive and extensive scale. Intensive measurements will be used to show the offtake of particular species, while extensive measurements will show the effect of all animals on the field layer.

6.5.2 Animals

Clarification of the grazing patterns is necessary and detailed information on the movements of both permanent and temporary herds will be required. Information on reproduction, recruitment, mortality and offtake will be very important and will need to be related to the different management systems used

as well as to varying climatic conditions. Disease investigation has not been included in the terms of reference as this should form a specialised study of its own. Characteristics of the breeding behaviour and biology of the cattle need closer investigation and, if possible, pregnancy diagnosis of cattle should be undertaken.

Another aspect of grazing ecology in the study area which merits close investigation is the management of the Huri Hills and the apparent fact that cattle go for 60 days without drinking free water.

6.5.3 People

A determination of the contribution made to the pastoral economy by grazing herbivores will be an essential part of the study. As other classes of stock also contribute, a high level of integration with the other members of the study will be necessary if meaningful data are to be collected. As with the other facets of the study data will need to be analysed in terms of different groups and different seasons.

REFERENCES

AUTHOR	DATE	TITLE	SOURCE
Anderson H.	1977	Rehabilitation of the Huri Hills.	UNESCO 1977a, pp. 21–22.
Baker R.	1975	'Development' and the pastoral people of Karamoja, North Eastern Uganda. An example of the treatment of symptoms.	Monod. 1975, pp. 187–205.
Baxter P.T.W.	1954	Social organisation of the Boran of Northern Kenya.	D. Phil. Thesis, Oxford University.
Bille J.C.	1971	Etude d'un écosystème sub-désertique. Principaux caractères de la végétation herbacée du Sahel Sénégalais.	ORSTOM, Paris.
Brown E.S. and Dewhurst C.F.	1975	The genus *Spodoptera* (*Lepidoptera, Noctuidae*) in Africa and the Near East.	Bull. ent. Res., 65:221–62.
Brown L.H.	1963	The development of the semi-arid areas of Kenya.	Mimeo report, Ministry of Agriculture, Nairobi.
Brown L.H.	1971	The biology of pastoral man as a factor in conservation.	Biol. Conserv., 3:93–100.
Dahl G. and Hjort A.	1976	Having herds; pastoral herd growth and household economy.	Stockholm Studies in Social Anthropology. University of Stockholm, Sweden.
Edwards D.C. and Bogdan A.V.	1951	Important grass land plants of Kenya.	Pitman, Nairobi.
FAO	1971	Range Development in Marsabit District.	AGP: SF/KEN 11. Working Paper 9, Nairobi.
Field C.R.	1968	Methods of studying the food habits of some wild ungulates in Uganda.	Proc. Nutr. Soc., 27:172–7.
Field C.R.	1975	Climate and food habits of ungulates on Galana Ranch.	E. Afr. Wildl. J., 13:203–20.
Fratkin E.	1977a	Health and disease in Ariaal Rendille.	UNESCO, 1977a, pp. 42–5.
Fratkin E.	1977b	The dual camel-cattle economy of the Ariaal Rendille.	IAS, 1977.
Gillet H.	1975	Plant cover and pastures in the Sahel.	UNESCO, 1975, pp. 21–7.

Grumm A.	1977	Rendille Settlements.	UNESCO, 1977a, pp. 41.
Hunting Technical Services	1974	Southern Darfur Land Use Planning Survey. Annex 3: Animal resources and range ecology.	Min. of Agriculture, Food and Natural Resources, Khartoum.
Hunting Technical Services	1976	Tigrai Rural Development Study. Annex 5: Livestock and range ecology.	Government of Ethiopia, Addis Ababa.
IAS	1977	Pastoral societies in Kenya.	Seminar, March 1977. Institute of African Studies, University of Nairobi.
King J.M., Kingaby G.P., Colvin J.G. and Heath B.R.	1975	Seasonal variation in water turnover by oryx and eland on Galana Game Ranch Research Project.	E. Afr. Wildl. J., 13:287–96.
King J.M. and Heath B.R.	1976	Game domestication for animal production in Kenya.	World Animal Review 16:23–30
King J.M., Heath B.R. and Hill R.E.	1977	Game domestication for animal production in Kenya: Theory and practice.	J. agric. Sci., (in Litt.)
Lamprey H.F.	1977	Summary.	UNESCO, 1977a, pp. 61–3.
Le Houérou H.N.	1972	An assessment of the primary and secondary production of the arid grazing lands ecosystems of North Africa.	International symposium on the ecophysiological bases of arid zones ecosystems productivity, Leningrad. FAO AGPC. MISC/5.
Le Houérou H.N. and Hoste C.H.	no date	Relationships between rangeland production and average rainfall. Part II: The Sahelian and Sudanian zones of Africa.	Mimeo report, ILCA, Addis Ababa.
Lewis J.G.	1977	Game domestication for animal production in Kenya: Activity patterns of eland, oryx, buffalo and zebu cattle.	J. agric. Sci., (in Litt.).
Mason I.L. and Maule J.P.	1960	The indigenous livestock of Eastern and Southern Africa. Commonwealth Bureau of Animal Breeding and Genetics.	Technical communication No. 14, England.

Monod T.	1975	(Ed.) Pastoralism in tropical Africa.	23rd International seminar, Niamey. Published for International African Institute by Oxford University Press.
Morrison F.B.	1950	Feeds and Feeding.	Ithica, U.S.A.
Norton-Griffiths M.	1975	Counting Animals. Eds. J.J.R. Grinsdell and H.T. Russell.	African Wildlife Leadership Foundation, Nairobi.
Payne W.J.A.	1970	Cattle production in the tropics. Volume I, Breeds and Breeding.	Longman.
Pratt D.J. Greenway P.J. and Gwynne M.D.	1966	A classification of East African Rangelands.	J. Appl. Ecol., 3:369–82.
Rainy M.	1977	Preliminary analysis of a continuous 71 year record of a single Rendille sub-clan settlement group.	UNESCO, 1977a, pp.45–8.
Republic of Kenya	1976a	Annual report of the Veterinary Department, Marsabit District.	Mimeo report.
Republic of Kenya	1976b	Marsabit District Development Plan 1974–78.	Mimeo report, Marsabit.
Sherbrooke W.C. and Paylore P.	1973	World desertification; cause and effect.	Arid Lands Information Paper No.3, University of Arizona.
Siefert	1975	Animal production and health in the Sahelian zone.	UNESCO, 1975, pp.55–60.
Sobania N.	1977	A history of the Lake Turkana region c1840–1920.	UNESCO, 1977a, pp.36–8.
Spencer P.	1965	The Samburu. A study of gerontocracy in a nomadic tribe.	Routledge and Kegan Paul, University of California Press.
Spencer P.	1973	Nomads in Alliance.	Oxford University Press.
Spinks R.	1967	East African Livestock Survey; Development requirements. Volume I.	FAO, 215 pp.
Torry W.	1973	Subsistence ecology among Gabra; nomads of the Kenya-Ethiopia frontier.	Ph.D. Thesis, Columbia University.
UNESCO	1975	The Sahel; ecological approaches to land use.	MAB technical notes, Paris.

UNESCO	1977a	Man and the environment in Marsabit District. Proceedings of symposium held at Mt. Kulal, December 1976.	Mimeo report, Nairobi.
UNESCO	1977b	UNESCO/UNEP Arid Lands Project, Mt. Kulal.	First Annual Report, Mimeo, Nairobi.
UNEP	1977	UNEP-MAB Integrated Project in Arid Lands (IPAL). Phase III 1977-80.	Regional Document, Nairobi.
Watson R.M.	1970	Aerial livestock surveys for Marsabit and Isiolo Districts.	Mimeo report, Ministry of Agriculture, Nairobi.

Appendices

I Cattle and Donkey Survey

Date .....

Tribe	Present Location		
Owner	FORA/GOP		
No. of people in camp:	Males	females	children
Movement in past 12 months:			
1. GOP:			
2. FORA:			
Herded by	No. milangos		
CATTLE			
Total No. cattle in manyatta		Types	
Number	Males	Castrates	Females
Under 1 year			
1 – 2 years			
2 – 3 years			
Greater than 3 years			
Pregnant females	Lactating females		Both
No. with vaccination ear mark/brand			
No. killed and eaten during past 12 months		Ceremonial	Other
No. sold during past 12 months		Price	
No. died during past 12 months		Stolen	
		Stray	
What cause of death?			
Special feeding?	Medicine?	Salt?	
How often drinking at present?		Where?	How far away?
Any selection of animals to be castrated?			
What age are calves weaned?			
How often are cows milked each day?			
If a cow is giving only a little milk do they stop milking it and let the calf have all the milk?		YES/NO	
Are cows ever reluctant to let their milk down?			YES/NO
If they are, is there anything that can be done to encourage milk let-down?			
How many calves can a cow produce in her life?			
	Maximum		
	Average		
How many of the 'Average' number of calves survive to have calves of their own?			
At what age do cows have their first calf?			
Do the cattle produce calves all the year round or are there special seasons when calves are born?			

For how long do cows lactate? Good year Bad year
During bad years do they try and exchange their cattle for camels, sheep or goats?

If a cow dies or is slaughtered, what do they do with the hide?
1. keep it?
2. sell it? Price
Does he know of the Government's Veterinary Department? YES/NO
Has he ever had his animals vaccinated? YES/NO
If YES, where? when?
If NO, why not?

Has he ever had any other contact with the Veterinary Department? YES/NO
If YES, give details

What determines the areas used to graze cattle?
Water Ticks
Grass Security
Traditional Grazing Areas
What could be done to help improve cattle production?

Does he ever sell cattle for cash? YES/NO
If YES, what sort or stock does he sell and what price does he get
To whom does he sell his stock?
Where?
Is there any reason why he would not sell cattle for cash if a good price could be obtained?

Any special customs or beliefs associated with cattle?

DONKEYS
Total No. donkeys in Manyatta

Number	Males	Castrates	Females
Under 1 year			
1--2 years			
2--3 years			
Greater than 3 years			
Pregnant females	Lactating females		Both
No. sold in past 12 months	Price		
No. died in past 12 months	Stolen		
	Stray		

Cause of death
Special feeding? Medicine? Salt?
How often drinking? Where? How far away?
Are they herded with other animals or by themselves?
What are the donkeys used for?
How often are they used?
At what age are foals weaned?
How many foals can a female produce during her life?
Maximum
Average
At what age do they have their first foal?
Any special customs or beliefs associated with donkeys?

II Terms of Refererence for Long Term Study

The study will investigate and describe in detail the grazing ecology of the study area. The results of the study will be integrated with the other ecological studies underway in the area and will help in forming long term, ecologically sound plans for the management and rehabilitation of the arid zone in northern Kenya. The duration of the study should be three years.

The study will be required to:–

1. Define and map the different plant communities used by grazing herbivores.

2. Determine the productivity in each community and relate the findings to soil type, rainfall and usage.

3. Determine the effect of closure from grazing on each plant community.

4. Monitor changes in the numbers, densities and distribution of grazing herbivores in the study area.

5. Relate the information collected in (4) to changes in vegetation and water distribution and other factors.

6. Collect and analyse data on the food habits of the important grazing herbivores and relate the findings to the availability of vegetation and the nutritional requirements of each species.

7. Determine the quantity and quality of the vegetation removed by animals from the field layer.

8. Determine the effects of different grazing intensities on the vegetation of the field layer.

9. Observe and record invertebrate use of field layer vegetation.

10. Determine the herd structure of the important grazing herbivores.

11. Collect and analyse data on the reproduction, recruitment and mortality of grazing herbivores. Relate this information to the different areas used and different forms of management.

12. Measure production and use of milk, blood and other products from domestic herds.

13. Measure offtake from domestic herds.

14. Relate the findings of (12) and (13) to human requirements and the contribution made by non-grazing animals and other food sources to human nutrition.

15 Investigate local animal husbandry practices.

16. Analyse the role of grazing herbivores in the pastoral economy.

17. Determine the water use and requirements of grazing herbivores.

18. In co-operation with other members of the project assist in describing the total ecology of the study area and in formulating future management plans.

19. Wherever possible assist the local people and development agencies in improving the management of livestock and range resources in the area.