The Movement Patterns of Elephant in the Kruger National Park in Response to Culling and Environmental Stimuli

Ian Whyte

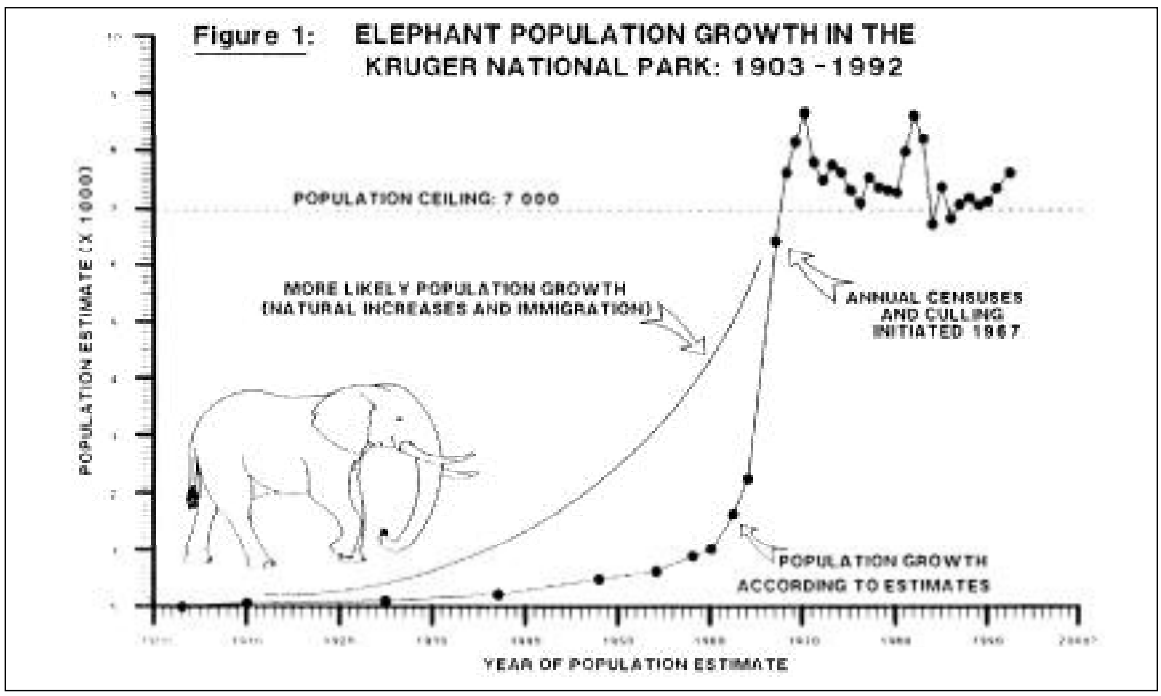
Introduction

The elephant population of the area now comprising the Kruger National Park (KNP) was almost extirpated before the proclamation of the area as a game reserve in 1903. The population then grew gradually through both immigration from Zimbabwe (then Rhodesia) and Mozambique, and through natural increases until 1967 when the decision was taken to restrict the population (through culling) to a level around 7,000. This policy has been successfully applied since then and the most recent census of the population in September 1992 indicated a total of 7,632 animals (Figure 1). The philosophy behind this policy has been discussed by Pienaar (1983) and defined by Joubert (1986).

The elephant population is censused annually in August/September using a Bell "Jet Ranger" 206 helicopter. The standardised method (Joubert, 1983) has delivered a total of between -4,4% and +7,9% of the expected result since 1982 (Whyte & Wood, 1993).

Elephant culling is conducted from a Bell 206""Jet Ranger" helicopter. Animals to be culled are darted using "Scoline" (Succinylcholine chloride) and are brain shot as soon as they become recumbent to prevent the inhumane effects of suffocation caused by the Scoline (de Vos *et al,* 1983). Younger, more tractable animals are immobilised using M99 (Etorphine hydrochloride) for translocation to other conservation areas. Approximately 360 animals are culled annually - 310 from breeding groups and 50 adult bulls.

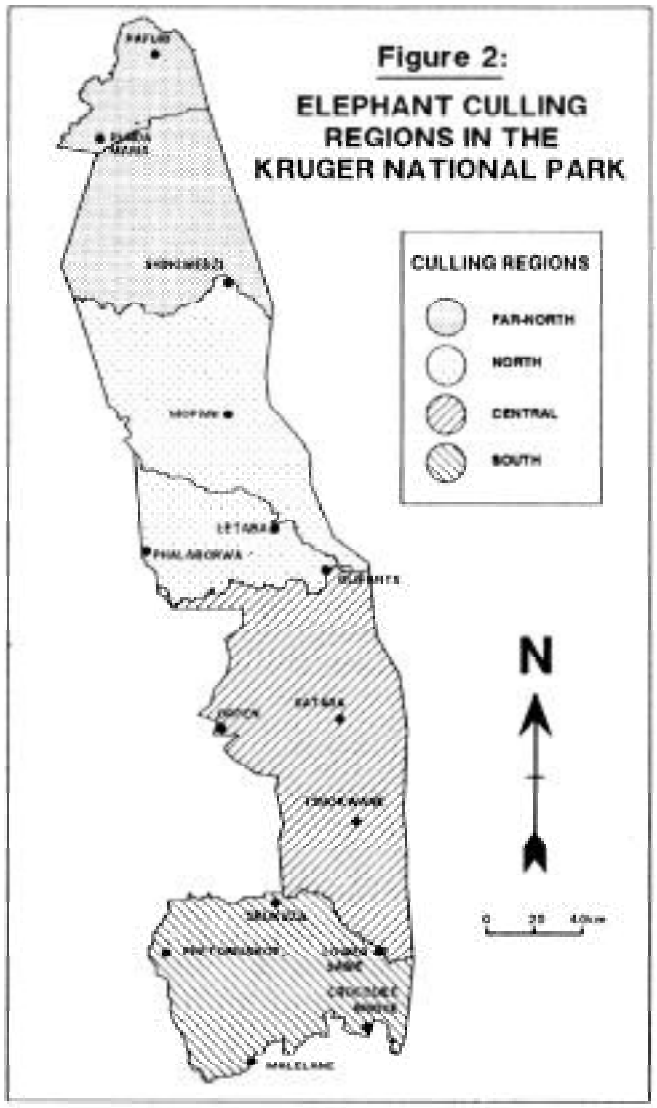
It has been suspected for some time that some form of disturbance results from such culling operations, as reports are received from field staff engaged in culling operations that the elephants had



"disappeared' after such culls. The actual cause of the disturbance is not known. It may be the activities and sounds of the helicopter itself or it may be that some form of "infra-sound" distress signal is emitted by darted animals which disturbs other nearby elephants. Experiences while immobilising elephants from the helicopter suggest that such movements are not instigated by the activities of the helicopter alone as such darted animals have not shown significant movements immediately after being collared. It is therefore suspected that research into the "infra-sound" signals emitted by elephants being culled would produce fruitful results.

For the purposes of the management of this elephant population, the KNP has been divided into four management regions (Figure 2). Culling operations are conducted in only one of these regions per year"- each region thus is "culled" once in four years. The question whether or not the culling programme induced movements across the regional (culling) boundaries in reaction to the culling programme has since arisen. Should this be the case, the practice of regional culling would require reconsideration.

The movements of elephants in the Kruger National Park have therefore been monitored by means of radio-telemetry for the past 3 years for the purposes of establishing home-range sizes of various "clans" and to determine the effects of the annual culling program on the movements of affected clans.



Methods

In each of the culling districts, adult elephant cows were radio-collared a few months in advance of scheduled culls to determine "normal" home ranges and movements. During and subsequent to the cull these were also monitored for comparison to determine the effects of the cull. Some culls were conducted on herds at varying distances from the collared animal while others were conducted on animals from the immediate family kinship groups of collared animals.

"Telonics" radio-collars and receivers were used and tracking was conducted from both vehicles and aircraft (Cessna 182 & 206). Data gathered from ground tracking was usually only in the form of a "fix" (the determining of a collared animals locality) on a map as collared animals could seldom be approached closely due to thick bush and to the wariness of animals of off-road vehicles. Aerial tracking on the other hand, can give an exact fix of the animals, the group size including the presence or absence of calves under a year old, and can also give data on the condition of the habitat - proximity of water, etc. This data was recorded to try to explain why the animals were located where they were,

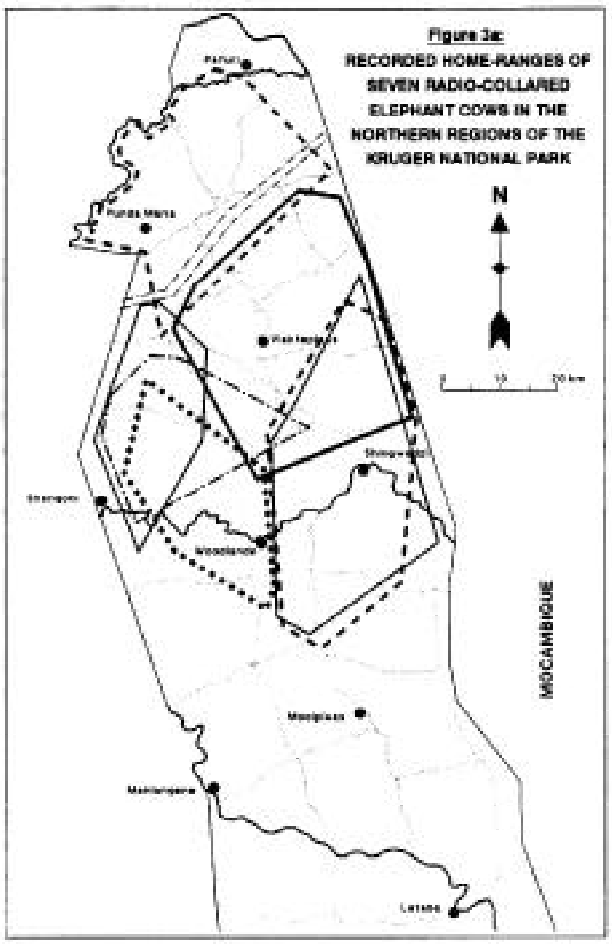
i.e. could the movements of elephants be correlated to habitat factors such as rainfall and/or the effects of rainfall on the vegetation? And how do these movements compare to those induced by the stresses involved with the culling program?

In this paper, two aspects were examined: the distance of any one fix of a collared animal from the previous one, and the increases in home-range size resulting from these movements. The two major limitations of the data are that:

* The distance of any one fix from the next may or may not be a function of the time lapsed between fixes.

* Long distance movements may or may not result in an increase in the recorded home-range size.

As far as was possible, home-ranges have been represented here by minimum convex polygons. The geographic features of the KNP rendered this not always possible where sharp corners occur in the fence line or where elephants do not cross rivers, etc. No statistical analysis of the home-range data has yet been undertaken as the study is still in progress.



Results

J. Home-range size

The recorded home-ranges of the respective marked animals are shown in Figures 3a (Northern KNP) and 3b (Central and Southern KNP). As is evident from these Figures, neighbouring clans have home-ranges which show a considerable overlap, but a closer analysis (not given here) shows that each clan utilises a core area which is relatively discrete from its neighbours.

Only one of the collared animals was recorded to move outside the boundaries of the KNP. This is an animal just to the north of Nwanetsi (Figure 3b) who was recorded to have moved in to Mozambique for a period of about two months. Reasons for her going there are not clear as flying over Mozambique was not possible. It was known that large fires had burned much of that area in Mozambique and a rain shower had subsequently passed through. This probably provided the stimulus. Fixes of her position while in Mozambique are estimates by "triangulation".

Recorded home-range size is a function of both time lapsed since marking and the number of times the animal's locality has been fixed. Recorded home-range sizes for collared animals in the KNP are given in Table I. It is clear that the longer an animal is tracked, the larger will be its recorded home range.

A linear regression analysis of all the recorded home-range sizes against the number of months since collaring gave a correlation coefficient of r=0.61.

Table 1: Recorded home-range sizes of 20 radio-collared adult elephant cows in the respective regions of the Kruger National Park.

Region	Number of marked animals	Mean period of observation (mths)	Mean home range size(km²)	Range (km²)	SD
Far-north	7	36	909	606 - 1255	282.4
South	5	17	613	200-1193	368.0
Central	8	12	383	129-727	238.9
Total	20	21.6	625	129 -1255	359.3

2. *Reaction to culling*

In terms of movements alone, results to date have proved variable and difficult to interpret as some animals reacted dramatically to a culling operation by moving many kilometres away while others showed no response at all.

Of the 20 collared animals, 10 can be regarded as having been "exposed" to culls by being in the immediate vicinity (at distances of up to seven kilometres) of other elephants being culled. Of these, four reacted to the cull by undertaking significant movements while the other six did not. Movements are regarded as significant if they exceed the mean distance between successive fixes. Many of the movements recorded are "significant" in that they exceed the mean recorded distance between fixes, but they are "normal" in that they could not be attributable to any specific stimulus. Some may be as a result of a longer time lapse between fixes but the reason for others could not be determined. Figures 4, 5 and 6 illustrate the results of tracking of a few selected collared animals which are considered to be representative. In these Figures, the line graphs connecting the dots show how the area of the recorded home-range of the animal increases with increasing number of fixes. The bar graphs show the distance recorded between respective fixes. Movements which could be attributable either to culling of rainfall are highlighted. Black columns highlight the distance moved in response to culling while hatched columns show the total movement ascribed to culling where such movement occurred over two or more successive fixes. Stippled columns highlight the movement attributable to rainfall.

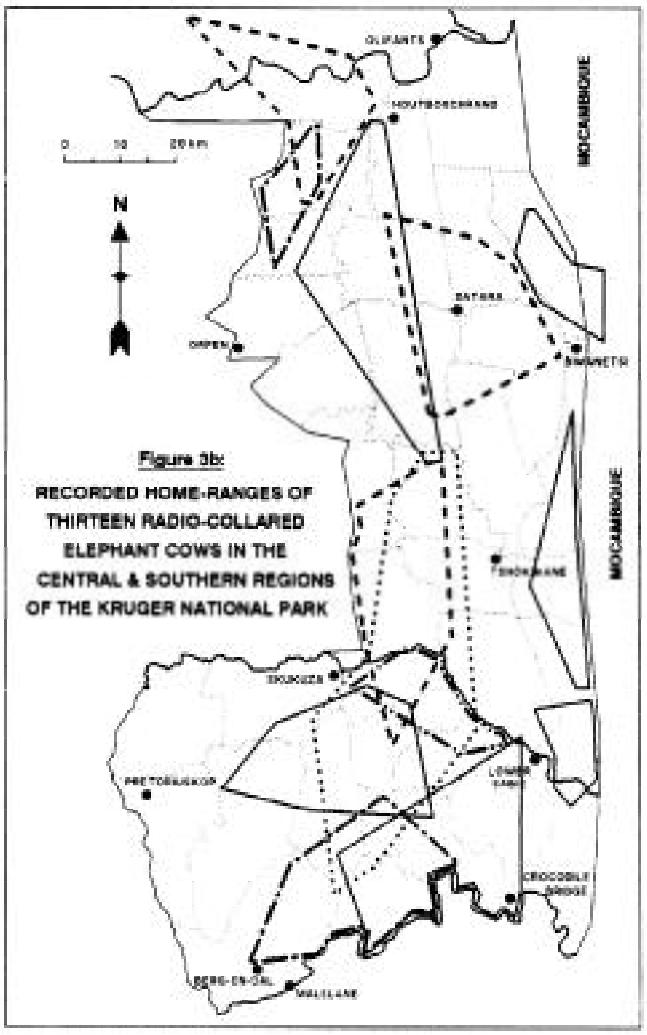


Figure 3b:
RECORDED HOME-RANGES OF THIRTEEN RADIO-COLLARED ELEPHANT COWS IN THE CENTRAL & SOUTHERN REGIONS OF THE KRUGER NATIONAL PARK

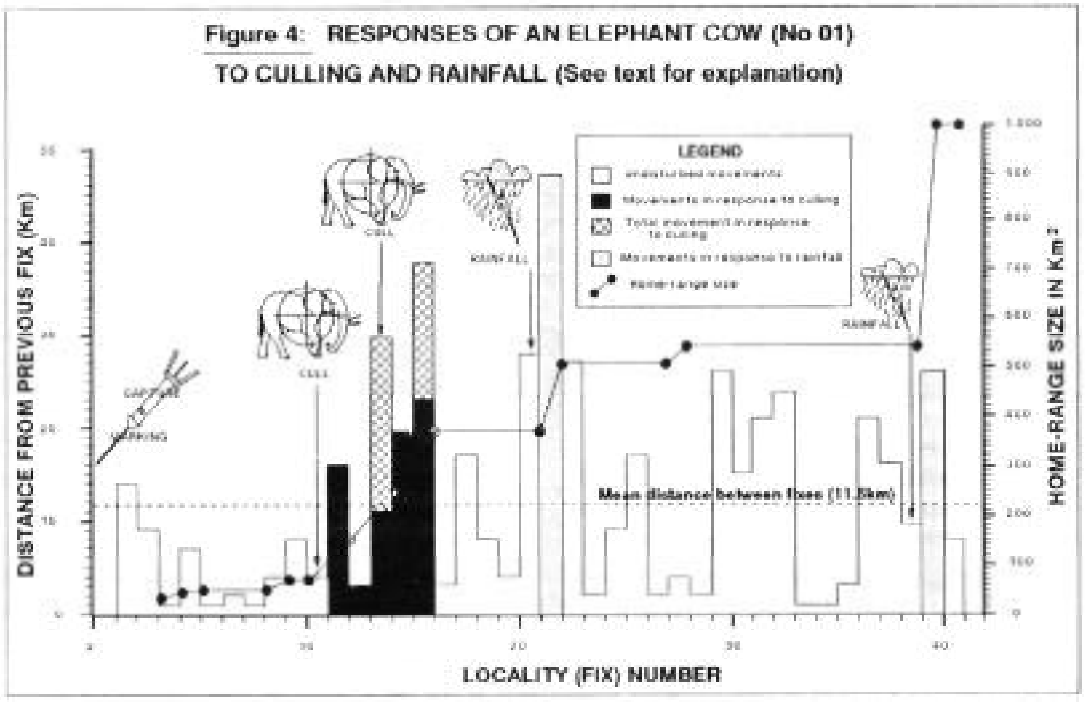
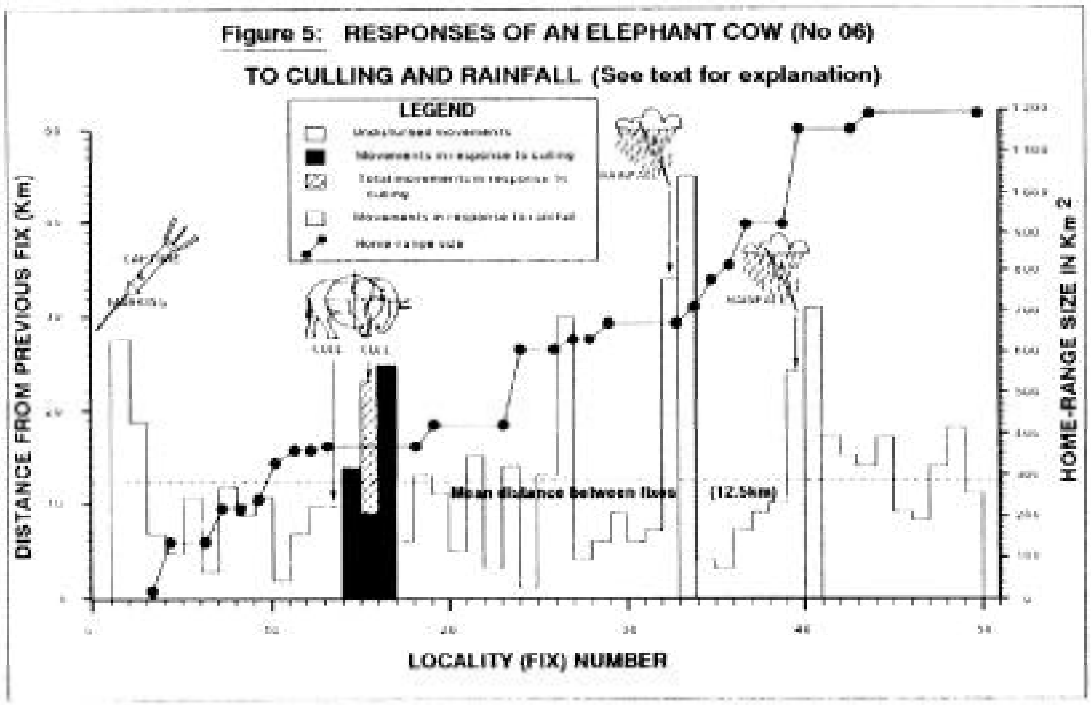
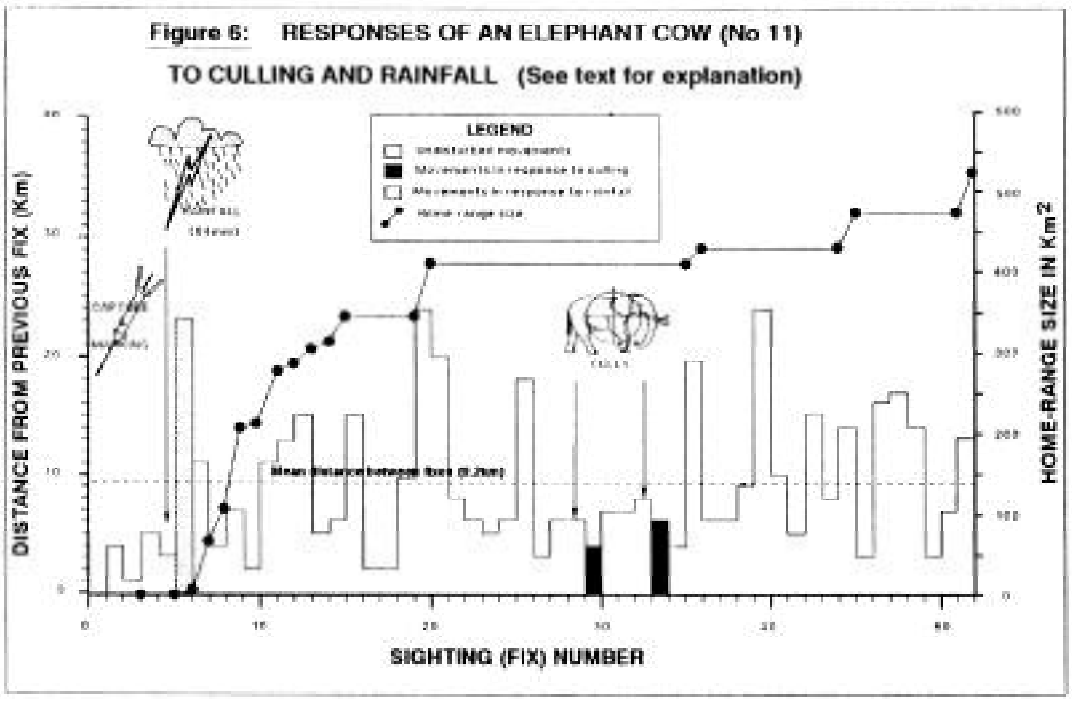


Figure 4 shows how elephant cow 01 responded to two culling operations by significant movements. After each cull her movements resulted in an increase in her recorded home-range. The first cull was conducted approximately 7km from her location in spite of which she responded by a significant movement of 30km in a straight line over two days (it would seem that "infra sound" (Langbauer *et a!,* 1991) must have played some role in the communication of the animals being culled and the radio-collared group as 7km is a long way for the sounds of the helicopter and





rifle to have been such a disturbing factors). The second cull was conducted very close by (<1km) which resulted in movements of 38km over a period of eight days. On two subsequent occasions, she again undertook significant movements in response to a localised rain showers which also resulted in an increase in her recorded home-range. In the second case, the movement took her way out of her "normal" home-range which nearly doubled its area. In this animal's case, the movements in response to rainfall were far more significant than to those in response to culling both in terms of distance between successive fixes and increase in recorded home-range size.

The responses of elephant cow 06 to culling are illustrated in Figure *5*. Culling was conducted out of a herd of 57 animals of which she formed part. She responded by moving 23km over the next two days. This herd had by then been joined by others and was 85 strong and was then culled again. She responded by moving all the way back almost to the previous culling site - 25km overnight. Although these movements were significant in terms of distance between successive fixes, it can be seen in Figure 5 that there were no concomitant increase in home-range size. In this animal's case, rainfall again induced movements which were significant in terms of distance and home-range size increase. In contrast to the above two cases, Figure 6 shows that elephant cow 11 showed a response to rainfall which resulted in only a small increase in home-range size (this was because all of the fixes obtained up to that time fell almost on a straight line). She was then exposed to two culls. In the first case she was located three kilometres from the cull while in the second, her immediate family group were culled. Culling of her group was actually under way when the pilot saw that she was carrying a collar and the culling for the day was stopped. She and four others (ages and sexes uncertain) were left. In spite of the trauma that this must have caused, her responses to both of these culls were very slight - 4km and 6km respectively, and neither of these resulted in home-range size increases.

3. *Long-term stability of home-ranges* A radio-telemetry study of the movements of breeding herd elephants in the Kruger National Park in the early 1980's was conducted by Hall-Martin (1984). The comparison of the results of his work with those of the present study suggest that clans may show a high degree of fidelity to home-ranges over a considerable period (10 years or more). Figures

7a & 7b illustrate the home-ranges he recorded overlayed with those of the present study. It is not known whether the animals he studied are definitely from the same clans as those presently under study, but this, with minor differences, would certainly seem to be the case. The home-range sizes recorded by me appear to be larger than those by Hall-Martin (1984) which may be related to the extreme drought conditions which have prevailed during most of the present study.

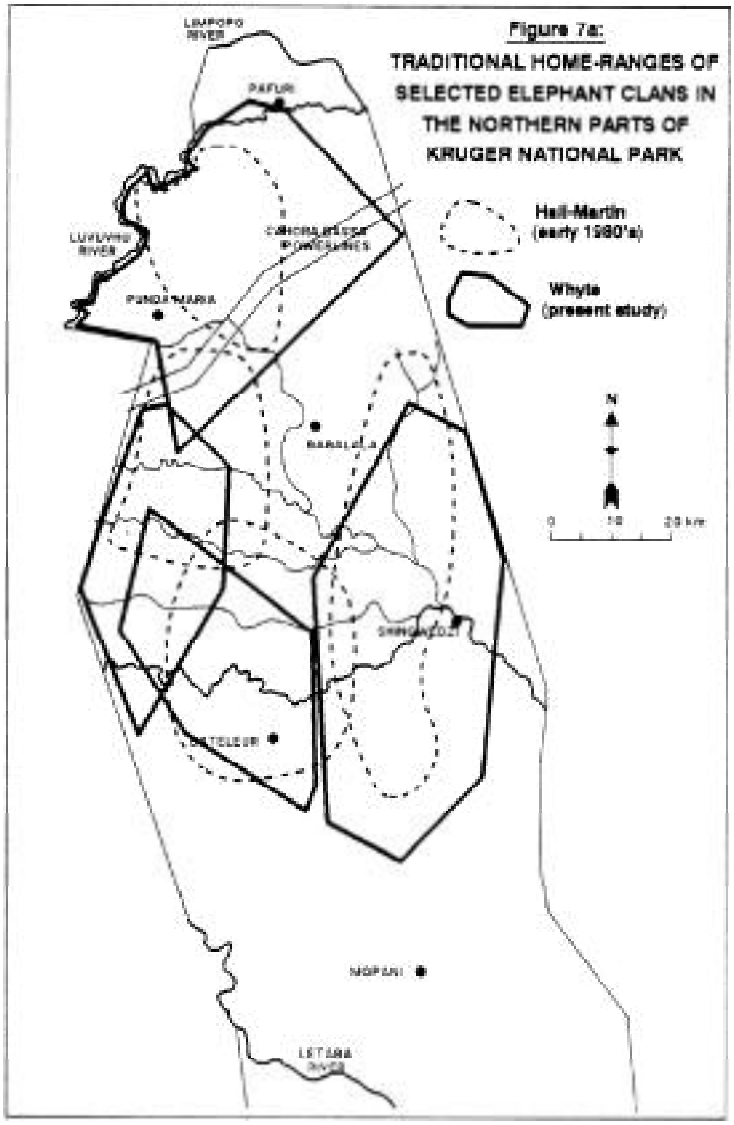


Figure 7a: TRADITIONAL HOME-RANGES OF SELECTED ELEPHANT CLANS IN THE NORTHERN PARTS OF KRUGER NATIONAL PARK

Discussion

As with other studies, the analyses of home-range and movement have not been entirely satisfactory as there are limitations to these kinds of data. The major limitations during this study were that:

1. Collared animals could not be tracked regularly. This makes the comparison of the distances between fixes difficult or even superfluous as periods between tracking varied from hours to weeks

2. Minimum convex polygons do not give an accurate idea of the actual area important to the collared animal. They give an indication of the total area that the animal may use but this tells nothing of how the range is utilised.

Given these two shortcomings, there is still some useful information that has emerged.

1. *Home-range size*
   It becomes apparent that home-ranges can never be satisfactorily determined when studied in this manner. The area of the home-range increases with time after collaring and the number of fixes. From Table I it is clear that the longer an animal is tracked, the larger will be its recorded home range. This continues to a point where it looks as if the picture is complete when suddenly a movement occurs in response to some stimulus which takes the animal outside of its previously recorded home-range and adds significantly to its area. Figure 4 illustrates this well. After fix 28 up to fix 39 it seemed as if the limits of the home-range had been determined. This was from 11 to 29 months after collaring when suddenly the area of the home-range increased by 87% in response to rainfall. The movement undertaken to achieve this increase was not particularly large (26km) considering the largest recorded by her was 47km.

   Home-range sizes differed considerably even though the animals had been collared for the same

period of time and had been tracked the same number of times. This must be related to the "quality" of the home-range in terms of its ability to provide all of the requirements of the elephant clan. No data are available on this aspect however.

2. *Reaction to culling*
The culling operation clearly instigated movements in some of the collared elephants - some of which took them outside of their previously determined home-ranges. This was mainly due to the short period of time since these animals had been collared. Subsequent to culling and with further study, all of these animals returned to areas in the vicinity of where culling had taken place and also back again into the areas into which they had "fled" from the culling operation. This suggests that the stress and/or trauma of the cull was not a sufficient stimulus to induce them to leave their home-ranges. Rainfall on the other hand induced some of the longest movements recorded and in the case of elephant cow 01 (Figure 4) appears to have provided a stimulus sufficient to induce her to leave her "normal" home-range. At the last fix she was still in the area added to her home-range by this movement. It may be that time will show that she repeatedly returns to this area when conditions are right and that it does in fact constitute part of her home-range.

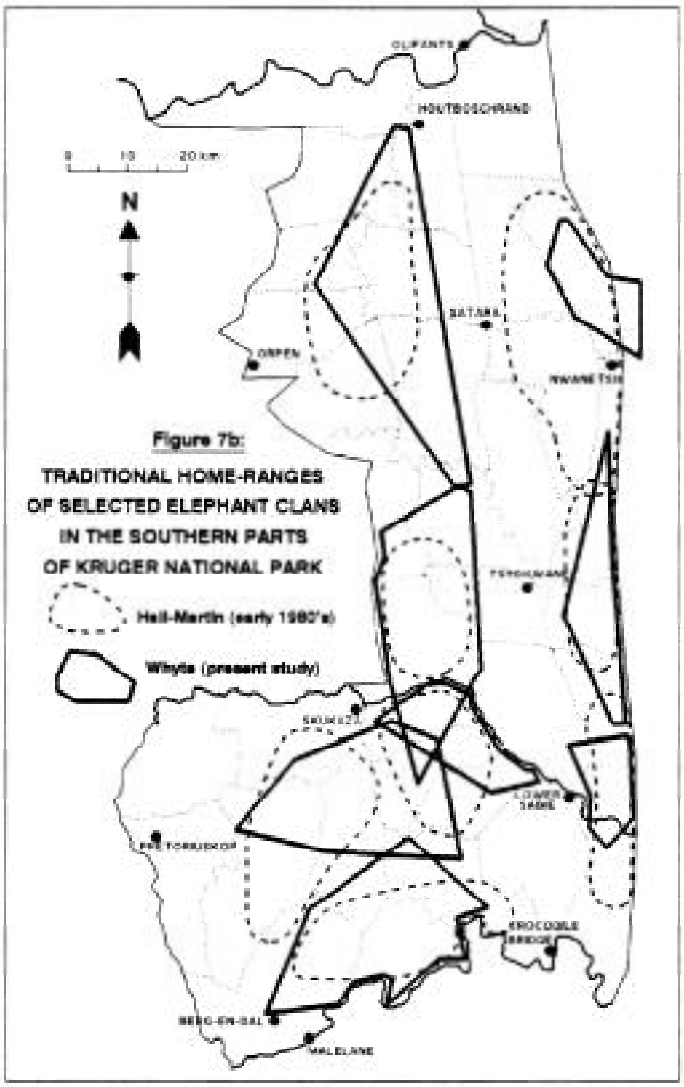


Figure 7b:
TRADITIONAL HOME-RANGES OF SELECTED ELEPHANT CLANS IN THE SOUTHERN PARTS OF KRUGER NATIONAL PARK

Hall-Martin (early 1980's)

Whyte (present study)

The inconsistency in the results of determining the responses of collared elephants to culling has made the interpretation difficult. It is clear that the response is not predictable and this must have to do with factors which may not be measurable. It may be, for instance that if the matriarch of a group is not culled, she may lead the remainder away from "danger" to other parts of the home-range. If she was one of those culled however, it may be that the younger animals are directionless without her leadership and thus remain in the area of the culling operation. These are unknown and unmeasurable factors which will always affect responses and which will remain factors in the culling of elephants.

3.Long-term stability of home-ranges
The home-ranges of collared elephants studied by Hall-Martin have as yet received only cursory analyses(Hall-Martin, 1984). They suggest however, that there is considerable conformity between them and those of the present study. This is entirely to be expected as elephants are long-lived intelligent animals who must get to know their respective home-ranges very well. Such knowledge would be learned by subsequent generations of calves, and having acquired familiarity with these home-ranges, would no doubt be reluctant to leave.

There is some degree of nonconformity however, and this begs the questions:

* Are the differences that have been recorded due to conditions prevailing during the two periods of study or to insufficient time spent and/or fixes obtained of the respective collared animals?
* Are "clans" discrete units each with their respective home-ranges or does each kinship group have its own favoured area which may overlap considerably with those of other kinship groups?
* If this latter should be the case, is the "clan" concept valid? A more intensive study of the individual adult animals constituting so-called clans may resolve the question.

Conclusions

1. Significant movements may or may not be induced in response to culling.
2. In terms of movement, radio-collared elephants showed a greater response to localised showers of rain and resultant vegetation "flushes" than to the trauma of culling.
3. Movements in response to a cull do not seem to take animals out of their normal home-ranges, while those in response to rainfall may do so. Longer term home-range studies may show that these areas used in response to rainfall may in fact form part of clan's normal home range.

4. Distance of the animals from the cull site does not appear to be a factor determining the response of the animals to the cull, as animals up to 7km from the cull showed a marked response while others who had had members of their immediate kinship group culled showed no response at all. The factors affecting this response may be social and may not be measurable or else only by long-term social studies of family groups and a subsequent experimental evaluation of the responses to specific culls.

   An investigation into infra sound vocalisations from elephants being culled, the distance that such vocalisations are audible to other elephants, and the effects on other elephants within hearing range would likely be a fruitful field of study.

References

de Vos, V., Bengis, R.C. & Coetzee, H.J. 1983. 'Population Control of Large Mammals in the Kruger National Park". In: Owen-Smith, R.N. (ed) *Management of Large Mammals in African Conservation Areas*. Haum Educational Publishers, Pretoria. pp 213-23

Hall-Martin, A.J. 1984. In: Joubert, S.C.J. (ed) "*Census Results for the Large Herbivore Species in the Kruger National Park"*. Unpublished Internal Report. Skukuza, National Parks Board.

Joubert, S.C.J. 1983. "A Monitoring Programme for an extensive National Park". In: Owen-Smith, R.N. (ed) *Management of Large Mammals in African Conservation Areas*. Haum Educational Publishers, Pretoria. pp 201-212.

Joubert, S.C.J. 1986. "Masterplan for the Management of the Kruger National Park". Unpublished Internal Memorandum. Skukuza, National Parks Board.

Langbauer,W.R., Payne, K.B., Charif, R.A., Rapaport, L. & Osborne, F. 1991. "African Elephants Respond to Distant Playbacks of Low-Frequency Conspecific Calls". *Journal of Experimental Biology* 157: 35-46.

Pienaar, U.de V. 1983. "Management by Intervention: The Pragmatic/Economic Option". In: Owen-Smith, R.N. (ed) *Management of Large Mammals in African Conservation Areas.* Haum Educational Publishers, Pretoria. pp 23-36.

Whyte, I.J. & Wood, C.A. 1993. "Census Results for Elephant and Buffalo in the Kruger National Park in 1992 and Culling Quotas for the 1992/93 Culling Year". Scientific Report 2/93. Unpublished Internal Report. Skukuza, National Parks Board.

Acknowledgements

I would like to acknowledge the role of the National Parks Board of South Africa in promoting and supporting this research. The field assistance of Messrs Steven Whitfield and Obert Mathebula is gratefully acknowledged as is the financial support given by the Rhino and Elephant Foundation and "Time Shoppe Sales".