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The status of the Amboseli rhino population

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Summary

The status of the Amboseli rhino population has given rise to particular concern, due to an apparently rapid decline since the 1950s.

Information on the causes of death is available over the last 3·3 years and ground counts give a reasonable picture of the gross population structure of the rhinos. Aerial counts indicate a significant decline and provide population estimates on which a reconstruction of changes is possible. It is shown that the population has been declining at an average of about 12% per annum over the last 4 years at least. Seventy-five per cent of mortality results from spear wounds inflicted by Maasai. Natality is dropping rapidly, while the level of spearing is increasing. Spearing is possibly non-selective, so that the age-distribution may be similar to previous periods when the population was more stable. As a result, natality is probably not responding to increasing mortality.

It is concluded that the rhino population is unable to effectively alter the magnitude of decline through intrinsic factors, or immigration. It would take a population over twice its present size to offset the impact of spearing.

The effect of a rapidly changing environment is considered, but although it may result in slightly less favourable conditions for the rhinos, any decline is completely masked by spearing.

The reasons for spearing and the recent increases are discussed, as well as the future prospects and implications.

Introduction

The Amboseli basin is one of the most popular game-viewing areas in East Africa. The number of visitors now approaches 70,000 per year with gross revenue in the order of K.shs. 75,000/km² within the 80-km² game sanctuary set aside by the Maasai Kajiado County Council in 1962. One of its principal attractions has been its rhino

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population (Williams, 1967; Royal National Parks of Kenya Annual Reports, 1955, 1957). Although this was probably true for the 1950s, it would be difficult to substantiate at present. Visitors long associated with the area have noted a sharp decline in the rhino population (Guggisberg & Zaphiro, personal communications). Rangers Kibore and Kamuti who have acted as tour guides since the early 1950s and know most of the rhinos individually report a large drop in sightings.

Additional support for higher numbers than at present can be gathered from wardens' reports. Warden Taberer, for example, saw thirty-one rhinos during a 2-h drive around Ol Tukai (Royal National Parks of Kenya Annual Reports, 1951), while it is now unusual to see as many as five in a full day. This figure alone is around 90% of the estimated present population for most of the basin. Taberer later built a water hole outside his house and recorded fifteen to twenty rhinos regularly watering there at night.

The present study is aimed at assessing the present trends of the Amboseli basin rhino population.

The area

Maasai Amboseli Game Reserve covers approximately 3260 km^2 along the Kenya–Tanzania border, from the northern slopes of Kilimanjaro to Meto, west of Oldoinyo Orok. Only a small area around Ol Tukai, in the east, is of any consequence as a tourist area. This dry season concentration area for wildlife, covering some 600 km^2, is based on perennial springs and swamps within the Amboseli basin. Originally the basin was a Pleistocene lake, which dried up and became colonized by vegetation. A relatively small area which still floods seasonally, is known as Lake Amboseli, and apparently resulted from down-faulting (M. J. Western, personal communication).

In the north, the edge of the basin is marked by a basement ridge of lateritic, red soil, contrasting sharply with the grey-white, saline and alkaline soils of the basin. South, and north-east, black clays and Olivine basalts border the basin, and to the east form a continuous ridge, damming an old effluent. In the west the shores of Lake Amboseli are banked by aeolian deposits.

Fig. 1 shows the distribution of vegetation types relevant to the present study. The vegetation outside the basin is predominantly wooded grasslands, ecological zone V of Pratt, Greenway & Gwynne (1966). Woody vegetation is dominated by *Commiphora* sp., *Acacia mellifera* (Vahl) Benth., *A. nubica* Benth. and *Balinites* sp., and the herb layer by *Aristida keniensis* Henrard, *Chloris gayana* Kunth, and *Sericocomopsis pallida* (Moore) Schinz. Vegetation within the basin shows a variety of seral phases from bare soil, seasonally flooded, through pioneer lake-bed grasses of *Odyssea jaegeri* (Pilger) Hubbard, alkaline grasslands of *Sporobolus marginatus* Hochst., *Sporobolus homblei* De Wild., and *Sporobolus spicatus* (Vahl) Kunth, and a fringing *Acacia tortilis* (Forsk.) Hayne woodland along the edge of the basin. The edge of the swamps, predominantly *Papyrus*, *Cyperus immensus* C.B.Cl., and fringing zones such as *Solanum incanum L.*, *Triplocephalum holstii* O. Hoffm., *Pluchea dioscordis* D.C., and *Sesbania goetzei* Harno. are governed by under-ground seepage from Kilimanjaro. *Acacia xanthophloea* Benth. woodlands with a shrub layer dominated by *Azima tetracantha* Lam. and *Salvador persica* L., are associated with the ground water-table, and like the swamps, fluctuate in extent depending on the magnitude of rainfall. This is particularly relevant to the rhino populations and will be discussed at a later stage.

An area of 250 km^2 is covered in the present survey. Most of this area is naturally

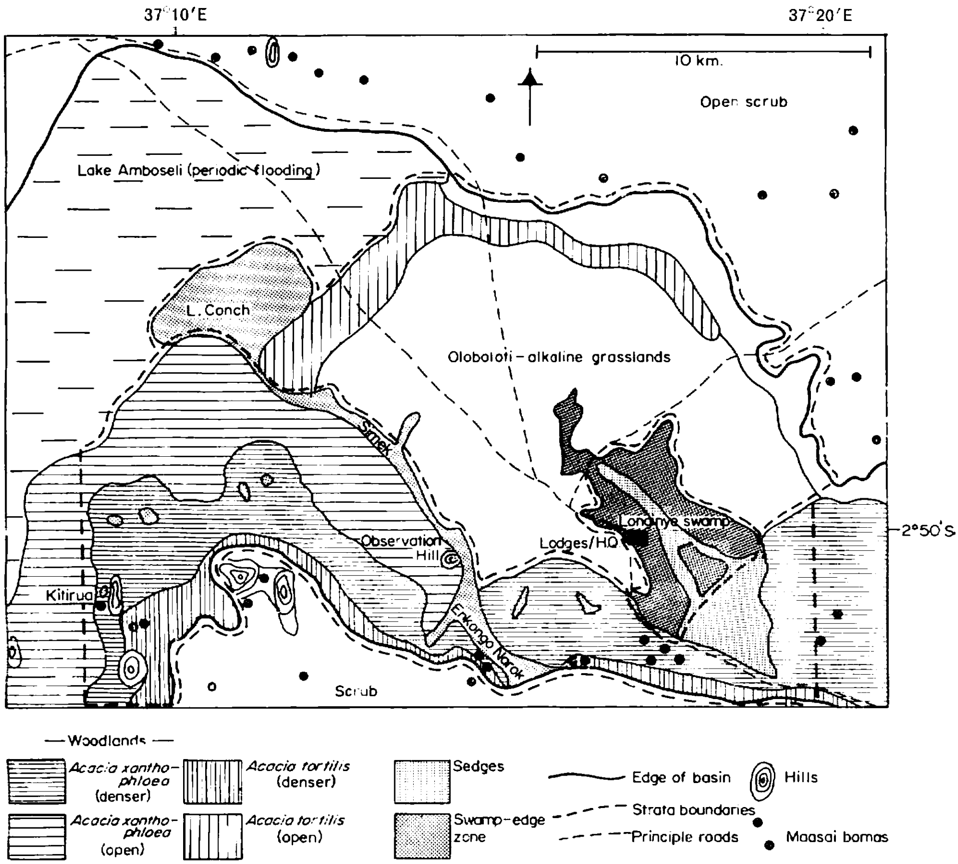

Fig. 1. Amboseli basin showing main vegetation and physical characteristics.

defined by the Amboseli basin and by Lake Amboseli, which in view of the pure grasslands or bare expanses, does not support any rhinos. The range of the basin population of rhinos is therefore fairly easily distinguished from the surrounding area by physical features.

Other reasons for using the basin-edge as boundaries of the study are based on the consistently high level of ranger-patrols and tourist coverage within the basin and its scheduled role in tourist development. Areas surrounding the basin support few rhino and are infrequently visited by rangers or tourists, so that mortality records are poor.

Methods

In estimating the changes in rhino numbers over the study period, two techniques were used, the first based on periodic aerial counts, the second on determining the balance of mortality and natality data.

Routine aerial counts

An area of 600 km^2, including the 250 km^2 relevant to this study was sampled routinely for all major large mammal species each month between December 1967 and July 1970 as part of an ecological survey of the Amboseli ecosystem. Only ground counts were possible in the early stage, but from March 1969 onwards, regular aerial counts were made. Ground counts produced slightly higher population estimates than aerial counts for most species, excluding rhino estimates, which were lower. The explanation for the lower estimates for rhinos is that the highest density rhino areas, the swamp-edge vegetation, was difficult to cover in a vehicle. The only meaningful rhino estimates are therefore based on aerial counts. Cost precluded any attempt at a total count.

Aerial counts were based on transect sampling, where transects were randomized and of equal size (Jolly, 1969). The aircraft, a Piper Cruiser, was piloted by Dr C. J. Pennycuick, while the observer (D.W.) sat in the rear seat and counted all animals sighted within a transect strip defined by two streamers attached to the wing struts. Before each count the door was removed to provide an unobstructed view of the transect strip. The aircraft was flown as close as possible to an altitude of 90 m as indicated by a pressure altimeter, and an average ground speed of 132 km/h, with the transect strip calibrated against measured ground points at 300 m. Altitude measured by a pressure altimeter will vary with changes in static air pressure. An effort was made to compensate for such bias, which can be appreciable during periods of rapid change in air temperature, such as early morning and late afternoon. Every three or four transects (30–40 min) the aircraft was flown just above ground and the pressure altimeter was reset to ground height. Since the ground sites used as check points differed by less than 7 m from each other, or in fact almost anywhere across the extremely flat basin, constant recalibration was possible. A known change in altitude resulted in a known change in transect width and so any drift in height between calibration checks was compensated by recalculating the area sampled. The techniques used and the results of these multi-species population estimates are to be published elsewhere.

Stratified aerial counts

Following the loss of seven rhinos through spearing in the last 5 months of 1970, and the concern of Parks rangers over a rapid fall-off in rhino sightings, a count was undertaken in January 1971, aimed at an accurate estimate of the population. The count was intended to indicate whether there had been any change in the estimated population size since the earlier counts, and to provide an estimate on which to calculate the population trend from the balance of natality and mortality figures. The count was based on a randomized sampling procedure, selecting with probability proportional to size (Jolly, 1969). The area was stratified, since this is considered a useful technique of reducing the sampling errors which tend to be high in areas of heterogeneous animal distribution and physiography (Cochran, 1963) such as Amboseli.

The area was stratified into high, medium and low density zones, referred to as the plains, woodlands, and swamp-edge strata (Fig. 1) on the basis of routine aerial counts. One zone omitted entirely was Lake Amboseli, which is an unsuitable habitat for rhinos (Table 2). The swamps are largely covered by sedge, indicating standing water, and the swamp-edge vegetation is dominated by *Solanum incanum*, *Triplocephalum hostii* and *Sesbania goetzei*. While the sedge areas, dominated by dense *Papyrus* and *Cyperus immensus*, are largely avoided, the swamp-edge vegetation, particularly bordering Longinye Swamp, contains the highest density of rhinos in the basin. The relatively small swamp-edge zone of 14 km^2 was therefore sampled intensively, while the sedge areas were included in the lower density woodlands stratum. Enkongo Narok, a long narrow swamp, although mainly sedge-covered, was included in the woodlands stratum because of the narrow band and broken patches of *Acacia xanthophloea* scattered along its length. Lake Conch, a vast area of sedge, was included in the plains stratum as a low density zone.

On the routine counts the aircraft height and transect width used were probably suitable for reliable population estimates of rhino in Amboseli, an area where the open terrain and grey–white soils facilitate their detection. For the stratified count, however, a more intensive count was considered desirable, to determine whether a smaller sampling unit from a lower altitude resulted in an increased population estimate. Goddard (1969) for example, found that a strip of 91 m wide counted at 76 m was necessary for reliable rhino estimates in the varying habitats of Tsavo, where counting conditions are, however, less favourable than Amboseli. For this reason the aircraft was flown as close as possible to an altitude of 60 m and an average ground speed of 130 km/h. A transect 125 m wide was used for counts in the swamps and woodland strata, and a 200-m transect in the plains stratum where the excellent counting conditions on the short-grass saline flats render rhinos extremely conspicuous. The plains stratum was sampled from 17.00 to 17.50 hours on 21 January, while the swamp-edge and woodland strata were sampled between 06.42 and 08.25 hours the next morning. From the previous counts and ground observations it can be inferred that the movement between these two strata and the plains would not be likely to affect the validity of the counts. Counting was restricted to late evening and early morning, corresponding to the peak activity period of rhinos, determined from ground studies and data published by Goddard (1967). During the count, cool weather prevailed, with thin high cloud, which would tend to extend the activity peak (Goddard, 1967), offering good counting conditions. The last six of the thirty-two transects in the woodland stratum were completed by ground transects, due to limitations on aircraft availability.

In this count Lawrence Gathua acted as an additional observer, counting out of the opposite side of the aircraft from the principal observer. His count was intended to provide an additional estimate of the population.

Mortality records

Within the 250 km^2, tourist vehicles generally guided by Park rangers, provide a good coverage almost daily, totalling 8500 vehicles per year. Any dead animals attracting vultures and predators are therefore likely to alert attention. Most of the rhino kills known were recorded in this way. From October 1969 onwards an antipoaching unit, with the use of a Landrover donated by the East African Wild Life Society, regularly patrolled the area and recorded a number of the kills. On some occasions speared rhino, which were still alive, were reported by the Maasai or by tourists. In some instances an aircraft had to be used in locating a carcass, when animals reported speared ran into the swamps. Such instances indicate that some rhinos may have died in the swamps and escaped notice.

Results

Routine aerial counts

Estimates of the rhino population for the 600 km^2 area, based on routine aerial counts in which rhinos were included are given in Table 1, together with relevant data on the counts. Estimates of the population size ($\hat{Y}$) and the standard error of the estimate given by $\sqrt{(\text{var } \hat{Y})}$ were calculated from the expression of Jolly (1969):

Table 1. Results of routine aerial counts

Date	Transect width (m)	Aircraft height (m)	No. of transects	Area sampled (%)	Population estimate ($\hat{Y}$) for 250 km²	SE ($\hat{Y}$), 5% confidence interval	Population estimate ($\hat{Y}$) for 600 km²	SE ($\hat{Y}$), 5% confidence interval
30 Sept. 1969	300	91	35	35	51	±38	56	±42
16 May 1970	300	91	24	24	42	±20	48	±29
15 June 1970	293	91	25	25	47	±41	52	±50
21 July 1970	297	91	24	24	43	±45	53	±39

$$\hat{Y} = N\bar{y}$$

$$\text{var}(\hat{Y}) = \sum \frac{N(N-n)}{n} \cdot \frac{1}{n-1} \left\{ \Sigma y^2 - \frac{(\Sigma y)^2}{n} \right\}$$

where N = number of units equal to the total area,
$\bar{y}$ = average numbers of animals per unit,
n = number of sample units,
y = number of animals in any one unit.

Population estimates for the 250 km² study area were computed using the same formula, since although the area was irregular in shape, the units differed insufficiently to noticeably increase the standard error (Table 1).

Stratified aerial count

Table 2 presents the data and results for the stratified random count in January 1971, where the population estimate and standard error were calculated from the expression of Jolly (1969):

$$\hat{Y} = \Sigma_i x_i \bar{d}_i$$

$$\text{var}\,\hat{Y} = \sum \frac{x_i^2}{n} \cdot \frac{1}{n_i - 1} \left\{ \Sigma\, d^2{}_i - \frac{(\Sigma d_i)^2}{n_i} \right\}$$

where for the ith stratum:
x_i = the total area,
$\bar{d}_i$ = the average density,
d_i = the density of animals in an individual sample,
n_i = the number of samples.

The rhinos were not apparently disturbed by the low-flying aircraft. Of the twenty-seven rhinos sighted by both observers during the count, none showed obvious agitation and all continued with the activity they were engaged in as the aircraft flew overhead.

Despite the better counting conditions associated with the stratified count—lower altitude, narrower transects and the fact that only rhinos were counted—the count produced an estimated population appreciably below that of the earlier routine counts. Also the estimated populations and standard errors calculated from each observer's counts, 34±19 (D.W.) and 38±15 (L.G.) showed good agreement.

Table 2. Results of stratified count January 1971

	Strata			
	Swamp-edge	Woodlands	Plains	Lake
Rhino densities/km² (determined from routine aerial counts)	0·75	0·18	0·02	0
Areas of strata (km²)	14	113	126	—
No. of transects counted/observer	15	32	16	—
Area sampled/observer	66%	20%	17%	—
Aircraft height (m)	61	61	61	—
Transect width (m)	125	125	200	—
Mean ground speed (km/h)	130	130	130	—
Estimated densities/km²				
D.W.	0·28	0·25	0	—
L.G.	0·60	0·14	0·07	—
	D.W.	L.G.		
Estimated population ($\hat{Y}$)	34	38		
SE ($\hat{Y}$), 5% confidence interval	±39	±29		

Population trend based on aerial counts

The large standard error of all the estimates is largely attributed to the clumped distribution and low densities of animals, resulting in a preponderance of sampling units having zero counts. Despite stratification, the standard error of the estimate for the 1971 count is larger than the earlier counts, but in view of the smaller sampling units used and the apparently lower rhino density, this is not unexpected. A consequence of the large standard error though, is that the differences between individual counts are not significantly different, although a downward trend in numbers is evident (Fig. 2). A regression line fitted to these points ($y=53{\cdot}15-1{\cdot}02x$, SD=2·94, $t=3{\cdot}95$) does show that there has been a significant decrease in the estimated population ($P<0{\cdot}05$). In this graph the estimates for the stratified random samples are derived from D.W.'s count only, to retain observer consistency with previous counts. Any bias in the counting techniques employed should be consistent, with the exception of the final count, where a higher population estimate might have been expected with the more intensive counting. In view of this, we regard the significance of the results established by the regression equation to be a realistic indication of a downward trend in the population.

Mortality data

Table 3 summarizes the data on known rhino losses from human agencies between September 1967 and the end of 1970. A total of fifteen were killed directly from spear wounds, while an additional three juveniles of speared females were too young to be left (less than 6 months old) and had to be taken to the Nairobi Orphanage, so were still lost to Amboseli. One of these three died on the journey to Nairobi. Another

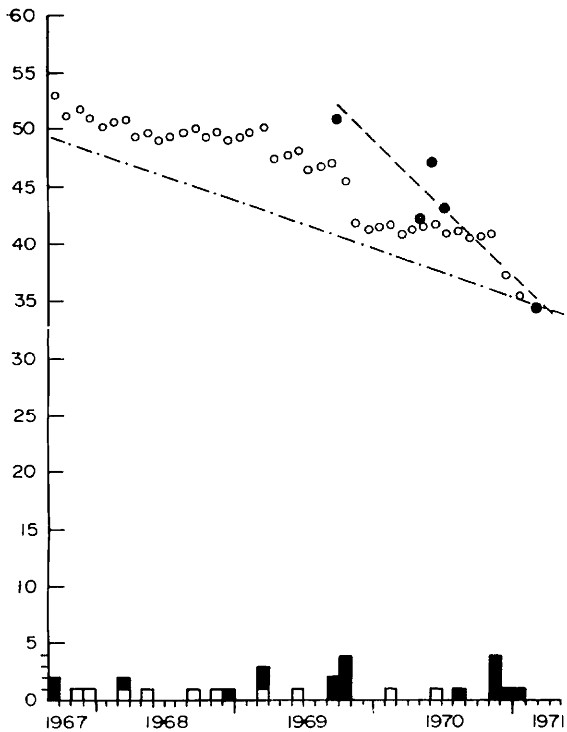

Fig. 2. Estimated changes in the Amboseli rhino population. ●, population estimates based on aerial counts; — —, regression line fitted to aerial counts ($y = 53{\cdot}15 - 1{\cdot}02x$, SD $= 2{\cdot}9$); ○, monthly population estimates calculated from mortality and natality data, where recruitment is taken as 7%; –·–·–, population changes assuming a recruitment rate of 10%; ■, losses and mortalities due to human agencies; □, mortalities due to undetermined causes.

juvenile, that of the female speared on 1 January 1971, was not captured, but whether it was old enough to survive on its own, was uncertain. A further two rhinos were reported speared but were not subsequently located. A male rhino involved in a fight with another male, fell down a refuse pit and had to be shot. It is certain, therefore, that a minimum of nineteen rhinos were lost through human agencies over the period recorded.

Over the same period an additional ten animals died from undetermined causes with two exceptions, one where a juvenile was killed by a lion, the other where an animal was found in such poor condition with a broken back, that it was shot. In the eight other instances, either the dead animal was found, or the carcass was clearly considered recent enough for the animal to have died after September 1967. All ten records are considered natural deaths for lack of any evidence of spearing, although it is possible that some of these did in fact die of spear wounds.

Both sets of records represent a minimum number of deaths in the population, but in view of the regular patrolling within the study area, it is unlikely that many deaths went unrecorded.

Natality data

Table 4 gives a breakdown of the Amboseli rhino population based on ground counts.

Table 3. Known rhino losses through human agencies in Amboseli basin, between September 1967 and December 1970

No.	Date	Sex	Age	Cause of loss
1	16 Sept. 1967	?	Adult	Speared, horn taken
2	17 Sept. 1967	?	,,	,, ,, ,,
3	29 March 1968	?	,,	,, ,, ,,
4	Nov. 1968	Male	,,	Fell in refuse pit, shot
5	21 March 1969	,,	,,	Speared, horn not taken
6	28 March 1969	,,	,,	,, ,, ,, ,,
7	15 Sept. 1969	,,	,,	,, ,, ,, ,,
8	29 Sept. 1969	?	,,	,, ,, ,, ,,
9	7 Oct. 1969	Male	,,	,, horn taken
10	10 Oct. 1969	Female	,,	,, ,, ,,
11	13 Oct. 1969	?	,,	,, ,, not taken
12	15 Oct. 1969	Female	3 months	Calf of female No. 10 sent to Nairobi Orphanage
13	Aug. 1970	Male	Adult	Speared, horn taken
14	18 Nov. 1970	Female	,,	,, horn not taken
15	18 Nov. 1970	,,	Juvenile	Calf of female No. 14, sent to Nairobi Orphanage
16	19 Nov. 1970	,,	Adult	Speared, horn not taken
17	19 Nov. 1970	,,	Juvenile	Calf of female No. 16, sent to Nairobi Orphanage
18	22 Dec. 1970	Male	Immature	Speared, horn not taken
19	31 Jan. 1970	Female	Adult	,, ,, ,, ,,

Table 4. The structure of four rhino populations. All except Amboseli are based on Goddard (1967, 1970)

	Amboseli	Ngorongoro	Olduvai	Tsavo
Adult males (%)	34	34·2	30·0	31·7
Adult females (%)	27	26·8	25·8	27·2
Immatures (%)	39 (Immatures + Calves)	19·4	24·2	13·4
(Immatures + Calves)		39·0	44·2	41·1
Calves (%)		19·6	20·0	27·7
Calves/year: adult females	0·25	0·25	0·25	0·30
Mean calving interval (years)	4·0	4·0	3·8	2·5 (3·3)*
Mean annual natality (%)	6·8	7·0	7·2	10·9 (8·2)*

* Calculated from Goddard's tables on field records

in which males, females and immatures were recorded. Rhino births are not likely to go undetected in Amboseli, where the small population is under continual observation. Many of the well-known rhinos are sighted almost daily, if not a number of times in a day. For 1969 when the most complete data is available to both authors, eight regularly-visited rhinos gave two births, or a calves/year: adult female ratio of 0·25 and a calving interval of 4 years. These eight females probably represented about 60% of the female population at that time. Additional data from five females known over 3·3 years suggests that a figure of 4 years for the calving interval is approximately correct. Three of the five had the same calf with them throughout this period and were not obviously pregnant (their body shape makes pregnancy difficult to detect). In another case the age of the calf a female was first seen with, suggested that the calving interval was in excess of 3·5 years. In the last case a female which gave birth to an earless calf in September 1968 was observed in an apparently successful copulation in May 1971, which, assuming a gestation period of 15 months (Goddard, 1967) suggests the calving interval will not be less than 4·1 years.

Goddard's data for Ngorongoro, Olduvai and Tsavo rhino populations are compared in Table 4 to the Amboseli data. Goddard's categories have been simplified to correspond to the categories recorded for Amboseli. Both Ngorongoro and Olduvai populations show similar structures to the Amboseli population while the Tsavo figures show a slightly higher recruitment rate, although the data calculated from his field records, given in brackets, show a lower recruitment than those calculated from his life tables.

Population trend based on natality/mortality

By starting from the estimated population of thirty-four rhinos for January 1971, and assuming a 7% annual natality, it is possible to give estimates of the changes since 1967, by adding known mortalities and deducting births. It is of course difficult to gauge exactly what figures to base the 7% natality on, but in fact the errors to the nearest whole number are negligible within the ranges involved. So anywhere between thirty-six and fifty rhinos gives an estimated annual natality of three rhinos, and between fifty-one and sixty-five gives four rhinos, to the nearest whole number. In view of this, the total number of deaths for each year are added on to the end-of-year population estimates and natality based on this total. The distribution of births is largely unknown, so they have been assumed to be uniformly distributed over each month, resulting in a smoothed picture of the changes. Fig. 2 illustrates the estimated population changes.

The overall change has been a 35% decline over the 3·3 years. The rate of decline has varied, 4% in 1967, 2% in 1968, 24% in 1969 and 17% in 1970, with a mean annual decline of about 12%. There has been a marked increase in both the numbers killed and rate of decline, and estimated natality has declined from four in 1969 and three in 1970, to an estimated two in 1971, even assuming no further spearing. Numbers are rapidly declining to a level where even a low constant rate of two to three spearings per year will continue to depress the population numbers. The mean annual number of spearings over the last 4 years has been six.

A reasonably good agreement is shown between the two methods of estimating changes; while the aerial estimates suggest a population of fifty-one in September 1969, the figure suggested by a reconstruction from the natality/mortality data is forty-seven rhinos.

Bias is probably towards an underestimation of the decline since the number of deaths is a minimum estimate. Errors in annual natality do not appreciably affect the estimated decline rate. If a 10% natality were assumed, i.e. calving interval of 2·7 years, the overall change would appear as 27% decline over the study period (Fig. 2). Similarly, errors in count estimates would not radically alter the magnitude of population change. For example, even assuming a population of forty-five rather than thirty-four rhinos during January 1971, the decline over the study period would still be 25% at a 7% annual natality or 23% at a 10% annual natality rate.

A crude check, at least, is possible on the aerial estimates. The area is largely covered almost daily by the rangers, generally with tourists. Consequently, most of the rhinos and their localities are known individually. Ranger Kamuti counted and estimated twenty-five to thirty rhino for the area during January 1971. Ol Tukai Orok and a section of the western end of the study area were excluded from his reckoning, since they are not so accessible, but would include less than ten. His figures are, therefore, within the same order of magnitude as the aerial counts.

Another relevant point is the similarity in population structures between Amboseli, and Olduvai-Ngorongoro. The Amboseli population is declining rapidly, while the latter are stable. This coupled with mortality data in Table 3 suggests that the spearings may be non-selective, so that the population age structure possibly reflects its previous stable period. The natality rate does not appear to have responded to the increased death rate.

It can therefore be concluded that the present rhino population is unable to effectively alter the magnitude of decline through intrinsic factors. It would take a population of about ninety rhinos with a 10% recruitment rate, or a population of around 130 with a 7% recruitment to offset the established minimum death rate. Both figures are significantly greater than the estimated population ($P < 0{\cdot}001$). Immigration is unlikely to appreciably offset the decline, since the surrounding bushland areas and Lake Amboseli, although constituting 70% of the ecosystem, support less than 20% of the rhino population. These areas are almost certainly suffering equal, if not greater, pressures due to lack of regular patrols.

A continuation of the present spearing rate is likely to exterminate the population by 1977.

The changing environment

The foregoing calculations were based on the assumption that, apart from the increased spearing, the environment is stable. But Western & Van Praet (unpublished data) have found the vegetation over most of the basin to be changing rapidly in response to a rising ground water-table. The effects are two-fold. Within the areas covered by *Acacia xanthophloea* woodlands, approximately 90% of the trees have died since 1950, while *Suaeda monoica* Forsk., has spread widely. To judge from the replacement of the hydrophilic *A. xanthophloea* by the halophytic *Suaeda monoica* and comparable changes in the herb layer, and from soil surveys, it seems likely that the rising water-table is resulting in widespread salinization of the woodland areas. In the low troughs and depressions of the basin, the swamps have expanded rapidly and are now twice as extensive as in 1950, drowning woodlands and resulting in less favourable vegetation cover for rhinos. But while the swamps have replaced former areas of woodlands with sedge, the swamp-edge vegetation has also increased, and possibly compensated this loss of suitable habitat. Changes within the woodlands are more difficult to assess. From the aerial counts it was found that the denser woodland areas that covered much of the area prior to 1955, have a mean rhino density of $0{\cdot}17/km^2$, while the spreading halophytic vegetation referred to in Fig. 1 as open woodlands, has a mean density of $0{\cdot}18/km^2$. It is likely that the changes within the woodlands have had a negligible effect on the rhino population density, but it would be extremely difficult from the present data to detect anything but a marked shift.

A number of Maasai elders claim that rhinos and particularly elephants moved into the basin area only after the woodlands spread extensively across the basin some

70–80 years ago. This would appear to correspond to a lowering of lake levels (Lamb, 1966), and presumably the water-table in Amboseli, towards the end of the last century. If this can be substantiated, then it is possible that the present habitat changes in Amboseli are leading to a slightly less suitable environment for rhinos. But the only reasonable documentation available for the period prior to the turn of the century suggests that even then the rhino population was very substantial (Thomson, 1885; Wickenburg, 1899; Höhnel, 1894; Schillings, 1910).

Reasons for spearing

In view of the major role of spearing in the decline of the Amboseli rhino population, the reasons for an increasing incidence were sought. These should, however, be examined within the broader context of land-use conflicts in Amboseli (Western, 1971).

The word spearing has been used in preference to poaching, which would appear more appropriate, but in Amboseli not all rhinos were speared for profit. Some rhinos were speared by known poachers, but others were killed in localities where the stealing of horns was easy and incidental to the main motive. It is certain that there is more than a single motive for the Maasai spearing rhinos in Amboseli. On examining the various political and social factors dominant at present, the following have been suggested as the most obvious reasons.

(a) *Conflict of interest.* Amboseli basin, by virtue of its permanent water and swamps, is as vital to Maasai livestock as wildlife. Both move into the basin during the dry season, reaching maximum numbers just prior to the rains of November–December and March–May. Then competition for grazing increases until both wildlife and cattle are concentrated on the perenially green, swamp pastures, where the Maasai and rhino come into closest contact. Most rhino speared in defence of livestock and self-defence are killed in this period. About three rhinos definitely come under this category.

(b) *Poaching.* A declining, relative milk yield, the result of an annual 3% rise in the Maasai population without comparable livestock increase, means that alternative supplementary subsistence is required at the end of the dry seasons. In most cases this is provided by the sale of stock and subsequent purchase of grain. But occasionally it would appear that if rhinos have been killed, for any reason, in a concealed area, there is sufficient incentive in avoiding sale of stock to remove the horn. At least three cases of this type are indicated by the September 1967 records.

At least five rhinos are known to have been poached by a particular individual, later arrested. These instances can be regarded as professional poaching, not opportunistic, as in the instance mentioned above. Professional poaching constitutes a minimum of about 30% of the animals lost through human agencies.

(c) *Social traditions.* Normally all the available man-power is put into use, in one way or another, during the dry seasons. Sparse grazing induces a reduction of herd size to maintain grazing efficiency and the greater number of herds demand more herders. Also grass shortage leads to employment of scouting patrols to locate areas of local abundance. This particularly involves the young men (Ilmorran) who are otherwise idle. The lax periods are associated with the rains and as long afterwards as reasonable pasture exists. During such times the Ilmorran have most time to exercise their bravery and high spirits, traditionally demonstrated on cattle raids, which are now largely curtailed. It is acknowledged that such motives account for some of the spearings, particularly during the rains when the horns are not taken, and probably some during the dry season.

(d) *Area politics*. Grazing is available outside the basin, beyond the dry season foraging range of most herbivores. The Government, recognizing the value of Amboseli as a natural resource, is scheduled to set aside an area within the basin, of approximately 400 km², as a wildlife 'Park'. Alternative water supplies for the Maasai will relocate them in the potential grazing areas, presently beyond their dry season limits. However, traditional dependence on the basin for salt, perennial water and dry season graze renders it difficult for the Maasai to relinquish the basin area, despite the potential elsewhere.

The negotiations leading to the present plans stretch back almost 20 years, during which time there has been a considerable amount of misunderstanding and vaciliation (Western, 1971). The local Maasai, through ten representative elders, now liaise with the Reserve Administration, and have co-operated in reporting game violations. A climate of uncertainty has, nonetheless, been of sufficient duration that frustrations, probably coupled with the need for some form of traditional self-expression by Ilmorran, have led to an increase of rhino spearings.

Discussion

General

There is reason to suspect that the present decline of the population began during the 1950s. The first reports expressing concern over the impact of spearings appear in the National Parks annual report of 1955, when four rhinos were reported killed by spearing. In 1959 further mention is made of another four lost as a result of 'high-spirited' Ilmorran. Subsequently, spearings became frequent and attracted particular attention after both 'Gertie' and 'Gladys' died from spear wounds.

Even as late as 1964, Guggisberg counted thirty-five rhinos and estimated a total of not less than fifty altogether in an area of approximately 85 km² (Guggisberg, 1966). The same area in January 1971 almost certainly had less than thirty; the aerial estimates indicate about twenty-five. It is certain that the Maasai have always killed a number of rhinos, but it is evident from early accounts by Thomson (1885), Höhnel (1894), Wickenburg (1899) and Schillings (1910), that the toll could not have been heavy, since they all note large numbers of rhinos in the neighbourhood. It is also obvious from their accounts that the Ilmorran spent a great deal of their time on raids as far as the coast.

Concern was expressed over the effect of similar spearing on the Ngorongoro rhinos in the late 1950s. Eight were speared in the Caldera alone, during 1960. Goddard (1967) suggested that this may have led to a temporary decline, but that the levying of severe penalties on the offenders kept the impact of spearings within tolerable limits in later years.

A radical decline in the rhino populations is regarded as a loss of one of Amboseli's major attractions. In view of the fact that its present income per hectare is almost as high as coffee, despite its negligible agricultural potential, appropriate resource management is a positive need. A number of other factors have increased the difficulties of managing the area optimally, given the present tourist numbers and an annual increase of 22%. These can basically be attributed to a salinization of much of the basin area. A disappearance of extensive sections of the woodland has led to greater visibility and higher effective tourist density in the flat basin. Similarly a decreasing animal diversity, coupled with the increasing visibility, has led to a greater concentration on lions and cheetahs, resulting in harassment, particularly of females with newborn cubs. Rhinos, particularly the famous long-horned females such as 'Gertie' and 'Gladys' are particularly functional in diversifying game viewing, although careful overall planning is needed to meet this problem. Long-horned rhinos are obviously a feature of the area, probably under genetic control. Two other females were recently of great interest for this reason. One was speared, though the other is still alive. Even as far back as the last century both Höhnel and Wickenburg noted the extraordinary length of horn attained by female rhinos in Amboseli, then known as Njiri. Such rhinos as 'Gertie' and 'Gladys' have obviously done great service in advertizing both Amboseli and East African wildlife in general, out of all proportion to the value of their horns. The conservation of the Amboseli population should not be overlooked for this reason.

Conclusions and recommendations

From the data presented it can be concluded that the Amboseli basin rhino population has an appreciably higher mortality rate than natality. Natural mortality possibly balances natality, but the impact of spearing, which accounts for at least 75% of all deaths, has caused a population decline averaging 12% per year over the period of observations. A number of reasons account for a step-up in the number of spearings, including financial incentives, displacement of social traditions and uncertainties over the future of the area.

The population numbers are now so low that a continued decline is almost inevitable, even if the spearings were in future limited to those of a defensive nature. It will be some time before the present plans for Amboseli Park are fully implemented, but early moves should be made, at least to full protection of the high density rhino areas in Longinye Swamp and along the Simek Circuit. With full protection for the 400 km^2 area only the profit-motivated spearing will remain a problem, but will be easier to control than at present, as there are now no restrictions on the passage of people through the area. In the interim, spearing will undoubtedly continue and the only feasible approach to reducing the level, is by increased ranger patrols and liaison with the Maasai committee. Restocking of rhinos would almost certainly speed up a recovery, but under the present circumstances, should be deferred until after the area is fully protected, when mortalities should be minimal. Full protection is, however, preferable to restocking, since it is economically desirable to conserve what is probably a genetic strain producing the long-horned rhinos of Amboseli.

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