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SOME POPULATION CHARACTERISTICS OF THE LION *PANTHERA LEO* IN THE KALAHARI GEMSBOK NATIONAL PARK

M. G. L. MILLS, P. WOLFF*, E. A. N. LE RICHE and I. J. MEYER

Kalahari Gemsbok National Park
Private Bag X5890
P. O. Gemsbok Park
8815

Abstract – Two methods of estimating the number of lions in the Kalahari Gemsbok National Park, Republic of South Africa, are described; the first gives a minimum figure (113) and the second a more realistic one (140). Data are presented on sex and age ratios and pride composition. The factors contributing to the low density are briefly discussed and some management practices in connection with lions trespassing out of the Park are suggested.

Introduction

During the last few years considerable trouble has been caused by lions *Panthera leo* going through the fences along the south and south-western boundaries of the Kalahari Gemsbok National Park (KGNP) Republic of South Africa, particularly into the Mier Coloured Settlement along the south-western boundary. The lions have also sometimes moved from the Mier Settlement into farming areas in adjacent South West Africa. During these expeditions the lions have usually killed wild animals, although on occasions they have also caused damage to domestic stock, particularly sheep; e.g. on 1975.12.26 four lions killed 56 sheep (C. F. S. A. le Riche *pers. comm.*). The policy of the management staff in the KGNP has been to return these animals to the Park whenever possible, either by driving them back through the fence or by immobilising them and then releasing them in the Park. On several occasions, however, it has been necessary to destroy lions and from January 1975 until October 1976 at least 15 lions had to be killed. In addition

*Present address:
Division of Nature Conservation
Private Bag X404
Skukuza
1350

two animals died after being immobilised and released back into the Park.

Although certain aspects of the ecology and behaviour of the lions in the KGNP have been studied by Eloff (1973a, b and c) there is little information on their population size and structure. It was therefore decided to undertake a project to investigate these, so as to obtain an idea of the state of the population. It was also felt that this knowledge would lead to a better understanding of the causes of these movements out of the KGNP and of the effects of the management practices outlined above on the population.

The KGNP can be divided up into two main habitats; the two dry river-beds of the Auob and Nossob and the dune areas in between them and to the west of the Auob (Bothma & de Graaff 1973). The highest densities of large herbivores (approximately 90%) occur in the river-beds, and the area west of the Auob has a higher large herbivore density than the other dune areas. The Nossob River forms the boundary between the KGNP (9 591 km^2) and the Gemsbok National Park (24 800 km^2) in the Republic of Botswana and is unfenced.

Methods

During the initial part of the study, between August and early October 1976, 60 lions were caught; 54 were marked by hot branding individually recognisable symbols of approximately 10 cm in length either on the shoulder or rump, two were already marked and four were too small to mark. Forty six (76,6%) were caught by the method of Smuts, Whyte & Dearlove (1977), nine (15,0%) by tracking spoor in the day and then darting the animals when they were caught up with, and five (8,3%) were darted when they were encountered whilst driving around during the day. All caught lions and some that could not be caught were sexed and assigned to age classes after Smuts (1976). Animals under about four months old were not included in the population estimations.

Because of the low density of lions in the KGNP it was soon realised that unless fresh lion spoor was encountered before putting out the bait, it was hardly worthwhile trying to attract lions to the capture site. Of 27 sites chosen 18 had fresh spoor in the vicinity and nine did not. Of the 18 sites with spoor, lions were attracted to the bait on 13 occasions, and of the nine sites without fresh spoor, lions only came to the bait once (Fisher exact probability test p=0,005).

No attempts were made to catch lions in certain areas, either because it was known that most of the lions were marked in the area (F. C. Eloff *pers. comm.*), or because recent observations had shown that there were few lions in the particular area. Thus the large middle block, between the Nossob and Auob River, was virtually left out, as lions are seldom encountered in this habitat (Table 1). Most of those that are, are believed to have part of their home ranges in one or other of the river-beds. In addition no lions were caught in the extreme south of the Park around Twee Rivieren. Sight records of lions in these areas, made six

Table 1

Frequency of sightings of lions in the two major habitats of the Kalahari Gemsbok National Park, 1975–1976

	Dry River Bed			Dunes between Nossob and Auob Rivers		
	Day	Night	Total	Day	Night	Total
Distance travelled (km)	17 895	8 355	26 250	5 738	2 695	8 433
Number of lions observed	144	83	227	12	3	15
Distance travelled (km)/lion	124	101	116	478	898	562

months or less before the survey, were included in making the initial population estimation.

From the completion of the marking program until the end of January 1977, all lions over approximately four months old sighted by us were carefully observed and the number of marked and unmarked individuals noted if possible. From these data a second population estimation was made by applying the Lincoln index.

Results

Population size

First estimation. Apart from the 56 lions over four months old that were caught, another 14 came to the bait or were seen whilst tracking spoor, but could not be caught. In addition, from tracks it was possible to account for another three animals which were attracted to the bait but did not arrive at the carcass. Apart from these, another 40 lions could be accounted for from recent sight records with a reasonable amount of certainty, thus giving a minimum total of 113 lions for the whole Park.

Second estimation. Of 149 lions observed from the completion of the marking program until the end of January 1977, 59 were marked, 76 were unmarked and 14 were indeterminable. Assuming that 61 animals were marked at the beginning of the study (the additional five animals being an estimation of the number of marked animals at this time in Eloff's study area), and that the proportion of repeat observations of marked and unmarked animals was the same, a 95% confidence interval for the lion population of animals over four months old in the KGNP is 108 to 181 with 140 being the best estimate.

Density, sex and age ratio

Assuming that there are 140 lions in the KGNP, which is 9 591 km² in area, the density is one lion per 68,5 km² (53,0 km²–88,8 km²). This is low in comparison with other African reserves, only the Masai Steppe of Tanzania having a lower density (Table 2).

Table 2

Lion densities in nine African reserves.

Reserve	No. km² per lion	Source
Manyara	2,5	Makacha and Schaller, 1969
Ngorongoro	3,7	Schaller, 1972
Nairobi	3,8	Rudnai, 1973
Central District Kruger	7,9	Smuts, 1976
Kafue	8,3	Mitchell, Shenton and Uys, 1965
Serengeti	10,6–12,7	Schaller, 1972
Selous	12,5	Rodgers, 1974
Kalahari Gemsbok	68,5	This study
Masai Steppe	306,0	Lamprey, 1964.

In addition to the 60 lions that were originally caught it was possible to determine the sex of another 13 that came to the bait but could not be caught (Table 3). From the table it can be seen that there is a preponderence of females in the adult and sub-adult classes (1 ♂:1,8♀). By way of comparison 357 adult and sub-adult lions observed whilst driving around the Park since 1972 give a sex ratio of 1 ♂:1,5♀(145 ♂:212♀). The small sample of cubs probably accounts for the distorted sex ratio in this age group.

Seventy four of the lions encountered during the marking program were placed in age classes; 67,6% of the sample being adults or sub-adults and 32,4% being cubs (Table 3).

Table 3

Sex ratio and age composition of lions from the Kalahari Gemsbok National Park

SEX RATIO n = 73

Adults	Sub-Adults	Adults and Sub-adults	Cubs	All ages
1♂:2,1♀ 10:21	1♂:1,4♀ 8:11	1♂:1,8♀ 18:32	1♂:1,6♀ 9:14	1♂:1,8♀ 26:46

AGE COMPOSITION n = 74

Adults	Sub-adults	Large cubs	Small cubs	Adults and sub-adults	Cubs
41,9% n=31	25,7% n=19	6,8% n=5	25,7% n=19	67,7% n=50	32,4% n=24

Pride composition

Although the exact nature of lion social organisation has not been established in the southern Kalahari, the indications are that it is similar to that which has been found in the Serengeti and other areas (Schaller 1972; Bertram 1975; Smuts 1976). The majority of the animals live in prides, the nucleus of which are a group of adult females and each pride has a territory which is defended against other lions. As far as we can ascertain there are about nine prides in the KGNP; two which focus their activity in the Auob river-bed and the area to the west, six in the Nossob river-bed and possibly one in the area between the Auob and Nossob rivers. In addition there may be another pride high up in the Nossob River around Union's End, but it probably focuses its activities in the Gemsbok National Park in Botswana.

The prides in the lower Nossob and Auob Rivers have been disturbed by man's activities when trespassing out of the KGNP, and the one in the upper Auob has also been affected, but not to the same extent. Table 4 shows the probable composition of four of the prides about which sufficient data are available, the most uncertain figures being those of adult females which are the minimum for each pride. We have assumed that animals seen together are members of the same pride.

Table 4

Probable composition of four lion prides from the Kalahari Gemsbok National Park

Pride	Date	Adult ♂	Adult ♀	Sub-adult ♂	Sub-adult ♀	Large cub	Small cub	Total
Mata Mata	Aug. '76	4	8	1	0	7	8	28
Jan se Draai	Oct. '76	3	5	1	3	0	3	15
Kasper se Draai	Oct. '76	1	4	1	4	0	3	13
Kwang	Oct. '76	2	5	2	2	0	6	17

In light of the observation of Schaller (1972) and Bertram (1975) in the Serengeti regarding the fate of sub-adult males evicted from a pride, the following observation is of interest. A sub-adult male which we marked left his pride (Jan se Draai) soon afterwards and joined a neighbouring one (Kasper se Draai) which already had one adult male. The sub-adult was observed in the area on several occasions from April 1977 including one observation on 1977.10.31 when he was found lying within 50 m of the adult male and several of the females of the pride.

Perhaps the fact that the Kasper se Draai pride had only one adult male (who had, about six months before we marked him, taken over the pride from two other males) motivated him to accept another, as the

period of tenure of a pride by two or more males is apparently greatly increased (Bertram 1975). At the same time the sub-adult male which we marked in the Kasper se Draai pride disappeared, illustrating perhaps how strong this eviction process is.

Discussion

In the first population estimation we do not think that any of the lions included as being seen within six months of the commencement of the survey in areas where none were caught, were in fact caught during the marking program, although it is possible that some had either died or moved out of the KGNP after they were last seen. Even so this figure is undoubtedly an underestimation, as some areas of the KGNP are not often visited and therefore the lions in these areas are not well known, and females in particular are not easy to recognise.

The assumption that the population is well defined, made when applying the Lincoln index, seems a reasonable one, as the observation period was short in comparison with this species rate of turnover and change. The second assumption that the average probability of observing a marked animal is equal to the average probability of observing an unmarked one, is more difficult to establish. The method used to mark the lions was chosen so as to minimise the chances of tourists recognising that an animal had been marked, and in this respect it was successful. However, it was not always easy for us to say if in fact an animal was marked or unmarked, and some marked animals were probably recorded as unmarked or indiscernible, and some unmarked animals were almost certainly recorded as indiscernible. It seems logical that the most common error would be to be unsure about unmarked animals, which would tend to make our population assessment too low. On the other hand 28,2% of the observations, all of unmarked animals, were made in those areas of the river-beds where no lions were caught (20% of the total area of the two river-beds), which biases the results in the other direction. Finally, the area between the river-beds received little attention, only three individuals were marked in this area and eight were seen during the observation period, three of which were marked. It is possible, therefore, that there are more lions in this area.

On balance, therefore, it would seem that there are a few more lions in the KGNP than the second assessment shows. However, all the prides along the Nossob river-bed also use some areas in the Botswana Park, and the density figure of 68,5 km^2 per lion is an overestimation for the KGNP.

We have assumed that the method of capture is random for all sex and age classes of the population and several observations lend strength to this assumption, as for example, when two females arrived at a carcass, and after staying for a few minutes left, returning later with three small cubs. Smuts *et al.* (1977) also concluded that the method catches all sex and age classes except for cubs under about one month of age.

Although the lion density in the KGNP is low, the indications are that the population is healthy, as 32,4% of animals encountered during the marking program were cubs and the adult and sub-adult segments were represented in similar proportions to lions in other large areas (Schaller 1972; Smuts 1976). In addition the neighbouring Gemsbok National Park in Botswana serves as a reservoir for the KGNP's lions and *vice versa*.

Schaller (1972) and Bertram (1973) have shown that an important factor regulating lion density is the amount of available prey over an extended period. This explains the low density in the KGNP, as the herbivores are concentrated along the two dry river-beds, which make up less than 2% of the total area of the KGNP, and their numbers fluctuate markedly from year to year and at different times of the year (Eloff 1959a and b, 1961, 1962; Bothma 1971, 1972; Bothma & Mills 1977). Furthermore the relative lack of cover in this semi-arid region, particularly in dry years, probably makes the habitat less suitable for lions (Eloff 1973b), Schaller (1972) showing the importance of this factor in hunting success.

In the Kruger National Park, Smuts (1976) has shown that through the provision of artificial water, game were able to colonise previously unsuitable areas and that this was followed by an increase in the lion population. In the KGNP the provision of potable artificial water has led to the establishment of a sedentary blue wildebeest (*Connochaetes taurinus*) population in the Auob river (Eloff 1966) and there are indications that the same might be happening in the Nossob River, as since 1972 the wildebeest numbers have undergone a steady increase (Bothma & Mills 1977). Whether this has led to an increase in the lion population in the Auob or will do so in the Nossob, is not known, although it is probably significant that the Mata Mata pride, which lives in the area with the highest year round wildebeest density, has more adult females than any other pride. The situation should therefore be carefully monitored as the effect of an increased lion population on other carnivores, in particular the brown hyaena *Hyaena brunnea* and cheetah *Acinonyx jubatus*, may be detrimental.

Most of the lions which trespass out of the KGNP do so into the Mier Settlement along the south-western boundary. A recent aerial survey in this area revealed a far higher prey biomass, made up of both wild and domestic animals (almost twelve times as many head), in this settlement than in a similar sized area on the other side of the fence. It is thus understandable that the lions would want to get at this richer food supply.

Although the number of individuals involved in trespassing and their status is not at present well known, it does seem that at least some of them are young males. Six of the 12 known sex and age animals killed in the last two years were classified as sub-adult or young males, three as adult males and three as young adult females. As it is known in the Serengeti that young adult males and some young females become

nomadic (Schaller 1972), it is reasonable to assume that some of these 'problem' animals are nomads. It is suggested that in future any sub-adults caught trespassing should be marked and released high up in the Nossob river-bed but not too near the South West Africa fence. Then there is a chance that at least some of them will be able to settle in one or other of the Parks where they will not be so likely to cause trouble. The only practical alternative is to destroy them.

For the most part resident adults that move out of the KGNP are certain individuals which persistently do so and once an individual has been returned to the KGNP a few times, there seems to be no alternative but to destroy it. The improvement of the south-western boundary fence by the addition of two strands of wire (during 1976) has already helped to alleviate the problem and hopefully the fence is to be further improved by the laying of wire netting into the ground (C. F. S. A. le Riche *pers. comm.*).

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