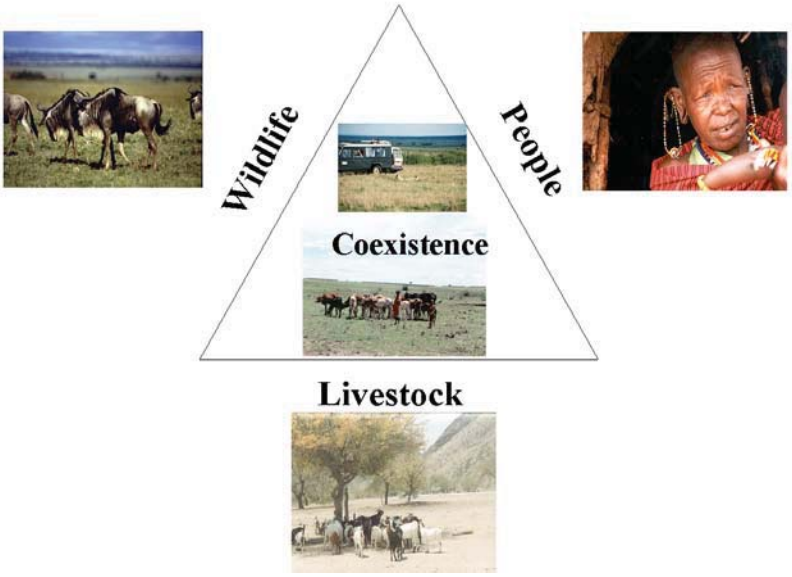
CHAPTER 4

COEXISTENCE OF PASTORALISM AND WILDLIFE IN KENYA: MOVING BEYOND PERCEPTION

A romantic notion persists that pastoralists co-exist with wildlife in a harmonious relationship. There are two contrasting perceptions with respect to the coexistence of pastoralism and wildlife in Africa. There are those who claim that pastoralism and wildlife continue to coexist harmoniously, and others who question the sustainability of this coexistence, arguing that increases in human and livestock populations would displace wildlife. The spatio-temporal extension of the model 'road to extinction)' developed in this chapter provides more insights into the conflict of resource use. The results shows we are at crossroad where some semi arid districts (with moist conditions livestock and agriculture predominates the land use, whilst in other arid and semi-arid districts the pressure to convert its land to agriculture or increasing the livestock is having an effect on the coexistence of the pastoralism and wildlife.



Chapter 4

Coexistence of pastoralism and wildlife in Kenya: moving beyond perception

Mohammed Y Said[1,2]*, Jan de Leeuw[2] , Andrew K Skidmore[2,3] and Herbert H T Prins[3]

[1]*Department of Resource Surveys and Remote Sensing (DRSRS), P.O. Box 47146, Nairobi, Kenya*
[2]*International Institute for Geo-information Science and Earth Observation (ITC), P.O. Box 6, 7500 AA Enschede, The Netherlands*
[3]*Tropical Nature Conservation and Vertebrate Ecology Group, Wageningen University, Bornsesteeg 69, 6708 PD Wageningen, The Netherlands*

Abstract

There are two contrasting perceptions with respect to the coexistence of pastoralism and wildlife in Africa. There are those who claim that pastoralism and wildlife continue to coexist harmoniously, and others who question the sustainability of this coexistence, arguing that increases in human and livestock populations would displace wildlife. The study analyzed the spatio-temporal relation between people, wildlife and livestock in 18 arid and semi-arid districts of Kenya. The result of this study has revealed four broad patterns. The first group of districts of densely populated districts with somewhat moister climatic conditions, livestock and agriculture is rapidly replacing pastoralism as an important economic resource, as indicated in the moderate increase in the ratio of human to livestock biomass (paired t-test; $t = 1.91$, $n = 5$, $p = 0.13$) and decline in wildlife (paired t-test; $t = 1.6$, $p = 0.18$). The second group of districts - the arid to very arid districts the trends over the past two decades reveals a further intensification of pastoralism, as expressed by a significant decrease in the ratio of wildlife to livestock in all eight districts (paired t-test; $t = -2.19$, $n = 8$, $p = 0.06$) and rapid decline of wildlife (paired t-test; $t = 2.41$, $n = 8$, $p = 0.04$). The third and fourth group of districts mainly the semi-arid districts with some potential for agriculture (and with low human population density) have continued to attract the emigrant population, and agriculture is increasingly replacing wildlife. The third group mainly consisting of coastal districts of Taita Taveta (contains the Tsavo National Park) and Lamu (Boni and Dodori Game Reserve) have suffered severely from illegal hunting – particularly the hunting of elephant and rhino in the 1970s and 1980s – that decreased the wildlife population drastically. The last group of districts of Narok, Kajiado and Laikipia have both high wildlife and livestock population, but are also facing high emigration and more pressure to convert some of their rangelands into agricultural land. There is no doubt from the results presented in this study that we are at crossroads regarding the coexistence of pastoralism and wildlife in Kenya.

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* *submitted to Biological Conservation*

4.1 INTRODUCTION

There are two contrasting perceptions with respect to the coexistence of pastoralism and wildlife in Africa. Those claiming that pastoralism and wildlife continue to coexist appear to be impressed by the historical coexistence between pastoralism and wild animals (see discussions in Siegal *et al*., 1980; Swift, 1982; Western, 1982; Ole Parkipuny, 1989; Homewood and Rodgers, 1991). Others question the sustainability of this coexistence, arguing that increases in human and livestock populations would displace wildlife (Brown, 1971; Lamprey, 1983; Osemeobo, 1988; Prins, 1992; Happold, 1995; Norton-Griffiths, 1996; Voeten, 1999; Prins, 2000). These two views reflect different traditions in analyzing eco-societal systems, focusing on different aspects of a study problem (Hjort, 1982; Prins, 1992; Happold, 1995). The proponents of the first view tend to emphasize social and ideological systems as the primary study object, whereas those of the second view tend to emphasize environmental conditions and production systems (Brown, 1971; Hjort, 1982; Happold, 1995). These two contrasting perceptions have led to contrasting approaches to the management of rangeland ecosystems and their wildlife resources.

Hjort (1982) suggests that present-day local conflicts over grazing should be analyzed not in ethnic terms that govern the contestants' perceptions, but in terms of competition between different economic systems over productive land. Prins (1992) partly addressed this problem in his model 'the road to extinction' (Figure 4.1). The model shows that at first livestock partly supplants wildlife; then, when the ratio between humans and livestock increases and wildlife is outcompeted by livestock, people switch to agriculture or horticulture and there is less and less space for wildlife. Ultimately, agriculture has to give way to urbanization. The shortcoming of this model is that it only analyzed the status and did not go further to analyze the direction of change over time. However, a fundamental problem in studying the relation between population and environment is the lack of data (Downing *et al.*, 1990; Prins, 1992; Happold, 1995). In addition to compiling comparable series of indicators on demographics and resources, the geographical regions and time intervals must be chosen to capture the underlying processes of change (Hjort, 1982; Downing *et al.*, 1990; Homewood *et al.*, 2001).

Over the past decades considerable effort has been directed at wildlife and livestock population surveys in many parts of Africa (Douglas-Hamilton *et al*., 1992; Said *et al*., 1995; East, 1999, and the references therein). Owing to uneven surveys at sub-national level, assessment of the status of and change in wildlife or livestock populations at national level has rarely been achieved, yet this kind of information would be crucial if more generic statements were to be formulated on the status of these resources and their relationship with human demography (Happold, 1995; Said *et al.*, 1995; Caro *et al.*, 1998; de Leeuw *et al.*, 1998; East, 1999).

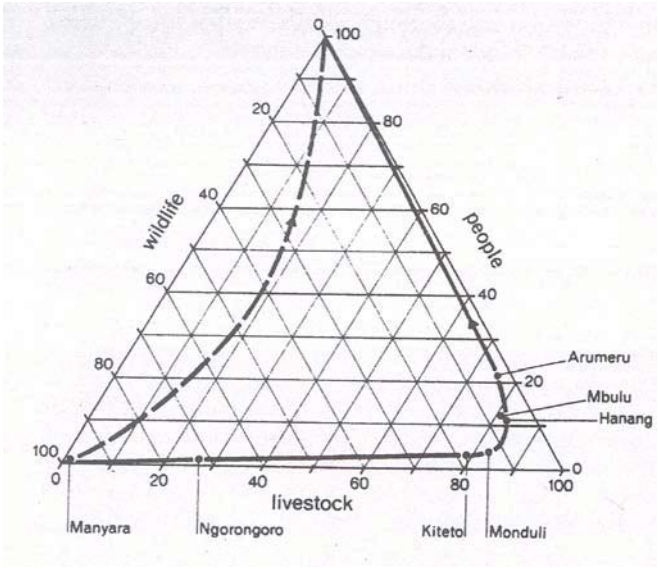

Figure 4.1: The 'pastoral road to extinction' is indicated by the black continuous line in the graph. It connects points representing the combinations of wildlife, livestock and people, as observed in different districts of East Africa based on aerial counts. The line also indicates the observed course of wildlife demise in a development from pure nature, via pastoralism, to urbanization. The broken line indicates the possible course of wildlife demise in a development from pure nature, via mixed agriculture, to urbanization. The three axes represent the metabolic weights per square kilometre of wildlife, livestock and people, respectively, as percentages of the total combined metabolic weights of these three categories. (From Prins, 1992; by permission of Cambridge University Press)

In view of the above issues, the first objective of this study was to analyze the 1978-1994 trends in wildlife and livestock in the Kenyan rangelands. Secondly, the study was intended to examine the relation between people, livestock and wildlife, based on the 'the road to extinction' model (refer to Figure 4.1) and incorporating the aspect of time (*dynamic changes in the system*). The study area consists of 19 rangeland districts that are heterogeneous in terms of land potential for wildlife, livestock and agriculture, with varying cultural backgrounds and land and land tenure policies. Aggregation of the analysis at district level and the detailed trend analysis of wildlife and livestock give a more holistic approach to comparing the status of the coexistence of pastoralism and wildlife across the country.

4.2 MATERIAL and METHODS

4.2.1 Study area

Kenya has a total area of about 581,700 km^2. Ten percent of the territory is protected under park and game reserves (Inamdar *et al.*, 1999). The size of the human population has more than doubled in the last 30 years (11 million in 1969 as against 28.7 million in 1999; CBS, 2001). The arid and semi-arid lands (ASAL) occupy about 80% of the country, and host less than 20% of the total human population (Figure 4.2). These rangelands host a unique assemblage of wildlife (Dorst and Dandelot, 1972; Stelfox *et al.*, 1979) and provide pastures for over 50% of the Kenyan livestock and a large proportion of the wildlife population (Peden, 1987; Norton-Griffiths, 1996).

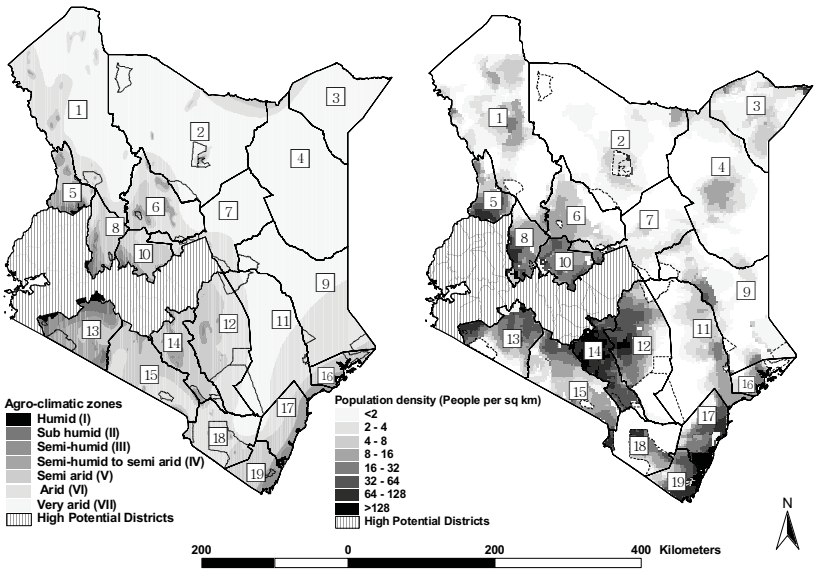

Figure 4.2: Agro-climatic zones (left) and human population density in 1999 (right) for the rangeland districts of Kenya. Protected areas are highlighted in broken line. Districts: 1-Turkana, 2-Marsabit, 3-Mandera, 4-Wajir, 5-West Pokot, 6-Samburu, 7-Isiolo, 8-Baringo, 9-Garissa, 10-Laikipia, 11-Tana River, 12-Kitui, 13-Narok, 14-Machakos, 15-Kajiado, 16-Lamu, 17-Kililfi, 18-Taita-Taveta, and 19-Kwale.

4.2.2 Data

The wildlife and livestock population data were compiled from aerial censuses conducted by the Department of Resource Surveys and Remote Sensing (DRSRS) over the period 1978-1994. Population estimates for wildlife and livestock were calculated according to Jolly

(1969). Observations derived from these surveys on elephant carcasses were used as an indicator of elephant mortality (Douglas-Hamilton and Hillman, 1981; Ottichilo *et al.*, 1987), while agricultural presence was used as an indicator of crop cultivation. The aerial census as practised by DRSRS is fully described in Norton-Griffiths (1978), Dirschl *et al.* (1981) and Ottichilo and Sinange (1985). Human population data were derived from the Kenya Central Bureau for Statistics (CBS, 1981, 1996, 2001).

4.2.3 Statistical analysis

The initial aim of the study was to address the question of whether there were declines in wildlife and livestock populations at national level. This posed a problem, since surveys had been executed at district rather than national level. First of all the number of surveys varied between the districts. Initial regression analysis at individual district level of the relation between estimated population size and time of survey led to the recognition that districts had such small sample sizes (ranging from five to 13) that there would be a realistic risk of committing a type II error. Hence we adapted the meta-analysis when analyzing the wildlife and livestock trends. This method allows many data sets to be analyzed simultaneously and thereby improves confidence in the result (see Arnqvist and Wooster, 1995; Adams *et al.*, 1997; Gurevitch and Hedges, 1999; Osenberg *et al.*, 1999).

The procedure used in this study was adopted from Arnqvist and Wooster (1995). First we regressed wildlife and livestock densities against time for each of the 18 districts (Machakos district was not included since the three surveys did not cover the whole study period). Animal densities were derived by converting the individual body weights (W in kg) of livestock and wildlife to metabolic body mass ($W^{0.75}$), which reflects energy expenditure by different groups in a comparable way (Moen, 1973). The average weights of the various wildlife species were derived from Prins and Olff (1998) and those of livestock from Peden (1987). Next we analyzed the correlation coefficients for the 18 districts in order to determine whether samples came from the same populations (Zar, 1996, pp 384). When the data were not homogenous, a Tukey test was conducted to allocate districts to homogenous groups. For groups of districts with homogenous rho, a weighted mean *r* and a 95% confidence interval were calculated and used to test the null hypothesis that the pooled rho equalled zero (H_o: rho = 0).

Next we used the 18 district regression equations (even when they were not significant at $\alpha'' = 0.05$) to predict the average metabolic weight ($kg.km^{-2}$) in 1978 and 1994. The metabolic weight values for the 18 districts were averaged, weighting the districts according to their area. This resulted in estimates of the national average metabolic weights of wildlife and livestock for 1978 and 1994 respectively. Based on these data, we calculated the annual rate of change in wildlife and livestock metabolic weight densities.

We then investigated the relationship between people, wildlife and livestock, using the model described in Prins (1992). The changes in the three variables for the period 1978-1994 we incorporated into the model. The non-parametric Wilcoxon signed rank test was used to investigate whether the changes in the ratio between wildlife and livestock, and in the ratio of metabolic weight between people and livestock densities differed significantly between 1978 and 1994. The ratio of metabolic weight of people to metabolic weight of

livestock has been used as an indicator of people switching to other sources of food production when they cannot be sustained by the 'minimum pastoral standard of living'. A ratio of 0.045 was used as the 'threshold', as it is assumed that a family of eight in a pastoral economy needs a minimum of 6600 litres of milk and 700 kg of meat per year (see Brown 1971; Lamprey 1983; Prins 1992).

4.3 RESULTS

The distribution of wildlife and livestock in the Kenyan rangelands is shown in Figure 4.3. High densities of wildlife are found in the Narok, Kajiado, Taita Taveta, Laikipia, Lamu and Samburu districts. Livestock are mainly concentrated in the Baringo, Kajiado, Laikipia, Machakos, Mandera, Narok, West Pokot, Turkana and Samburu districts. Lamu and Taita Taveta are the only districts that show higher densities for wildlife than for livestock.

Statistical summaries of trends in wildlife densities for the 18 districts are shown in Table 4.1. Out of 18 districts, 16 had a negative sign for the regression. However, at $\alpha'' = 0.05$ the null hypothesis was rejected in seven out of the 18 cases. The test for homogeneity of wildlife densities indicated that the 18 districts did not share the same population rho ($\chi^2 = 40.29$, df = 17). A Tukey test revealed that the trends for Kajiado and Laikipia differed from those for the other 16 districts. Hence, the trends of Kajiado and Laikipia were not used for calculating the weighted mean regression for all districts. Wildlife trends in the remaining 16 districts revealed a significant decline ($r = -0.71$, df = 119, $P < 0.001$). The 95% confidence interval of the correlation coefficient was between -0.61 and -0.78. Wildlife density declined between 1978 and 1994 at an annual rate of 2.5% per annum.

Statistical summaries of the trends in livestock densities for the 18 districts are shown in Table 4.2. Livestock revealed a negative sign in 11 out of the 18 cases. However, depending on the model the null hypothesis was rejected in only one out of the 18 cases. The chi-square analysis on livestock shows the homogeneity of the data ($\chi^2 = 22.01$, df = 17, $P > 0.05$). The weighted mean regression (r) was equal to -0.23 and was highly significantly different from zero ($P < 0.001$). Livestock density in the ASAL is declining at an annual rate of 0.6% per annum.

Table 4.3 is a statistical summary of the relation between people, wildlife and livestock. At national level there was no significant difference between the 1978 and the 1994 ratio of wildlife to livestock. The arid to very arid districts, however, revealed a significant decline in the ratio of wildlife to livestock (Wilcoxon's signed rank test, $P < 0.05$; Figure 4.4) compared with the semi-arid districts (Wilcoxon's signed rank test, $P = 0.38$). The ratio of humans to livestock increased significantly between 1978 and 1994 (Wilcoxon's signed rank test, $P < 0.001$; Figure 4.4), with the semi-arid districts displaying significant changes (Wilcoxon's signed rank test, $P < 0.003$) but not the arid to very arid districts. It is noteworthy that the ratio in these latter districts remained close to 0.045, which is the theoretical threshold ratio for sustainable pastoral ecosystem.

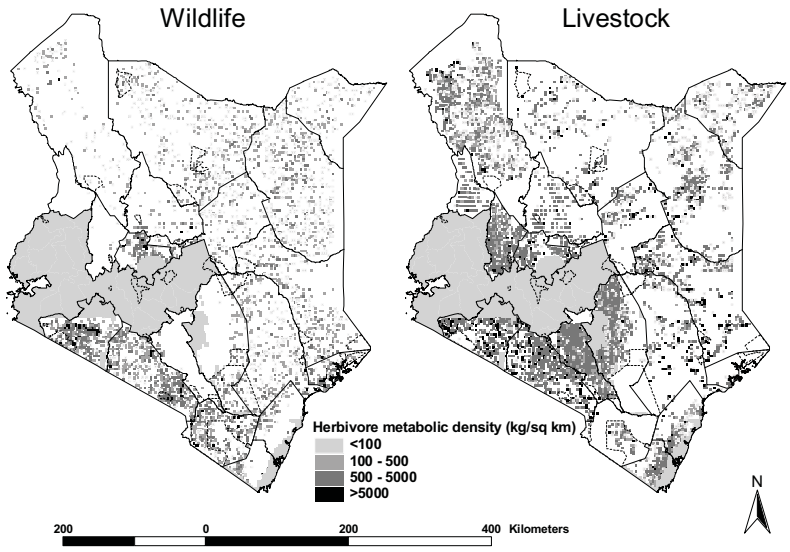

Figure 4.3: Distribution of wildlife and livestock in Kenya based on census conducted in 1994. Areas not surveyed are highlighted in continuous grey colour and protected areas in broken line.

Table 4.1: Statistics summarizing linear and log-linear regression of wildlife densities against time for the each of the 18 districts (significant p values in bold).

		Y = a + bx			Ln(Y+1) = a+ bx		
District	n	sign	r	P	sign	r	P
Baringo	13	-	0.518	0.070	-	0.497	0.084
Garissa	5	-	0.938	**0.018**	-	0.967	**0.007**
Isiolo	6	-	0.285	0.585	-	0.387	0.448
Kajiado	12	+	0.168	0.601	+	0.209	0.514
Kilifi	7	-	0.800	**0.031**	-	0.795	**0.033**
Kitui	7	-	0.598	0.156	-	0.620	0.137
Kwale	6	-	0.080	0.880	-	0.081	0.878
Laikipia	12	+	0.670	**0.017**	+	0.680	**0.015**
Lamu	11	-	0.809	**0.003**	-	0.866	**0.001**
Mandera	5	-	0.863	0.060	-	0.783	0.117
Marsabit	7	-	0.422	0.345	-	0.337	0.460
Narok	12	-	0.745	**0.005**	-	0.755	**0.005**
West Pokot	4	-	0.036	0.964	-	0.439	0.561
Samburu	7	-	0.618	0.139	-	0.511	0.241
Taita Taveta	9	-	0.658	0.054	-	0.621	0.074
Tana River	7	-	0.944	**0.001**	-	0.947	**0.001**
Turkana	5	-	0.917	**0.028**	-	0.849	0.069
Wajir	5	-	0.502	0.389	-	0.422	0.480

Table 4.2: Statistics summarizing linear and log-linear regression of livestock densities against time for the each of the 18 districts (significant p values in bold).

		Y = a + bx			Ln(Y+1) = a+ bx		
District	n	sign	r	P	sign	r	p
Baringo	13	+	0.332	0.268	+	0.379	0.202
Garissa	5	-	0.344	0.571	-	0.332	0.585
Isiolo	6	+	0.218	0.677	+	0.186	0.724
Kajiado	12	+	0.381	0.222	+	0.401	0.196
Kilifi	7	-	0.710	0.074	-	0.662	0.106
Kitui	7	-	0.097	0.836	-	0.116	0.804
Kwale	6	-	0.957	**0.003**	-	0.937	0.006
Laikipia	12	-	0.438	0.155	-	0.332	0.291
Lamu	11	-	0.347	0.295	-	0.348	0.244
Mandera	5	-	0.161	0.796	-	0.172	0.783
Marsabit	7	+	0.019	0.968	+	0.102	0.828
Narok	12	-	0.386	0.215	-	0.392	0.207
West Pokot	4	+	0.471	0.529	+	0.508	0.492
Samburu	7	-	0.683	0.091	-	0.640	0.121
Taita Taveta	9	-	0.260	0.067	-	0.275	0.473
Tana River	7	-	0.539	0.212	-	0.573	0.179
Turkana	5	+	0.110	0.860	+	0.015	0.980
Wajir	5	+	0.099	0.874	+	0.064	0.981

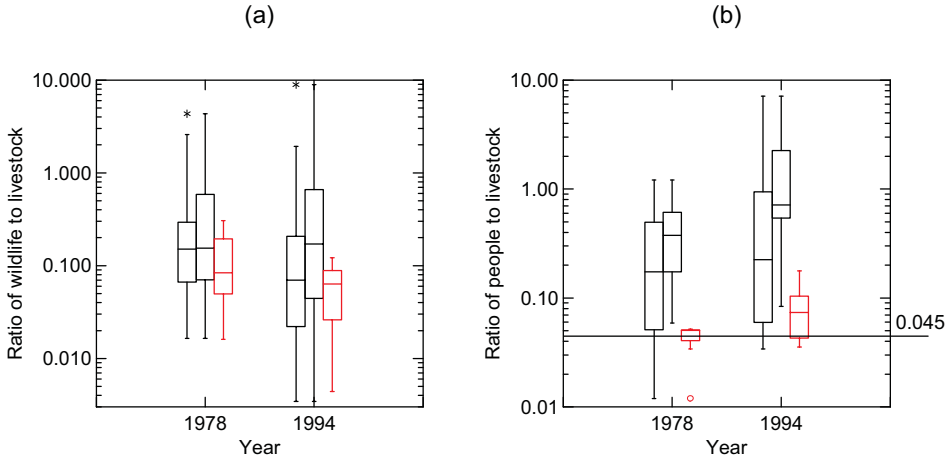

Figure 4.4: Boxplot showing the ratio of metabolic densities of wildlife to livestock and the ratio of metabolic densities of people to livestock for the semi-arid and arid to very arid rangelands (refer to text for statistical results). In both (a) and (b) the plots on the left represent all the rangeland districts, those in the middle mainly semi-arid districts (Baringo, Kajiado, Kilifi, Kitui, Kwale, Laikipia, Lamu, Narok, West Pokot and Taita-Taveta) and those on the right arid to very arid districts (Isiolo, Turkana, Marsabit, Mandera, Wajir, Tana River, Samburu and Garissa). The value 0.045 in (b) is the theoretical threshold ratio for a sustainable pastoral ecosystem, and a number of arid to very arid districts fall within this category.

Table 4.3: Statistical summary of the interrelationship between people, wildlife and livestock in the Kenyan rangelands. The densities of wildlife and livestock in 1978 and 1994 were based on the interpolation of regression models.

	Wildlife density ($kg.km^{-2}$)		Livestock density ($kg.km^{-2}$)		Ratio of wildlife to livestock		Ratio of people to livestock		Human population	
District	1978	1994	1978	1994	1978	1994	1978	1994	Growth rate	Density (km^{-2})
Baringo	15	3	603	888	0.025	0.003	0.584	0.705	3.9	42
Kilifi	84	40	544	236	0.155	0.171	0.953	4.554	3.6	72
Kitui	51	13	467	446	0.108	0.030	0.645	1.240	2.5	25
Kwale	63	72	1201	492	0.052	0.146	0.423	1.923	2.6	60
West Pokot	10	11	609	748	0.016	0.015	0.308	0.599	2.7	29
Group 1	**45**	**28**	**685**	**562**	**0.071**	**0.073**	**0.583**	**1.804**	**3.1**	**46**
Garissa	154	60	591	545	0.261	0.111	0.051	0.076	0.3	3
Isiolo	60	49	634	743	0.095	0.066	0.059	0.084	5.0	5
Mandera	26	10	737	699	0.036	0.014	0.051	0.074	0.5	5
Marsabit	33	25	397	402	0.084	0.063	0.012	0.035	0.1	1
Samburu	129	77	883	631	0.146	0.122	0.052	0.142	2.6	6
Tana River	169	28	550	395	0.307	0.071	0.050	0.177	2.8	4
Turkana	12	4	756	946	0.016	0.004	0.048	0.047	1.5	3
Wajir	43	32	631	663	0.069	0.049	0.034	0.040	-1.0	2
Group 2	**78**	**36**	**647**	**628**	**0.127**	**0.063**	**0.045**	**0.084**	**1.5**	**4**
Lamu	921	361	213	40	4.331	8.913	0.377	7.110	4.5	17
Taita Taveta	633	377	244	196	2.591	1.928	1.206	2.631	2.1	13
Group 3	**777**	**369**	**229**	**118**	**3.461**	**5.421**	**0.792**	**4.871**	**3.3**	**15**
Kajiado	304	351	1091	1405	0.279	0.250	0.154	0.285	6.8	27
Laikipia	238	434	1049	721	0.227	0.602	0.184	0.716	4.6	35
Narok	2140	1084	1751	1496	1.222	0.725	0.163	0.492	6.4	43
Group 4	**894**	**623**	**1297**	**1207**	**0.576**	**0.526**	**0.167**	**0.498**	**5.9**	**35**

Figure 4.5a displays the relation between people, wildlife and livestock in the Kenyan rangelands in 1978 and 1994. Figure 4.5b reveals groups of districts with distinct patterns. The first group consists of the densely populated districts with somewhat moister climatic conditions (Kilifi, Machakos, Kitui, Baringo, Kwale and West Pokot). Here agriculture is rapidly replacing pastoral economies as an important resource. This is expressed by an upward movement of these districts along the right-hand side of the triangle and a moderate increase in the ratio of human to livestock biomass (paired t-test; $t = 1.91$, $n = 5$, $p = 0.13$). Human population growth averaged 3.1%, which was slightly lower than the national average of 3.3%. Most of these districts have a net emigration towards urban centres. Downing *et al.* (1990) observe that urban and rural areas are inextricably linked. The emergence and growth of urban areas influence the rate of population growth in rural areas, by facilitating access to inputs and markets, by creating an increased demand for agricultural goods, and by the transfer of remittances from urban workers to their rural families.

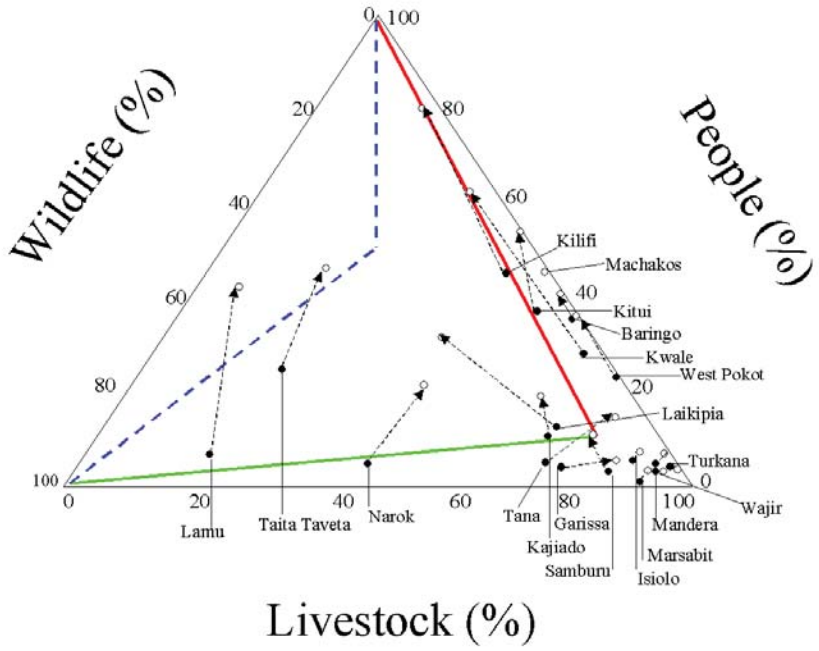

Figure 4.5a: The relation between people, wildlife and livestock in 19 Kenyan rangeland districts in 1978 (●) and 1994 (○). The three axes express the relative contribution (%) of people, wildlife and livestock to the total combined metabolic densities of the three categories. The broken line indicates a course that leads to equal proportion of wildlife, livestock and people. The continuous line indicates the observed course of wildlife demise in a development from more nature (mainly wildlife and pastoralism), via predominantly pastoralism, to mainly agriculture and urbanization. Note the figure is an extension of Prins (1992), which showed a number of other districts from Tanzania.

The second group is formed mainly of the arid to very arid districts of Mandera, Garissa, Wajir, Marsabit and Turkana, with low population growth rates (below the national average), and the trends show increased pastoralism, with more livestock and less wildlife. These districts are located in the lower right-hand corner of the figure, indicating livestock-based economies. The aridity of these districts precludes the development of rainfed agriculture (except on mountain slopes in Marsabit), while Tana River is the only district with potential for the development of irrigated agriculture. The trends over the past decades reveal a further intensification of pastoralism, expressed by a significant decrease in the ratio of wildlife to livestock in all eight districts (paired t-test; $t = -219$, $n = 8$, $p = 0.06$; Table 4.4).

Table 4.4: Statistical summary of the interrelationship between people, wildlife and livestock for Groups 1 and 2.

	Group 1			Group 2		
	Rate	t	P	Rate	t	P
Change in wildlife density	2.2	-1.60	0.18	3.1	-2.41	0.04
Change in livestock density	1.0	-0.69	0.52	0.2	-0.39	0.71
Change in ratio of wildlife to livestock	0.2	0.06	0.95	2.9	-2.19	0.06
Change in ratio of human population to livestock	12.3	1.91	0.13	5.1	2.52	0.04

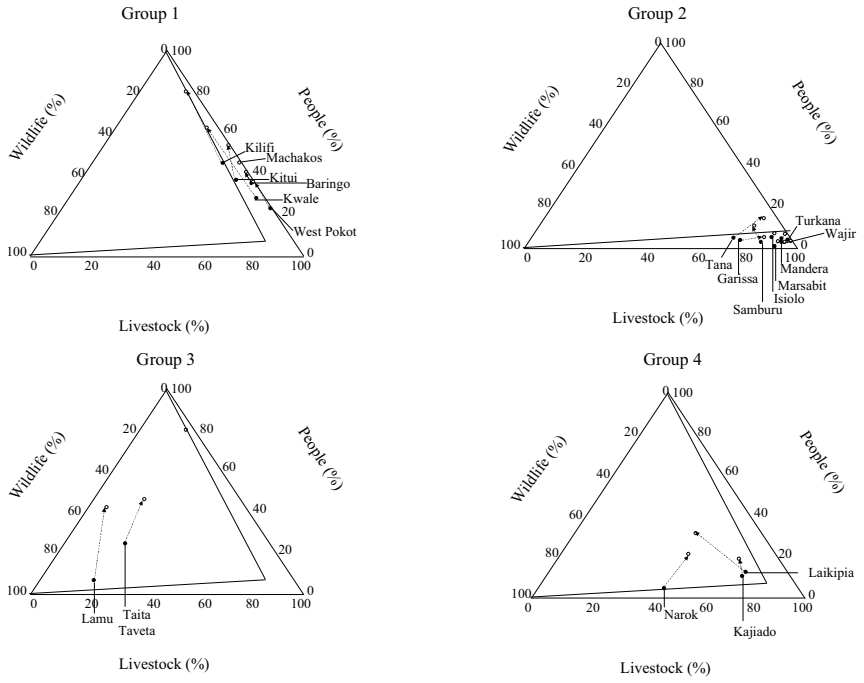

Figure 4.5b: The four broad patterns on the relation between people, wildlife and livestock in the Kenyan rangelands are highlighted in the above figure. Group 1 consists of districts with moist climatic conditions, where agriculture and urbanization are rapidly replacing pastoralism and wildlife; hence the movement of these districts along the right-hand side of the triangle. Group 2 consists of the arid to semi-arid districts with low population, which are increasingly moving towards the lower right corner, indicating more livestock. The two districts (Tana River and Samburu) with slight potential for agriculture show a slightly higher human population density. Group 3 shows districts that once were dominated by wildlife (have large tracts of parkland) but have suffered heavy poaching; later resettlement programmes increased the population in these districts. Group 4 consists of districts that have high populations of both wildlife and livestock, with the potential for agriculture. The pattern here is mixed, with Narok having a severe decline in wildlife, Laikipia having an increase in wildlife and a decline in livestock, and Kajiado having stable populations of both wildlife and livestock. All three districts continue to have an increasing human population.

The third group consists of the coastal districts of Lamu and Taita Taveta and has moved from a wildlife-dominated system towards a human-dominated system. We attribute this partly to the heavy poaching in the late 1970s and 1980s (refer to Figure 4.6 and Ottichilo *et al.*, 1987) and the severe droughts that occurred in the early 1970s (affected mostly the elephants in Taita Taveta). During the last 30 years the human population has grown rapidly in both districts (partly due to the resettlement of people – Munzinger *et al.*, 1978; Von Boguslawski and Wiese, 1992), as has the intensification of agriculture to sustain the expanding urban population on the coast and the expanding tourist market (Dijkstra, 1996).

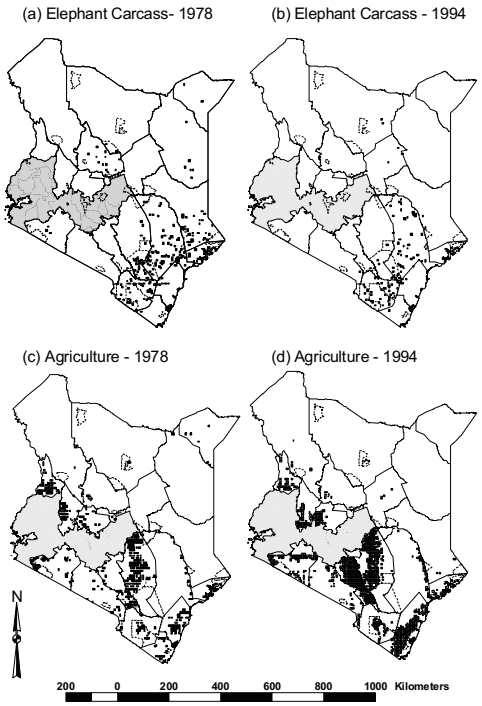

Figure 4.5: Elephant carcasses as recorded from the aerial surveys in 1978 and 1994. The carcasses indicate high levels of illegal hunting in the 1970s compared with the 1990s. The current status of agriculture indicates that coastal districts (Kilifi, Kwale, Lamu and Taita Taveta), southern rangelands (Machakos, Kitui, Kajiado and Narok) and a few northern rangelands (Baringo, West Pokot, Laikipia and Samburu) have high agricultural activities. In the arid districts of Tana River and Isiolo the agricultural activities occur mainly on river courses or on footslopes as in the case of Marsabit.

Finally, the semi-arid districts of Narok, Kajiado and Laikipia have high wildlife and livestock populations. Over the last 20 years the wildlife population has been declining in Narok district; Kajiado shows a stable population; and in Laikipia there has been an increase in wildlife and a slight decline in livestock population. All these districts have

varying potential for agriculture and there is a large increase in the human population in all these districts.

4.4 DISCUSSION

The results of this study indicate that the perception of harmonious coexistence between pastoralism and wildlife is questionable. The coexistence between pastoralism and wildlife that once existed may well be the result of low human population, tribal warfare, diseases (rinderpest, cholera and smallpox), famine and droughts rather than a reflection of harmony (see Ochieng', 1980; Lamprey, 1984; Waller, 1990; Homewood and Rodgers, 1991; Prins, 1996). This seesaw of disease interaction, tribal wars, famine and restrictions on free settlement during the colonial administration (East Africa Royal Commission, 1955) may have enabled coexistence without severe competition before independence. This study has revealed that the coexistence of pastoralism and wildlife has not been harmonious in recent decades.

The spatio-temporal extension of the 'road to extinction' model that analyzed the regional patterns indicates that most of the semi-arid districts have already built up high human population densities through the conversion of most of their land to agriculture. Some other less densely populated semi-arid districts still retain significant populations of wildlife in coexistence with livestock (but are experiencing increased population growth, a mounting immigrant population and rapidly expanding agriculture). The arid to very arid districts appear to have completed their movement towards a pastoralist-dominated system, with marginal wildlife populations remaining. These observed changes are related to land potential and population pressure (higher population growth rates and in-migration – Downing *et al.*, 1990), land policies that encourage, exclude, restrict or give a comparative advantage to some land uses (Prins, 1992; Norton-Griffiths and Southey, 1995; Child, 2000; Homewood *et al.*, 2001), and land tenure (Norton-Griffiths, 1996). However, not all districts showed declines in wildlife; Kajiado (constant) and Laikipia (increase) showed trends in wildlife densities that are partly related to the recent intensive promotion of rural or community-based wildlife integration programmes (Western, 1982; Lindsay, 1987; Norton-Griffiths, 1996; Elliott and Mwangi, 1997).

The regional pattern presented in this study is also exhibited at continental scale. The trends in West Africa show high declines in herbivore populations that are mainly related to population pressure (Osemeobo, 1988; Happold, 1995; Brashares *et al.*, 2001). In West Africa bushmeat has also taken a toll on wildlife species, particularly in forested habitats (Anadu *et al.*, 1988; Bowen-Jones and Pendry, 1999; Fa and Garcia-Yuste, 2001). Southern Africa still retains a high diversity of wildlife outside protected areas, presumably because most of the areas are still lowly populated. The trends in East Africa appear intermediate in relation to those reported from West Africa and Southern Africa. All three East African countries are facing high declines in wildlife due to the rapid increase in human population and the expansion of agriculture onto forested and marginal lands (Kiss, 1990; Lamprey and Michelmore, 1996; Newmark, 1996; Norton-Griffiths, 1996; Caro *et al.*, 1998; de Leeuw *et al.*, 1998). This pressure will continue with either pastoralists or wildlife

or both being relegated to ecologically marginal environments (Swift, 1982; Ole Parkipuny, 1989; de Leeuw *et al.*, 2001).

What is the future of the coexistence of pastoralism and wildlife in East Africa? The first view is more or less directed at improving the status of pastoralists (less emphasis on wildlife), based on ecological (mobility, habitat management, herd composition, land rights − Dyson-Hudson and Dyson-Hudson, 1980; Hjort, 1982; Swift, 1982; Western and Finch, 1986; Homewood and Rodgers, 1991) and local economic strategies. But Thornton (2002) reports that in some communities in East Africa the cultural value of nature and animals transcends economic or ecological value. The outcomes of this study shows the realization that the fabric for the coexistence of pastoralism and wildlife is at crossroads and that new initiatives are needed in promoting the harmonious coexistence of people, wildlife and livestock (more emphasis on both wildlife and livestock, but also paying attention to the social dimension). Most of the new initiatives have arisen from a concern over the last few years about economics and land use management, and about how to develop the best compromise between the needs of humans and the needs of wildlife (McNeely, 1993; Christoffersen, 1995; Happold, 1995).

These conflicting views need to be reconciled. The way forward would be to further develop a framework for ASAL that integrates the dynamics of people, wildlife and livestock in order to reduce conflicts over resource use (refer to the discussions of the various modalities in Western and Ssemakula, 1981; Kiss, 1990; McNeely, 1990; Prins, 1992; McNeely, 1993; Norton-Griffiths, 1996; Hackel, 1998; Inamdar *et al.*, 1999; Newmark and Hough, 2000; Oba *et al.*, 2000). These initiatives are based on multiple land use and on the devolution and decentralization of the proprietorship of wildlife resources and land entitlement to the local community. New strategies, apart from addressing the issues of ownership, should establish effective institutions and mechanisms for ensuring the equitable sharing of benefits that are accrued from wildlife. But equally opportunities (infrastructure, marketing, security, improved tourism facilities) should also be accorded to the arid and very arid areas that harbour pastoralism and wildlife but do not reap the benefits of their wildlife resources.

4.5 CONCLUSION

This study has revealed an increased conflict between pastoralism and wildlife and agriculture in the ASAL districts of Kenya. This spatio-temporal extension of the 'pastoral road to extinction' model provided more insights into the antagonistic relation between people, livestock and wildlife. Also it allowed localizing areas of conflict that need specific attention if pastoralism and wildlife are to coexist in harmony. The scale and perspective of the model accommodated the regional perspectives (ecological outlook) and the detailed localized information (through meta-analysis) about the pattern of land use through the long-term trends of wildlife and livestock (social and ideological changes). There is no doubt from the results presented in this study that we are at crossroads in the coexistence of pastoralism and wildlife. Immediate action is needed to address the conflict if we are to ensure the harmonious coexistence of people, wildlife and livestock in the arid and semi-arid ecosystems.

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REFERENCES

ADAMS, D. C., GUREVITCH, J., and ROSENBERG, M. S., 1997, Resampling tests for meta-analysis of ecological data. *Ecology,* **78,** 1277-1283.

ANADU, P. A., ELAMAH, P. O., and OATES, J. F., 1988, The bushmeat trade in southwestern Nigeria: a case study. *Human Ecology,* **16,** 199-208.

ARNQVIST, G., and WOOSTER, D., 1995, Meta-analysis: synthesizing research findings in ecology and evolution. *Trends in Ecology and Evolution,* **10,** 236-240.

BOWEN-JONES, E., and PENDRY, S., 1999, The threat of primates and other mammals from bushmeat trade in Africa, and how this threat could be diminished. *Oryx,* **33,** 233-246.

BRASHARES, J. S., ARCESE, P., and SAM, M. K., 2001, Human demography and reserve size predict wildlife extinction in West Africa. *Proceedings Royal Society of London Biological Sciences,* **268,** 2473-2478.

BROWN, L. H., 1971, The biology of pastoral man as a factor in conservation. *Biological Conservation,* **3,** 93-100.

CARO, T. M., PELKEY, N., BORNER, M., CAMPBELL, K. L. I., WOODWORTH, B. L., FARM, B. P., OLE KUWAI, J., HUISH, S. A., and SEVERRE, E. L. M., 1998, Consequences of different forms of conservation for large mammals in Tanzania: preliminary analyses. *African Journal of Ecology,* **36,** 303-320.

CBS, 1981, *1979 Population Census. Volume II Analytical Report*, Nairobi.

CBS, 1996, *Kenya Population Census 1989, Analytical Report Volume III: Population Dynamics of Kenya*. Government Printer, Nairobi.

CBS, 2001, *Kenya Population Census 1999*. Government Printer, Nairobi.

CHILD, B., 2000, Making wildlife pay: converting wildlife's comparative advantage into real incentives for having wildlife in African savannas, case studies from Zimbabwe and Zambia. In *Wildlife Conservation by Sustainable Use* (ed. H. H. T. Prins, J. G. Grootenhuis and T. T. Dolan), pp. 335-387. Kluwer Academic Publishers.

CHRISTOFFERSEN, L., 1995, Development finance for national parks and wildlife management. In *African Heritage 2000: The Future of Protected Areas in Africa* (ed. R. Robinson), pp. 93-96. National Parks Board of South Africa, Pretoria.

DE LEEUW, J., PRINS, H. H. T., NJUGUNA, E. C., SAID, M. Y., and DE BY, R. A., 1998, Interpretation of DRSRS animal counts (1977-1997) in the rangelands districts of Kenya. DRSRS and ITC.

DE LEEUW, J., WAWERU, M. N., OKELLO, O. O., MALOBA, M., NGURU, P., SAID, M. Y., ALIGULA, H. M., HEITKONIG, I. M. A., and REID, R. S., 2001, Distribution and diversity of wildlife in northern Kenya in relation to livestock and permanent water points. *Biological Conservation,* **100,** 297-306.

DIJKSTRA, T., 1996, Food assembly markets in Africa: lessons from the horticultural sector of Kenya. *British Food Journal,* **98,** 26-34.

DIRSCHL, H. J., NORTON-GRIFFITHS, M., and WETMORE, S. P., 1981, Training observers for aerial surveys of herbivores. *Wildlife Society Bulletin,* **9,** 108-115.

DORST, J., and DANDELOT, P., 1972, *A Field Guide to the Large Mammals of Africa*, 2nd edition. Collins, London.

DOUGLAS-HAMILTON, I., and HILLMAN, A. K. K., 1981, Elephant carcasses and skeletons as indicators of population trends. In *Low Level Aerial Survey Techniques.* ILCA Monograph 4, pp. 113-129. ILCA, Nairobi.

DOUGLAS-HAMILTON, I., MICHELMORE, F., and INAMDAR, A., 1992, *African Elephant Database*. United Nations Environmental Programme: Global Environmental Monitoring System, Nairobi.

DOWNING, T. E., LEZBERG, S., WILLIAMS, C., and BERRY, L., 1990, Population change and environment in Central and Eastern Kenya. *Environmental Conservation,* **17,** 123-133.

DYSON-HUDSON, R., and DYSON-HUDSON, D., 1980, Nomadic pastoralism. *Annual Review of Anthropology,* **9,** 15-61.

EAST, R., 1999, *African Antelope Database 1998*. IUCN/SSC Antelope Specialist Group. IUCN, Gland, Switzerland, and Cambridge, UK.

EAST AFRICA ROYAL COMMISSION, 1955, Report presented by the Secretary of State for the Colonies to Parliament by Command of Her Majesty. Her Majesty's Stationary Office, London.

ELLIOTT, J., and MWANGI, M. M., 1997, Making wildlife 'pay' in Laikipia, Kenya. Wildlife Economics. Conservation, Economics and Commerce Programme. African Wildlife Foundation, Nairobi.

FA, J. E., and GARCIA-YUSTE, J. E., 2001, Commercial bushmeat hunting in the Monte Mitra forests, Equatorial Guinea: extent and impact. *Animal Biodiversity and Conservation,* **24,** 31-52.

GUREVITCH, J., and HEDGES, L. V., 1999, Statistical issues in ecological meta-analyses. *Ecology,* **80,** 1142-1149.

HACKEL, J. D., 1998, Community conservation and the future of Africa's wildlife. *Conservation Biology,* **13,** 726-734.

HAPPOLD, D. C. D., 1995, The interaction between humans and mammals in Africa in relation to conservation: a review. *Biodiversity and Conservation,* **4,** 395-414.

HJORT, A., 1982, A critique of ecological models of pastoral land use. *Nomadic Peoples,* **10,** 11-27.

HOMEWOOD, K., LAMBIN, E. F., KARIUKI, A., KIKULA, I., KIVELIA, J., SAID, M. Y., SERNEELS, S., and THOMPSON, M., 2001, Long term changes in Serengeti-Mara

wildebeest and land cover: pastoralism, population or policies? *Proceedings of the National Academy of Sciences,* **98,** 12544-12549.

HOMEWOOD, K., and RODGERS, W. A., 1991, *Maasailand Ecology: Pastoral Development and Wildlife Conservation in Ngorongoro, Tanzania*. Cambridge University Press, Cambridge.

INAMDAR, A., DE JODE, H., LINDSAY, K., and COBB, S., 1999, Capitalizing on nature: protected area management. *Science,* **283,** 1856-1857.

JOLLY, G. M., 1969, Sampling methods for aerial census of wildlife populations. *East African Agricultural and Forestry Journal,* **34,** 46-49.

KISS, A., 1990, Living with wildlife: wildlife resource management with local participation in Africa, pp. 217. World Bank Technical Paper.

LAMPREY, H. F., 1983, Pastoralism yesterday and today: the over-grazing problem. In *Ecosystem of the World 13. Tropical Savannas* (ed. F. Bourliere). pp. 643-666. Elsevier Scientific Publication Company, Amsterdam.

LAMPREY, R. H., 1984, Maasai impact on Kenya savanna vegetation: a remote sensing approach. PhD thesis, University of Aston.

LAMPREY, R. H., and MICHELMORE, F., 1996, The wildlife protected areas of Uganda: preliminary aerial survey results and their assessment plus initial recommendations. EC Wildlife Support Project, Ministry of Tourism, Wildlife and Antiquities, Kampala.

LINDSAY, W. K., 1987, Integrating parks and pastoralists: some lessons from Amboseli. In *Conservation in Africa: People, Policies and Practice* (ed. D. Anderson and R. Grove). Cambridge University Press, Cambridge.

MCNEELY, J. A., 1990, How conservation strategies contribute to sustainable development. *Environmental Conservation,* **17,** 9-13.

MCNEELY, J. A., 1993, Economic incentives for conserving biodiversity: lesson for Africa. *Ambio,* **22,** 144-150.

MOEN, A. N., 1973, *Wildlife Ecology: An Analytical Approach.* Freeman, San Franscisco.

MUNZINGER, P., DEUBLER, C., JATZOLD, R., LEITNER, D., MELCHER, R., MEY, U., and RATHERT, G., 1978, The Hindi-Magogoni settlement scheme in Lamu district, coastal province of Kenya. Prefeasibility study, Vol. IV-22, pp. 162.

NEWMARK, W. D., 1996, Insularization of Tanzanian parks and local extinction of large mammals. *Conservation Biology,* **10,** 1549-1556.

NEWMARK, W. D., and HOUGH, J. L., 2000, Conserving wildlife in Africa: integrated conservation and development projects and beyond. *BioScience,* **50,** 585-592.

NORTON-GRIFFITHS, M., 1978, *Counting Animals*. African Wildlife Foundation, Nairobi, Kenya.

NORTON-GRIFFITHS, M., 1996, Why Kenyan conservation is failing. *Swara,* **19,** 6-8.

NORTON-GRIFFITHS, M., and SOUTHEY, C., 1995, The opportunity costs of biodiversity conservation in Kenya. *Ecological Economics,* **12,** 125-139.

OBA, G., STENSETH, N. C., and LUSIGI, W. J., 2000, New perspectives on sustainable grazing management in arid zones of sub-Saharan Africa. *BioScience,* **50,** 35-51.

OCHIENG', W. R., 1980, *A History of Kenya*. MacMillan, Nairobi.

OLE PARKIPUNY, M. S., 1989, So that the Serengeti shall never die? In *Nature Management and Sustainable Development, Proceedings of the International Congress, IOS* (ed. W. D. Verwey), pp. 256-264. Amsterdam, The Netherlands.

OSEMEOBO, G. J., 1988, Animal wildlife conservation under multiple land-use systems in Nigeria. *Environmental Conservation,* **15,** 239-249.

OSENBERG, C. W., SARNELLE, O., COOPER, S. D., and HOLT, R. D., 1999, Resolving ecological questions through meta-analysis: goals, metrics, and models. *Ecology,* **80,** 1105-1117.

OTTICHILO, W. K., KUFWAFA, J. W., and STELFOX, J. G., 1987, Elephant population trends in Kenya: 1977-1981. *African Journal of Ecology,* **25,** 9-18.

OTTICHILO, W. K., and SINANGE, R., 1985, Differences in the visual photographic measurements in the estimation of strip widths for aerial censuses of animal population. DRSRS, Ministry of Planning and National Development, Nairobi, Kenya.

PEDEN, D. G., 1987, Livestock and wildlife population distributions in relation to aridity and human populations in Kenya. *Journal of Range Management,* **40,** 67-71.

PRINS, H. H. T., 1992, The pastoral road to extinction: competition between wildlife and traditional pastoralism in East Africa. *Environmental Conservation,* **19,** 117-123.

PRINS, H. H. T., 1996, *Ecology and Behaviour of the African Buffalo: Social Inequalities and Decision Making*. Chapman and Hall, London.

PRINS, H. H. T., 2000, Competition between wildlife and livestock in Africa. In *Wildlife Conservation by Sustainable Use* (ed. H. H. T. Prins, J. G. Grootenhuis and T. T. Dolan), pp. 51-80. Kluwer Academic Publishers.

PRINS, H. H. T., and OLFF, H., 1998, Species richness of African grazers assemblages: towards a functional explanation. In *Dynamics of Tropical Communities* (ed. D. M. Newbery, H. H. T. Prins and D. N. Brown), pp. 449-490. Blackwell Press.

SAID, M. Y., CHUNGE, R. N., CRAIG, C. G., THOULESS, C. R., BARNES, R. F. W., and DUBLIN, H. T., 1995, *African Elephant Database 1995*. IUCN, Gland, Switzerland.

SIEGAL, B. J., BEALS, A. R., and TYLER, S. A., 1980, Nomadic pastoralism. *Annual Review of Anthropology,* **9,** 15-61.

STELFOX, J. G., KUFWAFA, J. W., MBUGUA, S. W., and PEDEN, D. G., 1979, Livestock and wild herbivore populations in Kenya rangelands in 1977 compared with 1978. Kenya Ministry of Finance and Planning, KREMU, Nairobi.

SWIFT, J., 1982, The future of African hunter gatherer and pastoralist peoples. *Development and Change,* **13,** 159-181.

VOETEN, M. M., 1999, Living with wildlife. Coexistence of wildlife and livestock in an East African savanna ecosystem. PhD thesis, Wageningen University.

VON BOGUSLAWSKI, M., and WIESE, B., 1992, Combatting poverty and development cooperation: the example of agriculture settlement in Kenya. *Geographische Rundschau,* **44,** 520-526.

WALLER, R. D., 1990, Tsetse fly in western Narok, Kenya. *Journal of African History,* **31,** 81-101.

WESTERN, D., 1982, Amboseli National Park: enlisting landowners to conserve migratory wildlife. *Ambio,* **11,** 302-308.

WESTERN, D., and FINCH, V., 1986, Cattle and pastoralism: survival and production in arid lands. *Human Ecology,* **14,** 77-94.

WESTERN, D., and SSEMAKULA, J., 1981, The future of savanna ecosystem. *African Journal of Ecology,* **19,** 7-19.
ZAR, J. H., 1996, *Biostatistical Analysis*, 3rd edition. Prentice-Hall International, Inc.