Ministry of Tourism & Wildlife

Kenya Rangeland Ecological Monitoring Unit (K.R.E.M.U.)

Distributions & Population Trend of Elephants and Rhinoceros in Kenya: 1977-1981

by
J.G. Stelfox
J.W. Kufwafwa
W.K. Ottichilo

KREMU, TECHNICAL REPORT NO. 43
APRIL 1981

DISTRIBUTIONS & POPULATION TREND OF ELEPHANTS AND RHINOCEROS IN KENYA: 1977 - 1981

J.G. STELFOX
Senior Surveys Biologist

J.W. KUFWAFWA
Senior Aerial Biologist

&

W. OTTICHILO
Aerial Biologist

MINISTRY OF ENVIRONMENT AND NATURAL RESOURCES
KENYA RANGELAND ECOLOGICAL MONITORING UNIT
NAIROBI, KENYA

KREMU TECHNICAL REPORT SERIES NO. 43

20 April 1981

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Figure **Page**

SUMMARY

Baseline information on the populations and distributions of the African elephant (Loxodonta africana) and the black rhinoceros (Diceros bicornis)was obtained during KREMU's 1977 and 1978 aerial surveys of all pastoral rangelands in Kenya. Population trends were determined by comparing population estimates for 1977 and 1978 for the entire rangelands and also comparing these values with results from 1980 surveys in South Kenya, and 1981 surveys results from North Kenya.

The aerial surveys were conducted along straightline transects in which the two rear-seat observers counted all animals observed within a strip of land 112 m wide on each side of the aircraft while the Cessna 185 aircraft flew at 91 m (300 ft) above ground level at a speed of 150 kph. Transects were spaced 10 km apart in 1977 (2.2% sampling intensity) and 5 km apart in 1978 (4.4% sampling intensity). During 1980 & 1981 surveys were conducted with two Partenavia aircraft. The 1980 strip width was 125 m on each side of aircraft (5.0% sampling intensity), while in 1981 North Kenya surveys, the strip width was 200 m, giving a sampling intensity of 8.0%.

The 1977 and 1978 surveys of South Kenya were conducted during the wet (January - May) season while the 1980 surveys were during the dry (July - October) season. The North Kenya surveys in 1977 and 1978 were dry (August-October) season while the 1981 surveys were wet (February-April) season. This provided useful information on the distributions of animals during both wet and dry seasons.

Minimum and maximum populations of elephants for all of Kenya were 64,800 - 97,600 in 1977 compared to 49,300-77,000 in 1978 and 39,700 - 55,000 in 1980-81. The 1978 population was 73.5% of that in 1977 showing a significant decline in the population in one year. The ratios of live to dead elephants decreased from 80:20 in 1977, 67:33 in

1978 and to 58:42 in 1980-81, providing further evidence of a declining population. All except 5,000-10,000 of these elephants were on the 500 000 km^2 pastoral rangelands with most occurring in the South Central, East Central-Coastal and South-East regions especially in the Hola, Ijara, Tsavo, Lamu, Mtito Andei and Jipe eco-units. Their numbers were also relatively high in the Laikipia, Meru and Mara eco-units.

The 5,000-10,000 present in the Agricultural Zone were present mainly in the Aberdare and Mt. Kenya National Parks (2,000 in each), Mt. Elgon and the Mau Forest.

Within the South Kenya rangelands, the elephant population declined by 42.3% from 52,000 in 1977 to 30,000 in 1980. About 50% of the South Kenya population occurred in the South East eco-region. Populations in each of the South East and the East Central-Coastal eco-regions declined by about 8,000 elephants between 1977 and 1980. The reduction was especially noticeable in the Lamu eco-unit. Elephant population increased by 26.5% from 7343 in 1977 to 9286 in 1981 within the North Kenya Rangelands. About 69% of the entire North Kenya population was in North Central eco-region C. In the Northern Rift Valley eco-region A, an increase of 67.6% between 1977 and 1981 was observed, but a decrease was noticed in the North Turkana eco-unit. In the Northern Volcanics, eco-region B, a decrease was noticeable, and more so in the Chalbi eco-unit where no sightings were made during the 1978 and 1981 surveys.

The North East eco-region D was not surveyed in 1981 due to security reasons, but Meru and Garissa eco-units were included in the 1980 South Kenya surveys.

Major differences in seasonal distributions of both elephants and rhinoceros are shown on distribution maps in this report.

Maximum populations of rhinoceros were 3636 in 1977, 1468 in 1978 and 1100 in 1980-81 for the entire

rangelands of Kenya. Another 300 animals existed in portions of the Agricultural Zone such as in the Aberdares.

For the entire rangelands, the rhinoceros population declined 60% during the 1-year period of 1977 to 1978 while in South Kenya the population declined a further 35.9% between 1978 and 1980. The greatest reduction occurred in the South East eco-region, especially the Tsavo, Mtito Andei and Jipe eco-units.

The 1980/81 population of rhinoceros throughout Kenya was probably about 1400 animals.

The distribution of rhinoceros continued to decline in South Kenya and they were observed in 8 eco-units in 1977, 7 in 1978 and only 4 in 1980. None were observed during the North Kenya surveys in 1981.

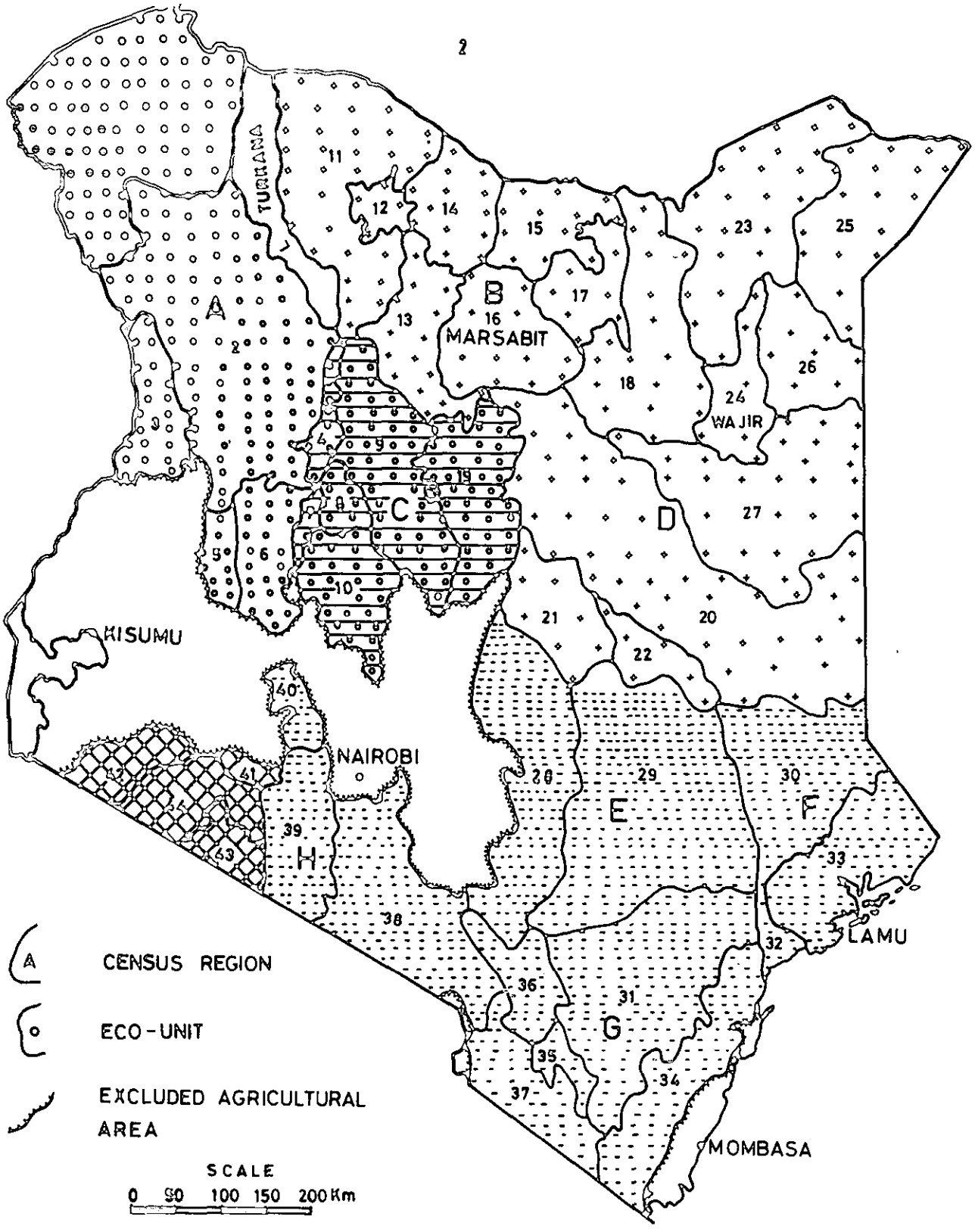
The very low and declining population of rhinoceros and their shrinking distribution presents a grave situation that warrants increased action to arrest and reverse this trend especially in Tsavo, Mtito Andei, Jipe, Hola and Meru eco-units. The downward trend in elephant numbers, although not as alarming as for rhinoceros and a trend that has slowed-up between 1978 and 1980/81, is still critical enough to warrant increased conservation measures.

KREMU should continue to monitor the populations and distributions of elephants and rhinoceros throughout the Kenya rangelands on a periodic basis for example once every three years. For the smaller, major ranges of these species, more detailed sampling is required, e.g. a sampling intensity of 25-30% once every five years.

1.0 INTRODUCTION

Global concern over the rapid depletion in numbers of African elephants (Loxodonta africana) and black rhinoceros (Diceros bicornis) and of their future welfare have resulted in special studies on their populations and distributions in Africa. One study initiated in the late 1980's by IUCN examined current and past populations and distributions of African elephants as well as reasons for population changes (Douglas-Hamilton 1979). Another study under the auspices of IUCN (International Union for the Conservation of Nature and Natural Resources), SSC (Survival Service Commissions African Rhino Group) and WWF (The World Wildlife Fund) examined past and present numbers of rhinoceros throughout the World. In Kenya, KRAG (Kenya Rhino Action Group) compiled information on rhino populations in Kenya and examined ways of reversing the drastic declines in rhino numbers (Hillman 1980).

The Kenya Rangeland Ecological Monitoring Unit (KREMU) is the Government agency responsible for monitoring livestock and wildlife populations and distributions throughout the rangelands of Kenya (Fig. 1). As part of this on-going monitoring programme, it is able to determine changes in elephant and rhinoceros populations and distributions every three years. South Kenya (Eco-regions D,E,F,G & H) is surveyed once every three years (1977,1980, 1983, 1986 etc.) and so is North Kenya (Eco-regions A,B,C & D) during 1978, 1981, 1984, 1987 etc. From these aerial surveys which collect information on populations of livestock and wildlife in relation to various environmental attributes (cultivation and crops; tree, shrub and herbaceous (grasses and herbs) cover; abundance of water bodies; rangeland burns etc.). KREMU is able to document changes in elephant



1977-1978 AERIAL CENSUS PROGRAMME

- 77-01 (JAN-MARCH)
- 77-02 (APRIL)
- 77-03 (MAY)
- 77-04 (AUGUST)
- 77-05 (SEPTEMBER-OCTOBER)
- 77-06 (NOVEMBER)

CENSUS REGIONS

- A NORTHERN RIFT VALLEY
- B NORTHERN VOLCANICS
- C NORTH CENTRAL
- D NORTH EAST
- E SOUTH CENTRAL
- F EAST CENTRAL-COASTAL
- G SOUTH EAST
- H SOUTH WEST

Fig. 1. KREMU'S 1977-1978 aerial survey programme.

and rhinoceros populations with associated land-use changes. Also recorded during these aerial surveys is information on numbers of elephant carcasses (fresh, bones, rot-patches) which is useful in documenting rates of mortality. Information on habitat preferences and the interspecific spatial arrangements for various wildlife and livestock species is also collected and will be analysed and reported on at a later date.

In 1979, KREMU produced it's first report on distributions, densities and trends of elephants and rhinoceros in Kenya for the period 1977 - 1978 (Stelfox et al 1979). This report is an update of KREMU Technical Report Series No. 24 and it includes the results from 1980 surveys throughout South Kenya and 1981 North Kenya Surveys.

In Kenya, elephant numbers had declined from 167,000 in 1973 to 68,425-71, 419 in 1976/77 (Hillman 1977). For the Tsavo, Garissa/Lamu and Tana River ecosystems the population declined 55% from 1973 to 1976. Direct hunting of elephants by man appeared to be the major cause of the recent declines (Hillman 1977). KREMU estimated that elephant numbers throughout Kenya declined from 59,800 - 87,600 in 1977 to 44,300 - 67,000 in 1978, a 26.5% decrease in one year (Stelfox et al 1979).

Rhinoceros populations in Kenya declined from 16,000 - 20,000 in 1969 to 1,500 - 2,000 in 1979 (KRAG 1979). KREMU calculated their numbers had declined by 60% in one year from 3636 in 1977 to 1460 in 1978 for the rangelands (Stelfox et al 1979). Another 300 were estimated to be present in the Agricultural Zone in 1978 (Fig. 1). This spectacular decline from 1969 to 1978 was primarily due to heavy poaching as the price of rhinoceros

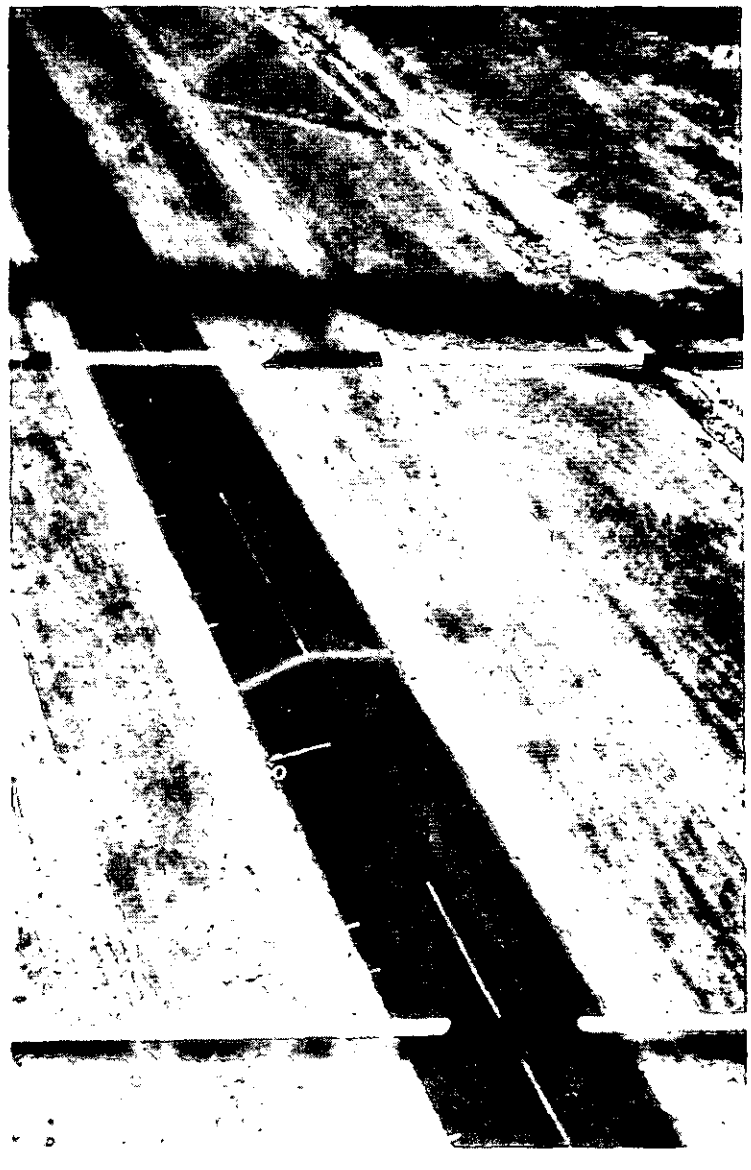


Fig. 2. Census strip method used by KREMU showing strut rods used to define the census strip for counting herbivores.

horn rose from $ 33/kilo in 1972 to $ 308/kilo in 1978 on the world market. In 1979 in S.E. Asia, the minimum wholesale price was $ 675/kilo, from $.35/kilo in 1976,(Hillman 1980) a 2000% increase in four years. A total of about 24 tonnes of rhinoceros horn was shipped overseas from East Africa between 1970 and 1976 which represented 8,280 rhinoceros while the 1980 entire African population was only 14,000 - 24,000 (Hillman 1980). For Tsavo National Park and adjacent area, the 1979 population of 50-200 rhinoceros was only 1.7% of the 1969 population of 6,000 - 9,000 (KRAG 1979 & Cobb 1976).

The purpose of this report is to present results obtained on these two species from KREMU's aerial surveys in 1977, 1978 and 1980/81. The results cover all the rangelands (500 000 km^2) or about 80% of Kenya (Fig. 1). Estimates are also given for the other 20% of Kenya, known as the High Potential Agricultural Zone, based on information obtained from the Kenya Game Dept. and National Park Wardens.

For details on populations and distributions of all wild and domestic herbivores throughout South Kenya in 1980, the reader is referred to KREMU Technical Report Series No. 33 (Kufwafwa et al 1981). A detailed study of elephant population trends and mortality factors in the Tsavo ecosystem for the period 1975-1980 is presented in KREMU Tech. Report Series No. 40 (Ottichilo 1981).

METHODS

In 1977, all the rangelands of Kenya were surveyed along east-west aerial transects spaced 10 kilometers (km) apart. The survey height was 300 feet (ft) above ground

level and the average strip width was 112 m on either side of the aircraft or 224 m for both sides. This provided a 2.2% coverage of the entire 500 000 km^2. The southern portion of Kenya was surveyed from January to May and the northern portion from August to November.

In 1978, the same rangelands were surveyed in exactly the same manner except that transect spacings were 5 km thus increasing the sampling intensity from 2.2 to 4.4%. The total areas surveyed were 11000 km^2 in 1977 and 22,500 km^2 in 1978.

During July - October 1980, South Kenya (Eco-regions D,E,F.G.H) were surveyed in the same manner as in 1978 except that the strip width was widened slightly and the sampling intensity increased to 5%. This resulted in a total area covered of 18,980 km^2.

The North Kenya survey, February - April 1981 covered A,B and C eco-regions. The survey was conducted at 400 ft A.G.L. with a total strip width of 400 m (200 m on either side of the aircraft) and a 5 km transect spacing. The resulting sampling intensity was 8% covering 14,588 km^2 of rangeland.

Three Cessna 185 aircraft were used to fly the surveys in 1977 and 1978, while two Partenavia aircraft were used in 1980 & 1981. Each aerial crew consisted of a pilot, front-seat observer who recorded information on the rangelands, and two rear-seat observers who counted all livestock and wild herbivores within the census strips. The eight aerial observers (4 pairs) received intensive training in 1976 and all were involved throughout the 1977 and 1978 surveys, thus providing continuity of observers and minimising human bias during these two years. These same observers, assisted by another observer recruited in 1979, did the counting in 1980 and 1981. The census strips on either side of the aircraft were delineated by two rods extending back from the wing struts and the strips were calibrated by photographing the strip widths projected onto the

Keekorok airstrip which had been marked off into 20 metre (m) portions (Fig. 2). All groups of 10 or more animals were photographed as well as counted visually. The visual counts were later corrected from counts of the photographs. All sightings were recorded on tape recorders and then transcribed to data sheets. The analysis was conducted by KREMU's Data Management Section and Aerial Observers, who determined the population estimate, standard error and confidence limits for each species using Government of Kenya IBM 370 Computer at the Central Bureau of Statistics, Nairobi, and also using KREMU's computer facilities.

RESULTS

Elephants *(Loxodonta africana)*

1. Distribution by eco-regions and eco-units - Originally distributed throughout most of Kenya, the elephant is now mainly found in the Woodland, Wooded and Bush Grassland vegetation types of the South Central, East Central-Coastal and South East Regions especially in the Hola, Ijara, Tsavo, Lamu, Mtito Andei and Jipe eco-units of 29,30,31,33,36 & 37 (Figs. 1 & 3). They are also widely distributed in eco-unit 10 (Laikipia) of the North Central region, eco-unit 21 (Meru) of the North East region and 44 (Mara) of the South West region.

For the Northern Rift Valley, the north, the north-west portion of eco-unit I (N. Turkana) was not surveyed in 1978 because of logistical problems following the loss of a second KREMU aircraft on October 13th. Thus no data was available for that unit to compare with 1977. We assume that the transitory population which periodically migrates to the Magila Range and Songot Mountain area from Kidepo Valley National Park in Uganda and were estimated to number 1,585 animals in 1977 was still using the Kenya range in 1978.

For the forested areas of the Agricultural Zone (Fig. 1), most elephants were located in the northern

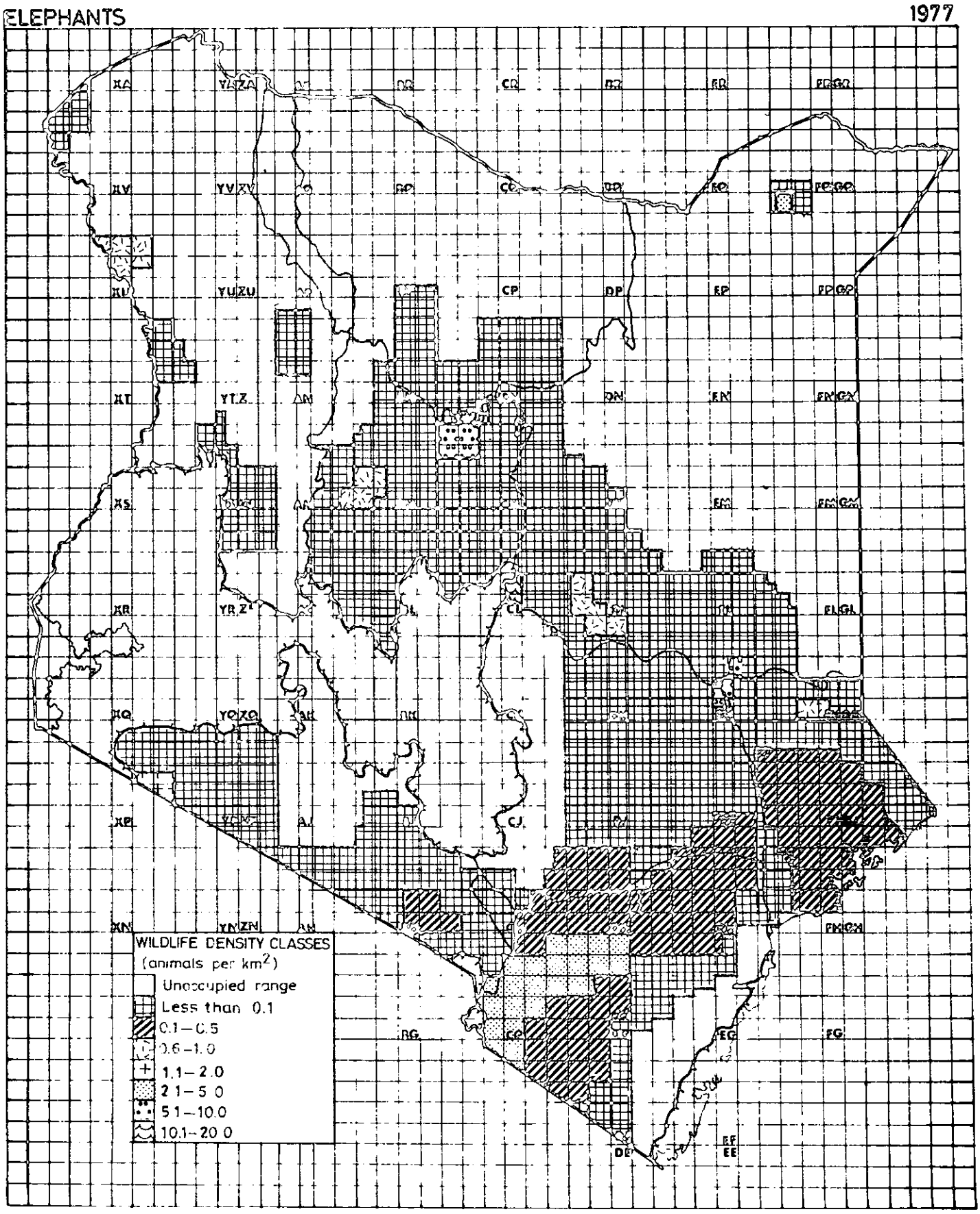


Fig. 3a. 1977 distributions and density zones for elephants throughout the rangelands of Kenya.

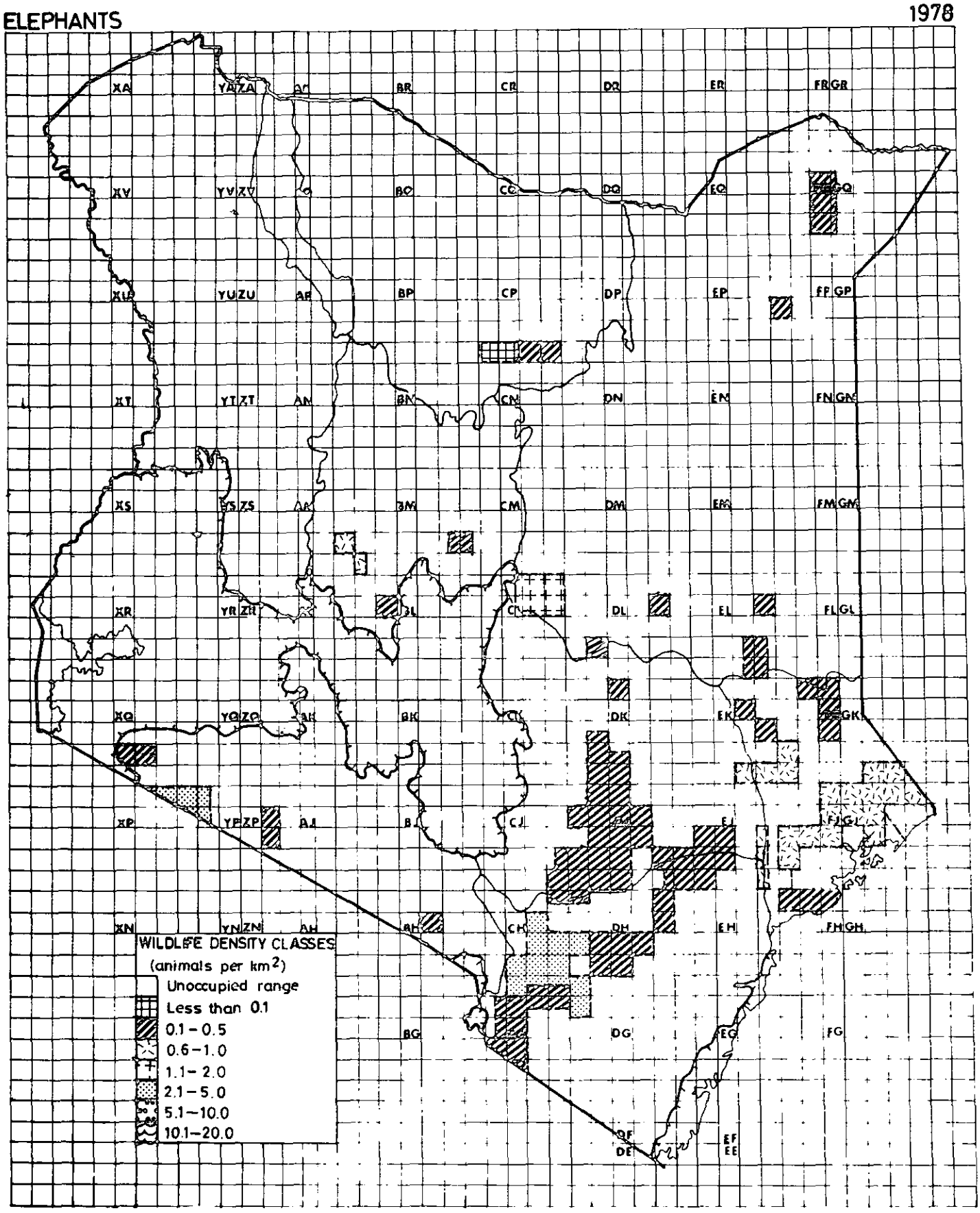


Fig. 3b. 1978. distributions and density zones for elephants throughout the rangeland of Kenya

portion of the Aberdare Range, the Mt. Kenya Forest, Mt. Elgon and the Mau Forest. Actual numbers were not known but it was estimated that up to 10,000 elephants were in this zone, based on estimates of 2000 in each of Mt. Kenya and Aberdare National Parks (pers. comm. Park Wardens April 1979). As mentioned earlier, the E. Afr. Wildl. Soc. stated in their 1977 report that elephants were declining in the Agricultural Zone due to poaching, drought and habitat distruction.

Although most elephants occur in National Parks and Reserves, some other areas such as Laikipia, Mt. Elgon, coastal forests and mountainous regions in northwestern Kenya still support many animals. They are well adapted to many habitat and landform types, ranging from the low coastal forests to the high upland mountainous forests and from cool, dense forests to the hot, arid, grassy shrublands. Recently, their distributions have been curtailed and they are now mainly confined to protected lands and those areas unaltered or lightly changed by man's activities.

Fig. 4 compares distributions in South Kenya, during the wet (January-May) season in 1978 with that during the dry (July-October) season in 1980. It can be seen that distributions were similar for both years and during both seasons. One major difference is seen in the greater concentration of elephants in the southern portion of Tsavo East and Tsavo West during the dry season.

2. Population estimates and trends: 1977-1978 - Table 1 shows the numbers of animals counted, the uncorrected population estimates and standard errors for each eco-unit and eco-region of the rangelands of Kenya. Results are presented for both 1977 and 1978 with total numbers for the 500 000 km^2 rangelands given at the bottom of the table.

The greatest numbers of elephants were found in the South East region (G) where estimates were 24,485 in 1977

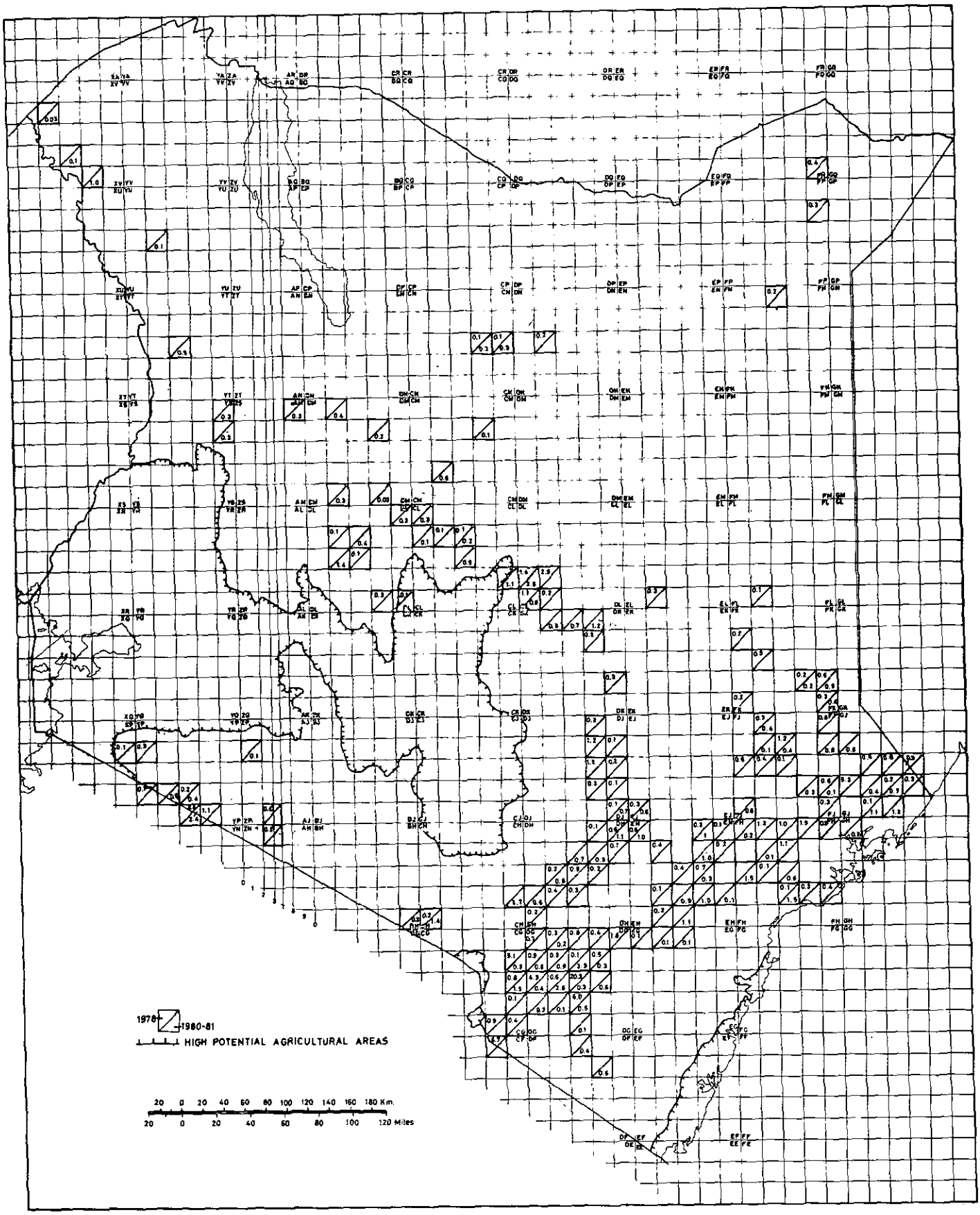


Fig. 4 Wet (January - May 1978) and dry (July - October 1980/81) season distributions of elephants in Kenya

Table 1. Numbers of live and dead elephants counted, population estimates and standard errors for various eco-regions and eco-units of Kenya from 1977, 1978, 1980 and 1981[2] KREMU aerial surveys

ECO-UNIT	NUMBERS COUNTED: LIVE			FRESH CAR.			BONES			POPULATION ESTIMATES*: LIVE			FRESH CAR.			BONES			S.E **			% LIVE/FR/BONES		
	1977	1978	1980/81	1977	1978	1980/81	1977	1978	1980/81	1977	1978	1980/81	1977	1978	1980/81	1977	1978	1980/81	1977	1978	1980/81	1977	1978	1980/81
NORTHERN RIFT VALLEY ECO-REGION A																								
1	356	-✓	35	0	-	2	1	-	0	1585	-	912	0	-	51	45	-	0	101.6	-	86.6	97/0/3	-	95/5/0
2	0	0	63	0	0	0	0	0	0	0		1514	0	0	0	0	0	0	-	-	57.9	-	-	100/0/0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-	-	-
5	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	24	-	-	-	-	-	0/0/100
6	0	0	10	0	0	0	0	0	0	0	0	230	0	0	0	0	0	0	-	-	97.0	-	-	100/0/0
Totals & Aves.	356	-	108	0	-	2	1	-	1	1585	-	2656	0	-	51	45	-	24	101.6	-	45.2	97/0/3	-	97/2/1
NORTHERN VOLCANICS ECO-REGION B																								
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-	-	-
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-	-	-
13	35	0	0	0	0	0	1	1	1588	0	0	0	0	0	0	0	44	22	97.5	-	-	100/0/0	0/0/100	0/0/100
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-	-	-
15	0	0	0	0	0	1	0	1	0	0	0	0	0	0	24	0	0	24	-	-	-	-	-	0/50/50
16	0	5	11	0	0	1	0	0	0	112	250	0	0	0	23	0	0	0	-	60.7	63.6	-	100/0/0	92/8/0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-	-	-
Totals & Aves.	35	5	11	0	0	2	0	2	2	1588	112	250	0	0	47	0	44	46	97.5	60.7	63.6	100/0/0	71/0/29	73/14/13
NORTH CENTRAL ECO-REGION C																								
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-	-	-
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	-	-	-
8	19	0	9	0	0	0	1	0	0	869	0	232	0	0	0	46	0	0	60.4	-	87.5	96/0/4	-	100/0/0
9	16	0	42	4	0	0	51	0	28	710	0	1176	189	0	0	2604	0	784	67.7	-	63.2	21/5/74	-	60/0/40
10	46	88	86	1	0	0	1	0	4	2093	1927	4106	51	0	0	51	0	191	93.3	75.4	52.6	96/2/2	100/0/0	96/0/4
19	11	0	38	0	0	0	23	46	43	498	0	866	0	0	0	1041	1056	980	50.1	-	61.9	32/0/68	0/0/100	47/0/53
Totals & Aves.	92	88	175	5	0	0	82	46	75	4170	1927	6380	240	0	0	3742	1056	1955	68.7	75.4	36.9	51/3/46	66/0/34	77/0/23
NORTH EAST ECO-REGION D																								
18	0	0	-	0	0	-	1	0	-	0	0	-	0	0	-	45	0	-	-	-	-	0/0/100	-	-
20	6	11	-	1	1	-	55	34	-	273	262	-	46	24	-	2505	809	-	98.9	60.7	-	10/1/80	24/2/74	-
21	183	102	192	3	0	0	39	21	23	8312	2379	4070	129	0	0	1757	490	488	76.0	53.3	48.1	81/2/17	83/0/17	89/0/11
22	7	0	0	0	0	0	2	5	19	297	0	0	0	0	0	1146	549	414	90.5	-	-	22/0/78	0/0/100	0/0/100
23	13	7	-	0	0	-	3	4	-	576	166	-	0	0	-	144	96	-	67.4	97.0	-	81/0/19	64/0/36	-
24	0	0	-	0	0	-	0	0	-	0	0	-	0	0	-	0	0	-	-	-	-	-	-	-
25	0	5	-	0	0	-	1	1	-	0	149	-	0	0	-	54	30	-	-	98.0	-	0/0/100	63/0/37	-
26	0	4	-	0	0	-	0	1	-	0	104	-	0	0	-	0	26	-	-	97.1	-	-	80/0/20	-
27	0	0	-	0	0	-	1	14	-	0	0	-	0	0	-	45	390	-	-	-	-	0/0/100	0/0/100	-
Totals & Aves.	209	129	192	4	1	-	102	80	42	9458	3060	4070	175	24	-	5696	2390	902	76.9	56.6	48.1	62/1/37	57/1/42	82/0/18

SOUTH CENTRAL ECO-REGION E																								
28	0	1	0	0	0	0	2	2	8	0	23	0	0	0	0	90	45	179	0	95.7	-	0/0/100	33/0/67	0/0/100
29	61	178	67	12	6	5	39	188	152	2763	4105	1459	563	135	111	1597	4531	3372	46.0	23.3	38.7	54/11/35	48/2/50	30/2/68
Totals & Aves.	61	179	67	12	6	5	41	190	160	2763	4128	1459	563	135	111	1687	4576	3554	46.0	28.7	38.7	53/11/36	48/1/51	29/2/69
EAST CENTRAL COASTAL ECO-REGION F																								
30	56	80	53	21	10	0	26	102	81	2729	2032	1299	1023	257	0	1267	2850	1988	41.8	36.9	38.8	54/21/25	42/5/53	40/0/60
32	0	2	0	-	1	0	-	13	17	0	41	0	-	21	0	-	269	402	-	92.7	-	-	6/13/81	0/0/100
33	215	290	154	-	6	2	-	43	65	11167	6378	4075	-	132	53	-	946	1720	18.1	30.5	31.6	100/0/0	86/1/13	70/1/29
Totals & Aves.	271	372	207	21	17	2	26	158	163	13896	8451	5374	1023	410	53	1267	4065	4110	22.8	32.4	25.0	86/6/8	65/3/32	56/1/43
SOUTH EAST ECO-REGION G																								
31	297	701	280	-	26	2	-	265	525	14215	15804	6745	-	586	48	-	5974	12743	31.2	60.4	37.9	100/0/0	71/2/27	34/1/65
34	13	0	0	1	0	0	2	16	28	610	0	0	47	0	0	94	389	737	76.2	-	-	81/6/13	0/0/100	0/0/100
35	0	7	36	0	0	0	0	5	4	0	177	1538	0	0	0	0	127	171	-	103.4	101.3	-	58/0/42	90/0/10
36	97	187	66	0	1	0	0	20	97	4453	4219	1709	0	23	0	0	451	2421	82.8	46.8	47.7	100/0/0	90/1/9	41/0/59
37	111	68	137	0	10	3	0	23	53	5207	1686	6554	0	248	83	0	570	1639	39.3	35.6	34.4	100/0/0	67/10/23	79/1/20
Totals & Aves.	518	963	519	1	37	5	2	329	707	24485	21886	16546	47	857	131	94	7511	17711	43.4	56.2	23.2	99/3/7	72/3/25	48/1/51
SOUTH WEST ECO-REGION H																								
38	13	4	34	-	0	0	-	7	10	559	87	817	-	0	0	-	152	240	66.9	97.7	97.4	-	36/0/64	77/0/23
39	0	0	0	-	0	0	-	0	0	0	0	0	-	0	0	-	0	0	-	-	-	-	-	-
40	0	0	0	-	0	0	-	0	0	0	0	0	-	0	0	-	0	0	-	-	-	-	-	-
41	0	0	1	-	0	0	-	2	0	0	0	27	-	0	0	-	50	0	-	-	96.3	-	0/0/100	100/0/0
42	0	2	0	-	0	0	-	1	0	0	48	0	-	0	0	-	24	0	-	95.8	-	-	67/0/33	-
43	0	16	0	-	0	0	-	0	0	0	417	0	-	0	0	-	0	0	-	68.1	-	-	100/0/0	-
44	29	108	66	-	0	0	-	7	0	1272	2629	1674	-	0	0	-	170	0	88.6	75.7	56.8	-	94/0/6	100/0/0
Totals & Aves.	42	130	101	-	0	0	-	17	10	1831	3181	2518	-	0	0	-	396	240	82.0	75.6	49.2	-	88/0/12	91/0/9
ALL RANGELANDS																								
Totals & Aves.	1584	1866	1380	43	55	16	254	822	1160	59776	42745	39253	2048	1426	393	12531	20038	28539	32.4	30.8	13.3	80/3/17	67/2/31	57/1/43

1. 1980 South Kenya Dry Season survey.
2. 1981 North Kenya Wet season survey.

* Sampling intensity ave. 2.2% in 1977, 4.5% in 1978, 5% in 1980, and 8% in 1981.

** Standard errors as a % of population estimate of live elephants only.

✓ Dashes (+) refer to no data.

21,886 in 1978, and 16546 1980-81. Most were in Tsavo East and Tsavo West National Parks. Other areas with relatively high numbers were Lamu (Unit 33) with 11,167 in 1977 and 6,378 in 1978; Meru (Unit 21) with 8,312 in 1977 and 2,379 in 1978; Ijara (Unit 30) with 2,729 in 1977 and 2,032 in 1978; Laikipia (Unit 10) with 2,093 in 1977 and 1,927 in 1978 and Mara (Unit 44) with 1,272 in 1977 and 2,629 in 1978.

The 1977 population estimate for the entire pastoral region of Kenya, except the Northern Rift Valley Region A, was 58,191 compared to 42,745 in 1978. The 1978 population estimate was 73.5% of that in 1977.

Another 1600 should be added for the Northern Rift Valley region which was not adequately surveyed in 1978 thus giving uncorrected total population estimates of 59,800 in 1977 and 44,300 in 1978.

It must be noted that the population estimates presented in Table 1 are only estimates calculated from numbers observed along survey transects. They should rightfully be rounded-off to the nearest 10 for estimates below 100 and to the nearest 100 for estimates above 1000. Thus an estimate of 1588 becomes 1600 and 273 becomes 270. Numbers were not rounded off in Table 1 so that the proportion of LIVE/FRESH CARCASSES/BONES-ROT PATCHES could be calculated more accurately.

The reader will also notice that population estimates for either year are not very accurate for individual eco-units due to the difficulty of accurately censusing elephants using the transect sampling method unless the sampling intensity is at least 15% and the area is stratified and sampled according to major vegetation types and density zone. The higher sampling intensity plus stratification greatly improves both the accuracy and precision of the population estimate.

The elephant is one of the most difficult herbivores in East Africa to census accurately and with high precision

because it occurs in a few large herds that are non-randomly distributed (Norton-Griffiths, 1978; Western, 1976a; Western 1976b; Pennycuick et al, 1977). However, it appears that over a large region and where elephants are numerous, population estimates will be fairly precise. KREMU's estimates of 59,800 elephants in 1977 and 44,300 in 1978 are believed to be 75-90% accurate. Limited tests over the past year at Meru National Park and Mara Wildlife Reserve indicate that we are counting at least 85% of the elephants on our 112 m strips on either side of the aircraft at a survey height of 300 ft for the habitats in those two areas. Of course, in heavy woodland and bushland we may be seeing only 75% of the elephants but it is unlikely if our experienced observers are seeing any less than 75% at this narrow census strip and low survey height except for a few small areas.

Assuming that our 1977 and 1978 counts were only 75% accurate then the estimates for all the rangelands of Kenya would be 77,600 in 1977 and 57,000 in 1978. Allowing for up to 10,000 elephants in the Agricultural Zone, then the upper estimate for all Kenya would be 87,600 in 1977 and 67,000 in 1978.

Regardless of the biases in KREMU's results, the data indicate conclusively that on a nation-wide basis the population trend was downward and the 1978 population was about 75% of that in 1977. The only exceptions to this downward trend were in the Northern Rift Valley region (Turkana 1 and 2) where populations seem to be at least increasing (Table 1).

3. Proportions of live to dead elephants - The proportion of live elephants to fresh carcasses and to bones - provides and index to current and past mortalities as well as to population trends.

Fig. 5 shows the proportions of live/fresh/bones

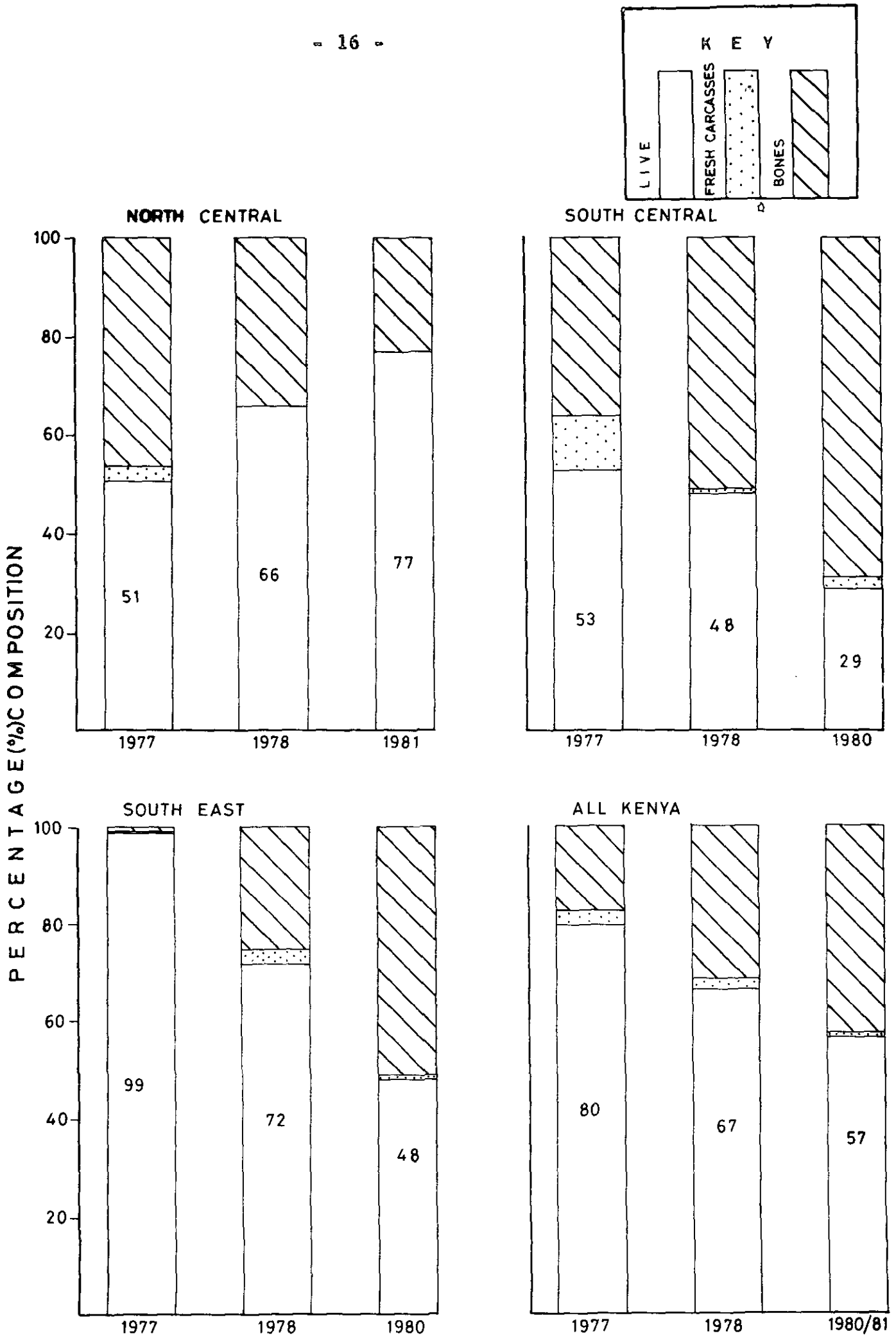


Fig.5. Proportions of Live/Fresh Carcasses/Bones of elephants in the three eco-regions and throughout Kenya, 1977, 1978 and 1980-81

for three eco-regions and for all of Kenya in 1977, 1978 and 1980/1981. For all of Kenya, the percent of live elephants declined from 80% to 67% while the percent of bones increased from 17% to 31%. This indicates an increase in mortality rate from 1977 to 1978 and a downward trend in the population. This trend is quite noticeable in the South, South Central and South East regions as well as the Meru (No. 21) eco-unit of the North East region. Sample size were too small in the other eco-units to draw any difinitive conclusions. For 1980/81, the percent of live elephants decreased to 57%, but the percent of bones increased to 43%. Once again, this clearly indicates an increase in mortality rate between 1978 and 1980/81, and a downward trend in elephant populations.

4. Population trend: 1977 - 1980 in South Kenya- Table 2 compares population estimates for 1977, 1978 and 1980 within each eco-unit of South Kenya. This table shows that the elephant population declined 22.4% in the 1-year period from early 1977 to early 1978. It then declined by an additional 25.1% during the 2-year period from 1978 to 1980. For the 3-year period from 1977 to 1980 the population declined by 41.9%. In other words, more than one-third of the elephant population was lost between 1977 and 1980.

About 51% of the elephants were within the South East eco-region G (Fig. 1) during all -three years even though the population declined by 32.4% from 24,500 in 1977 to 16,500 in 1980 (Table 2). At least 75% of the animals in eco-region G occurred in the Tsavo (31), Mtito Andei (36) and Jipe (37) eco-units but the proportion in each varied considerably from year to year and from season to season. None were seen in the Kilifi-Kwale (34) eco-unit during 1978 and 1980 surveys compared to an estimate of about 600 in 1977. There was a noticeable exchange of animals between the Jipe and Tsavo eco-units between years and Jipe was more important as a dry-

Table 2. Population estimates of elephants for each eco-unit in South Kenya for 1977, 1978 and 1980.

ECO-UNIT NO.	NAME	1977 WET PE	1977 WET SE%	1978 WET PE	1978 WET SE%	1980 DRY PE	1980 DRY SE%	1977 - 1980 PE AVES.
				NORTH EAST				
21	Meru	8312	76.0	2379	53.3	4070	48.1	4921
22	Garissa	297	90.5	0	-	0	-	99
Totals & Ave.		8609		2379		4070		5020
	%	16.7		5.9		12.3		
				SOUTH CENTRAL				
28	Kitui	0	-	23	95.7	0	-	8
29	Hola	2763	46.0	4105	23.3	1459	38.7	2776
Totals & Ave.		2763		4128		1459		2784
	%	5.4		10.3		12.8		
				EAST CENTRAL COASTAL F				
30	Ijara	2729	41.8	2032	36.9	1299	38.8	2020
32	Tana Delta	0	-	41	92.7	0	-	14
33	Lamu	11167	18.1	6378	30.5	4075	31.6	7207
Totals & Ave.		13896	22.8	8451	32.4	5374	25.0	9241
	%	26.9		21.1		17.5		
				SOUTH EAST				
31	Tsavo	14215	31.2	15804	60.4	6745	37.9	12255
34	Kilifi/Kwale	610	76.2	0	-	0	-	203
35	Taita Hills	0	-	177	103.4	1538	101.3	572
36	Mtito Andei	4453	82.8	4219	46.8	1709	47.7	3460
37	Jipe	5207	39.3	1686	35.6	6554	34.4	4482
Totals & Ave.		24485	43.4	21886	56.2	16546	23.2	20972
	%	47.5		54.7		49.9		
				SOUTH WEST				
38	Amboseli	559	66.9	87	97.7	817	97.4	488
39	Magadi	0	-	0	-	0	-	0
40	Naivasha	0	-	0	-	0	-	0
41	Narok	0	-	0	-	27	96.3	9
42	Lolgorien	0	-	48	95.8	0	-	16
43	Loita	0	-	417	63.1	0	-	139
44	Mara	1272	88.6	2629	75.7	1624	56.8	1858
Totals & Ave.		1831	82.0	3181	75.6	2518	49.2	2510
		3.5		7.9		7.6		

ENTIRE SOUTH KENYA

Totals	51584	40025	29967	40,526
% change		-22.4	25.1	

season than as a wet-season range. Elephants migrated from the Mtito Andei and Tsavo ranges onto the Jipe and Taita Hills (35) during the wet season. Few animals were present in the Taita Hills during the dry season (Table 2).

The next largest population occurred in the East Central-Coastal eco-region F, although the population has declined 61.4% from about 14,000 animals in 1977 to 5400 in 1980. Whereas 27% of the elephants in South Kenya were in eco-region'F in 1977 this value had declined to 18% by 1980. This indicates that a higher percentage of the 1977 population had been lost from this eco-region than from the other three eco-regions (Table 2). The reduction was especially noticeable in Lamu (33) where the population declined 63.5% from 11,200 in 1977 to 4,100 in 1980. There was no apparent difference in populations in each eco-unit between dry and wet seasons.

About 12% of the total elephant population was in the North East region D. (Meru and Garissa eco-units) in 1980. There was a 53% decline in numbers between 1977-1980 period. The reduction was greatest in the Garissa eco-unit, where no elephant were sighted during the 1978 and 1980 surveys (Table 2).

In the South West Eco-region H, the elephant population averaged 2510 animals during the 1977-1980 period. There was no significant difference in populations among the three years. At least two-thirds of the animals were found in Mara (44) eco-unit. A few animals exist in the Loita (43) and Lolgorien (42) eco-units

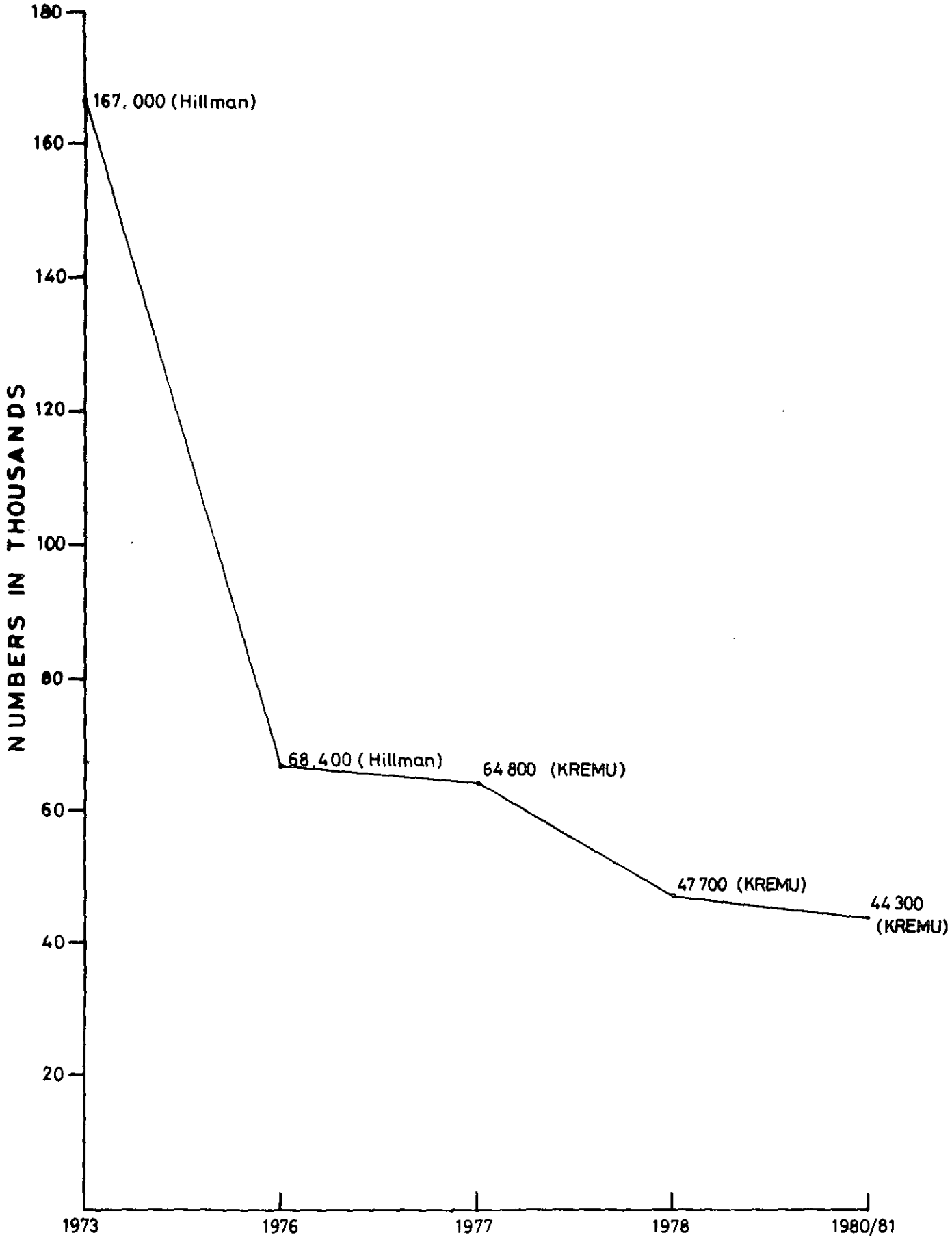


Fig. 6. Changes in elephant numbers, 1973 - 1981 in Kenya (Minimum Estimates)
(Hillman 1977 and KREMU 1979 and 1982)

but their numbers are so small that sometimes they are not detected during aerial surveys (Table 2).

Fig. 6 shows changes in elephant numbers from 1973 - 1981 in Kenya (Hillman 1977, and Stelfox 1979)

Population trends: 1977 - 1981 in North Kenya

Elephant population estimates for 1977, 1978 and 1981 for each eco-unit in North Kenya are shown in Table 3. The elephant areas not covered during the 1978 surveys were fully surveyed in 1981. There was a 26.5% increase from 7343 elephants in 1977 to 9286 elephants in 1981. The 72.2% decrease in numbers in 1978 was largely due to the fore mentioned areas not being surveyed.

Distribution of elephants in Northern Kenya is shown in Fig. 4. About 68.7% of the elephant were in the North Central eco-region C during the 1981 surveys, compared to 56.8% in 1977 and to 94.5% in 1978. Throughout the three years, the highest number of elephants were in Laikipia eco-unit. There were no observation in Suguta Hills and Lorogi eco-units during the three years. The three year average for North Central was 4160.

In the Northern Rift Valley, there was a 67.6% increase between 1977 and 1981. The 1981 population was 2,656 compared to 1585 in 1977. The greatest increases were observed in South Turkana and Baringo eco-units (Table 3). A decrease of 42.5% was observed in the North Turkana eco-unit in 1981. In the Northern volcanics eco-region B, the elephant population was 21.6% in 1977, compared to 5.5% in 1978 and to 2.7% 1981 of the entire North Kenya population. The 1978 population of 112 was a 92.9% reduction of the 1977 population of 1588 elephants. The elephants then increased to 250 in 1981 an increase of 123.2% between 1978 and 1981. Though 100% of elephants in 1977 were in Chalbi eco-unit, there were no observation during the 1978 and 1981 surveys. Similarly, all elephants were in the Marsabit eco-unit in 1978 and 1981.

Table 3. Population estimates of elephants for each eco-unit in North Kenya for 1977, 1978 and 1981.

ECO-UNIT NO.	NAME	1977 DRY PE	1977 DRY SE%	1978 DRY PE	1978 DRY SE%	1981 WET PE	1981 WET SE%	1977-1981 PE AVES
				NORTHERN RIFT VALLEY				
1	North Turkana	1585	101.6	0	-	912	86.6	832
2	S. Turkana	0	-	0	-	1514	57.9	505
3	Pokot	0	-	0	-	0	-	0
5	Kerio Valley	0	-	0	-	0	-	0
6	Baringo	0	-	0	-	230	97.0	77
Totals & Ave.		1585		0		2656		1414
	%	21.6		0		28.6		
				NORTHERN VOLCANICS				
11	Ileret	0	-	0	-	0	-	0
12	N. Hall	0	-	0	-	0	-	0
13	Chalbi	1588	97.5	0	-	0	-	329
14		0	-	0	-	0	-	0
15	Sololo	0	-	0	-	0	-	0
16	Marsabit	0	-	112	60.7	250	63.6	121
17	Chers	0	-	0	-	0	-	0
Totals & Ave.		1588		112		250		450
	%	21.6		5.5		2.7		
				NORTH CENTRAL				
4	S. Hills	0	-	0	-	0	-	0
7	Lologi	0	-	0	-	0	-	0
8	Maralal	869	60.4	0	-	232	87.5	367
9	Samburu	710	67.7	0	-	1176	63.2	629
10	Laikipia	2093	93.3	1927	75.4	4106	52.6	2709
19	A. Post	498	50.1	0	-	866	61.9	455
Totals & Ave.		4170		1927		6380		4160
	%	56.8		94.5		68.7		
				ENTIRE NORTH KENYA				
	Totals	7343		2039		9286		
	% change	-		-72.2		26.5		

Rhinoceros (Diceros bicornis)

1. Distributions by eco-regions and eco-units - Fig. 7 shows the 1977 and 1978 distributions of rhinoceros throughout the rangelands of Kenya and the locations of major density areas. The map shows they were mainly confined to the South East and South West regions, in particular eco-units 31 (Tsavo), 36 (Mtito Andei) and 37 (Jipe) in the South East and eco-unit 44 (Mara) in the South West. They were present on both the shrubby grasslands and the woodlands of Meru National Park and the adjacent Bisanadi Conservation Area in 1977. However, by March 1978 they had been virtually eliminated from all habitats except the heavy bushland and woodland areas of Meru National Park.

Our 1977 and 1978 surveys produced no sightings throughout the North West, Northern Volcanics or North Central regions. In the North East region they were observed only in eco-unit 21 (Meru), while in the South Central region they were only observed in a small portion of eco-unit 29 (Hola). They were observed in only a few locations in eco-units 30 (Ijara) and 33 (Lamu) of the East Central-Coastal region.

They were not observed in any eco-units of the South west region except 43 (Loita) and 44 (Mara).

For the Agricultural Zone, a few are known to be present in the north portion of the Aberdare especially on the west side of Mt. Kenya and in the Mau Forest. The 1979 estimate was 40 on the Laikipia Plateau, 40 in Mt. Kenya Forest and 200 in Mt. Kenya and Aberdare National Parks (pers. comm. Park Wardens April 1979).

Fig. 7 shows a major reduction in the distribution of rhinoceros in 1978 compared to 1977. As of 1978 their distribution had been constricted mainly to a few localities in the national parks and wildlife reserves.

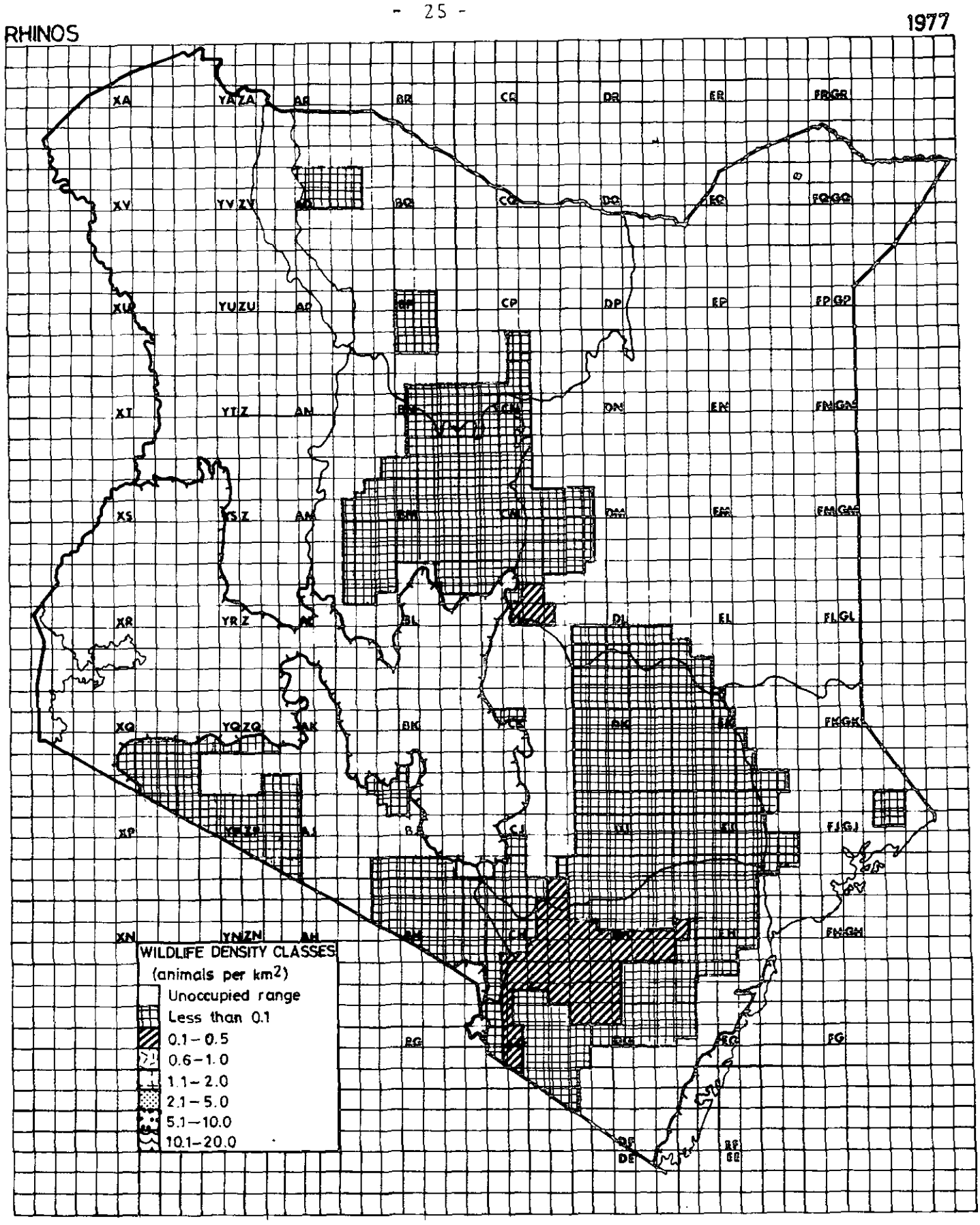


Fig. 7a. Distributions and density zones for rhinos on the rangelands of Kenya

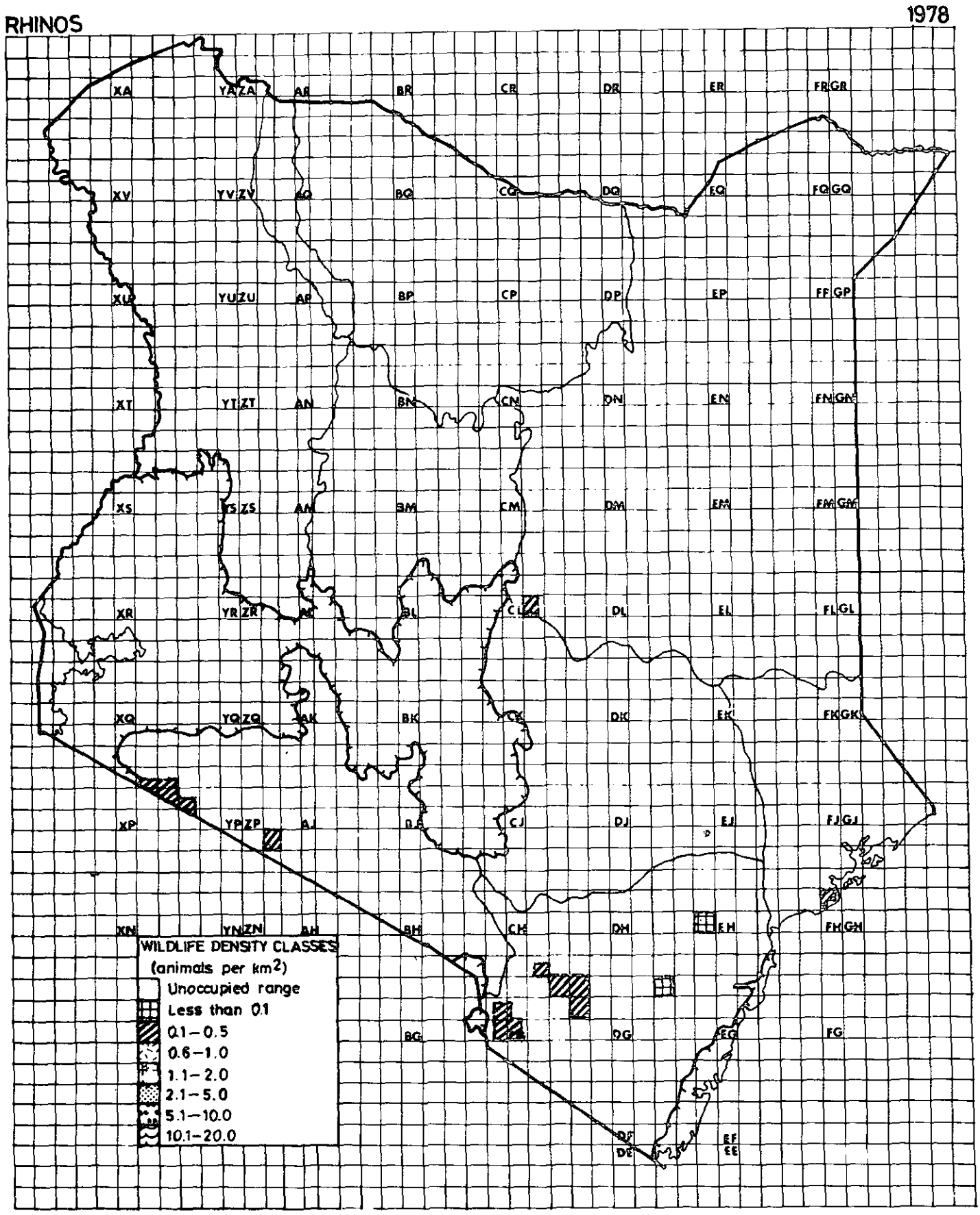


Fig. 7b. Distributions and density zones for rhinos on the rangelands of Kenya.

Fig. 8 compares the density distributions of rhinoceros during the wet season in 1978 with those during the dry season of 1980. Because the numbers observed during 1978 and 1980 were so small, only broad generalizations can be made from the occupancy maps of Figs. 7 & 8. Apparently, the distribution has continued to decline because even though the sampling intensity of the aerial surveys increased with each survey year, the numbers of eco-units where rhinoceros were observed in South Kenya decreased from 8 in 1977 to 7 in 1978 and 4 in 1980. The major change observed in 1980 was that no longer were most of the animals located in the South East eco-region as they were in 1977 and 1978 but now there appeared to be more in the Central-Coastal eco-region, especially Ijara and Lamu eco-units. Although none were observed in the South West in 1980, KREMU's 17 monthly and seasonal surveys of the Mara and Loita Plains during 1979 and 1980 indicated there were still 12-24 rhinoceros in eco-units 43 & 44 (Stelfox et al 1980, Amuyunzu 1981). There was also no sighting in Meru eco-unit, although rhinos reside in the Meru National Park.

2. Population estimates and trends: 1977-1978 - Table 4 shows the numbers counted, population estimates (uncorrected) and standard errors for each eco-unit and eco-region as well as for the entire rangelands of Kenya. It also presents the 1978 estimates as a percentage of the 1977 estimates.

The uncorrected 1978 population estimate of 734 rhinoceros for all regions was only 40.4% of the 1977 estimate of 1818 animals. Although we recognize that there are considerable sampling biases involved in surveying this species, especially when their numbers are very low and most of those remaining have sought refuge in heavy bush cover where they are less visible, we still believe KREMU's counts and estimates reflect a pronounced decline from 1977 to 1978. They reveal that the population is at a dangerously low level with the groups so small and scattered that productivity will

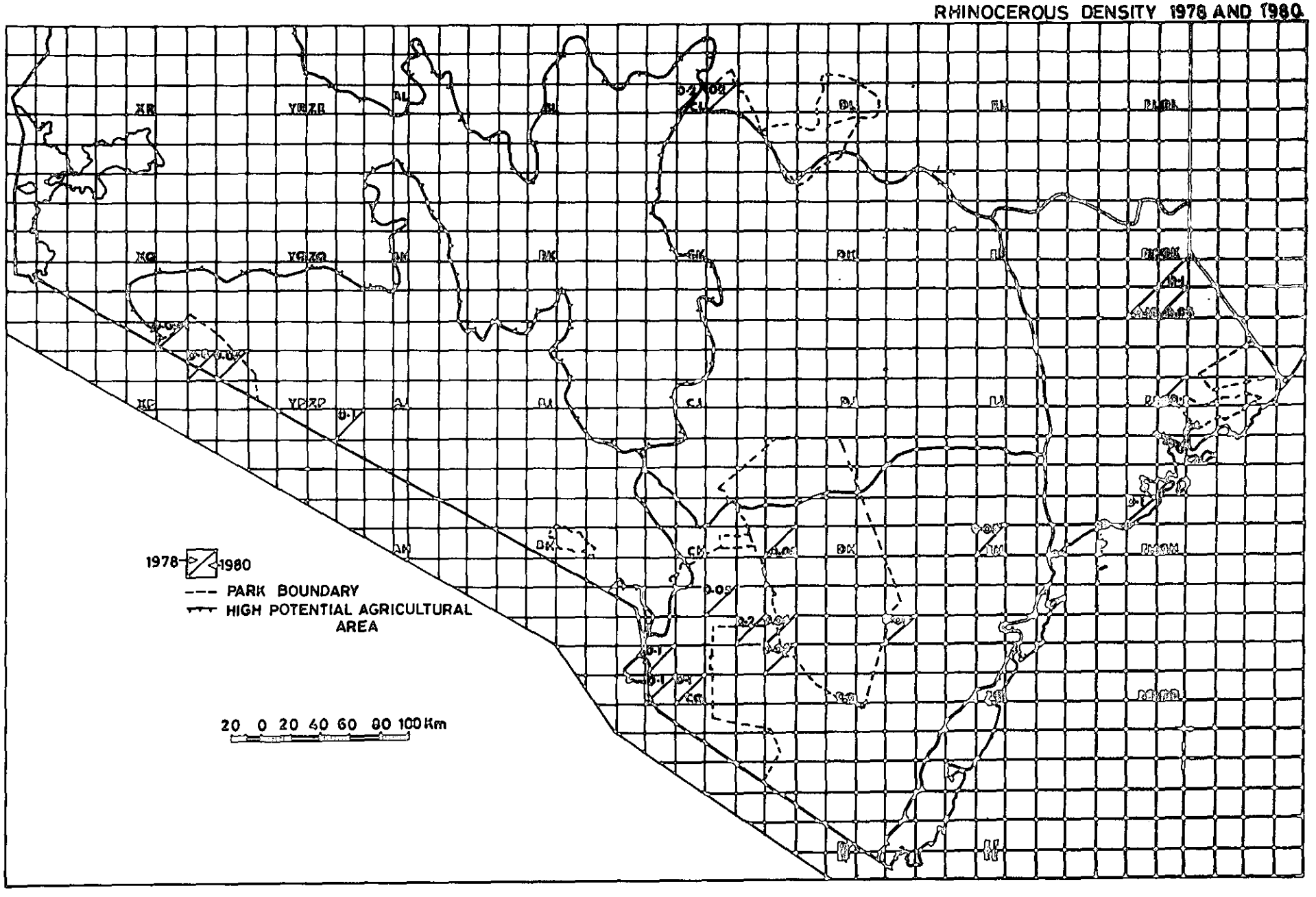


Fig. 8. Wet (January - May 1978) and dry (July - October 1980) season distributions of rhinoceros in South Kenya.

Table 4. Numbers counted, population estimates✓ and standard errors of rhinos in various eco-regions and eco-units of Kenya from 1977 and 1978 KREMU aerial surveys.

ECO-UNIT	SAMPLING INTENSITY		NO. COUNTED (SAMPLE SIZE)		POP. ESTIMATE✓		STANDARD ERROR*		1978 EST. AS %
	1977	1978	1977	1978	1977	1978	1977	1978	OF 1977 EST.
			NORTH WEST REGION A						
1	2.21	-	0	0	0	0	-	-	-
2	2.13	-	0	0	0	0	-	-	-
3	2.13	-	0	0	0	0	-	-	-
5	2.18	-	0	0	0	0	-	-	-
6	2.22	-	0	0	0	0	-	-	-
Totals & Aves.	2.17	-	0	0	0	0	-	-	-
			NORTHERN VOLCANICS REGION B						
11	2.14	4.38	0	0	0	0	-	-	-
12	2.17	4.51	0	0	0	0	-	-	-
13	2.27	4.52	0	0	0	0	-	-	-
14	2.24	3.59	0	0	0	0	-	-	-
15	2.08	3.48	0	0	0	0	-	-	-
16	2.06	4.47	0	0	0	0	-	-	-
17	1.99	4.33	0	0	0	0	-	-	-
Totals & Aves.	2.14	4.18	0	0	0	0	-	-	-
			NORTH CENTRAL REGION C						
4	2.08	-	0	0	0	0	-	-	-
7	2.18	-	0	0	0	0	-	-	-
8	2.21	-	0	0	0	0	-	-	-
9	2.16	-	0	0	0	0	-	-	-
10	2.04	-	0	0	0	0	-	-	-
19	2.33	4.17	0	0	0	0	-	-	-
Totals & Aves.	2.17	-	0	0	0	0	-	-	-
			NORTH EAST REGION D						
18	2.23	4.40	0	0	0	0	-	-	-
20	2.33	4.20	0	0	0	0	-	-	-
21	2.33	4.58	2	7	86	159	93.0	-	0
22	2.36	4.58	0	0	0	0	-	-	-
23	2.08	4.21	0	0	0	0	-	-	-
24	2.26	4.11	0	0	0	0	-	-	-
25	1.87	3.34	0	0	0	0	-	-	-
26	2.27	3.86	0	0	0	0	-	-	-
27	2.21	3.59	0	0	0	0	-	-	-
Totals & Aves.	2.22	4.10	2	0	86	159	93.0	-	0
			SOUTH CENTRAL REGION E						
28	2.22	4.50	0	0	0	0	-	-	-
29	2.32	4.46	2	0	86	0	73.2	-	0
Totals & Aves.	2.27	4.48	2	0	86	0	73.2	-	0
			EAST CENTRAL-COASTAL REGION F						
30	2.05	4.28	1	0	49	0	100.0	-	0
32	2.06	4.84	0	0	0	0	-	-	-
33	1.93	4.55	0	2	0	44	-	100.0	200+
Totals & Aves.	2.01	4.56	1	2	49	44	100.0	100.0	89.8
			SOUTH EAST REGION G						
31	2.21	4.44	18	7	815	158	35.7	39.2	19.4
34	2.13	4.11	1	0	47	0	100.0	-	0
35	1.98	3.95	0	0	0	0	-	-	-
36	2.18	4.43	6	1	275	23	70.9	95.7	8.4
37	2.13	4.03	7	5	328	124	46.0	77.4	37.8
Totals & Aves.	2.13	4.19	32	13	1,465	305	46.7	59.0	20.8
			SOUTH WEST REGION H						
38	2.33	4.61	0	0	0	0	-	-	-
39	2.30	4.74	0	0	0	0	-	-	-
40	2.12	4.57	0	0	0	0	-	-	-
41	2.03	3.97	0	0	0	0	-	-	-
42	2.13	4.13	0	0	0	0	-	-	-
43	2.06	3.84	0	2	0	52	-	100.0	200+
44	2.28	4.11	3	7	132	170	65.1	47.6	128.8
Totals & Aves.	2.18	4.28	3	9	132	222	65.1	59.9	168.2
			ALL OF 500 000 KM^2 PASTORAL REGIONS OF KENYA						
Totals & Aves.	-	-	40	24	1818	730	-	-	31.4

*Standard error as a % of population estimate.

✓ Uncorrected population estimates not adjusted for accuracy.

undoubtedly be sub-normal. In many areas their numbers may be below the "threshold-for-survival" where normal productivity rates could not be achieved unless the sparse population is augmented by introduction of animals from elsewhere.

How accurate are KPEMU's population estimates and how must they be adjusted to arrive at a more correct population estimate. The two main sources of survey bias for rhinoceros are:-

1. Counting bias, or what percentage of the animals present along the survey strips are actually counted;

2. Sampling bias, or errors in the sampling design due to the non-random distribution of rhinos and an inadequate sampling intensity.

In the first instance, we believe we count at least 75% of the rhino on our narrow 112 m - wide strip at the 300 ft survey height for all shrubby grassland and savannah habitats. However, in bushland and woodland with greater-than 50% canopy cover we may be counting only 50% or less of the animals on the strips. This means that with the current trend of fewer animals present in the open and semi-open bushland and in shrubby grassland; and a proportional higher percentage in the more densely wooded areas, our observability bias increases. This would result in our 1978 counts being less accurate than those in 1977.

In the second instance, we recognize that 2.2% and 4.4% smapling intensities are inadequate for determining population estimates on an eco-unit basis, although they are reasonably accurate for the larger eco-regions and on a nation-wide basis. For example, in Meru National Park and the Bisanadi Conservation Area we counted 7 rhinoceros in 1978 using a 4.4% sampling intensity. In February 1979 we surveyed the area at 5.6, 9.0 and 18.3% sampling inten-

sities as well as a stratified survey which sampled the High Density Grassland at 17.8% intensity and the low Density Woodland at 6.0% intensity. No animals were seen at the 5.6% sampling intensity giving a population estimate of 0; whereas 4 were seen at the 9.0% intensity giving a population estimate of 44 rhinoceros. At the 18.3% sampling intensity, 3 animals were counted giving an estimate of 16. The stratified survey (17.8 & 6.0% intensities) counted 4 rhinoceros giving an estimate of 34 animals. Probably the true population lay somewhere between 16 and 44. The 1978 population estimate for Meru eco-unit of 163 was undoubtedly an over-estimate and should have been about 75-100. Similar adjustments may have to be made for eco-units 29,30 and 34. Considering both biases discussed above, we believe KREMU's 1977 and 1978 surveys produced estimates that were 50-75% of the true populations. This means that the corrected maximum populations were 3636 in 1977 and 1460 in 1978. Certainly, the population in 1978 was critically low and the trend rapidly downward. Six, and probably 10, of the 44 eco-units still contained rhinoceros but several of these could be devoid of this species by 1980 if the current trend were to continue.

The decline was just as rapid within the National Parks such as Meru and Tsavo (see eco-units 21 and 31 in Table 3) as in non-park areas. This pronounced decline was apparently of recent origin as Goddard (1970) and Cobb (1976) showed that the population in Tsavo was stable during the 1960's and early 1970's.

The number present in the Agricultural Zone was estimated in early 1979 to be about 300 based on estimates by Park Wardens (pers. comm. April 1979).

3. Population trends: 1977 - 1980 in South Kenya-

Table 5 compares population estimates for 1977, 1978 and 1980 within each eco-unit of South Kenya. The drastic

Table 5. Population estimates of rhinoceros for each eco-unit in South Kenya for 1977 and 1978, and for the entire rangelands in 1980.

ECO-UNIT	1977 PE	1977 SE(%)	1978 PE	1978 SE(%)	1980 Area	1980 Source	1980 Estimate
		NORTH EAST					
21 Meru	86	93.0	163	96.3	Aberdare and Mau Forest	Warden	200
22 Garissa	0	-	0	-	Mt. Kenya N.P and Forest	Warden	80
Totals	86		163		Marsabit N.P	Warden	5
		SOUTH CENTRAL					
28 Kitui	0	-	0	-	Nairobi N.P	Warden	25
29 Hola	86	73.2	0		Meru N.P	KREMU & Warden	15
Totals	86		0		Amboseli N.P	Warden/ Western	10
		EAST CENTRAL COASTAL					
30 Ijara	49	100.0	0	-	L.Nakuru N.P	Warden	3
32 Tana Delta	0	-	0				
33 Lamu	0	-	44	100.0			
Totals	49		44		Oldonyo Sambuk	Warden	3
		SOUTH WEST					
31 Tsavo	815	35.7	158	39.2	Sigor/Kerio area	Warden	20
34 Kilifi/	47	100.0	0	-			
35 Taita Hills	0						
36 Mtito Andei	275	70,9	23	95.7	Laikinia Ranches	E.A.W.S.	20
37 Jipe	328	46.0	124	46.0	Tsavo Eco-system	Ottichilo	150
Totals	1465	46.7	305	59.0			
		SOUTH WEST					
38 Amboseli	0	-	0	-	Masai Mara Game Reserve	KREMU/ Warden	25
39 Magadi	0	-	0	-	Sibiloi N.P	KREMU	1
40 Naivasha	0	-	0	-	Boni Forest/ Lower Tana	KREMU	126
41 Narok	0	-	0	-			
42 Lolgorian	0	-	0	-			
43 Loita	0	-	0	-			
44 Mara	132	65.1	170	47.6			
Total	132		222				
		ENTIRE RANGELAND					
Total	1818		734				683
Corrected	3636		1468				-

* 1980 population estimates were derived from special KREMU studies (1980) and other sources and not KREMU alone because KREMU nationwide sampling intensity was too low to provide reliable estimates.

decline between 1977 and 1978, when the population declined by 59.6 was lessened during the next two years with a further reduction of 79.6 of the population.

Assuming a 50% visibility bias (Goddard 1970), the rhinoceros population throughout South Kenya declined from 3636 in 1977 to 1468 in 1978 and to 1100 in 1980.

Whereas 81% of the population in 1977 was in the South East by 1980 none were observed in this eco-region and about 84% were in the East Central-Coastal eco-region (Table 5).

The reader is again reminded that the 1978 and 1980 populations were so low and so few animals were seen during the surveys that these values may be misleading.

Detailed seasonal aerial surveys by KREMU of the Tsavo ecosystem in 1979 and 1980 indicated there were still about 75 - 150 rhinoceros within Tsavo East and Tsavo West National Parks (Ottichilo 1981). As mentioned earlier there were still 12-24 animals left in eco-units 43 & 44 during 1979 - 80 even though none were seen during the 1980 South Kenya survey.

However, aside from these sampling errors it seems evident that the greatest reduction in rhinoceros numbers between 1977 and 1980 occurred in the South East, especially in the Tsavo, Mtito Andei and Jipe eco-units. The East Central-Coastal eco-region seemed to contain at least as many animals in 1980 as in 1977. During the 1981 North Kenya surveys no rhinos were observed in any of the eco-units surveyed.

Fig. 9 presents changes in rhino populations for 1969-1981.

CONCLUSIONS & RECOMMENDATIONS

Aerial surveys of all Kenya rangelands (500 000 km^2) in 1977 and 1978 by KREMU showed that both elephants and

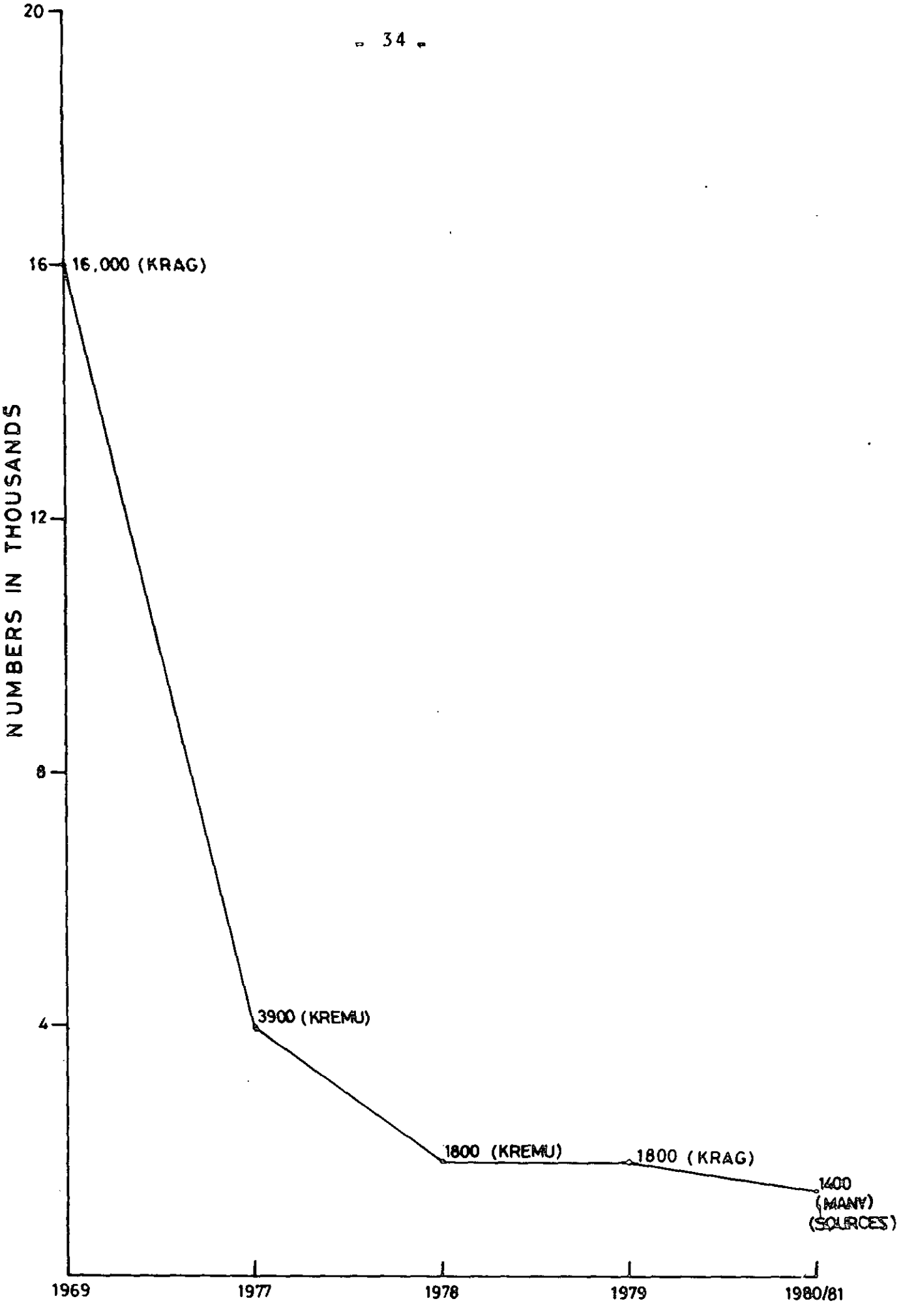


Fig. 9. Changes in rhinocerous numbers, 1969-1981 in Kenya (Maximum Estimates) (KRAG 1979 and KREMU 1979 and 1982)

rhinoceros were declining in numbers. Minimum - maximum numbers of elephants for these rangelands were 59,800-87,600 in 1977 and 47,700 - 67,000 in 1978. In addition 5,000 - 10,000 occurred in the wooded regions of the Agricultural Zone. For all of Kenya, KREMU's population estimates were:

	Minimum	Maximum
1977	64,800	97,600
1978	47,700	77,000
1980/81	44,300	65,000

The 1978 population on the rangelands was 73.5% as high as in 1977 based on those regions where comparable counts were available for both years. Greatest numbers occurred in the South East region where uncorrected population estimates were 24,500 in 1977 and 21,900 in 1978. Most of these animals were in Tsavo East and Tsavo West National Parks. Other eco-units with relatively high numbers were Lamu, Ijara, Laikipia and Mara.

The ratios of live: dead elephants decreased from 80:20 in 1977 to 67:33 in 1978 providing further evidence of a declining population. Eco-regions showing the greatest reduction in numbers were the North Central, North East and East Central-Coastal regions, especially within the Meru, Lamu and Jipe eco-units. The 1980/81 surveys of showed a further decrease, with the live: dead elephant ratio at 57:43

In South Kenya, the elephant population declined by 42.3 from 52,000 in 1977 to 30,000 in 1980. About 51% of the animals occurred in the South East during this 3-year period even though the South East population declined by about 8,000 animals during this period. There was a noticeable exchange of animals between Jipe and Tsavo and Jipe was especially important as a dry-season range. The population in the East Central-Coastal

eco-region declined 58% from 14,000 in 1977 to 5400 in 1980. The reduction was especially noticeable in Lamu eco-unit.

The 1978 rhinoceros population was only 40.1% of that in 1977 for all Kenya rangelands. Population estimates for all of Kenya were:-

	Minimum	Maximum
1977	2118	3936
1978	1030	1760
1980	683	1366

All about 300 were outside the Agricultural Zone.

Most rhinoceros were confined to the South East and South West region, in particular the Tsavo, Mtito-Andei, Jipe and Mara eco-units. Greatest decreases were occurring in the Tsavo, Mtito Andei, Jipe, Hola and Meru eco-units. Their distributions were greatly constricted in 1978 compared to 1977 and few remained on savannah and shrubby grassland ranges. Rhinoceros distributions continued to decline into 1980 as the number of eco-units where they observed in South Kenya declined from 8 in 1977 to 7 in 1978 to 4 in 1980. By 1980 the South East ranges had been depleted of rhinoceros and more animals were present in the East Central-Coastal eco-region.

Throughout South Kenya the rhino population declined a further 35.9% between 1978 and 1980. The 1980 population of 1100 animals was only 29.4 of the 1977 population. No rhino were observed during the 1981 North Kenya survey except one which was outside counting strip in Sibiloi National Park.

There were probably about 1400 rhinoceros left in all of Kenya in 1981.

We recommend that KREMU continue to monitor population trend of elephants and rhinoceros on a continous basis e.g. once every three years. Seasonal ranges and critical

habitats should be carefully mapped out and documented based on KREMU's rear-seat and front-seat observer data.

Because the densities of both species are now very low throughout Kenya an effort should be made to conduct more detailed aerial surveys, e.g. sampling intensity of 25-30%, for the major elephant and rhinoceros ranges. This could be done once every 3 to 5 years.

Increased management and research on these two important species to find ways of stopping and ultimately reversing the drastic downward trend in population and constrictions in their distributions.

Increased inter-disciplinary collaboration in planning and implementing programmes for preventing the annihilation of rhinos and elephants over large areas of their former range and for maximising their numbers in harmony with multiple land-use objectives.

As poaching is cited as the major factor responsible for these population declines, a more efficient means of controlling poaching must be found. Hopefully, the new anti-poaching units will be effective in achieving this goal.

Prime ranges for elephant and rhino must be delineated and a multi-disciplinary land-use programme drawn up for these critical areas in order to optimise the distribution and abundance of these important species while maximising multiple-use objectives.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the following KREMU staff who have contributed significantly to the report:

Senior Survey Biologist Dr. H. J. Dirschl & Biologists S.P. Wetmore, C. Amuyunzu who directed the surveys and acted as front-seat observers:

Observers H. Mukanga, G. Muriuki, S. Sikawa, B. Raburu, J. Chemjor, G. Kiilu, S. Akumonyo and S. Bokea who acted as rear-seat observers and counted all livestock and wild herbivores along the census strips;

Data Management Section staff (Systems Ecologists) Dr. D. Peden, G. Townsend, J. Mwanje, T. Belsoi and S. Ng'ang'a who analysed the data for the Aerial Surveys Section.

Park Wardens of Mt. Kenya and Aberdare National Parks who provided population estimates for these National Parks. Project Manager D.K. Andere who reviewed the report and provided constant support and encouragement to the Aerial Surveys Section.

R E F E R E N C E S

Amuyunzu, C. (1981) Seasonal populations and distributions of wildlife and livestock within the Mara study area during 1980. KREMU Tech. Report Series No. 34. May 1981.

Douglas-Hamilton, I. (1979) Elephant carcasses and skeletons as indicators of population trends. Paper presented to the International Workshop on Aerial Survey Methods. Nairobi, 6-12 November 1979.

Goddard, J(1970) Age criteria and vital statistics of a black rhinoceros population. E. Afr. Wildl. J. 8, 105-121.

Hillman, A.K.K. (1977) IUCN elephant survey and conservation programme. Interim report on status of elephants in Kenya, 1977.

_____, (1980) African Rhino Group Newsleter No.1, April 1980. Nairobi, Kenya.

KRAG (Kenya Rhino Action Group) (1979) Past and present estimates of rhinoceros numbers in Kenya. Compiled by Hillman A.K.K. IUCN African Rhino Group, Elephant Survey and Conservation Programme and The Kenya Rhino Action Group, May 1979.

Kufwafwa, J.W. Mbugua, S.W. & Amuyunzu, C. (1981) Populations and distributions of Livestock and wildlife in South Kenya: July - October 1980. KREMU Tech. Report Series No. 33. April 30, 1981.

Norton-Griffiths, M. (1978) Counting animals. Handbook No. 1 2nd edition, ed. J.J.R. Grimsdell. Serengeti Ecological Monitoring Programme. African Wildlife Leadership Foundation, Nairobi.

Ottichilo, W.K. (1981) Population studies of elephant (Loxodonta Africana Blumenbach) in Tsavo ecosystem: 1975-1980. KREMU Tech. Report Series No. 40. July 15, 1981.

Pennycuick, C.J., Sale, J.B., Stanley Price, M. & Jolly, G.M. (1977) Aerial systematic sampling applied to censuses of large mammal populations in Kenya. E. Afr. Wildl. J. 15, 139-146.

Stelfox, J.G., Kufwafwa, J.W. & Mbugua, S.W. (1979) Distributions, densities & trends of elephants and rhinoceros in Kenya, 1977 - 1978 from KREMU's aerial surveys. KREMU Tech. Report Series No. 24. 30 April 1979.

_____., Peden, D.G., Mbugua, S.W. & Hudson, R.J. (1980) Populations, stocking rates and distributions of wildlife and livestock on Mara and Loita Plains: December 1978 - November 1979. KREMU Tech. Report Series No. 19. December 1980.

Western, D. (1976a) An aerial method of monitoring large mammals and their environment, with a description of a computer program for survey analysis. Project Working Document 9, UNDP/ FAO Kenya Wildlife Management Project (KEN/71/ 526, Nairobi.

_____, (1976) The distribution of animals in relation to resources. Handbook No. 2, ed. by J.J.R. Grimsdell and H.T. Russell. Serengeti Ecological Monitoring Programme. African Wildlife Leadership Foundation, Nairobi.

COBB - S (1976) Distribution and abundance of large herbivores in Tsavo National Park. PhD. Thesis Oxford University.