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THE ECOLOGY OF THE SABLE ANTELOPE HIPPOTRAGUS NIGER NIGER (HARRIS 1838) IN THE MASEBE NATURE RESERVE, LEBOWA

MSc (Zoology) UP 1991

THE ECOLOGY OF THE SABLE ANTELOPE *HIPPOTRAGUS NIGER NIGER* (HARRIS 1838) IN THE MASEBE NATURE RESERVE, LEBOWA

by

Carla Bianchi Machiné

Submitted in partial fulfilment of the requirements for the degree of

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in the
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" Clad in their 'black attyre' like the chief mourner at a funeral...
looking as black as an undertaker's mute...
with all the pomposity and self-importance of village billy-goats...
so brilliant an addition to the catalogue of game quadrupeds -
so bright a jewel amid the riches of zoology! "

Captain W. Cornwallis Harris 1840

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Supervisor: Professor R.J. van Aarde
Mammal Research Institute
Department of Zoology
University of Pretoria
Pretoria

ABSTRACT

An investigation of certain aspects of sable ecology was undertaken in an attempt to assess the success of the relocation of the herd from the Potlake Nature Reserve to the Masebe Nature Reserve in Lebowa. The available habitat within the study area was classified into four distinct types. Analysis of observational and telemetric data indicated that the sable herd selected the plateaus above the other three habitat types, namely valleys, slopes and riverine vegetation. Home range of the herd was recorded and its size and position were related to water dependence. Results of faecal analysis of sable diet were compared to dietary items recorded in the literature and a significant increase in browsing during the dry period was noted. Behavioural investigations indicated typical hierarchical behaviour for sable antelope despite the small herd size of nine individuals.

Management recommendations based on the findings of this study and on general theoretical conservation principles are proposed. It is suggested that sable distribution may be related to avoidance of competition from other grazers such as impala, or to predator avoidance. Theoretical implications of relocation are discussed with particular reference to genetic conservation.

ACKNOWLEDGEMENTS

The study was initiated by the Department of Agriculture and Environmental Conservation of Lebowa. I am deeply grateful for the financial support and facilities made available to me by the Department. The untiring assistance and keen interest shown by employees of this department, especially H.R. "Riem" Venter and Antionet van Wyk, are gratefully acknowledged.

My sincere appreciation is extended to the University of Pretoria and the Foundation for Research Development for financial support during the fieldwork for this study. The National Botanical Institute is acknowledged for its assistance in identifying plant samples collected.

The Mammal Research Institute, under the auspices of which this project was undertaken, provided the administrative and logistical backbone for the study. To all the staff and students who were always willing to assist through fieldwork, computer knowledge, or merely an encouraging word, my heartfelt "Thanks". My grateful appreciation is expressed to my supervisor, Professor R. J. van Aarde who believed in me despite the "hitches" and provided constant encouragement and motivation throughout the study. Dr H. M. Dott compiled the computer program for use with the Image Analyser and Professor D. Meltzer of the Faculty of Veterinary Science provided valuable assistance during the capture and darting of the sable herd. Their assistance is gratefully acknowledged.

I am indebted to Mr P.J. Coombes of the Nature Conservation Division of the Transvaal Provincial Administration for making the time available to assist with the analysis of the data through his knowledge of statistics and computers. The Department of Water Affairs and Forestry is acknowledged for the leave and official time granted to me for the completion of this project.

Lastly I must thank the people outside the academic realm of this project who nevertheless were involved since its inception, being there when I needed them. To my parents and to Annelise Drewes and Christopher Willis - you are a major part of all this and I cannot thank you enough.

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CHAPTER ONE

GENERAL INTRODUCTION

" Great is the art of beginning, but greater is the art of ending"
Longfellow 1881

The sable antelope *Hippotragus niger niger* (Harris 1838), which is currently considered vulnerable (Smithers 1986), is of great economic and and aesthetic value. Several conservation authorities are presently involved in breeding projects on these animals. The population estimate for sable antelope in 1974 showed no increase in total numbers since 1962. Lamprechts (1974) noted that 100 of the 800 sable present in the Transvaal at that stage (excluding the Kruger National Park) occurred as introduced herds in nine localities. The Letaba district, holding approximately 560 sable in 1974 was, and still is, the most important area of natural occurrence of the species (East 1989).

Some of the larger nature reserves with breeding herds of sable in the northern Transvaal are Pilansberg National Park in Bophuthatswana (D. Magome, *pers. comm.*), Messina, Percy Fyfe, Hans Merensky, Langjan, Doorndraai Dam, Loskop Dam and Rustenburg Nature Reserves in the northern Transvaal (East 1989). These and other smaller provincial and private reserves, estimated at approximately 90 in total (East 1989) continue breeding sable to a greater or lesser degree of success. In 1979 a herd of 10 sable was introduced to the Messina Nature Reserve in the northern Transvaal which in the past 10 years has increased approximately five-fold (J. Botha, *pers. comm.*). East (1989) estimated that the sable numbers in the Transvaal had increased from the 800 recorded in 1974 to 1400 in 1989.

D.T. Magome, Pilansberg National Park, P.O. Box 1201, Mogwase, 0302, Bophuthatswana.

J. Botha, Nature Conservation Division, Transvaal Provincial Administration, P.O. Box 217, Pietersburg, 0700.

Generally, however, the success in breeding has been low, with a very slow or non-existent increase in many populations (S. Basson, *pers. comm.*), and no exception to this was the Potlake Nature Reserve in Lebowa (24°16'S ; 29°55'E). It became apparent to members of the Department of Agriculture and Environmental Conservation of Lebowa that the population of sable on this reserve was not breeding to its expected potential and a decision was made to relocate them to the Masebe Nature Reserve (28°31'-28°38' E ; 23°36'-23°41'S) in the northern Waterberg region (H. R. Venter, *pers. comm.*). Figure 1 shows the locality of these two reserves in relation to one another.

In an attempt to assess the success of the relocation of the sable herd from Potlake Nature Reserve to the Masebe Nature Reserve, an investigation of their diet, activity and range was undertaken. Intensive fieldwork was carried out from June 1988 to February 1989 but also to a lesser extent for two months prior to and five months after this period.

This thesis is intended to contribute to our understanding of the interactions between the sable antelope and their physical environment, thereby providing a scientific foundation for management policies directed at improving their chances of survival, despite the apparent deterioration of suitable habitat for them in unprotected areas. Relocation and re-introduction of animals as a species conservation tool have become controversial issues in the academic sphere of ecology (Greig 1979, Scott & Carpenter 1987, Conant 1988, Berry 1989, Griffith, Scott, Carpenter & Reed 1989, Kleiman 1989, Stanley Price 1989). The implications of executing a relocation are complex and manifold. The concept is attractive yet often expensive (Kleiman 1989) and the long-term implications, such as genetic conservation, are also being adressed (Greig 1979, Conant 1988). In contemporary conservation few re-introduction projects have yet achieved total success or even final conclusions, but the number of well-planned attempts around the world is increasing (Stanley Price 1989).

S. Basson, Sable Antelope Study Group, Private Bag X502, Letsitele, 0885.
H.R. Venter, Department of Agriculture and Environmental Conservation, Private Bag X01, Chuenespoort, 0745.

STATUS OF THE SABLE ANTELOPE

TAXONOMIC STATUS

The sable antelope *Hippotragus niger niger* (Harris 1838) is a large bovid artiodactyl of the subfamily Hippotraginae. It is one of the two extant species of the genus *Hippotragus*, the other being the roan antelope, *Hippotragus equinus* (Desmarest 1804). The extinct bluebuck, *Hippotragus leucophaeus* (Pallas 1766) is regarded by some authors to have been a subspecies of the roan (Haltenorth 1963).

The distinction between the various subspecies of sable antelope is somewhat unclear (Ansell 1972). There is little doubt that the giant sable *H. niger variani* (Thomas 1916) is a valid subspecies, occurring in Angola between the Londo and Cuanza rivers (Dorst & Dandelot 1970; Huntley 1974; East 1989). The second subspecies, *H. niger kirkii* (Gray 1822) occurs thoughout Zambia, eastern Angola, Zaire, Malawi, and Mozambique north of the Zambezi River (Estes & Estes 1970 in Grobler 1973). The distributional overlap with *H. niger niger* is not clear but it is probably in the region of the Zambezi River valley.

GEOGRAPHICAL DISTRIBUTION - PAST AND PRESENT

The subspecies *H. niger niger* is a inhabitant of woodland savannas, in particular those with *Combretum* and *Brachystegia* associations in the Transvaal Lowveld and Zimbabwe (Pienaar 1974). In southern Africa it occurs south of the Zambezi River, in Zimbabwe, northern and north-eastern Botswana, South Africa (eastern and northern Transvaal) and Mozambique, except in the extreme south and south-east (Grobler 1974; Smithers 1983). Figure 1 shows the current distribution of the sable antelope in southern and south-central Africa as compiled by East (1989), and the past distribution, modified from Dorst & Dandelot (1970).

In South Africa the southernmost limits of its distribution are the Komati River in the east and the Magaliesberg range in the west (Pienaar 1974). In Namibia, Bigalke (1958) recorded sable in the eastern Caprivi, along the

Kwando River but less abundantly in Ovamboland and the western Caprivi. The type specimen described by Harris (1840), was collected west of Pretoria in the vicinity of Marico, but sable are no longer found in this area, having been forced to retreat from much of their original distribution in the face of development.

The present distribution of sable antelope is more localised than the past (Fig. 1), as sable have become rare, surviving mainly in nature reserves. Attempts at introducing sable outside the natural limits of their distribution have little chance of success due to the selective food and habitat requirements of the species (Pienaar 1974; Wilson 1975).

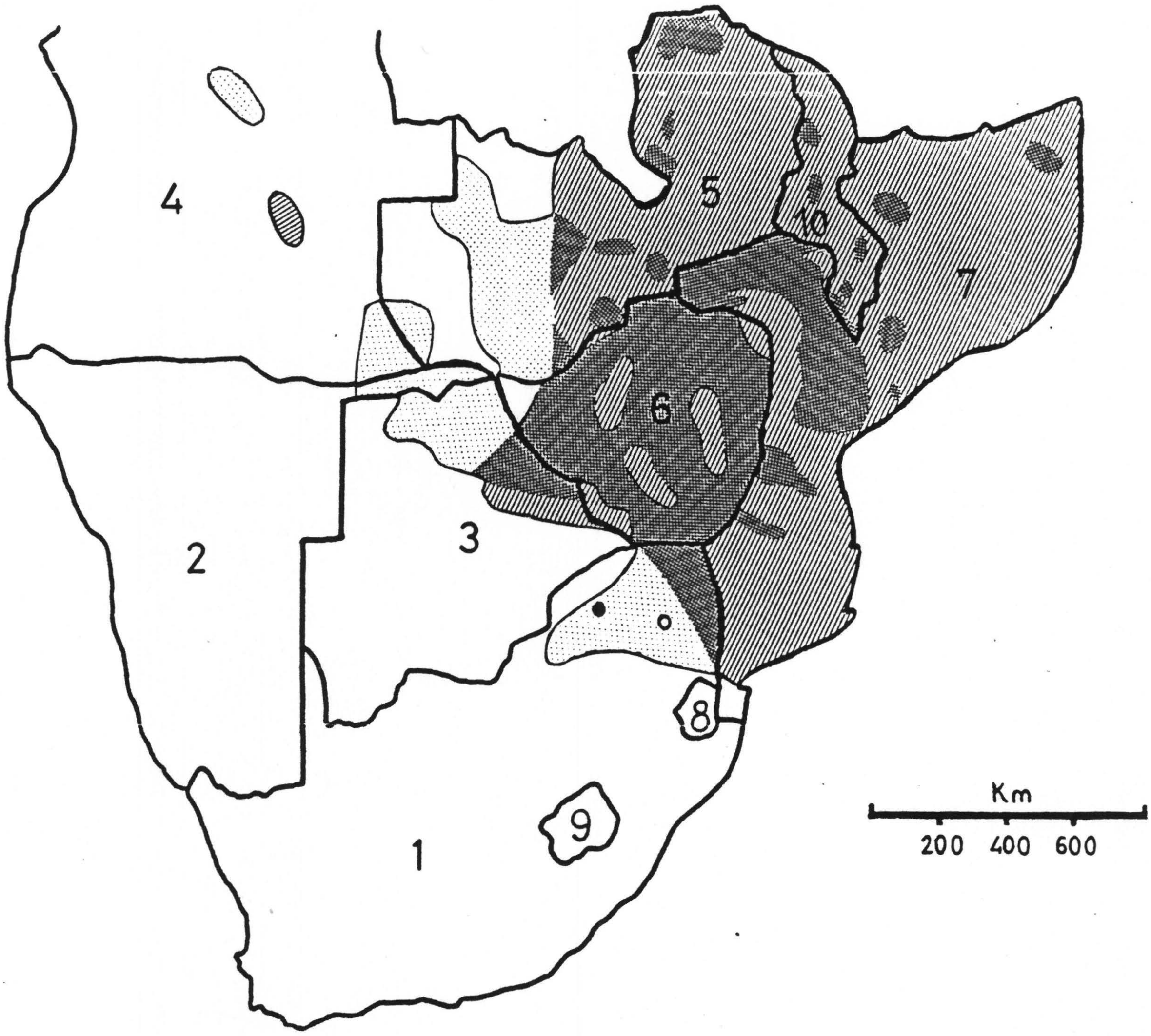


Figure 1: Past and present distribution of sable antelope in south-central Africa. Hatched areas represent the past distribution (adapted from Dorst & Dandelot 1970) and dotted areas represent the present distribution (East 1989). The darkly shaded areas indicate the overlap in past and present distributions. The approximate positions of the Masebe Nature Reserve (●) and the Potlake Nature Reserve (o) are also indicated. 1 = South Africa, 2 = Namibia, 3 = Botswana, 4 = Angola, 5 = Zambia, 6 = Zimbabwe, 7 = Mozambique, 8 = Swaziland, 9 = Lesotho, 10 = Malawi.

OBJECTIVE

The present study is aimed at assessing the reaction of the relocated herd to its new environment as part of the overall assessment of the success of the relocation from the Potlake Nature Reserve to the Masebe Nature Reserve.

KEY QUESTIONS

At the onset of the study the following key questions were set:

1. How are the relocated sable utilising the available space at the Masebe Nature Reserve?
2. What is the habitat preference of the sable and what factors contribute to this?
3. What interspecific relationships occur between sable and other large herbivores in the study area?
4. If applicable, what factors are responsible for mortalities amongst the relocated sable and/or their offspring?
5. What recommendations can be made concerning the management of the sable population on Masebe?

THE STUDY AREA

LOCATION

Masebe was proclaimed as a nature reserve in 1985 by the Department of Agriculture and Environmental Conservation of Lebowa. The reserve covers an area of 4542 ha and is situated approximately 85 km north-west of Potgietersrus in the Mokerong 2 district of Lebowa (28°31' to 28°38' E ; 23° 36'to 23°41' S). It is divided into two camps by the provincial road connecting the towns of Potgietersrus and Marken, each camp being completely fenced and separate from the other. The study area was restricted to the west camp which is slightly larger than the east camp, the former comprising 2825 ha.

GEOLOGY AND TOPOGRAPHY

The Masebe Nature Reserve lies in the northern Waterberg area, consisting of conspicuous plateaus intersected by narrow steep valleys (Fig 2). In altitude, the area ranges from 941 m above sea level in the valleys to 1247 m at its highest point.

The rocks of the Waterberg group, a mainly sedimentary succession, were deposited in the northern portion of the so-called late-Waterberg basin (Jansen 1975), a large shallow intra-cratonic depression whose northern boundary was structurally controlled. Of the six geological formations recognised in the Waterberg group, the study area is represented by the Mogalakwena Conglomerate formation (Brandl 1986). This formation reaches a thickness of about 1500 m and consists of purplish brown, coarse-grained sandstone with interbedded conglomerate and boulder conglomerate. The well-rounded clasts may attain a diameter of 80 cm but in general measure between 3 and 10 cm. These consist largely of rocks present in the Limpopo Mobile Belt. The reddish colour of the conglomerate is attributed to the amount of felsitic and other igneous debris present in the original sediments as well as to oxidising conditions during or after deposition (Brandl 1986).

The coarse arenaceous succession resembles deposition in braided streams. Palaeocurrent directions, inferred from cross-bed attitudes in the sandstones, indicate that most of the sediments were carried from a source lying north-east and east of the Waterberg basin (Tickell 1975).

CLIMATE

The mean daily maximum and minimum temperatures for the area vary from 28° to 31°C and from 14° to 19°C respectively in summer and 22° to 28°C and 6° to 13°C respectively in winter. Mean monthly temperatures recorded at Marnitz, a weather station 52 km north-west of the study area, are shown in Fig. 3. These values are from records provided by the Weather Bureau over an 11 year period (1978-1988).

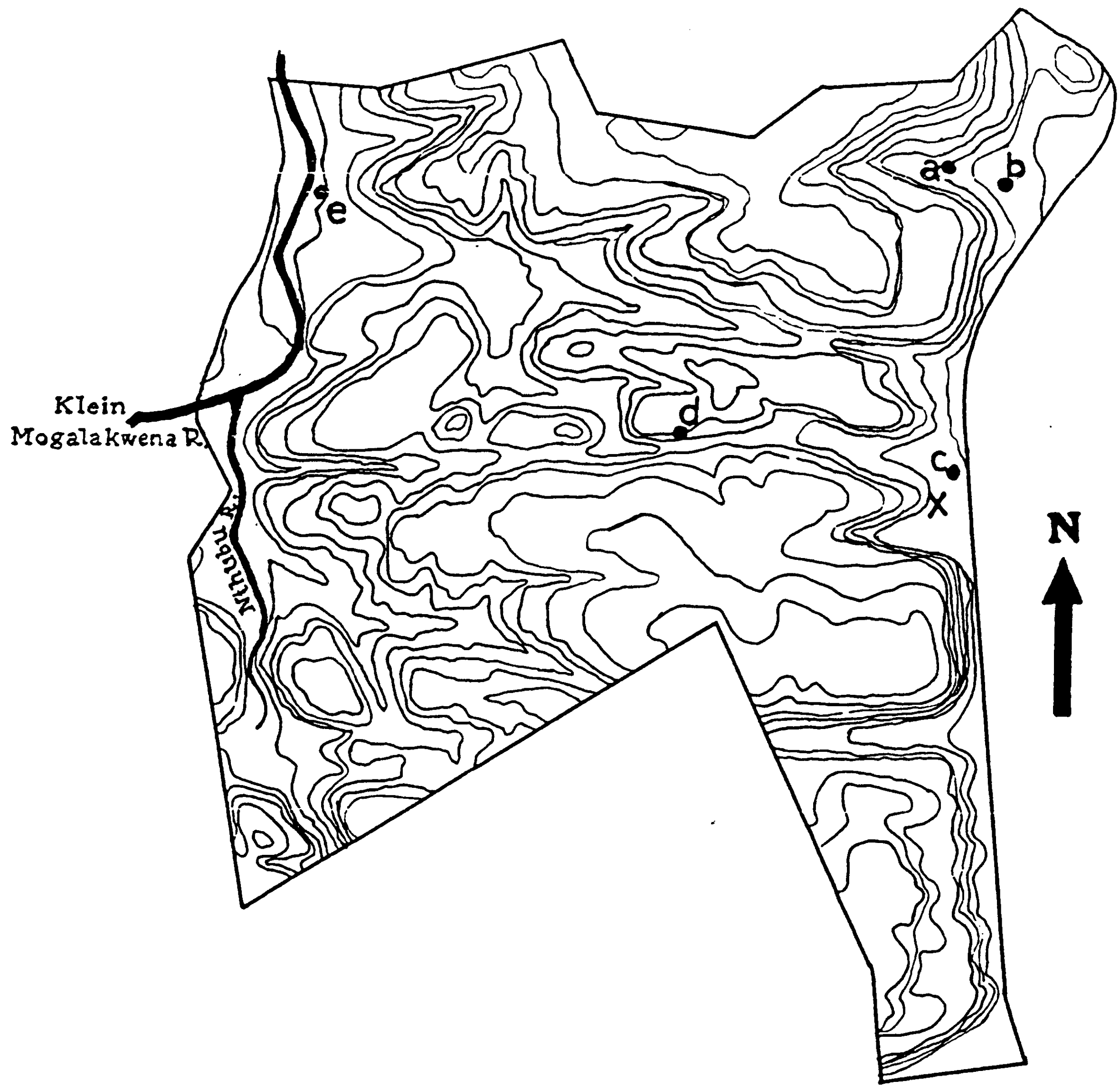


Figure 2: Topographical map of the west camp of the Masebe Nature Reserve. Watering points (a-e) and the point of release of the introduced sable herd (X) are also indicated. The Klein Mogalakwena River and its tributary, the Nthubu, are shaded in black. Scale = 1 : 50 000 . Contour intervals = 20 m.

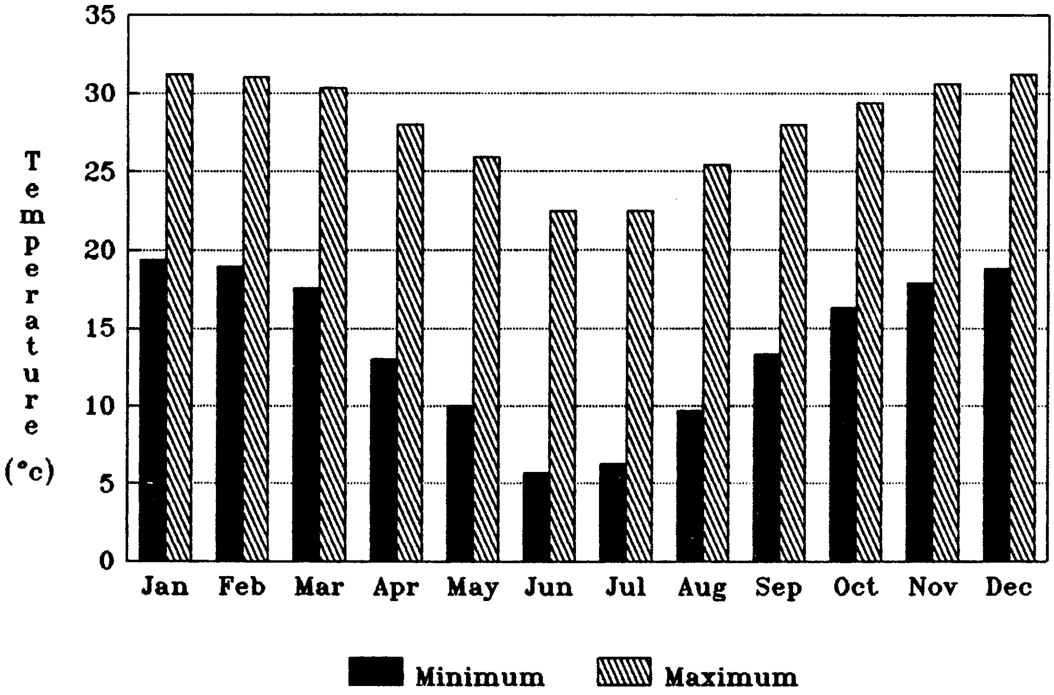


Figure 3: Mean monthly temperatures recorded at Marnitz over 11 years (1978-1988). Black shading represents mean minimum temperatures and hatched shading represents mean maximum temperatures.

Most of the rain (400-500 mm) falls during the summer months (October-March), with only 60-90 mm falling during the winter months (Fig. 4). On average 30-40 rainy days can be expected per year, with 80-85% of those occurring between November and April each year. Rainfall may be somewhat erratic as is evident from Fig. 5. Winds are usually mild north-easterly, but may change direction, blowing from the south, particularly during summer thunderstorms.

VEGETATION

This area is classified by Acocks (1975) as sour bushveld, although the more rugged parts such as those found in the study area, consist of mixed bushveld. The veld is a merging of *Combretum apiculatum* veld on the rocky areas and *Terminalia sericea* in the sandy valleys. A more detailed analysis of the vegetation structure is presented in Chapter 2 of this thesis.

WATER AVAILABILITY

A non-perennial river, the Klein Mogalakwena, and its tributary, the Nthubu, both pass through the study area along its western boundary. The study area has five man-made watering points (Fig.2) of which four (excluding point 'a') were supplied with water throughout the study period. Due to the rocky nature of the plateaus, water during the rainy season was also available in natural rock pools on the mountains (Fig.6).

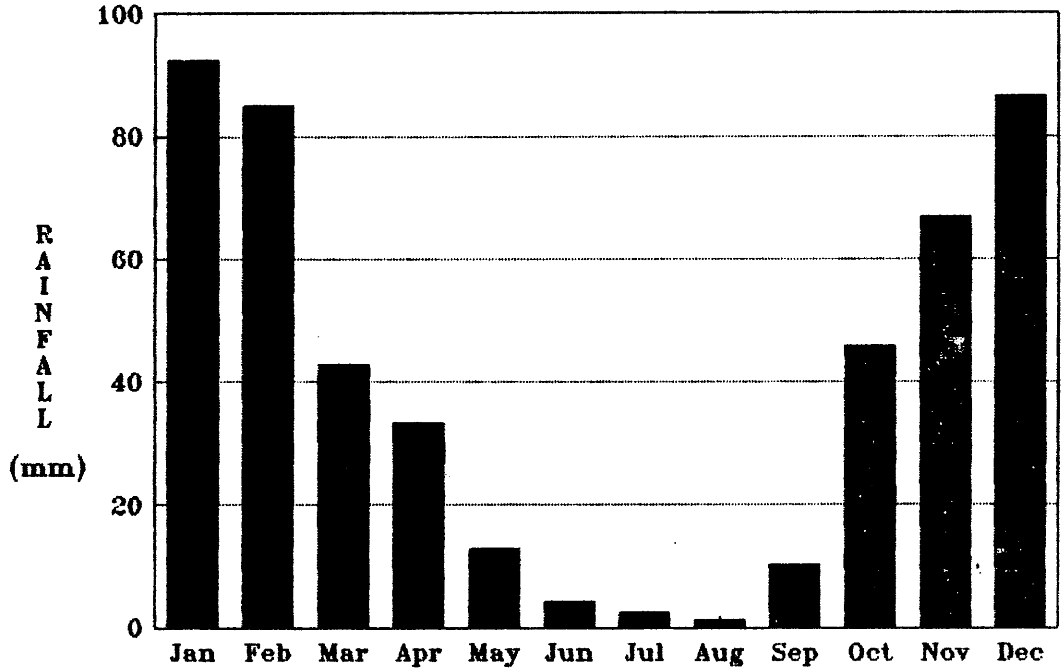


Figure 4: Mean monthly rainfall as recorded by the Weather Bureau for the period November 1948 - May 1976 in the vicinity of the Masebe Nature Reserve.

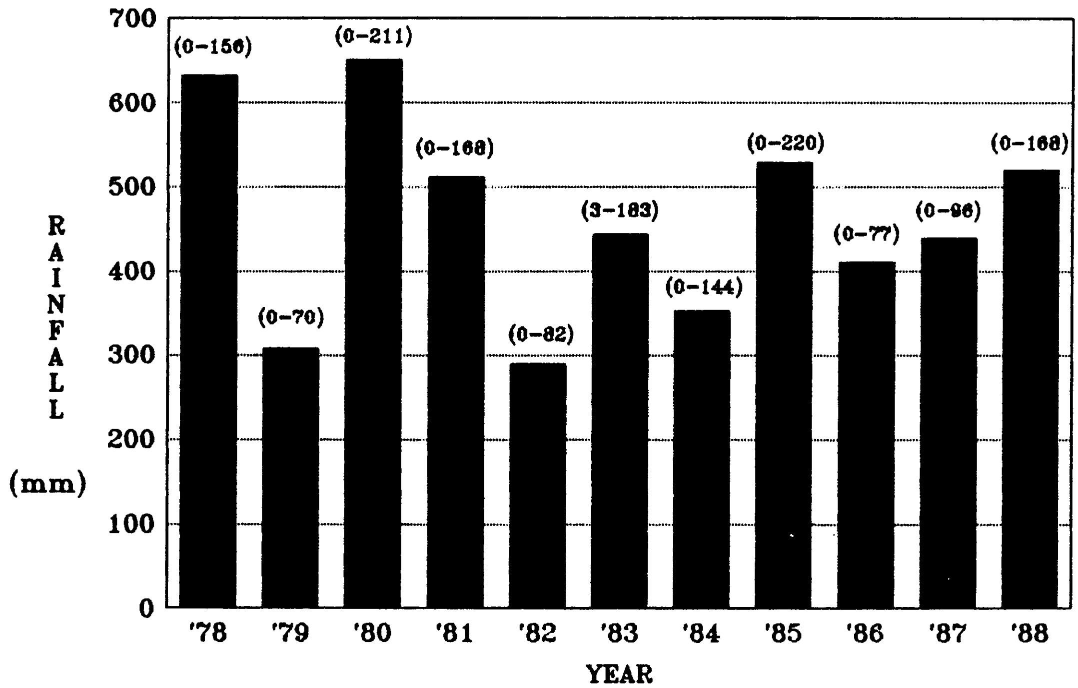


Figure 5: Mean annual rainfall for the period 1978 - 1988 as recorded by the Weather Bureau at seven weather stations in the vicinity of the study area. Note: The rainfall figures for 1988 were recorded on the Masebe Nature Reserve directly (i.e. not obtained from the Weather Bureau). Monthly rainfall range (mm) indicated on chart in brackets.

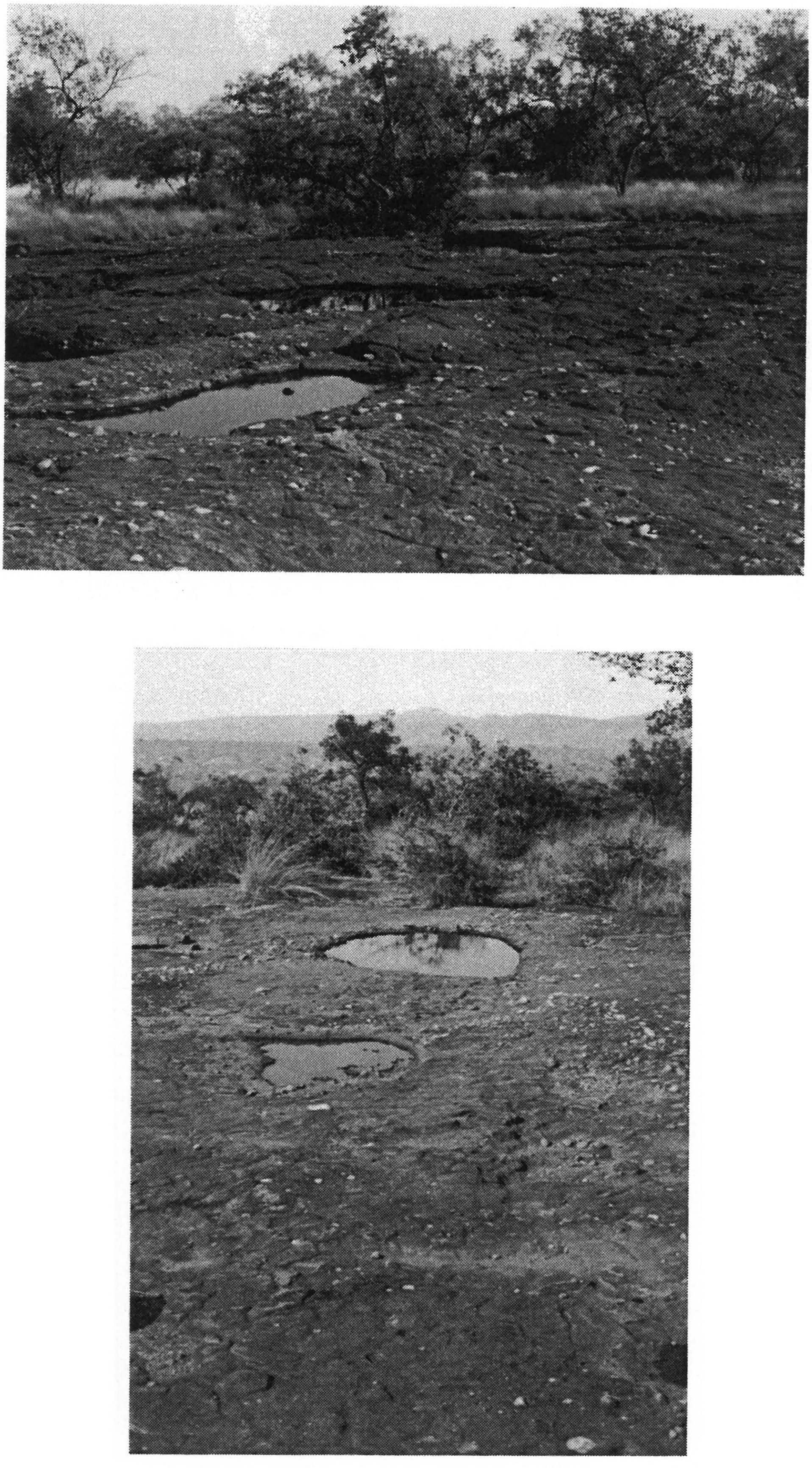


Figure 6: Pools of water accumulating on rocky surfaces of the plateaus after rain.

CHAPTER TWO

HABITAT CLASSIFICATION

" *Nature will bear the closest inspection. She invites us to lay our eye level with her smallest leaf, and to take a view of its plain.* "

Thoreau 1839

INTRODUCTION

The vegetation of any ecosystem is an important physiognomic feature and must therefore be considered to a greater or lesser extent in all ecological studies. In order to assess the habitat preferences of the sable herd released on the Masebe Nature Reserve, it was necessary to assess the various vegetation communities or "habitats" available to them.. The term "habitat" is used here to describe an area within the reserve which differs significantly from another in plant composition, topography or both.

The distribution and abundance of wild animal populations are directly related to the available habitat. Unquestionably then, one must be able to evaluate the habitat in order to control and manipulate an animal population. Habitat evaluation through the use of vegetation parameters has been extensively described and the available methods are being constantly criticised, reviewed and adapted (Walker 1970, De Vos & Mosby 1971, Mueller-Dombois & Ellenberg 1974, McNeill, Kelly & Barnes 1977, Edwards 1983, Jónasson 1988). From all the methods available, a selection was used in this study to provide a general overview of the vegetation structure on the Masebe Nature Reserve. These were chosen in order to provide not only a floristic checklist but also a structural appraisal of the vegetation within the various habitats.

Three veld types or "habitats" have been previously distinguished within the study area by means of aerial photographs and stereoscopy (J. Botha, *pers.*

comm.). The areas can be briefly described as riverine vegetation, sandy valleys, and rocky slopes and plateaus. For the purposes of the present study the three veld types recorded by Botha (*pers. comm.*) were further divided according to topography, thus separating the slopes and plateaus into two distinguishable entities. In order to determine the different habitat types available to the sable, sampling was carried out in these four predetermined habitat types (Fig. 7).

By relating the habitat selection of the sable to the various vegetation parameters measured, one can determine which environmental factors are being selected for by the sable within the study area. Habitat selection is examined in the context of both temporal and spatial use of the available area exhibited by the sable herd during the study period. According to Smithers (1983), sable antelope are a savanna woodland species, usually dependent on vegetation cover and water. They tend to prefer open woodland with adjacent vleis or grassland with medium to high grass.

J. Botha, Nature Conservation Division, Transvaal Provincial Administration, P.O. Box 217, Pietersburg, 0700.

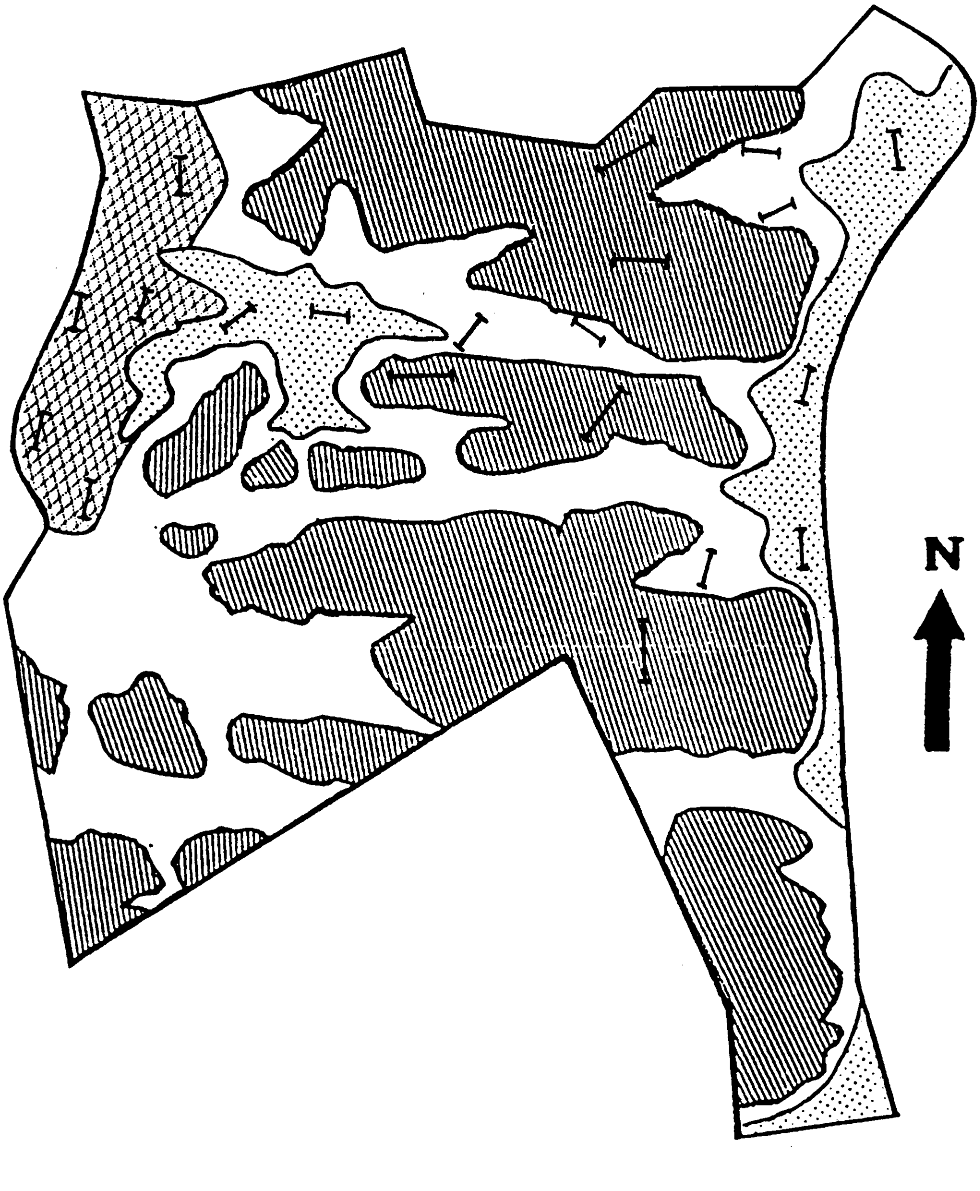


Figure 7: Partitioning of the study area into four distinct veld types or "habitats". Diagonal hatching = plateaus; unshaded = slopes; dotted = valleys; cross-hatching = riverine area. Transect lines used in vegetation monitoring are depicted by black bars (five transect lines per veld type).

MATERIALS AND METHODS

VEGETATION DENSITY

Lateral visibility was used as an index of vegetation density (Wilson 1975). Five transect lines were subjectively placed within representative areas of the four predetermined habitat types, each transect line being 200 m long. At points 10 m apart along the transect, an assistant walked away from the observer, in a direction perpendicular to the transect line. When he/she became obscured by the vegetation at a height of 1,5 m, the distance between the observer and the assistant was measured and recorded. One hundred points per habitat type were measured (5 transects, 20 points per transect). Transect lines used in all methods of vegetation monitoring are indicated in Figure 7.

GRASS HEIGHT

Grass height was measured using a density board (Wilson 1975) along the same transects as described above. At 10 m intervals along the transect line, an assistant stood 10 m away from the observer, along a line perpendicular to the transect line. The density board was divided into alternating black and white blocks, each 20 cm high. The number of blocks obscured by the grass were recorded at 100 points in each habitat type (Fig. 8). A block was considered obscured if at least 25% was covered by vegetation. This method was not intended to provide a precise estimate of grass height, but was used to determine whether or not the grass height differed significantly between the four habitat types.

CANOPY COVER

Canopy cover was measured using a method similar to that described by Emlen (1967), except that observations were done directly and not by using a canopy viewer. The observer walked a transect and recorded each pace as either positive or negative depending on the presence or absence of tree canopy above his head at that point (Fig. 9a). The ratio of positive to negative paces is considered to be the percentage canopy cover.

Figure 8: Use of a density board for measuring grass height. In this example the grass height would be recorded as a "1", i.e. grass height is approximately 20cm.

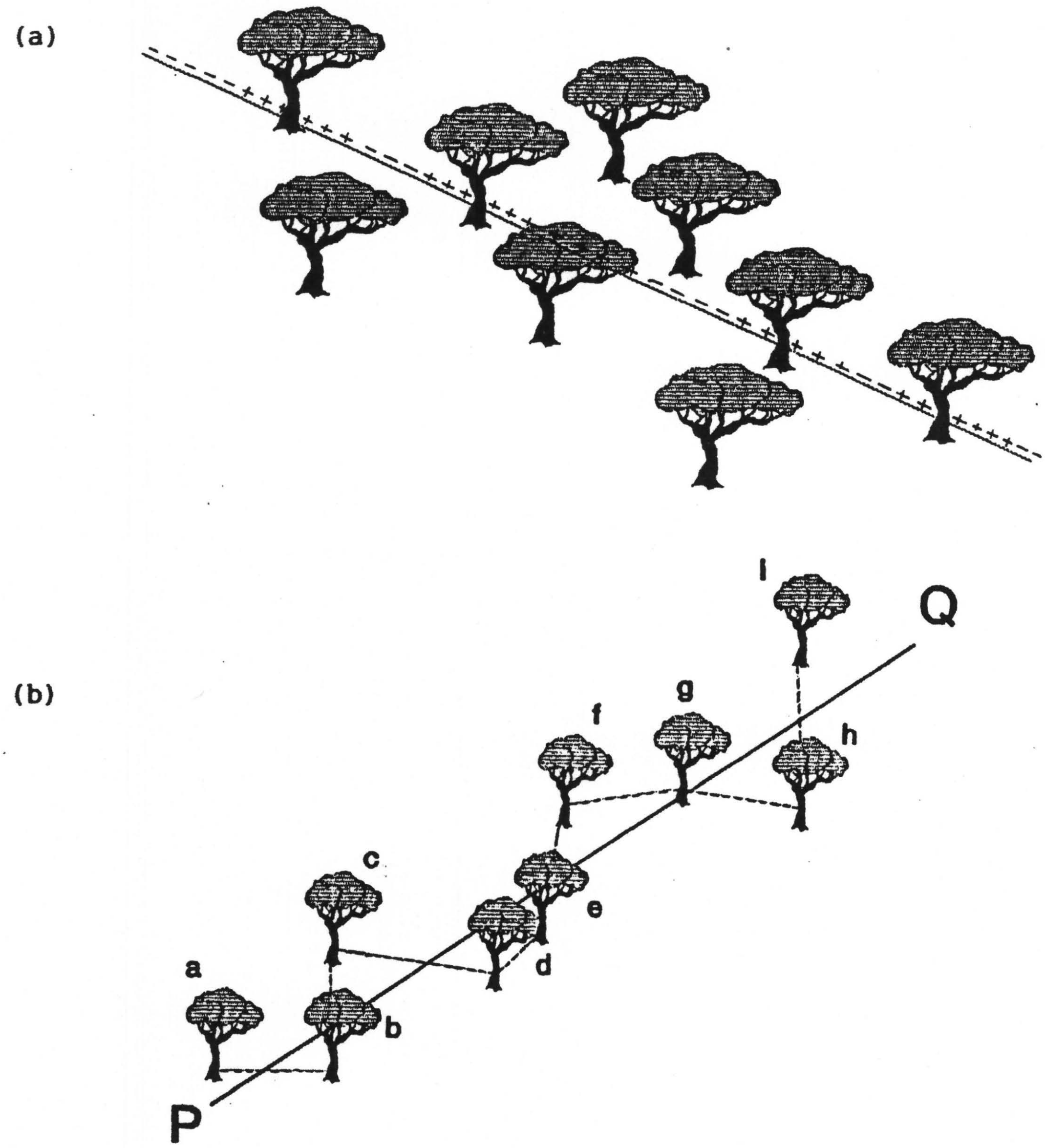


Figure 9: Diagrammatic representation of two sampling techniques for assessing canopy cover. (a) Straight line transect (Emlen 1967). (b) Zig-zag path a,b,c,....i along the transect PQ to approximate the two-sided Delaunay model. Measurements commence at tree "a". The next tree, "b" is selected as the adjacent tree nearest to the transect line (after Penridge & Walker 1988).

approximating the Delaunay model of triangulation where the smallest interior vertex angle is as large as possible (Fig. 9b). The crown-gap ratio is calculated by dividing the mean crown gap by the mean crown diameter. It can then be used to predict percentage canopy cover by referring to the table presented by Penridge & Walker (1988). For comparative purposes, both methods were used along the same transect lines. These were the same transect lines used in all the methods described above.

BASAL COVER

The wheel-point method, first described by Tidmarsh & Havenga (1955) was used to determine the percentage basal cover in each habitat type. Two thousand points per veld type were recorded as "hits" or "misses" depending on whether the marked spoke of the wheel landed on a tuft of grass or on bare rock or soil. Basal cover was calculated as the percentage of "hits".

SPECIES COMPOSITION AND DENSITY

(i) Grasses

Using the wheel-point method 2000 points in each habitat type were recorded. Each time the predetermined spoke struck a grass at its base the plant was identified and recorded.

(ii) Trees

For practical purposes a tree was defined as woody vegetation over 2 m in height. The "Third-nearest" method (McNeill *et al.* 1977) was used to determine the species composition and density of trees in the four habitat types in the study area. The same five transects as previously described were used. Every 10 m along the transect line, the third nearest tree to this point along a transect was identified and the distance between the centre of the stem (irrespective of the position of the canopy) and the sampling station was measured to the nearest 10 cm (Fig. 10). On the plateaus, however, the sampling points were 20 m apart (due to the lower tree density) to ensure that no individual tree was recorded more than once.

along a transect was identified and the distance between the centre of the stem (irrespective of the position of the canopy) and the sampling station was measured to the nearest 10 cm (Fig. 10). On the plateaus, however, the sampling points were 20 m apart (due to the lower tree density) to ensure that no individual tree was recorded more than once. Hence the transect lines in Figure 7 are twice as long on the plateaus as in the other three veld types.These measurements were then converted to plant density using the formula:

$$D = \frac{2}{\pi N} \cdot \Sigma \left(\frac{1}{r_i^2} \right)$$

where D = density (trees/m)

N = number of sampling stations

r_i = distance measured at the ith station

(McNeill *et al.* 1977)

PROPORTION OF HABITAT TYPES AVAILABLE

The four habitat types were marked on a 1:50 000 topographical map and measured using a planimeter. Because of the extremely undulating topography of the study area, a further measurement of these four habitat types was made, taking the slope of the area into account. This was done using a Q520 Image Analyser*. A program was written specifically for this purpose by Dr H. Dott (Mammal Research Institute, University of Pretoria). The spacing between contour lines on a 1:50 000 topographical map were incorporated into a formula which calculated the area of each habitat type.

* S.M.M. Instruments (Pty) Ltd, P.O. Box 38622, Booysens, Johannesburg.

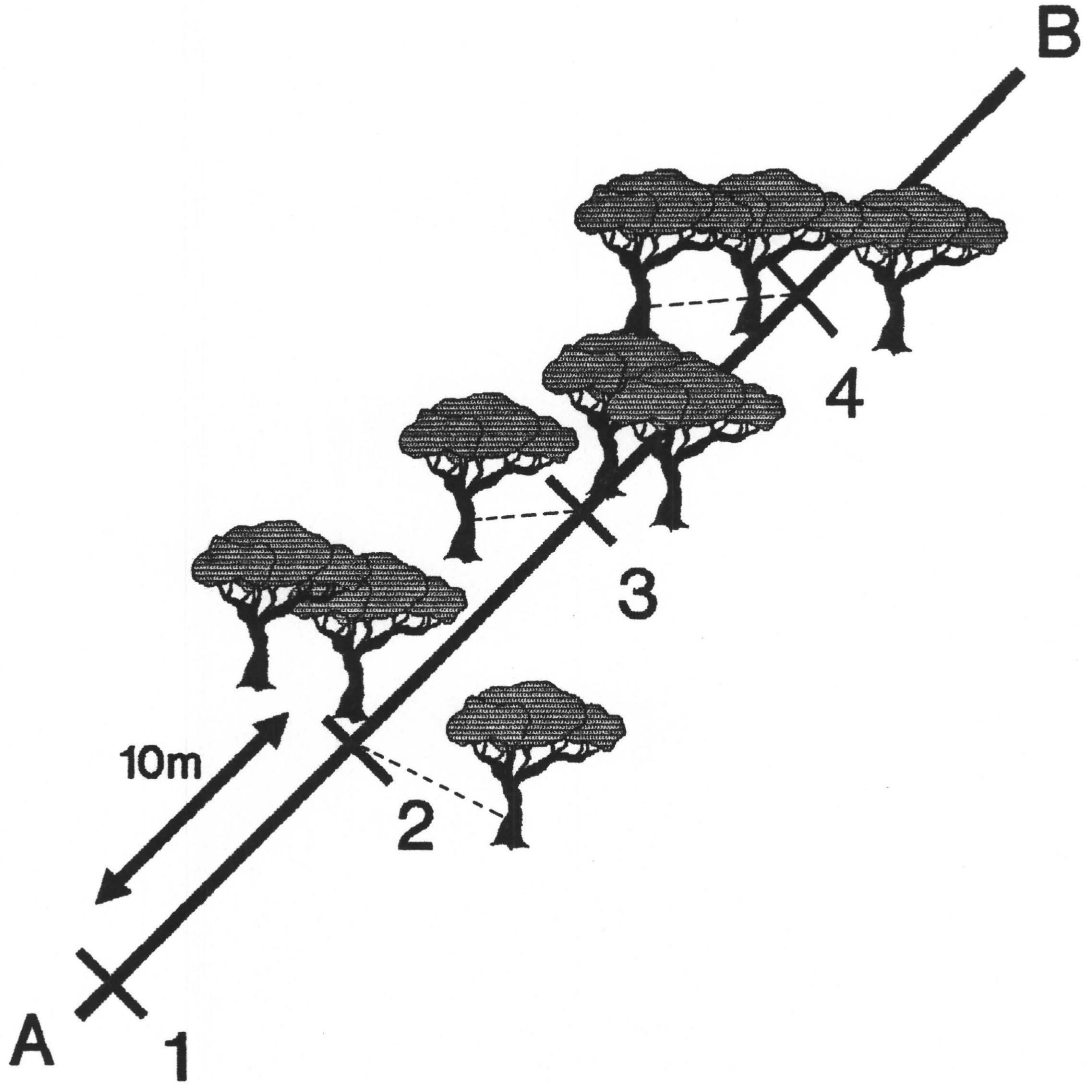


Figure 10: Diagrammatic representation of the "Third-nearest" method used to determine the species composition and density of trees (McNeill et al. 1977). Sampling stations (1,2,3,4....) along the transect line AB are situated 10 m apart. The distance from the third nearest tree to the sampling station (dashed line) is measured.

RESULTS AND DISCUSSION

The four habitat types can be arranged along an altitude gradient as the topography within the study area is extremely undulating. The lowest point within the study area is the Klein Mogalakwena River along the western boundary. The tree density, and thus indirectly also the lateral visibility and canopy cover, follow a similar gradient to the topography, progressing from closed woodland along the banks of the river through to open woodland on the plateau.

VEGETATION STRUCTURE

The mean values for the lateral visibility index are presented in Table 1. The plateaus have the highest mean visibility (72,3 m) and they differ significantly from the other three habitat types (Tukey test; P < 0,05). There is no significant difference in the lateral visibility of the valleys, slopes and riverine forest (Tukey test, P > 0,05). The lateral visibility index, used to assess the density of the vegetation, is not restricted to trees only (unlike the sampling for tree density and canopy cover). Thus bushes and shrubs, which may affect an animal's perspective of the vegetation structure, are also accounted for.

Mean grass heights for the four habitat types are listed in Table 1. The shortest grass occurred on the plateaus (mean = 33,2 cm in summer and 28,0 cm in winter). The longest grass, both in summer and winter, was recorded in the riverine areas, with the valleys and slopes fitting in along the gradient between riverine and plateau vegetation.

In summer there was no significant difference between the grass height of the slopes and the valleys (Tukey test; P > 0,05), but in winter the height of the grass in the valleys dropped to a mean of 34,4 cm, making it significantly lower (Tukey test; P < 0,05) than on the slopes and similar to that of the plateaus (Tukey test; P > 0,05). The grass height on the plateaus, slopes and riverine vegetation differed significantly (Tukey test; P < 0,05) from one another during both seasons.

Table 1: Mean lateral visibility index, mean grass height, basal cover and tree density recorded in the four habitat types in the study area. Mean values are followed by one standard deviation of the mean.

PARAMETER	PLATEAU	SLOPE	VALLEY	RIVERINE
Lat. Vis. (m)	72,3 ± 115,9	23,4 ± 12,5	33,6 ± 20,6	22,4 ± 7,1
Grass ht (cm)				
summer:	33,2 ± 14,5	41,2 ± 15,5	40,8 ± 16,6	48,9 ± 17,9
winter:	28,0 ± 13,1	47,9 ± 23,3	34,4 ± 16,5	73,7 ± 21,4
Basal cover	20%	22%	12%	19%
Tree density (Trees/ha)	192,9	499,1	345,7	1101,6

The rock cover and shallow soils, rather than the grazing intensity of the plateaus are probably responsible for the consistently lower grass height in these areas, as they were utilised by few animals during the study period (Chapter 3). The decrease in grass height in the valleys during winter, resulting in a significant difference between this area and the slopes (which was not evident in summer), can be explained by the increased grazing pressure in this area during the dry season, as all the man-made watering points are situated in the valleys.

The results of the two different methods in measuring canopy cover are presented in Table 2. The "zig-zag" transects (Penridge & Walker 1988) yield a slightly higher percentage canopy cover for all four habitat types than the "straight" transects (Emlen 1967), but this difference is not significant (F=0,016, P > 0,05). The Tukey test applied to the data indicates that only the riverine areas differ significantly (P < 0,05) in percentage canopy cover

Table 2: Results of two methods used to determine canopy cover in the four habitat types of the study area. Mean canopy cover is presented as percentage derived from the crown-gap ratio as described in the text. Mean values are followed by one standard deviation of the mean.

HABITAT TYPE	CANOPY COVER	
	Straight transect (Emlen 1967)	Zig-zag transect (Penridge & Walker 1988)
Plateau	17 ± 11%	36 ± 9%
Slope	36 ± 8%	49 ± 10%
Valley	41 ± 20%	43 ± 10%
Riverine	60 ± 6%	74 ± 3%

from the other three habitat types. This holds true for data collected from the "straight " transects (F = 265,49) and from the "zig-zag" transects (F = 89,48). Canopy cover therefore follows the same trend as tree density, being lowest on the plateaus and highest in the riverine vegetation. The different species composition of trees in the four habitat types does not alter this trend.

SPECIES COMPOSITION

A description of the typical trees and grasses in each veld type is presented in Fig. 11. These "typical" trees and grasses are those which, according to the third-nearest method (for trees), and the wheel-point method(for grasses), are the dominant species in each veld type. Appendix I contains a list of all tree and grass species recorded in each veld type.

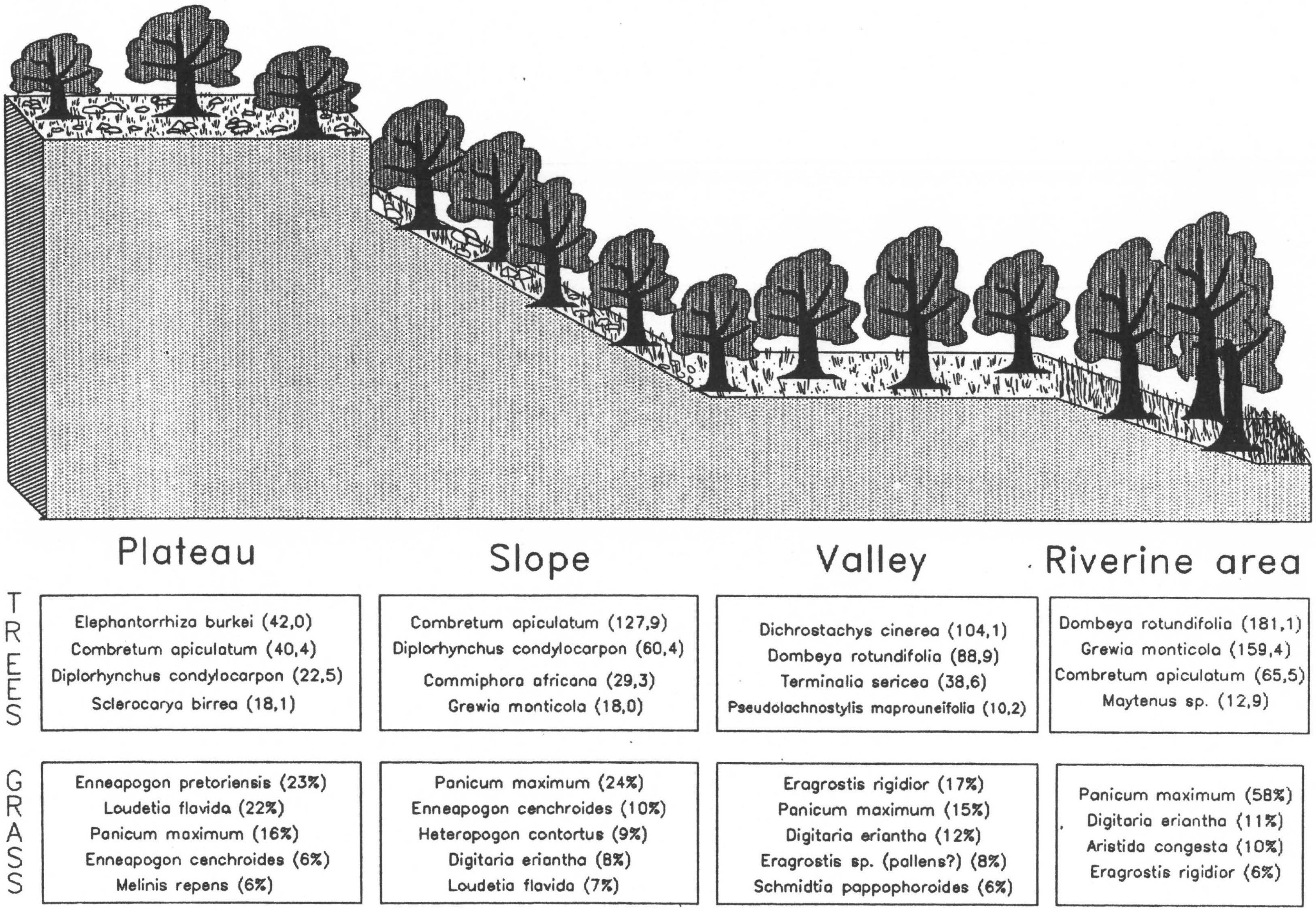


Figure 11: Diagrammatic representation of the four habitat types in the study area. The most prominent trees and grasses found in each habitat type are listed. Numbers in brackets represent trees/ha and percentage of overall species composition of grasses.

The vegetation is characterised by the reed *Phragmites mauritianus* in the river bed and the grasses *Panicum maximum*, *Digitaria eriantha*, *Aristida congesta* and *Eragrostis rigidior* along the banks. The woody vegetation along the river banks is dense and characterised by *Dombeya rotundifolia*, *Grewia monticola* and *Combretum apiculatum*.

The valleys are characterised by grasses such as *Eragrostis rigidior*, *Panicum maximum*, *Digitaria eriantha* and *Schmidtia pappophoroides*, growing on sandy soils. The trees in these areas are less dense than along the river, the dominant species being *Dombeya rotundifolia*, *Terminalia sericea* and *Pseudolachnostylis maprouneifolia*. The large percentage of *Dichrostachys cinerea* indicates severe bush encroachment, which explains the low lateral visibility in the area (Table 1).

The slopes and plateaus are characterised by similar trees, namely *Combretum apiculatum* and *Diplorhynchus condylocarpon*, growing on rocky sandstone and conglomerate. On the slopes the dominant grasses are *Panicum maximum*, *Enneapogon cenchroides*, *Heteropogon contortus* and *Digitaria eriantha*, whereas on the plateaus *Loudetia flavida*, *Enneapogon cenchroides* , as well as *E. pretoriensis*, *Melinis repens* and *Panicum maximum* are predominant.

The abundance of *Panicum maximum* in all four habitat types indicates that a climax vegetation is present. This is further emphasised by the high basal cover (Table 1) in all areas (G. Rootman, *pers. comm.*). Much of the grass, however, particularly in the bush encroached valleys, is old and fibrous, and may require controlled burning to renew the growth (Chapter 6).

A comparison of two methods for assessing the area of each veld type is presented in Figure 12. The shaded bars of the histogram represent the areas as measured on a 1:50 000 topographical map, using a planimeter. The black bars represent the same areas, measured using the Q520 Image Analyser, which account for the increase in area due to slope. The numerical results from these two methods, as well as the percentage each veld type contributes to the total area, are presented in Table 3.

G. Rootman, Towoomba Research Station, Private Bag 1615, Warmbaths, 0480.

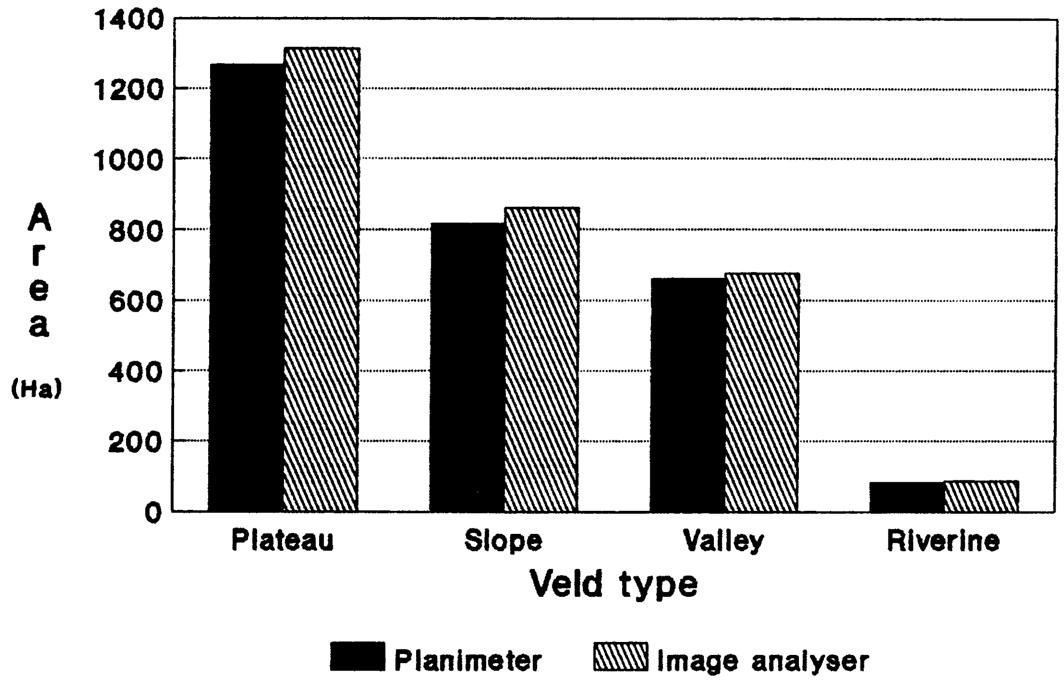


Figure 12: Area (ha) contributed by each habitat type to the total study area. The black bars represent "two-dimensional" measurements using a planimeter. The hatched bars represent "three-dimensional" measurements using a Q-520 Image Analyser to account for the increase in area due to slope.

Table 3: Area (ha) of each habitat type in the study area using two different methods. "Flat area" was calculated using a planimeter and a 1:50 000 topographical map. The "Three-dim. area" was measured using a Q520 Image Analyser which considered the topography in its calculations of surface area. Proportional percentage contributed by each habitat type to the total is presented for both methods.

HABITAT TYPE	FLAT AREA	% OF TOTAL	THREE-DIM. AREA	% OF TOTAL
Plateau	1265	45	1314	45
Slope	817	29	861	29
Valley	660	23	675	23
Riverine	83	3	88	3
TOTAL	2825	100	2938	100

Almost half (45%) the total study area is covered by the relatively flat, high plateaus which are characteristic of the Waterberg. The slopes, leading down to the valleys are steep and rocky, often topped by sheer sandstone and conglomerate cliffs, and they comprise 29% of the study area. The flat, sandy valleys, often consisting of just a narrow strip between two slopes, make up 23% of the study area (further explaining why the grazing pressure increases during the dry season). The riverine bush consists of a narrow belt along the western boundary of the study area and contributes a mere 3% to the total western camp of the Masebe Nature Reserve.

Although taking the topography into account did show slight increases in the measurements of the surface area, these differences were not great enough to alter the proportional contribution made by each veld type. This indicates that for practical purposes, when dealing with a small area or with one that is relatively flat, a two-dimensional estimate of the area is accurate enough. If, however, a researcher or manager is involved with an extensive and/or undulating area, the method applied here may prove useful in improving the accuracy of the estimates.

CHAPTER III

HABITAT UTILISATION

"The most fortunate of men, be he king or commoner, is he whose welfare is assured in his own home"

Goethe 1787

INTRODUCTION

Habitat utilisation may be defined as the extent to which a species uses the area it inhabits. This includes spatial and temporal occupancy of an area, habitat preferences and diet. Habitat selection is related to the distribution of a species rather than the niche or role which it fulfills in that habitat (Melton 1987). Selection of a certain habitat is determined not only by the availability of preferred food, but also by factors such as shelter from exposure to the elements and predation, availability of surface water and competition between species (Pienaar 1974). Hence "differential habitat selection is one of the principal relationships which permit species to co-exist" (Rosenzweig 1981).

It is therefore essential when planning for the management and conservation of a species, to attempt to understand the factors influencing habitat selection. Once that has been established one must also have some indication as to when, and to what extent, the species utilises its preferred habitat. Only by knowing which habitat type is selected by the sable, which variables influence the selection, and to what extent the habitat is being utilised, can one manage the population efficiently.

Previous research indicates that sable are dependent on surface water (Estes & Estes 1970 in Grobler 1973), prefer open woodland above dense canopy cover (Coetzee 1980), and avoid areas with short grass (Carr 1986). Ben-Shahar & Skinner (1988), however, found low correlations between the sable distributions and the habitat variables they examined. This trend could be due to the exclusion (from their study) of the environmental characteristics affecting sable distribution, or to the fact that sable distribution is affected by other ungulates. Alternatively, they postulate, it could also indicate that, despite common belief, sable exhibit an opportunistic strategy of resource selection.

In the previous chapter habitat types were evaluated not only from a floristic point of view, but also including other variables which may be relevant to the animals such as slope, rockiness, lateral visibility and availability of shade. In the present chapter these habitat variables are related to utilisation in order to better comprehend the environmental requirements of the sable.

MATERIALS AND METHODS

RELOCATION OF SABLE

On the 20th of May 1988 the sable herd on the Potlake Nature Reserve was located by helicopter and two individuals, one adult male and one adult female, were chased into an enclosure for darting and collaring. A third individual (adult male) was darted from the helicopter outside the enclosure. The two adult males, one solitary and one associated with the herd, were immobilised with 75mg Azaperone# and 5mg M99 (Etorphine)# while the dosage for the female was 50mg and 4mg respectively. All three individuals were fitted with collars bearing radio transmitters (Telonics Inc.*, configuration MOD-500 transmitter with CLM collar). The animals were revived using the antidote M50/50 (Diprenorphine)# and released.

Two weeks later (June), eleven sable were captured at Potlake Nature Reserve, kept in the enclosure overnight and transported in a truck the following day. The herd was released at the Masebe Nature Reserve at 14h00 on that same day and comprised two adult males (both collared), one collared adult female, three uncollared adult females, two subadults, one juvenile (born 1987 season) and two calves (born 1988 season). The animals were released in the west camp of the Masebe Nature Reserve (Fig. 7) and intensive monitoring of their movements and behaviour began subsequently.

TELEMETRY

Using a Yaesu 290-R March-2 transceiver radio and a portable H-antenna (Telonics, Inc.*) signals from the three collared animals (150 MHz) were received and used to plot their position.

* Telonics Incorporated, 932 E. Impala Avenue, Mesa, Arizona, U.S.A.

\# Supplier: Game Immobilisation Division, Reckitt & Colman S.A.(Pty) Ltd, P.O. Box 1097, Cape Town.

The location of each collared individual was determined through triangulation, using up to 15 known points within the study area from which to take compass bearings. In this study a single operator using one receiver moved by vehicle between two known points in order to determine the position of the animals.

The source of error caused by animal movement between readings while the operator changed location (Brander & Cochran 1971) was considered negligible. The intention of the telemetry was not that of monitoring slight movements of individual animals (e.g. when grazing), but rather to determine when they moved over longer distances (e.g. from the plateau down to the water in the valley). The inaccuracy which may have existed due to the topography, or the time lapse between readings is therefore tolerated in the analyses.

The triangulation, tested using a stationary transmitter in a known position, was accurate to $\pm$ 60 m. Due to the deflection of signals off cliffs, it was considered risky to presume any greater accuracy. The location of the sable was recorded at hourly intervals between 06h00 and 18h00.

DATA ANALYSIS

(i) Home range

By selecting telemetry readings taken at 06h00, 12h00, and 18h00, throughout the study period, either through triangulation or direct observation, home range size was calculated. The cumulative home range size was calculated to determine whether the range had been adequately measured (Ables 1969). Because the cumulative range includes all telemetry points, irrespective of whether these positions are true representatives of the area utilised by the animals or merely exploratory roamings, further analysis of the data was essential.

According to Burt (1943, in Wolton 1985) the areas in which the animals carry out such activities as feeding, mating, resting and caring for their young, and which exclude the exploratory roamings of the herd, are more accurately defined as the home range of the herd. The home range size for the sable herd was calculated using three different methods for comparison. The minimum convex polygon (MC) method, described by Mohr (1947), and widely applied in home range calculations (Odendaal & Bigalke 1979, Rowe-Rowe 1982, Norton & Lawson 1985, Norton & Henley 1987, Creswell & Harris 1988, Hiscocks & Perrin 1988), was compared to the restricted polygon (RP) method (Wolton 1985). A third method, a variation of the latter, which for convenience will be called the "core convex polygon" method (CC), has been mentioned by Kenward (1987) as one of the many variations of the basic method which are subjectively applied according to the requirements of each research project.

The MC method includes the area of a convex polygon linking all the outermost points. The RP method includes only those points where the distance between two adjacent points is less than or equal to the mean distance between the arithmetic mean (Hayne 1949) and all the points. The CC polygon method excludes those points whose distance from the arithmetic mean is greater than the mean distance between the arithmetic mean and all the points.

For two of the three methods (MC and CC), the influence of topography on home range size was also taken into consideration. Using a Q520 image analyser* and the same program as described in Chapter II, a three-dimentional estimate of home range size was made. In all cases the home ranges were calculated on a monthly basis, grouping data collected during three consecutive weeks of fieldwork for each month. Due to circumstances, insufficient data were collected during January and June 1989, so these have been excluded from all home range calculations. Seasonal variation in home range size and locality was also compared.

(ii) Centres of activity

The arithmetic centres of activity (Hayne 1949) were calculated on a monthly basis and plotted on a 1:50 000 map of the study area. This provided an indication of the herd's movements in order to assess whether or not the sable herd established a specific home range in a specific veld type within the study area or whether it utilised the whole area available to them.

* S.M.M. Instruments (Pty) Ltd, P.O. Box 38622, Booysens, Johannesburg.

(iii) Habitat preference

Having determined the available habitat types in the study area, habitat preference was shown by comparing the observed and expected number of "hits" per veld type. The "observed" number of points consist of the recorded location of the sable herd at 06h00, 12h00 and 18h00 throughout the study period. The "expected" number of points per veld type was calculated by dividing the total number of sable positions (hits) proportionally into the four habitat types. (Neu, Randall Byers & Peek 1974, Don & Rennolls 1983, Randall Byers & Steinhorst 1984, Mackie & Nel 1989). This was then statistically compared using a 2 x 4 contingency table. A 90% probability level was considered to be significant.

It was, however, necessary after finding the Chi-Square value significant, to determine which habitat type was responsible for the statistical difference. This was done using the Bonferroni-t statistic (Neu *et al.* 1974, Odendaal 1977). The use of the Bonferroni-t statistic adjusts the level of significance of the confidence intervals. For estimations using a single parameter, the probability of an incorrect interval estimate is controlled at a level of significance, α (i.e. the resulting interval estimate is termed a $(1-\alpha)$ x 100% confidence interval). When estimating two or more parameters, however, the probability that any one interval estimate is incorrect increases beyond α and is partially dependent upon the number of simultaneous estimates being made (Neu *et al.* 1974). In order to bind the probability error rate at α, a scaling down of the significance level of each estimate is required. This is achieved by using the Bonferroni t-statistic. The resulting interval estimates are then termed a $(1-\alpha)$ x 100% family of confidence intervals with a $(1-\alpha)$ confidence coefficient (Neu *et al.* 1974).

The confidence interval is expressed as follows (Neu *et al.* 1974, Odendaal 1977, Randall Byers & Steinhorst 1984):

$$\bar{P}_i - t_{\left(\frac{1-\alpha}{2}\right)}\sqrt{\frac{\bar{P}_i(1-\bar{P}_i)}{n}} \leq \bar{P}_i \leq \bar{P}_i + t_{\left(\frac{1-\alpha}{2}\right)}\sqrt{\frac{\bar{P}_i(1-\bar{P}_i)}{n}}$$

where:

$\bar{P}_i$ = proportion of observed locations in the *i*'th habitat category
n = sample size
k = number of simultaneous estimates being made, i.e. four
α = 0,1

Standard t-tables were used to arrive at an approximation of the Bonferroni t-statistic. According to Miller (1966, in Odendaal 1977) this will suffice for most applications of this method. The hypothetical occurence of sable in any given habitat type (as shown by the confidence limits) is then compared with the expected occurrence divided by the total number of occurrences (P_{io}). If the expected value lies above the confidence interval, a significant selection against the habitat is indicated and *vice versa*.

In order to express the selection more simply, a selection index was calculated for each habitat type (Odendaal 1977). The index is calculated as follows:

Selection index = observed/expected

If the selection index = 1, there is no selection (for or against the habitat)
If the selection index > 1, there is a positive selection (for the habitat)
If the selection index < 1, there is a negative selection (against the habitat)

It is not enough merely to know *which* veld type the sable are selecting for, one must also ask the question "*why*?". In order to attempt to understand the factors affecting habitat selection, Simple Correspondence Analysis was applied to the data with the use of the computer program SIMCA (version 1.2)*.

* Prof. M.J. Greenacre, Dept. of Statistics, University of South Africa, P.O. Box 392, Pretoria, 0001.

Correspondence analysis is a multivariate analysis which displays rows and columns in a two-way contingency table. The technique is similar to principal component analysis but it is particularly suited to discrete data, whereas the former is usually applied to data measured on a continuous scale (Greenacre 1984).

A data matrix was created with the four veld types represented as columns. The habitat parameters and the frequency of occurrence of the sable in each veld type made up the rows. Although the data do not lend themselves fully to the potential of this analysis, the use of correspondence analysis nevertheless aids one in interpreting the results obtained, through its hypothetico-inductive approach (Mentis 1988). Hypothetico-deductive schemes evaluate the truth of *a priori* hypotheses, but *inductive* schemes attempt to develop knowledge and generate hypotheses from the data (Mentis 1988).

(iv) Incidental observations

Due to the topography and dense vegetation of the study area, the use of line transects as described by Gates, Marshall & Olson (1968), Gates (1969), Hemingway (1971) and Eberhardt (1978) for determining distribution and density of other herbivorous species in the area was unsuitable in this case. For this reason all incidental observations of large herbivores were recorded, taking note of the date, time of day, number of individuals and grid reference position. These were then plotted in order to assess the extent of interspecific overlap of habitat utilisation.

RESULTS

HOME RANGE

The cumulative home range of the sable antelope over the whole study period is presented in Figure 13. The sable roamed over 1692 of the available 2825 hectares available to them. The sable herd did not, however, utilise this whole area as its home range. Instead, it had smaller areas in which it remained for a period of days or weeks before moving on again. This is seen in Figure 13, where the cumulative home range size is not depicted as a gradual slope but as a step-wise progression.

Table 4 presents a comparison of results of three different methods used to calculate home range size, using the same data in all cases. The Minimum Convex Polygon calculations provide the largest mean range size for the sable herd and the Core Convex Polygon method the smallest. Similarly, the standard deviations of home range size follow the same gradient.

The use of the Q520 Image Analyser showed a slight, but statistically insignificant increase in home range size in both the MC (Chi-Square = 1,475; P > 0,99) and the CC (Chi-Square = 0,486; P > 0,99) methods of home range estimation (Table 4).

The arithmetic centres of activity (Hayne 1949) are portrayed in Fig. 14. On the map of the study area, with the 13 centres of activity connected to the original point of release of the sable herd, a distinctive aggregation of points is visible in the north-east quarter (Fig. 14). The position of a point outside the boundaries of the reserve (Oct. '88) is explained by the fact that the centre of activity is a theoretical point, calculated from the actual co-ordinates of the herd's position (Hayne 1949).

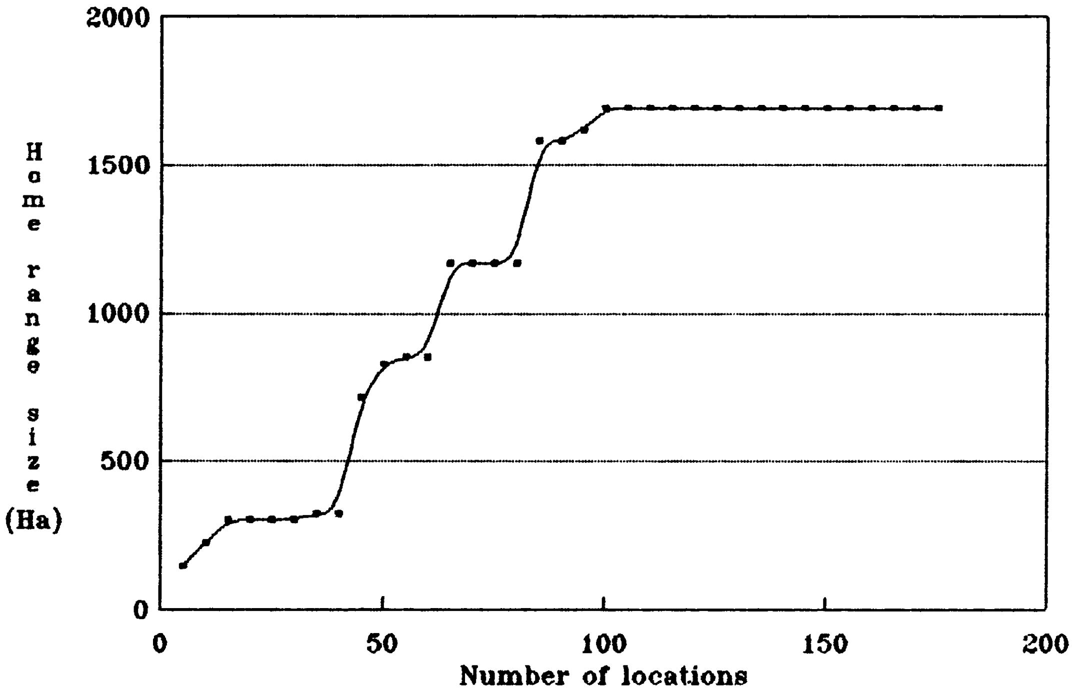


Figure 13: Cumulative home range size of the sable antelope herd on the Masebe Nature Reserve. Each point represents the effect of an additional five telemetry locations on the cumulative area.

Table 4: Home range sizes (mean values followed by one standard deviation of the mean) calculated using three different methods. MC = Minimum Convex Polygon method (Mohr 1947); RP = Restricted Polygon method (Wolton 1985); CC = Core Convex Polygon method (Kenward 1987). Mean home range sizes calculated by means of the Q520 Image Analyser are included for two of the three methods: MC (3-Dim.) and CC (3-Dim.) for comparative purposes.

METHOD	HOME RANGE SIZE MEAN	S.D.
MC (2-Dim.)	356,1 ha	325,0
MC (3-Dim.)	362,3 ha	330,1
RP (2-Dim.)	93,0 ha	110,7
CC (2-Dim.)	69,4 ha	57,4
CC (3-Dim.)	70,9 ha	58,3

Only twice, in October 1988 and February 1989 did the sable settle in an area outside the north-eastern quarter of the reserve for any length of time (Fig.15). If one compares this to the rainfall figures of the study period (Fig. 16), one can see that it was when heavy rains followed an extended dry period that the sable moved out of the north-east corner and traversed to the southern region of the study area.

Similarly, when plotting monthly range size on the same graph as rainfall, a pattern developed (Fig. 16). As the monthly rainfall increased during the study period, so did the home range size of the sable herd. The regression between range size (RP method) and rainfall is highly significant ($r = 0,96$; $P < 0,0005$; $F = 82,2$; $y = 20,01 + 2,77x$, where y = home range size and

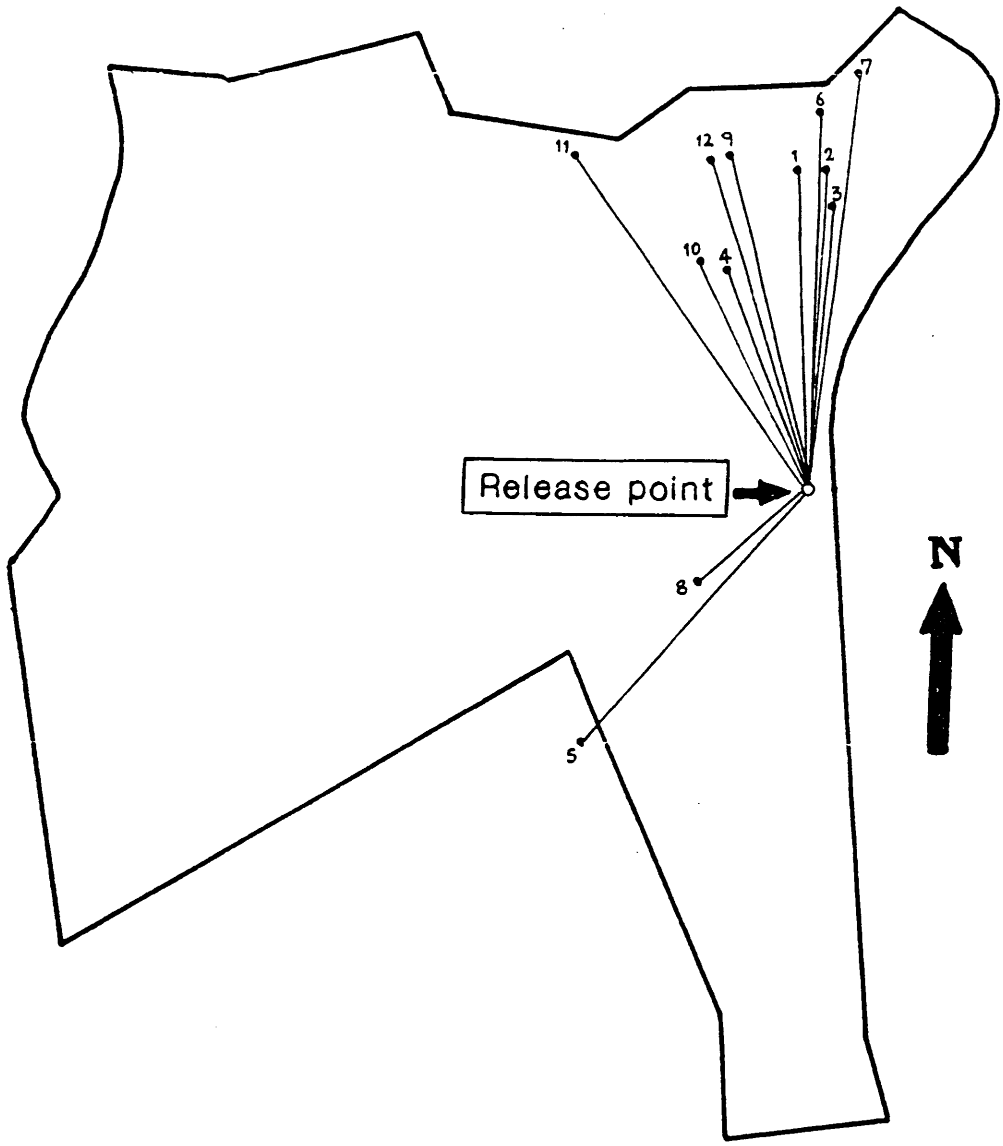


Figure 14: Arithmetic centres of activity (Hayne 1949) of the sable herd on the Masebe Nature Reserve calculated from the co-ordinates of actual positions recorded monthly. 1=June 1988, 2= July 1988, 3= August 1988, 4=September 1988, 5=October 1988, 6=November 1988, 7=December 1988, 8=February 1989, 9=March 1989, 10=April 1989, 11=May 1989, 12=July 1989.

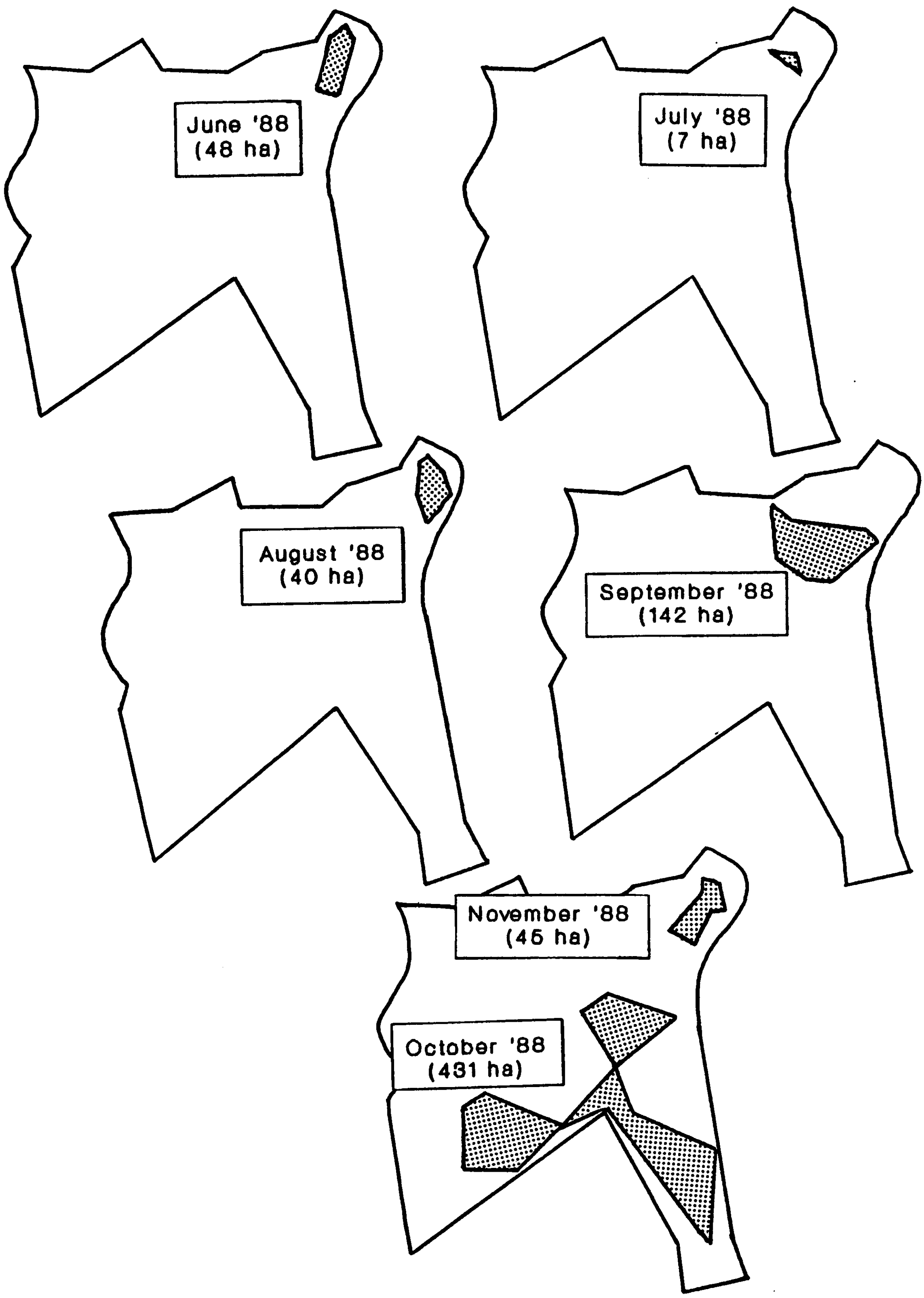


Figure 15: Monthly home range areas of sable antelope on the Masebe Nature Reserve for the period June 1988 to November 1988. Home ranges calculated according to the RP method.

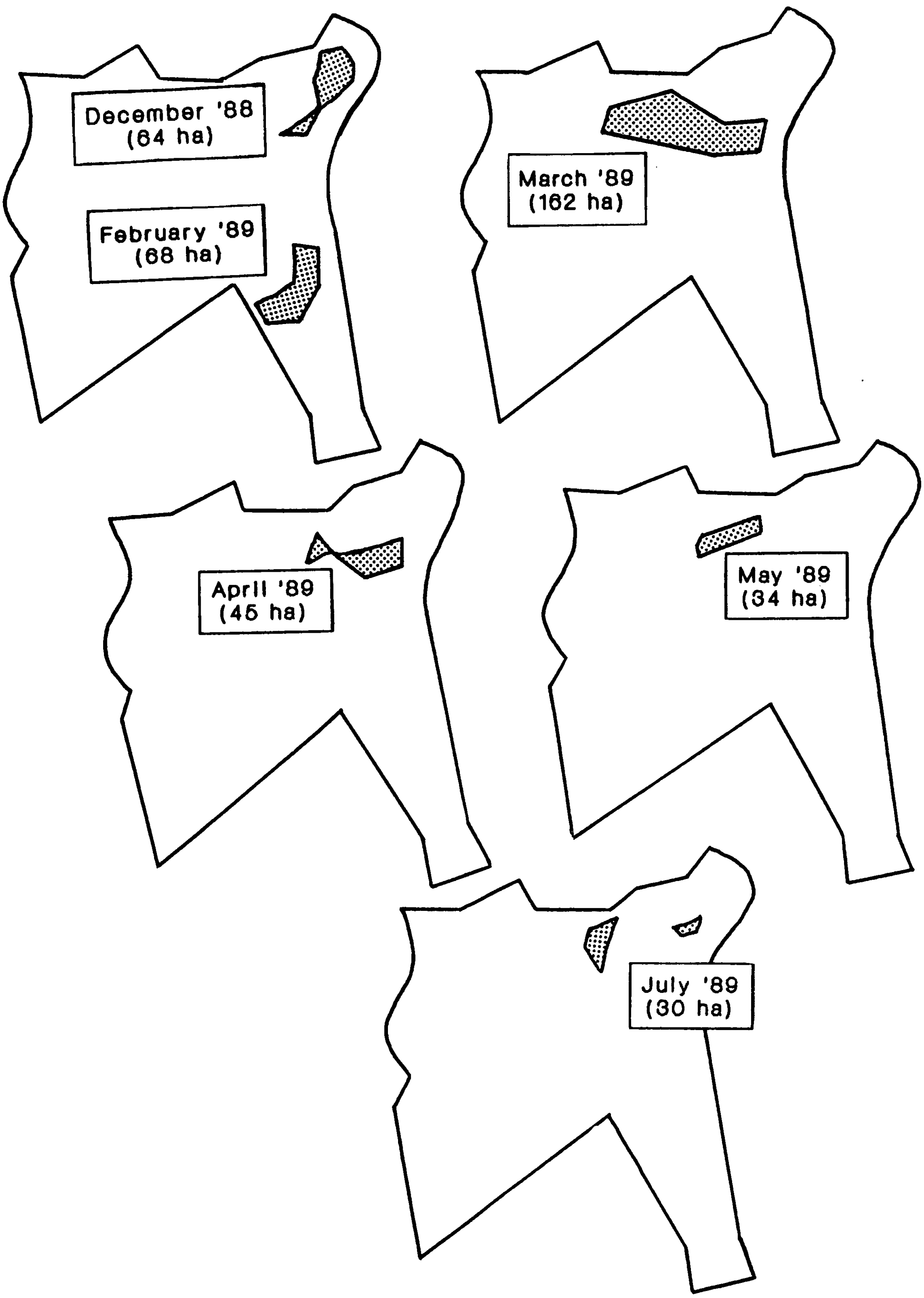


Figure 15 (cont.): Monthly home range areas of sable antelope on the Masebe Nature Reserve for the period December 1988 to July 1989. Home ranges calculated according to the RP method.

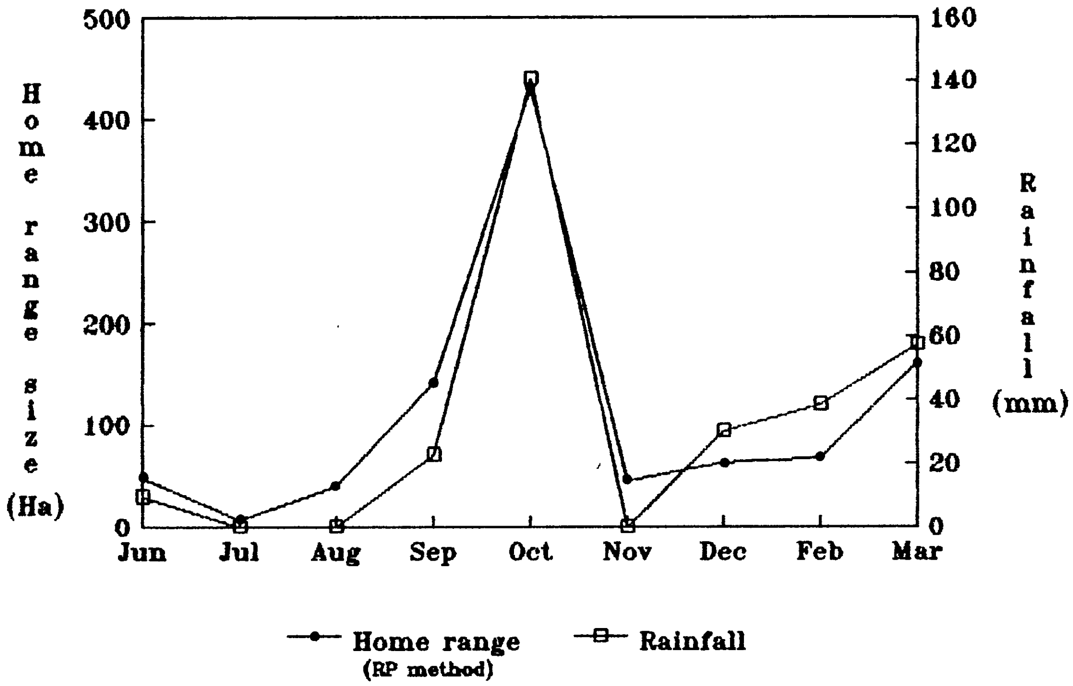


Figure 16: Monthly home range size (June 1988 - March 1989, excluding January 1989) and monthly rainfall measured during the study period in the study area. Home range size calculated according to the RP method.

x = rainfall). Several seasonal cycles would be necessary, however, to ascertain whether or not the trend observed in this study is a consistent reality.

HABITAT SELECTION

The observed and expected number of locations of the sable herd in each veld type are shown in Table 5. A selection index is also presented in this table, giving an indication of which veld type is being selected for or against. Significant differences exist between the expected and observed locations of the sable antelope herd (Chi-Square = 14,22; $P < 0,005$).

The Bonferroni intervals are presented in Table 6, which statistically confirm the results of the selection index presented in Table 5, i.e. that the sable exhibited a positive selection only for the plateaus, no selection for or against the valleys and a negative selection for the other two habitats.

The interpretation of the correspondence analysis is based on the numerical output (Table 7) and the graphical display (Fig. 17). To facilitate the examination of the results, all the values in Table 7 have been multiplied by 1000 and rounded to integers.

The inertia along the principal axis (in this case the eigenvalue is 0,186) is equal to the weighted sum of squared distances to the origin of the row profiles, or equivalently, column profiles. Each term in these sums can be expressed as a percentage of the first principal inertia (Greenacre 1984). For example, in Table 7, the parameter for tree density (Td) has a mass of 0,775 (x 1000 = 775) and a distance from the centroid of 0,196 (x 1000 = 196). Its absolute contribution (CTR) to the first principal inertia is thus $0,775 \times (0,196)^2 = 0,030$, which is 15,8% of 0,186.

Table 5: Observed and expected number of locations in each veld type, and the selection index calculated from these values.

VELD TYPE	AREA (ha)	PROPORTION OF TOTAL AREA	EXPECTED	OBSERVED	SELEC. INDEX	SELECTION
Riverine	88	0,03	6	1	0,17	Negative
Valley	675	0,23	42	42	1,00	None
Slope	861	0,29	54	38	0,70	Negative
Plateau	1314	0,45	83	104	1,25	Positive
TOTAL:	2938	1,00	185	185	-	-

Table 6: Confidence intervals using the Bonferroni approach (Miller 1966 in Neu *et al.* 1974) to indicate the significance of the selection in each veld type. P_i is the actual proportion of utilisation while P_{io} is the expected proportion of utilisation. P_{io} values above the confidence interval indicate a significant selection against a veld type and *vice versa*.

VELD TYPE	P_{io}	P_i	BONFERRONI INTERVALS	SELECTION
Riverine	0,032	0,005	$0{,}003 \leq P_i \leq 0{,}013$	Negative
Valley	0,227	0,227	$0{,}177 \leq P_i \leq 0{,}278$	None
Slope	0,292	0,205	$0{,}156 \leq P_i \leq 0{,}254$	Negative
Plateau	0,449	0,562	$0{,}502 \leq P_i \leq 0{,}622$	Positive

Table 7: Decomposition of the two principal axes in terms of row and column contributions.

(a) ROW CONTRIBUTIONS

NAME	QLT	MASS	INR	K=1	COR	CTR	K=2	COR	CTR
Td	1000	775	158	196	996	160	11	3	42
Lv	995	55	268	- 953	988	268	82	7	160
Cc	994	73	10	- 123	606	6	- 99	388	308
Gh	988	30	15	- 241	598	9	-195	390	488
Hp	998	67	549	-1242	998	556	- 4	0	0

(b) COLUMN CONTRIBUTIONS

NAME	QLT	MASS	INR	K=1	COR	CTR	K=2	COR	CTR
VA	950	176	21	-127	721	15	- 72	229	391
SL	844	228	9	64	549	5	- 47	295	214
PL	1000	153	699	-928	998	708	45	2	136
RI	1000	443	271	338	988	272	37	12	259

NAME : Name of variable (Key to abbreviations in Fig. 17)

QLT : Quality of representation (sum of the two COR columns)

INR : Inertia, relative to total inertia

K=n : Co-ordinate of the element with respect to the n'th axis

COR : Relative contribution of the axis to the inertia of the element (i.e. $\cos^2 \theta$, or "correlation")

CTR : Absolute contribution of the element to the axis

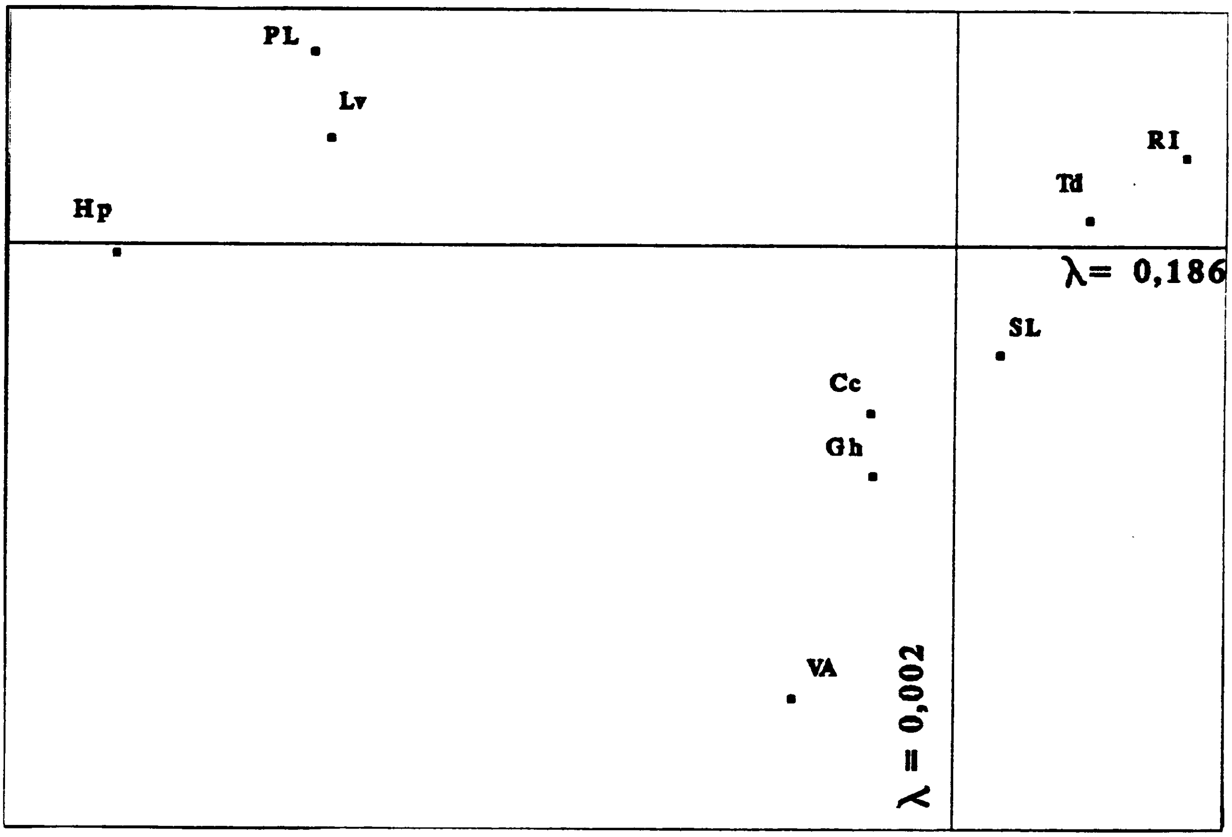


Figure 17: Graphical display by correspondence analysis of habitat variables and sable selection for four habitat types. Columns: PL = Plateau, SL = Slope, VA = Valley, RI = Riverine area; Rows: Td = Tree density, Cc = Canopy cover, Gh = Grass height, Lv = Lateral visibility, Hp = Sable locations.

Another way of estimating the importance of the points is to examine the angle between the true profile point vector and the principal axis (Fig. 18). $Cos^2 \theta$ gives the contribution of the axis to the inertia of points (relative contribution). If the value is high then the axis explains the points inertia very well, In other words, if is small, then the profile vector is said to lie in the direction of the axis, or "correlate" with the axis (Greenacre 1984).

Thus the contributions are interpreted in two ways (Table 7). Firstly, one compares the absolute contributions to the axes (in this case only two principle axes) in the column headed "CTR". Secondly, one compares the relative contributions in the column headed "COR" to identify the axes which represent the point well.

The principal (horizontal) axis has an inertia, or eigenvalue, of 0,186 or 98,52% while the vertical axis has an inertia of 0,002 or 1,23% (Fig. 17). For the interpretation of the graph, emphasis can therefore be placed on the horizontal axis, as the vertical axis makes almost no contribution to the graph. This is further confirmed by the values of relative contributions, which are higher for all the points for axis 1 than for axis 2.

The outerlying veld types along the principal axis are the riverine habitat and the plateau at opposite extremes. There is also a close association between this axis and two of the habitat variables, namely tree density (Td) and lateral visibility (Lv). The principal axis therefore reflects a gradient, from the river to the plateau, with the density of the vegetation decreasing from right to left. The data values for tree density and lateral visibility are inversely related, thus pushing these two variables to opposite quadrants on the graph. The position of the sable on the graph indicates a selection towards low vegetation density such as is found on the plateaus and away from the dense riverine vegetation.

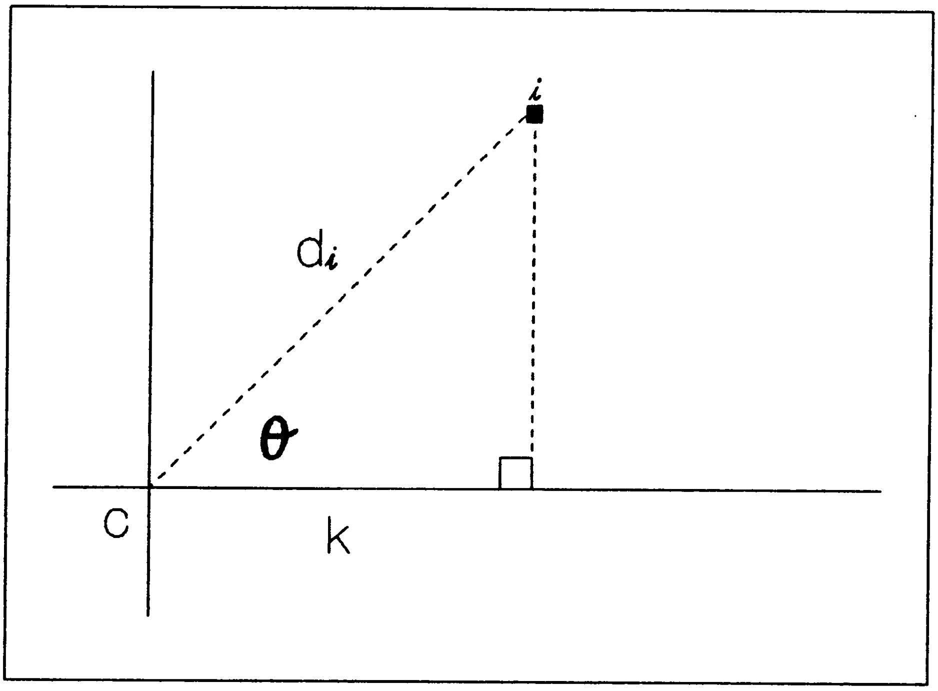


Figure 18: The relative contribution of axis k to the i'th point expressed as the value of $\cos^2 \theta$ where d_i is the distance from the centroid (c) and i'th row profile (after Greenacre 1984).

INTERSPECIFIC OVERLAP

Figure 19 (a-c) shows the cumulative home range of the sable herd (RP method) and its position in the study area, with the sightings of other large herbivores superimposed over it. The two species most commonly sighted were the kudu (*Tragelaphus strepsiceros*) and impala (*Aepyceros melampus*) as these are the most abundant of the large antelopes in the area, confirmed by aerial census in 1989 (Table 8). The other species, such as waterbuck (*Kobus ellipsiprymnus*), gemsbok (*Oryx gazella*), bushbuck (*Tragelaphus scriptus*), mountain reedbuck (*Redunca fulvorufula*) and klipspringer (*Oreotragus oreotragus*) although present in the study area, were less abundant.

The overlap between the home range of the sable and the sightings of the impala (Fig. 19a) occurred predominantly in the north-eastern corner of the study area. This area, where both sable and impala occur together, was in the close vicinity of the water hole utilised by the sable.

The overlap in distribution between sable and kudu was relatively high (Fig.19b), and observations of the sable herd often revealed these two species in close proximity, both spatially and temporally. Although one sighting of waterbuck fell within the home range of the sable in the south-western corner of the reserve these two species were never observed utilising the same area at the same time and the sable herd were only recorded once in this area during the month of October 1988.

Four out of five sightings of gemsbok occurred on the plateaus, within the area utilised by sable, (Fig. 19c). Direct observations also confirmed this, as the gemsbok were seen on the plateaus on three occasions when the radio-collared sable were tracked on foot.

There was no overlap between the distribution of the sable antelope and the bushbuck in the study area. Similarly, the overlap between the sightings of klipspringer and the mapped home range of sable is minimal. The mountain reedbuck in the study area were only observed three times during the study period, yet in all three cases they were seen in the vicinity of the sable antelope, i.e. on the northern plateaus of the study area.

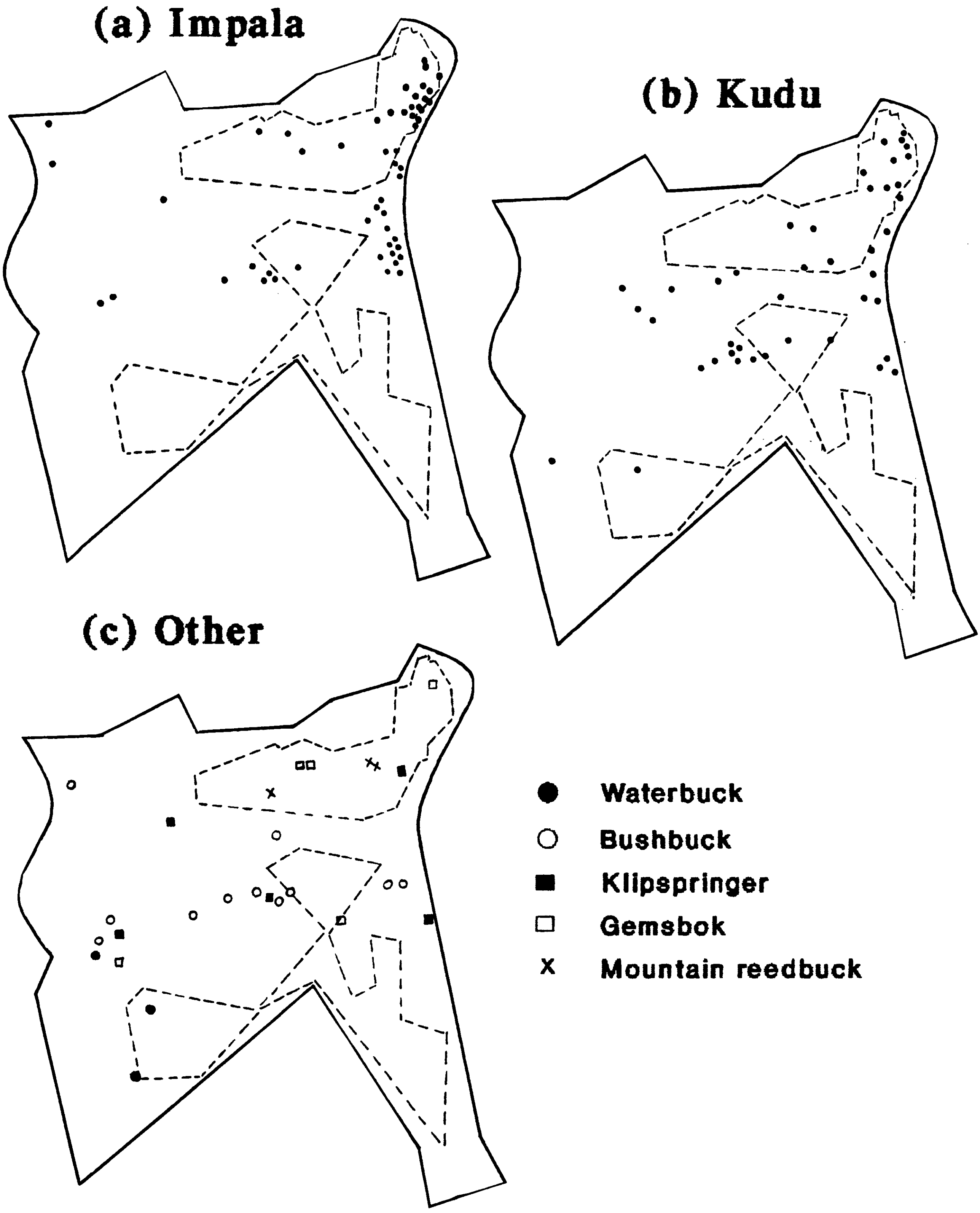


Figure 19: Cumulative home range of sable antelope, using the RP method of range size calculation and sightings of (a) impala, (b) kudu and (c) other antelope during the study period (June 1988 - May 1989). Dashed lines demarcate the home range of the sable herd.

Table 8: Numbers of large herbivores sighted during the 1989 aerial census carried out on the Masebe Nature Reserve by the Department of Agriculture and Environmental Conservation of Lebowa. The figures have not been extrapolated to account for animals not spotted during the aerial census.

SPECIES	NUMBER OBSERVED
Aepyceros melampus (Impala)	48
Tragelaphus strepsiceros (kudu)	39
Kobus ellipsiprymnus (Waterbuck)	26
Redunca fulvorufula (Mountain reedbuck)	16
Tragelaphus scriptus (Bushbuck)	15
Oryx gazella (Gemsbok)	10
Oreotragus oreotragus (Klipspringer)	7

DISCUSSION

The mean monthly home range size of 356 ha, calculated using the minimum convex polygon (MC) method is comparable to those recorded for sable by other authors. Wilson (1975) recorded the mean monthly home range for sable on the Percy Fyfe Nature Reserve as 234 ha and on the Rustenburg Nature Reserve as 273 ha. The mean range size on the Loskop Dam Nature Reserve was lower (135 ha) which Wilson (1975) attributed to the availability of recently burned grazing in the area. Grobler (1973) noted home range sizes ranging between 240-280 ha in the Rhodes Matopos National Park. Estes & Estes (1969 in Wilson 1975) recorded a home range size of 890 ha for a large herd of 48 sable in Kenya but indicated that this range size was reduced to 650 ha when the herd was in the company of a territorial bull. In the Victoria Falls National Park, however, they recorded a home range of about 260 ha for a herd of sable (Estes & Estes 1970, in Wilson 1975). Carr (1986) stated that the home range for sable in the Transvaal can vary between 200 and 500 ha.

None of the above authors mentioned the systematic exclusion of locations applied in this study, which may indicate that the sable on the Masebe Nature Reserve have a slightly larger home range than those in the other areas mentioned. All three authors do however mention that within these home ranges sable antelope have smaller "activity areas" in which they may remain from a period as short as a few hours (Wilson 1975) to as long as fourteen days (Grobler 1973). These activity areas can range from 2 - 84 ha (Grobler 1973, Wilson 1975). On the Masebe Nature Reserve these activity areas were observed but not measured.

The use of the restricted polygon and core convex methods of home range estimation produce much smaller home ranges than the minimum convex polygon method. These values may be a more accurate estimate of the actual spatial needs of the animals, assuming that all outerlying points are exploratory. From a management point of view, however, it may be wrong to assume that these outerlying points can be excluded from an animal's range. Should more sable be introduced to the area, an underestimation of a herd's spatial requirements could lead to overstocking and thus also an overlap in ranges and territories. For this reason, the home range sizes attained by the application of the MC method should be used in all practical applications of this dissertation.

The application of the Q520 Image analyser to account for slope in home range estimations proved to be unnecessary. Although the method may have its applications when calculating vast areas of undulating topography, for the purposes of this study the differences in area were negligible.

Due to the death of the only solitary bull in the group, two weeks after relocation, no study of territoriality could be carried out on the relocated sable. Previous studies do, however, note the existence of solitary, territorial bulls. Grobler (1973) stated that the territory of the bull lies within the herd's home range and that it is defended by the bull against other solitary adult males. These territories range from 25 - 40 ha in area (Grobler 1973, Wilson 1975). The herd on the Masebe Nature Reserve had one adult bull which remained with the herd throughout the study period. Although he did exhibit agonistic behaviour towards other members of the herd (Chapter 5) actual defence of a territory against another male, albeit a younger one, was not observed.

The relocated sable herd showed a significant preference for the plateaus above the other three available veld types. From the correspondence analysis it appears that the "openness" of the area is the determining factor which makes this veld type more favourable. This preference for open woodland has been mentioned by several other authors (Grobler 1973, Pienaar 1974, Wilson 1975, Smithers 1983, Ben-Shahar & Skinner 1988, Scogings, Theron & Bothma 1990). Although this may often correspond to a medium to tall grass height, in this study the open plateaus also had the shortest grass. Wilson (1975) found great variations in the grass height of the preferred sable habitats which seems to indicate that grass height is not a limiting factor.

The arithmetic centres of activity indicate that the relocated sable herd remained almost consistently in the north-east corner of the study area. The only two times that the sable moved to the southern plateaus of the reserve for a long period of time was during October 1988 and February 1989, the two months with the highest rainfall during the study period. This, and the fact that sable are dependent on water on a daily basis (Estes & Estes 1970 in Grobler 1973, Scogings *et al.* 1990), may explain their restriction to this one quarter of the study area. When water was freely available in rock pools on the plateaus the sable did move out of their usual range. The other watering points within the study area were available to the sable, but they were all surrounded by somewhat denser vegetation than the one in the north-eastern corner of the reserve, possibly explaining the sable's preference for the latter.

The sable's necessity to drink daily explains why they showed no selection for nor against the valleys. The water hole at which the sable drank regularly was situated in this veld type, thus resulting in the herd descending from the plateaus on a daily basis. Direct observations and radio locations therefore located the sable in the valleys more often than would otherwise be expected. The monthly home ranges of the sable as plotted in Fig. 15 also extend into the valleys more than would otherwise be expected due to their regular visits to the water hole. The strong correlation between the home range size of the sable herd and the monthly rainfall during the study period may also be due to the animals' dependence on water. When water was plentiful throughout the reserve, the herd increased its home range, wandering further afield from its usual range near the water holes in the northern half of the study area.

The concentration of sightings of other species of herbivores on the northern half of the reserve may be attributed to two factors. Firstly, the fact that the researcher spent more time in this area as the sable were concentrated here, and secondly because the system of roads was also limited to the northern half of the reserve. The paucity of sightings in the southern half may, however, be a realistic representation of the distribution of animals as, in winter at least, the animals are restricted in their distribution by the availability of water. No man-made watering points are found south of the road traversing from east to west across the middle of the study area (see Chapter 1, Fig. 2).

Whether the plotted sightings are a true representation of the animals in the southern half of the reserve or not, does not influence this discussion, as the concern of this study is to assess whether or not an overlap exists between *the range of the sable* and that of the other large herbivores, and what the consequences of such an overlap may be.

The overlap of the impala and the sable in the north-east corner of the reserve, in the vicinity of a water hole, is not entirely natural. The frequent occurrence of sable in the valley can be largely attributed to their dependence on water as has been previously discussed. The impala, on the other hand, are usually found in the valleys, even when they are not in the proximity of a water hole. It would therefore appear that the spatial distribution of sable and impala does not overlap greatly. Scogings *et al.* (1990) recorded that impala selected the lower altitudes and greater tree density. These authors also stated that through correspondence analysis a distinct separation in habitat selection of the impala and sable occurred in burnt veld.

The few sightings of impala on the plateau within the home range of the sable consisted of small bachelor herds or individual males, which are less likely to exert much pressure on the sable as far as competition for food is concerned. The large herds of impala (often between 20-50 in a herd) were usually seen in the valleys.

The fact that the kudu are browsers and the sable are grazers, explains how this close overlap between the two species is feasible. The only time that competition for food may exist between these two species is during the dry season. At this time sable switch to a greater extent to browsing (Chapter 4) and may therefore, should the resources be limited, compete with kudu for food.

According to the distribution maps for gemsbok in Smithers (1983), the occurrence of these animals in the Waterberg is unnatural. It is therefore difficult to assess the habitat requirements of a species which have not been studied in their introduced environment. The habitat description for gemsbok in Smithers (1983) is that of open grassland, open bush savanna and light open woodland. As has been previously discussed in this and the previous chapters, the plateaus are the only areas on the Masebe Nature Reserve that provide this open woodland, thus explaining the overlap between the gemsbok and sable in the area.

Smithers (1983) describes the preferred habitat of bushbuck as dense riverine underbrush, thickets and areas with water and good cover. In his description of the habitat of the klipspringer this author explains that they are closely confined to hills, gorges and sometimes riverbeds, all with very rocky slopes on which these animals move with ease. For this reason there is very little or no overlap in the distribution of these species and the sable antelope due to their extremely different habitat requirements.

The mountain reedbuck inhabit dry, grass-covered stony slopes of hills and mountains but avoid sheer cliffs and steep slopes, not having the anatomical specialisations of the klipspringer (Smithers 1983). Their occurrence in the same area as the sable on the Masebe Nature Reserve is therefore not surprising. They may, however, utilise the slopes somewhat more than the sable, as they prefer a certain degree of cover in the form of trees and bushes. The fact that they are almost exclusively grazers and that their habitat requirements appear to resemble those of the sable antelope in the study area, means that they are the species most likely to be competing with the sable on the Masebe Nature Reserve. Three observations are, however, far too few to state this conclusively. Management recommendations concerning the interspecific overlap in the study area are discussed in Chapter 6.

CHAPTER FOUR

DIET

" Tell me what you eat and I will tell you who you are."
Brillat-Savarin 1825

INTRODUCTION

The study of the diet of any animal is essential for a deeper understanding of its nutritional preferences and ecological requirements. A considerable amount of work has been done on dietary analyses of African herbivores (Stewart & Stewart 1970, 1971, McAllister & Bornman 1972, Grunow 1980, Monro 1982, Owen-Smith & Cooper 1987) yet much controversy still exists concerning the accuracy and applicability of the methods used. While faecal analyses present several drawbacks as a method for dietary analysis, they nevertheless provide a readily available and easily collectable source of information.

The problems of assessing qualitative and quantitative information from microscopic analysis of faeces are many. The plant particles in faeces are often too small to identify, and sieving the sample to remove small particles only serves to increase the bias which may already exist due to differential digestion (Monro 1982). Furthermore, as only certain parts of the plant tissue (usually the epidermis) have characteristics that can be used to identify the species, describing the diet according to proportions based on identifiable epidermal types alone, introduces an unacceptable bias (Norbury 1988). If the ratio of identifiable to unidentifiable epidermis were similar for all species, the quantitative assessment of dietary ratios would be valid; this is however, not the case, and variations may even occur within a single species depending on its stage of growth (Storr 1961). Despite these unavoidable sources of error, quantitative evaluations have been used in determining food preferences (Stewart & Stewart 1970, 1971, McAllister & Bornman 1972).

The sable antelope is primarily a grazer but does browse to a certain extent, particularly towards the end of the dry season (Pienaar 1963, Child & Wilson 1964, Grobler 1973, Wilson 1975, Smithers 1983). Grobler (1973) recorded 28 plant species utilised as food by the sable. Of these only four were dicotyledons : *Dombeya rotundifolia*, *Grewia flava*, *Lippia javanica* and *Tarchonanthus camphoratus*, the latter being an important browse plant especially prior to the rains. Wilson (1969) also records *Acacia karroo*, *Dichrostachys glomerata*, *Lippia oatzii*, *Rhus lancea* and *Grewia monticola* as browse plants utilised by sable. In addition to Grobler's (1973) list of species, 27 other species of grasses have been recorded (Wilson 1969, Wilson 1975 and Ben-Shahar 1986) as well as the fruits of *Dichrostachys glomerata* and *Ziziphus mucronata*.

Sable are reported to select the green succulent parts of the grass, biting off lengths of up to 30 cm (Grobler 1973). Their feeding preferences vary throughout the year depending on availability, growth form, phenology, rainfall and other factors (Wilson 1975).

This chapter is aimed at presenting the species of grasses identified in the faeces of the sable on the Masebe Nature Reserve during the study period, and at assessing whether or not the sable switched to browse during the drier months of the year.

MATERIALS AND METHODS

For the purposes of this study it was necessary to use faecal analysis as a method of dietary evaluation as the animals were too elusive to allow accurate observations of their grazing. It was, however, decided that to assume any quantitative results from the faecal analyses would be inaccurate and presumptuous (Stewart 1967, Putman 1984). The results presented in this chapter, although brief, are mostly qualitative, based on data which could be accurately collected. Seasonal variation in the ratio of monocotyledons to dicotyledons was tested using a 2 x 2 contingency table.

REFERENCE COLLECTION

Because plants growing in different habitats have been shown to have slightly different epidermal characteristics (Stewart 1965), a set of microscopic slides had to be prepared as a reference collection from which the grass fragments in the faecal samples could be identified. Fifty-four grass species were collected from the study area and identified at the National Botanical Institute, Pretoria.

Both the reference grasses and the faecal samples were treated in a similar way for microscopic preparation. The method used was a variation of those described by Storr (1961), Stewart (1967), Stewart and Stewart (1970), McAllister and Bornman (1972) and Ben-Shahar (1986). The method described by Norbury (1988), using sodium hypochlorite instead of nitric acid, was tried but did not produce satisfactory results. The reference collection consisted only of epidermal tissue from leaf fragments since identification of all the fragments of every other part of the plant would have been extremely time-consuming.

Fragments of the leaf, approximately 5 mm long were placed in a beaker containing 30 ml of concentrated nitric acid and heated to boiling point. The contents of the beaker were allowed to boil for 1-2 min until a brown vapour was released from the solution and the leaf fragments were seen to disintegrate into small colourless particles. It was at this stage that the cuticle became separated from the fibres. The cuticles were then removed from the acid by pouring the suspension through a 0,3 mm metal strainer and rinsed with distilled water. They were then stained in a 50:1 saffranin-gentian violet solution for at least 30 min (overstaining never occurred). Thereafter the particles were thoroughly rinsed in distilled water and mounted onto glass slides using glycerine jelly as a mounting medium. The epidermal structure was then microphotographed (magnification: x 1600).

FAECAL SAMPLES

Faecal samples were collected in the study area immediately after direct observations of the sable herd had taken place in a certain area. Only fresh samples were collected in order to ensure that the dung was undoubtedly that of sable and that an accurate date could be allocated to each sample. A minimum of 70g (fresh weight) was collected from each pile found (Stewart & Stewart 1971, Scotcher 1979). The samples were oven-dried to a constant weight and stored until processed.

Five pellets from each sample were crushed and thoroughly mixed, from which a 1 g subsample was then taken. The subsample was boiled in 50 ml concentrated nitric acid in the same way as described above. The contents were then sieved in a 0,3 mm sieve and left in the saffranin-gentian violet solution for a minimum of 30 minutes. Thereafter the sample was rinsed in the sieve to remove excess stain and transferred into dilute glycerine jelly. A drop of the jelly/ particle suspension was then placed on a microscope slide, covered with a glass slip and allowed to dry and harden before examination. By varying the proportion of mounting medium to suspended particles, it was possible to control the density of particles on the slide.

MICROSCOPIC EXAMINATION

A total of 17 faecal samples, collected over a period of ten months, were analysed. A minimum of 400 fragments per sample were included in the analysis as a baseline sample indicated that 400 particles were sufficient to ensure that no new grass species were likely to have remained unrecorded and that the monocotyledon/dicotyledon ratio reached an asymptote. Fragments with sufficient recognisable characteristics were identified from the reference collection. All fragments, whether identifiable or not, were counted and recorded as a ratio of monocotyledons to dicotyledons.

RESULTS AND DISCUSSION

Table 9 lists all the species of grass which have been recorded as having been eaten by sable in this and other studies of their diet. As no attempt has been made to quantify the data and thus present any one species as being eaten in greater quantities than any other, the species have been listed alphabetically for convenience. By indicating which species of grass have been consistently found in sable diet (in different areas and at different times) some indication of the most important species can be gained. This is especially so as the factor of differential digestion is cancelled out by the inclusion of results by authors who used other methods besides faecal analyses. One must, however, presume that not all the species listed in Table 9 were present in all the study areas. It is therefore not possible to accurately assess relative levels of food selection in relation to the total spectrum available to them. The table may nevertheless assist managers in determining whether or not an area under question will be able to support the nutritional requirements of sable antelope. Relocation projects will have a better chance of succeeding if one has the prior knowledge that the areas into which the animals will be released contain grass species known to be eaten by them.

The species which have been recorded in three or more independent studies of sable diet are *Aristida congesta*, *Cynodon dactylon*, *Digitaria eriantha*, *Eragrostis rigidior*, *Heteropogon contortus*, *Hyperthelia dissoluta*, *Panicum maximum*, *Melinis repens*, *Themeda triandra* and *Tricholaena monachne*.

Themeda triandra, *Cynodon dactylon* and *Hyperthelia dissoluta* were never recorded on the plateaus of Masebe during vegetation studies, which may explain why they were not noted in the faeces of the sable during this study. On the other hand, *Loudetia flavida*, one of the dominant grasses on the plateaus, was recorded in the sable diet only in this study. The fact that the grass species most likely to be selected for by sable were available in greater abundance on veld types other than the plateaus (Appendix I), further supports the idea that the selection for the latter may be based on other factors besides species composition of the vegetation.

Table 9: List of grass species found to be eaten by sable antelope during this and other studies. Crosses in the respective columns indicate the presence of the species in the sable diet. Species have been named according to Gibbs Russell, Watson, Koekemoer, Smook, Barker, Anderson & Dallwitz (1990). Table continues on pg. 67 and 68.

SPECIES	This study	Wilson (1969)	Grobler (1973)	Wilson (1975)	Ben-Shahar (1986)	Theron# (1990)
Andropogon gayanus			x			
Aristida adscensionis	x					
Aristida congesta	x		x	x		
Aristida diffusa				x		
Aristida scabrivalvis				x		
Aristida stipitata				x		
Aristida sp.		x		x	x	
Brachiaria brizantha			x			
Brachiaria nigropedata				x	x	
Brachiaria serrata	x					
Brachiaria xantholeuca			x			
Chloris virgata			x			
Chrysopogon serrulatus	x				x	
Cymbopogon excavatus				x		
Cymbopogon plurinodis		x				
Cynodon dactylon		x	x	x		
Dactyloctenium aegyptium			x			
Digitaria argyrograpta	x					
Digitaria eriantha	x		x	x	x	x
Digitaria monodactyla				x		
Diheteropogon amplectens						x

J.M. Theron (*pers. comm.*): Results are from utilisation data gathered at the Hans Merensky Nature Reserve, Transvaal.

SPECIES	This study	Wilson (1969)	Grobler (1973)	Wilson (1975)	Ben-Shahar (1986)	Theron[#] (1990)
Elionurus muticus				x		
Enneapogon pretoriensis	x					
Enneapogon scoparius					x	
Enneapogon sp.	x					
Enteropogon macrostachyus	x					
Eragrostis barbinodis				x		
Eragrostis chloromelas				x		
Eragrostis curvula				x		
Eragrostis gummiflua	x			x		
Eragrostis heteromera	x					
Eragrostis jeffreysii				x		
Eragrostis rigidior	x		x	x		x
Eragrostis superba	x					x
Eragrostis sp.	x	x		x	x	
Eustachys paspaloides	x					
Heteropogon contortus	x	x	x	x	x	x
Hyparrhenia hirta				x		
Hyparrhenia rufa	x					
Hyparrhenia sp.		x				
Hyperthelia dissoluta		x	x	x		
Loudetia flavida	x					
Melinis nerviglumis	x					
Melinis repens	x		x	x	x	x
Miscanthus junceus			x			
Panicum maximum	x	x	x		x	x
Pennisetum glaucocladum			x			
Phragmites mauritianus		x	x			
Pogonarthria squarrosa	x			x		
Schizachyrium exile			x			
Schizachyrium jeffreysii				x		
Schizachyrium sanguineum					x	

SPECIES	This study	Wilson (1969)	Grobler (1973)	Wilson (1975)	Ben-Shahar (1986)	Theron# (1990)
Schmidtia pappophoroides	x					x
Setaria incrassata			x			
Setaria sphacelata (var. sphacelata)				x		
Setaria verticillata			x			
Sporobolus africanus	x					
Sporobolus sp.	x					
Themeda triandra			x	x		x
Trachypogon spicatus				x		
Tricholaena monachne	x			x		x
Trichoneura grandiglumis	x			x		
Urochloa oligotricha		x	x			
Urochloa mosambicensis		x	x			
Urochloa panicoides		x				
Urochloa sp.						x

The fact that sable antelope tend to browse to a greater or lesser extent, particularly during the dry months of the year, has been recorded by several authors (Wilson 1969, Grobler 1973, Wilson 1975, Smithers 1983, Ben-Shahar 1986). The increased browsing by sable during dry months of the year was tested by comparing the number of fragments of dicotyledon epidermis in the faecal samples collected during dry months (< 20 mm rainfall per month) and wet months (> 20 mm rainfall per month). The mean percentage of dicotyledon fragments in faecal samples collected during dry months was 8,8%, which is significantly higher than the 0,9% recorded during wet months (Chi-Square = 66,39; P < 0,05). This indicates a definite switch to mixed feeding during drier periods, a fact which should be taken into account when considering the management of the population. From direct observations the herd of sable antelope on the Masebe Nature Reserve appeared to be in good condition, which suggests that the herd did not suffer from nutritional deficiencies. Indices of body condition could not be measured within the limitations of this study.

CHAPTER FIVE

ASPECTS OF POPULATION BIOLOGY

"The quality of life is determined by its activities"
Aristotle

INTRODUCTION

Ecologically a species is seen as a unit or subsystem within a community, harvesting energy and resources of specific types. The individuals are not only physiologically adapted to their environment, but socially and behaviourally too. By natural selection, each species tends to maintain or improve its niche within the ecological community by developing new productive relationships, improving established ones or reducing the loss of individuals or of resources to other species. The population biology of a species contributes to the description of the species' role in its surroundings. From a conservation perspective, in order to manage and manipulate a species correctly, one must understand the biological patterns which the species has evolved to ensure its survival and successful reproduction.

The reproductive patterns, causes of mortality, intra- and interspecific interactions and activity patterns of sable antelope are presented, based on the findings of this and previous studies of the species.

MATERIALS AND METHODS

The description of the sable biology which follows is based on three sources. The first source is the telemetric data collected during the study period, as described in Chapter 3. The second is the direct observation of the sable herd during the study period and subsequently, including the capture and relocation of the sable herd to the Masebe Nature Reserve. The third is from previous studies on sable biology.

During the study period the sable were located by homing in on signals emmitted from their radio-collars and observed from a distance. The distance from which the sable were observed depended on factors such as wind direction, slope and vegetation density. Usually the observer had the best chance of watching the sable herd across a valley, with binoculars, as the sable on the opposite plateau were apparently unaware of the observer and continued with their normal daily activities. The activities of the sable were recorded throughout the period of observation, noting how many individuals were involved in different activities (e.g. walking, lying, drinking, etc.) at two-minute intervals. If any individuals were out of the view of the observer at any time, this was recorded. As far as possible, where animals could be identified as recognisable individuals involved in a particular activity, this was also noted.

The information for the description of sable biology has also been taken from the available literature on the subject. The limited time available for field work and the presence of only one small herd of sable antelope on the Masebe Nature Reserve did not allow for extensive study of the sable's biology. The existing information on the subject, both from published and unpublished work, has therefore been included in this chapter to supplement the data.

RESULTS AND DISCUSSION

POPULATION SIZE AND STRUCTURE

Herd size

The group of sable which was relocated to the Masebe Nature reserve in June 1988 consisted of eleven individuals comprising two adult bulls, four adult cows, two subadults (of which one was a young bull and the other's sex remained unknown), one juvenile/yearling (sex unknown) and two young calves (one male, one sex unkown). Within the first two weeks after relocation the group had been reduced to nine individuals. The one solitary, adult bull was found dead by local labourers and one young calf disappeared but the carcass was never found. The possible causes of death are discussed later in this chapter.

Grobler (1974) describes three basic components of the sable population group structure. The breeding groups, also known as nursery herds, consist of adult females, subadults, yearlings (juveniles) and calves. The adult males may either associate in bachelor groups of two to twelve individuals or become territorial bulls occurring solitarily or in the presence of breeding groups.

On the Masebe Nature Reserve the relocated group of sable remained as one herd throughout the study period, with the exception of one bull. From the date of the release into the reserve this bull remained separate from the herd and was found dead two weeks later. The other adult bull remained with the herd throughout the study period, being under no pressure from other mature males to move away and/or establish a territory. Territoriality was therefore never observed at the Masebe Nature Reserve although it is well documented in the literature (Grobler 1973, Estes & Estes 1969 in Wilson 1975, Choate 1975, Carr 1986).

As a breeding nucleus, the size of the herd on the Masebe Nature Reserve was satisfactory (discussed in Chapter 6) but sable herds in a natural, stable population tend to be larger. Wilson (1969) recorded herd sizes ranging between 20 - 30 animals per herd in the Rhodes Matopos National Park, with only one smaller herd (ten individuals) being mentioned. Grobler (1973), working in the same area, found seasonal variation in the herd sizes. From March to July the mean group sizes ranged from 10 - 19 individuals, but after July there was a tendency for sable to concentrate on selected grazing areas, irrespective of range boundaries, increasing the mean herd sizes to 18-35 individuals. The actual variation in herd size during the year was extremely high, however, with the smallest "herd" recorded consisting of a single individual (presumably not a solitary bull) and the largest herd recorded consisting of 76 individuals (Grobler 1973).

Hierarchical arrangement

Malan (1989), in his study on captive sable antelope, found that the two oldest females of the herd led the group significantly more often than any other individual. This was also apparent in the herd relocated to the Masebe Nature Reserve, where the oldest cow always led the herd in flight reactions and when the herd moved off to graze. The old cow was then followed by the other three cows (not in any particular order), then the sub-adults, the juvenile and the calf (although the latter sometimes ran with the females) and lastly, often more distanced from the procession, the bull brought up the rear. The oldest cow was also noticed to be the last to lie down to rest and the first to be alerted when danger was sensed, thus appearing to be the "watchdog" of the herd.

On numerous occasions dominance displays were seen, where one individual rushed at another, butting the latter with its horns, and causing the subordinate to move away. This was often the case as the herd settled down to rest in the heat of the day; individuals would assert their dominance by forcing subordinates to rise from where they were lying and move off to another site, while the dominant individual took over the vacated spot. This aggressive behaviour exhibited by individuals of the herd towards one another is recorded in Table 10. The sub-adults were most often the recipients of the aggressive behaviour, but also acted as the aggressors in almost half the incidents observed. This may be due to their transition from juvenile to adult which caused friction in the herd as they attempted to assert themselves within the hierarchy. The bull, who exhibited aggressive behaviour almost as

Table 10: Matrix indicating aggressive behaviour between individuals of the sable herd on the Masebe Nature Reserve. Numerical values represent the total number of aggressive displays observed between any two individuals during the study period.

RECIPIENT	AGGRESSOR					
	Bull	Oldest cow	Other cows	Sub-adult	Juvenile	Calf
Bull	-	0	0	0	0	0
Oldest cow	0	-	0	0	0	0
Other cows	1	0	2	0	0	0
Sub-adult	9	0	3	5	0	0
Juvenile	1	0	0	5	-	0
Calf	0	0	2	2	0	-

often as the two sub-adults, was never the recipient of such aggression, indicating that his position at the top of the hierarchy was never contested, although it was displayed. The oldest cow, on the other hand, also at the top of the hierarchy as the matriarch of the herd, was never seen inflicting nor receiving any form of aggression. The juvenile (yearling) and the calf were on several occasions the recipients of aggression, but never attempted to assert any dominance. The hierarchical arrangement of the sable herd is diagrammatically presented in Fig. 20, from which the ranking of the individuals can be extrapolated. It is interesting to note the direction of the aggression between individuals, as this behaviour was always exclusively directed at subordinates.

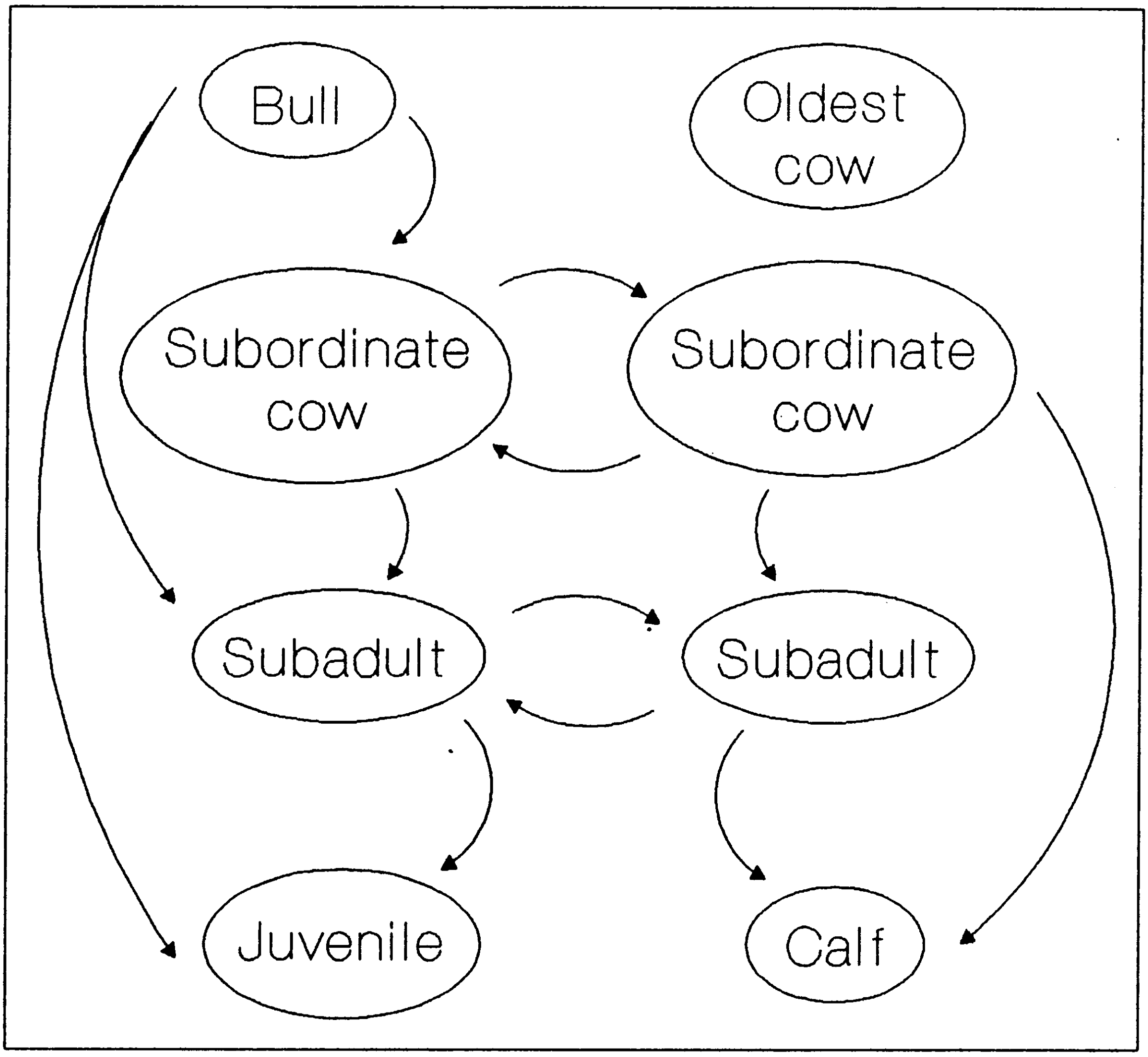


Figure 20: Diagrammatic representation of direction of aggressive interactions recorded in the herd of sable antelope on the Masebe Nature Reserve.

MORTALITY

Hunting and poaching

Although natural mortality plays a role in the control of sable populations, much of the decline in sable numbers in southern Africa can be attributed to mortality induced by man. Du Plessis (1969) recorded 37 657 sable removed over a 40 year period in Zimbabwe for tsetse fly control and also stated that the sable were removed in great numbers from the periphery of their range through indiscriminate hunting. Pringle (1982) mentions an incident in 1947 where in one typical group of farms, 72 owners killed 263 sable between them.

The situation has, however, ironically been reversed. Landowners, now realising the rarity and economic value of these animals, are attempting to conserve and increase the depleted sable population in the Transvaal, and hunting of these antelope is strictly controlled. Poaching is, however, still being carried out by rural inhabitants who, living close to game farms and nature reserves, trap and snare wildlife indiscriminately for meat.

The death of the solitary adult bull on the Masebe Nature Reserve, two weeks after relocation, may well have been caused by poachers. Since only the head and skin of the sable were handed over to the authorities by the labourers of the reserve who reported the death, no possibility for a *post mortem* investigation existed. An investigation of the site where the carcass was found revealed a pile of rumen contents of the sable (confirmed by labourers), which indicates that the bull had been feeding before his death. The site was also within walking distance to water, thus eliminating the option of dehydration due to a lack of water. The fact that the carcass was found still fresh enough for the meat to be utilised also indicates that poachers may have been involved. Poaching within the boundaries of the nature reserves of Lebowa is not uncommon (H.R. Venter, *pers. comm.*).

H.R. Venter, Department of Agriculture and Environmental Conservation, Private Bag X01, Chuenespoort, 0745.

Predation

Predation by large carnivores is an obvious cause of death in reserves large enough to contain them (Mitchell, Shenton & Uys 1965, Pienaar 1969) and in smaller fenced reserves calves may be particularly susceptible to predation by leopards (Grobler & Wilson 1972). This may explain the disappearance of the one calf soon after its relocation to the Masebe Nature Reserve, as leopards are known to roam the area.

Parasites and disease

No information in this regard is available for the herd released on the Masebe Nature Reserve. Wilson (1975) recorded no fewer than four protozoal parasites implicated in the deaths of juvenile sable. *Cytauxzoon* sp. was identified in the blood and organs of the majority of juveniles, whilst *Babesia* sp. was unquestionably the cause of death in one sable and appeared in combination with *Chlamydia* and *Cytauxzoon* in two others. *Pneumocystis carinii* was found in one sable calf. Helminthiasis was found by Wilson (1975) to be only a secondary problem with sable on Transvaal reserves. Worm burdens may have led to loss in body condition but even so, were not considered to be the primary cause thereof.

Grobler (1981) considered parasitism to be the main cause of mortality in Matopos, Zimbabwe, with internal parasites being the primary cause of death while the external parasites were in most cases secondary to other factors which influenced rate of infestation. High tick infestations played and important role in mortality, particularly in animals in poor condition. Circumstantial evidence suggests that healthy sable could cope with moderate tick infestations but as soon as the animal became ill, tick infestation increased rapidly and deterioration of the animal's condition followed.

The secondary effects of tick infestation, such as that of tick-borne diseases through transmission of internal parasites, and the formation of large rotting wounds where blue flies (*Chrysomya bezziana*) deposit their eggs into small wounds initiated by ticks, also often resulted in eventual death of the animal.

Nutritional deficiency

Wilson (1975) suggested that the loss of body condition of sable was caused by primary deficiencies in diet which then made them more susceptible to other factors such as parasite infestations and stress. Poor nutrition not only affected the adults, but directly affected the calves through the production of milk which apart from low protein levels also held sub-normal concentrations of trace elements such as iron, copper and cobalt. Grobler (1981) also mentioned that a reduction in body condition was a catalyst which allowed parasite infestation to cause mortality in sable. No information in this regard could be obtained during the present study.

Intraspecific aggression

Several authors recorded intraspecific aggression as an important cause of mortality amongst sable antelope (Stevenson-Hamilton 1947, Wolhuter 1948, Grobler 1973, Wilson 1975). This included aggression directed by the adult bull in the herd towards younger males, which may then die from injuries or stress, as well as fighting between two adult males, particularly during the rut. From case histories at Percy Fyfe Nature Reserve (Wilson 1975, J. Birchmore *pers. comm.*) it appears that the intolerance shown by adult bulls to younger pubertal bulls may be related to restrictions of available space, a factor which must be considered when keeping sable in small camps or nature reserves.

Climate

Droughts have led to severe losses amongst sable antelope in the Kruger National Park (Pienaar 1963), indicating a sensitivity to adverse habitat conditions and a dependence on a consistent water supply. Mortalities from exposure to wet and cold have also been recorded, especially in early spring when the animals tend to be in poor condition and there is often a sudden drop in ambient temperature accompanying the first heavy rains (Wilson 1975).

J. Birchmore: Department of Agriculture and Environmental Conservation, Private Bag X01, Chuenespoort, 0745.

REPRODUCTION

Although sable antelope breed annually, the timing and duration of the calving season varies over their distributional range. The calving period for sable in Zambia has been recorded as June to September (Ansell 1960, 1963), in the Kruger National Park (South Africa) as February / March (Fairall 1968) while in Zimbabwe the peak has been recorded in March (Child & Wilson 1964, Wilson 1969) and later corrected by Grobler (1973) to early February. In northern Botswana, Child (1968 in Wilson 1975) recorded the peak in January and early February. Other calving peaks have been given as April to August in the South African Zoological Gardens (Brand 1963) and May / June in Angola (Estes & Estes 1970 in Grobler 1973). In Kenya two calving peaks were recorded by Estes & Estes (1969 in Grobler 1973), one in January / February and one during July to September. These periods seem to coincide with the height of the vegetation growing season and the peak of available nutritious foraging for lactating females in the various areas (Wilson 1975).

Female sable become sexually mature when two years old and calve for the first time when three years old (physically they are only fully mature at five or six years). They may continue to breed up to an excess of ten years (Grobler 1973, 1980). Males become sexually mature at approximately 36 months but only reach physical maturity at seven or eight years of age.

The gestation period lasts for eight months (Wilson 1975) after which the female leaves the nursery herd to have her single calf which can weigh 13 to 18 kg. Sable calves are born with reddish fawn-coloured hair covering the body with pale facial markings and underside. For the first two weeks of life, unable to run with the herd, they rely on their camouflage and apparent lack of odour to avoid predators, lying in the grass, usually with the head and neck bent back along the body (Grobler 1973).

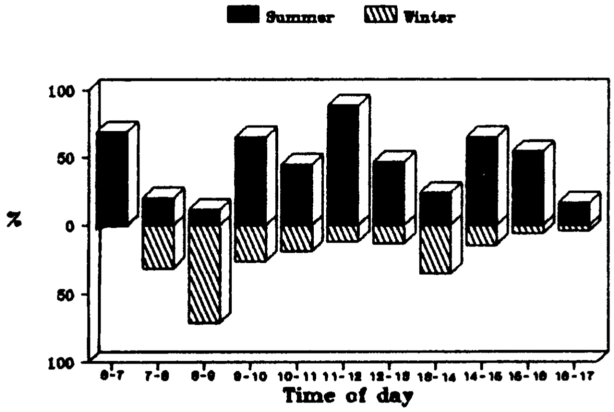
The sable herd which was relocated to the Masebe Nature Reserve was first seen from a helicopter on the Potlake Nature Reserve in March 1988. At this stage the two calves, still fawn-coloured, were already running with the herd. They were therefore estimated to be approximately two months old. At the time of relocation in June 1988 the calves had the adult facial markings but were still lighter in colour than the adults, thus making their estimated age, according to the hair moulting sequence recorded by Grobler (1980), approximately five to six months old. It can therefore be presumed that the calves were born towards the end of January or early in February of the same year.

The main rutting season was then presumably eight months earlier, i.e. late May and/or early June. This being the case, it provides one explanation for the lack of calves during 1989. At the time when the sable should have been mating, they may have been prevented by the human disturbances surrounding the capture, collaring and relocation of the herd. The adult sable bull which remained with the herd after relocation was observed exhibiting flehmen behaviour, as described by Estes & Estes (1969 in Grobler 1973), on one occasion in August 1988, but the female was not receptive and no copulation was recorded.

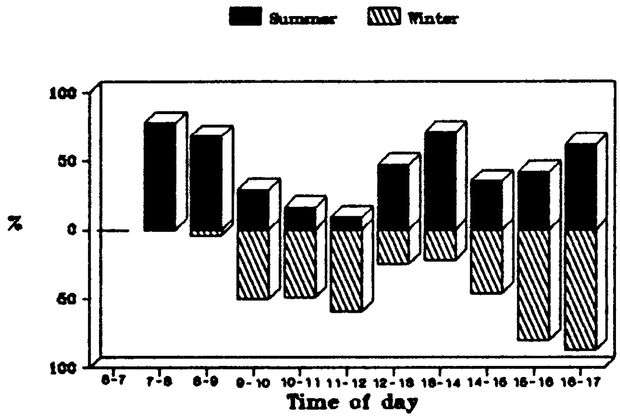
TIME BUDGET AND ACTIVITY PATTERNS

The percentage of time allocated by the sable to different activities is presented, for summer and winter, in Fig. 21. The frequency distributions representing the amount of time spent per hour involved in each activity differed significantly in summer and winter. Three 2 x 10 contingency table applied to grazing, lying and standing data yielded Chi-Square values of 197,96, 265,75 and 55,14 respectively (in all cases $P < 0,05$). In summer, the animals tend to alternate between grazing and lying down (probably ruminating) and spend very little time standing. In winter, however, there appears to be a grazing peak at approximately 08:00 - 09:00. In winter there is a significant increase in the time spent standing ($t = 3,16$; $P < 0,05$) and decrease in the time allocated to grazing ($t = 2,32$; $P < 0,05$). There is, however, no significant seasonal difference in the amount of time which the animals spend lying down ($t = 0,12$; $P > 0,05$). The reduction in time spent standing, in summer, can be explained climatically, as the animals avoid the heat by lying under the shade of trees during hot periods. The difference in amount of time spent grazing is, however, not so clear. It may possibly be related to the different nutritional resources available in summer and winter which consequently affect feeding patterns. Drinking, whenever it was

(a) Grazing



(b) Lying



(c) Standing

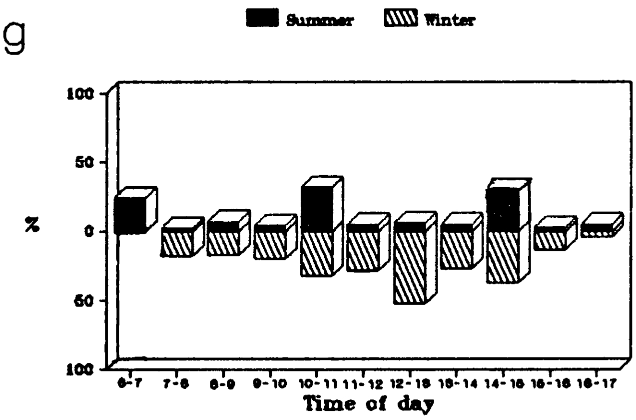


Figure 21: Percentage of time allocated by the sable herd to three different activities during the day in summer and winter.

observed, took place in the early morning or late afternoon. The study site and conditions on the reserve made observations in twilight or darkness unfeasible.

The hourly distance moved by the sable herd has been calculated for summer and winter from telemetry and observed localities of the sable, recorded between 06:00 and 18:00. These movements are presented in Fig. 22, from which it is evident that the sable herd did not move over great distances in an hour. The greatest distance moved was recorded between 06:00 and 07:00, when both in summer and winter the herd moved over 500 m in that hour. Direct observations of the herd indicated that this early morning movement occured as the herd moved away from the watering point, back to the plateau where it often remained for the rest of the day. The shorter distances moved throughout the day may be linked to the grazing behaviour of the herd, as they moved about selecting food items and progressing to new feeding areas. The deviations from the means are in some cases very large (Fig. 22), indicating that other environmental factors, such as the presence or absence of other fauna and/or climatic conditions, may also play a role in determining movement patterns of the sable.

Due to the fact that the data were collected from a single herd, no replication of data was possible. Hence it would be statistically inaccurate to attempt to compare seasonal differences in the hourly movements of the herd. This is in contrast to the statistical analyses applied to grazing, lying and standing data which were collected from *individuals* within the herd and are therefore considered valid for statistical comparisons (Zar 1984).

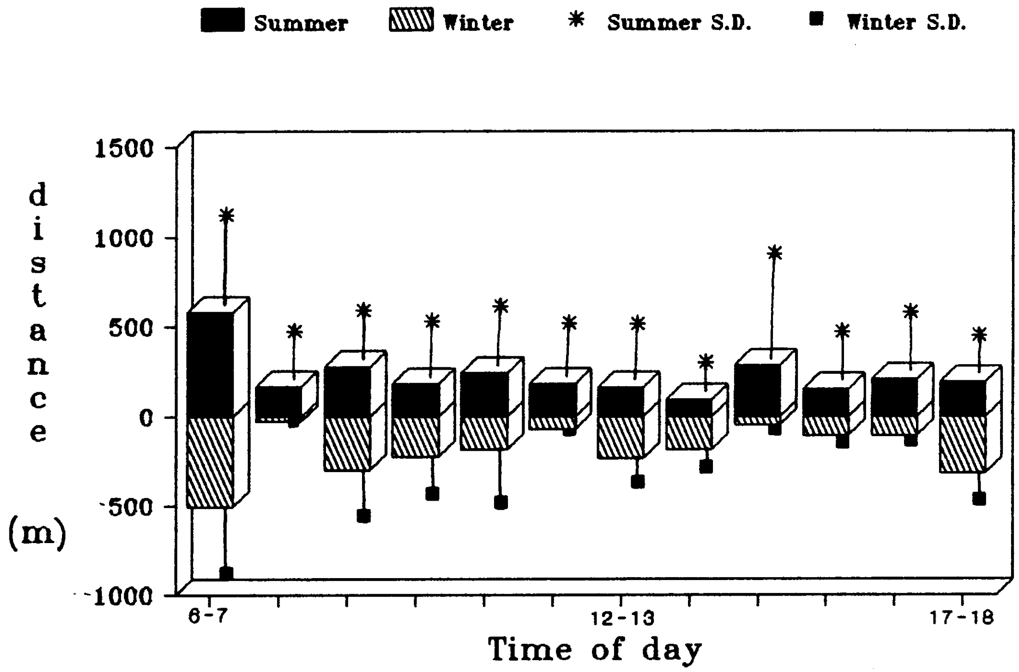


Figure 22: Mean hourly movements of sable calculated for summer and winter. One standard deviation of the mean is graphically presented.

CHAPTER SIX

MANAGEMENT RECOMMENDATIONS AND CONCLUSIONS

"Let us be both humble before the complexity of the natural world and the data needed to interpret it, yet honest enough to ditch unhelpful and unproven concepts which so beset us. Ecology is about why is what where; its essence is where genes and geography meet."

Berry 1989

Management of the population of sable antelope under the control of the Nature Conservation Division of Lebowa can be broadly divided into two sections. The first concerns the management of the sable herd on the Masebe Nature Reserve, with reference to the findings of the post-release monitoring program. The second involves the future management of the "whole population", albeit scattered amongst several smaller reserves. Several factors must be considered when deciding whether to keep the herds separate or whether to amalgamate them into a single larger herd.

THE RELOCATED HERD

From the eight months of direct monitoring of the sable herd after its release into the Masebe Nature Reserve, certain conclusions and recommendations can be presented. One must, however, realise that the consequences of such a translocation are often only apparent during a long-term re-evaluation (Conant 1988). Although no calves were born during the study period, the birth of three calves in 1990 has since been recorded (H.R. Venter, *pers. comm.*). Considering that only four adult cows were present in the herd, the birth of three calves, less than two years after relocation, is an encouraging sign. Nevertheless, it remains to be seen how many of these will survive to maturity and reproduce.

Nutritional requirements

The herd of sable on the Masebe Nature Reserve appeared to be in good physical condition (Chapter 4). The sable did not readily make use of the salt and mineral licks available to them, indicating that the natural vegetation and/or water on the reserve was minerally adequate, or that the sable were not accustomed to utilising these. Wilson (1975) considered the nutritional status of the sable antelope to be potentially the primary limiting factor within the Transvaal, due to the the severe seasonal drop in protein content of sourveld grasses (browse was significantly higher in protein content). He also found the body condition of sable in the Transvaal (using the Kidney Fat Index and several blood parameters) to be poor. He did, however, explain that a likely cause for this may have been the high interspecific grazing competition in the sable enclosure from which he acquired his animals for sampling.

The Masebe Nature Reserve is at present understocked as far as large herbivores are concerned, in relation to the potential carrying capacity of the reserve (Van Wyk, *pers. comm.*), thus reducing the competition for food. It must, however, be stated that to ensure that this advantage is maintained, the carrying capacity should be calculated according to the winter, rather than summer, plant biomass. Grass samples should be collected at a time when the available vegetation is at its poorest, i.e. the end of winter, as it is at this time that food may become the limiting factor on the carrying capacity of the reserve. The findings of this study were that the sable antelope showed a significant switch to browse during the winter months, thus further reducing the nutritional pressure exerted on them by the environment during the dry season. The species of grasses recorded in the diet of the sable on the Masebe Nature Reserve overlap to some extent with those listed by other authors as being important components of sable diet (Wilson 1969, Grobler 1973, Wilson 1975, Ben-Shahar 1986), indicating that the habitat on Masebe probably does provide these animals with their nutritional requirements. Water was not a limiting factor in the study area, as man-made watering points ensured that an unlimited supply of water was available to the animals throughout the year.

A. van Wyk: Department of Agriculture and Environmental Conservation, Private Bag X01, Chuenespoort, 0745.

Habitat utilisation and competition

As has been mentioned previously, the Masebe Nature Reserve is currently understocked with large mammalian herbivores, minimising the inter- and intraspecific competition for space and food. The small sable herd released into the reserve had ample space to establish its home range, especially as the absence of other adult sable bulls eliminated the necessity of establishing any form of territoriality. These factors are, however, temporary, and need to be seen as potential problems which may require some consideration in the future.

Firstly, when considering intraspecific competition, mention must be made of the existing literature reviewed in Chapter 5, concerning the territorial and aggressive behaviour exhibited by adult bulls towards subordinate males, especially if the available space is restricted. Carr (1986) recommended a minimum camp size of 2000 ha for sable antelope, having noted this aggressive behaviour on reserves where sable were confined to camps of 1000 ha or less. He did not, however, specify *how many* sable, particularly bulls, could be accommodated satisfactorally in such an area, although one may assume that an average sized herd (approximately 50 individuals) applies.

Secondly, should the stocking rate of the Masebe Nature Reserve be increased to near its carrying capacity, interspecific competition is likely to become a factor affecting the well-being of the sable population. In Chapter 3 it was made evident that the sable antelope were selecting the plateau habitat above the other three types available to them. Through correspondence analysis of the data, the suggestion was made that this selection may be related to the low vegetation density on the plateaus. If this is in reality the case, one can hypothesize that predator avoidance is the main factor influencing this selection, especially as it is well documented that sable prefer open savanna-woodlands (Smithers 1983).

On the other hand, looking at the distribution of other large herbvivores, it may be highly likely that the selection by sable for the plateaus is in order to avoid one of its main competitors for food, namely the impala (Carr 1986, *pers.comm.*).

Scogings *et al.* (1990) state that sable antelope consistently selected for areas which had not been burnt, i.e. " the old lands and shale grasslands, which had the tallest grass and greatest phytomass ". They also found that correspondence analysis separated very clearly the sable and impala populations into "burnt" and "unburnt" vegetation. It may therefore be likely that once again, as in the case at Masebe, the sable are not actually selecting the unburnt area, but rather avoiding the burnt areas inhabited by impala. Theron (*pers. comm.*), on her studies of the sable antelope on the Hans Merensky Nature Reserve noticed a marked improvement in the population growth of these animals when a burning practice was implemented on the reserve. Her findings, despite being preliminary results which require further investigation before being published, indicate that sable did select for these burnt areas in which to graze, in direct contradiction to the findings of Scogings *et al.* (1990). Ben-Shahar (1986) states that the brief experiments carried out at Lapalala Wilderness concerning fire as a means of vegetation management, revealed that roan antelope did show some preference for newly burnt areas but he does not mention any preference by sable for or against them. These contradictory findings tend to indicate that the factor influencing sable habitat selection is not the presence or absence of fire in a given area. The primary factor influencing sable habitat preference may therefore be the population density and distribution of competitors.

R.D. Carr, Nature Conservation Division, Transvaal Provincial Administration, Private Bag X209, Pretoria, 0001.

J.M. Theron, Private Bag X502, Letsitele, 0885.

A controlled burning practice was not implemented on the Masebe Nature Reserve during the study period, although it should be considered as a tool for rejuvenating the vegetation and removing the dense and highly fibrous basal cover which occurs in the area. The systematic eradication of *Dichrostachys cinerea*, which is already in progress in the study area, should also improve the grazing potential of the valleys and riverine bush. Ben-Shahar (1986) recommended this reduction of shrub density in order to improve the basal cover and prevent soil erosion. His recommendation is one of general environmental management and may not necessarily have any direct impact on the sable population, as neither in his study, nor in this one (Chapter 3), were the sable found to be selecting for these areas.

CONSIDERATIONS FOR FUTURE MANAGEMENT

The theoretical considerations concerning translocation and re-introduction of wild animals are a current and somewhat controversial issue. While some ecologists strongly recommend these methods of wildlife management in order to replenish dwindling populations of threatened species, others argue that translocations should be limited to a minimum in order to conserve genetic variation (Greig 1979, Conant 1988, Griffith *et al.* 1989). These theoretical considerations will be briefly discussed with particular reference to the localised sable populations in the northern and eastern Transvaal.

Tear (1989) divides the process of reintroduction into four stages. The first stage, which covers the first two years after the introduction of the Arabian Oryx (*Oryx leucoryx*) to Oman is described as a period of very high risk to the small population with a strong need for monitoring / management and a low percentage of surviving offspring. As more individuals are added to the population, through reproduction within the initial group or through the addition of immigrants, the percentage of surviving young increases, the need for monitoring decreases and the risks to the population decrease as the population stabilizes. As Stanley Price (1989) so aptly states " A successful re-introduction seems to require the release of an adequate number of individuals. The precise number needed may be hard to assess, for it will depend on the species' patterns of fecundity and survivorship and on the impact of chance events. Despite this, it appears that a critical level of released animals must be exceeded for a re-introduced population to establish itself......The numbers of founders may partially explain the success or failure of a re-introduction."

By adding more individuals to the small herd of sable presently at Masebe Nature Reserve the genetic variability will be increased. At present there is only one mature male in the herd and although there are at least two younger males in that group, they may be closely related to the adult. The responsible authorities need to decide on their objectives for wanting sable on their nature reserves and manage the population accordingly.

In order to ensure a successful relocation program, it is important to first implement a feasibility study before relocating. In this way, if the relocation is unfeasible, scarce and/or valuable animals such as the sable antelope will be saved rather than unnecessarily eliminated. The aspects to consider when deciding whether or not to relocate are:

the ecology of the species in its original habitat;
the reasons for the extinction originally and whether or not these still apply today (e.g. poaching, food shortage, drought, etc.);
whether or not the genetic stock is suitable;
and whether the necessary funding is available.

Once it has been decided that the relocation is feasible the following must be established (Stanley Price 1989):

the animals' origins, experience and the new conditions to which they will be exposed;
the number of animals to be relocated and their sex and age ratio;
the absence of any contagious diseases in the animals to be moved;
the availability of a vacant or partially filled niche in the ecosystem into which they will be introduced (absence of competitors);
the release site in the new area (release into a suboptimal habitat encourages the herd to disperse, vacating the site for subsequent relocations);

and the season during which animals are released (animals released in winter are forced to disperse and select the most suitable habitat for their needs).

In the northern and eastern Transvaal, the sable populations have become so fragmented amongst small nature reserves and private farms, that it is difficult, if not impossible, to determine their original genetic stock. Wildlife auctions are common, during which animals are bought and sold, intermingling the genetic stock beyond all hopes of tracing the original lineage of individual animals. The most feasible suggestion for the management of the sable populations in these areas is that all these small herds be considered as one population with similar gene pools, which can continue to be translocated within the area to supplement existing groups or to re-establish new herds. What should be avoided at all costs, however, is the mingling of this "Transvaal population" with established populations elsewhere in Southern Africa. Sable antelope are still widely distributed in southern Africa (East 1989), albeit in isolated nature reserves. This isolation should not be destroyed without serious evaluation of the genetic implications, especially if one considers the variation within the species at subspecies level (discussed in Chapter 1).

Greig (1979) mentions numerous examples of animal populations relocated to new areas, especially of different latitude, longitude or altitude, which were then unable to adapt to the different photoperiodism and thus bred at the wrong time (e.g. in the coldest months of the year). Instead of increasing the genetic variability and strengthening the existing population, such translocations caused a genetic mingling which often weakened the population as a whole. Greig (1979) further argues that despite the "historical prejudice against inbreeding", other arguments counteract this consideration. Mayr (1963 in Greig 1979) pointed out that viable populations often arise from a small breeding nucleus (founder population) which contain only a fraction of the overall gene complement of the species.

The implications of translocating animals, and the decision to allow inbreeding or to reduce the genetic variability of different populations is not a simple one. "It is in fact probable that generalizations would be quite misleading here and there is ample evidence to show that species may be divided into those which are adapted to inbreeding on the one hand, and those which are 'obligate outbreeders' on the other, with all shades of difference between them....nature conservation authorities in this country should now develop the themes of genetic conservation and evolutionary ethics, and work their principles into present management practices." (Greig 1979).

CONCLUSION

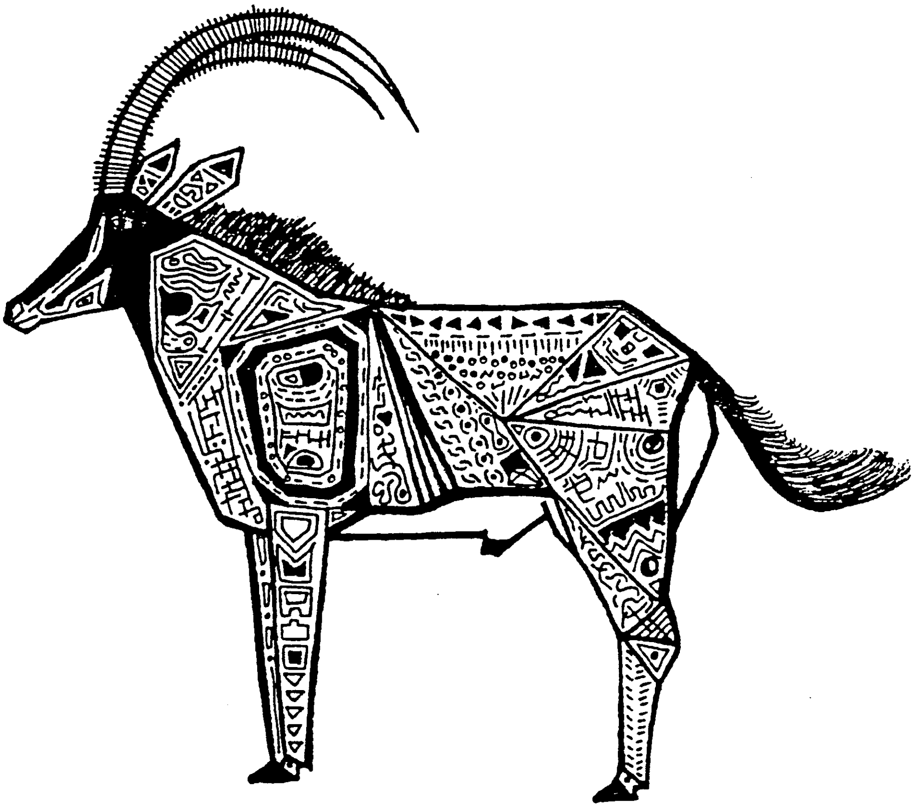
The relocation of the sable herd to Masebe Nature Reserve was carried out successfully although only in the long term will it be possible to determine the extent of that success. Considering that the main reason for the decline in numbers of sable in the northern Transvaal is mainly due to human interference (habitat destruction, hunting, etc.), it seems likely that establishing viable populations of sable antelope in the area should be possible.

Not only from a biological, but also from a socio-economic point of view, the successful relocation of the sable has long term benefits. Despite the financial expense involved in such a conservation project, the introduction of sable into a "new" area has many advantageous repercussions: For the local human population it is an opportunity for education and training, both for scholars and for students in conservation. A species re-introduced into an area where it originally occurred creates a more complete community, making it an area more likely to be conserved. Economically, it provides employment for local people in the form of game guards and rangers, improves tourism, and, with successful breeding, creates a re-usable resource and financial income in the form of controlled hunting.

Environmental conservation, however, faced with ever-increasing development and overpopulation, must extend beyond the preservation of single species. It is the duty of all those involved in the field of ecology, whether scientists, managers, farmers or politicians, to increase the general level of public awareness concerning man's attitude towards his natural environment. This study, as would any ecological study, has once again brought to light the inevitable interactions between a single species and its environment, and its dependence on both other forms of life and the abiotic conditions. Man is no exception to this rule, and therefore has an obligation, in preserving his own species, to preserve his own "ecosystem" as well.

" Let us add compassion to conservation. As we begin
to ask ourselves the why as well as the how of
of research we will begin to realise our
responsibilities as People of the Earth"

Scheffer (1975)



SUMMARY

The sable antelope is one of the two extant species of the genus *Hippotragus* and it currently considered vulnerable. Because of its economic and aesthetic value, several private and government organisations in South Africa are actively attempting to conserve and increase the existing populations of sable antelope.

A herd of 11 sable antelope was relocated by the Department of Agriculture and Environmental Conservation of Lebowa from the Potlake Nature Reserve to the Masebe Nature Reserve. An investigation of certain aspects of sable ecology was undertaken with the intention of assessing the success of the relocation, improving our understanding of the species' ecology and providing a scientific basis for the formulation of management plans.

The study site was located in the Waterberg mountain range with an approximate annual rainfall of 400-500 mm, most of which falls in summer. The veld type of the area has been described as sour bushveld although the more rugged parts consist of mixed bushveld. The study site was subdivided into four "habitats" or veld types characterised by different vegetation structure and species composition. Grass height, lateral visibility (an index of vegetation density), tree density, basal cover and species composition of trees and grasses were described for each habitat.

The plateaus comprised 45% of the study area and were characterised by short grass, low tree density, high visibility and rocky ground, with the dominant tree species being *Combretum apiculatum* and *Diplorhynchus condylocarpon*. The slopes, which occupied 29% of the study area had a similar species composition to the plateaus but had a higher vegetation density, basal cover and grass height than the plateaus. The valleys were sandy, characterised by trees such as *Terminalia sericea* and *Dombeya rotundifolia* but with a similar vegetation structure to the slopes. Twenty-three per cent of the study area consisted of these sandy valleys. The riverine areas were restricted to the north-western corner of the study area, contributing only 3% to the total area. They had a high tree density, basal cover, grass height and hence a low lateral

visibility. The dominant trees in these areas were *Dombeya rotundifolia* and *Grewia monticola*.

The sable herd showed a significant selection for the plateaus in the study area, moving down into the valleys to drink at the watering points situated there. Increased home range size was correlated to increased rainfall, indicating that the sable antelope's dependence on water may have been a restricting factor on their movements. The home range size of the sable herd was calculated using three different methods and the results were comparable to those recorded in previous studies. The arithmetic centres of activity of the herd were calculated monthly and the results showed a distinct aggregation of points in the north-east corner of the study area.

The sightings of other large herbivore species were plotted on a map and the overlap with the sable herd's location was discussed. The possibility that the selection for plateaus exhibited by the sable herd was in order to avoid populations of impala in the valleys was considered. The main interspecific overlap in spatial and temporal distribution occurred between the kudu and the sable. This tolerance of one another may be explained by their different food items. While kudu are browsers, sable antelope are predominantly grazers although they did show a significant switch to browse during the dry winter months. The grass species identified by means of faecal analysis are presented and compared to dietary items recorded in other studies.

Aspects of the population biology of the sable were investigated. The findings of this study were supplemented by information gathered from the existing literature on sable biology. Aspects such as reproduction, mortality, hierarchical arrangement and activity patterns were presented. Dominance displays were observed as individuals asserted their position within the herd. Some of the factors affecting mortality were discussed, such as hunting and poaching, predation, parasitism, nutritional deficiencies and intraspecific aggression. Reproductive patterns were not observed during the study period due to the timing of the relocation project and the limitations of the study but information from other studies was presented. Seasonal variation in the time budget and activity patterns of the sable herd were recorded.

Based on the findings of this and other studies, management recommendations were presented in two sections. The first dealt with the management of the sable herd on the Masebe Nature Reserve, with reference to the post-release program. Besides the accepted management practices such as burning and culling, factors specific to sable introductions must be considered. These include the territoriality of sable bulls, home range size, dependence on water and preference for plateaus.

The second aspect was the theoretical consideration of relocation as a conservation tool. The importance of thorough planning prior to relocating and the controversial issue of genetic conservation were discussed. The relocation of the sable herd was presented in the broader context of the socio-economic benefits for the community. The importance of environmental conservation and education was stressed.

OPSOMMING

Die swartwitpens is een van twee nog bestaande spesies van die genus *Hippotragus* en word huidiglik as kwesbaar beskou. Hul ekonomiese en estetiese waarde het veroorsaak dat etlike privaat- en owerheidsinstansies in Suid-Afrika 'n aktiewe poging aanwend om die bestaande swartwitpensbevolking te bewaar en te vermeerder.

'n Trop van 11 swartwitpense is deur die Departement van Landbou en Omgewingsbewaring van Lebowa vanaf die Potlake Natuurreservaat na die Masebe Natuurreservaat oorgeplaas. Navorsing oor sekere aspekte van die ekologie van die swartwitpens is onderneem. Die doel daarvan was om die sukses van die hervestiging te bepaal, om kennis van die spesie se ekologie te vermeerder en om 'n wetenskaplike basis vir die opstel van bestuursplanne te verskaf.

Die studiegebied is in die Waterbergreeks geleë met 'n benaderde jaarlikse reënval van 400-500 mm. Die neerslag kom grootendeels in die somer voor. Die gebied se veldtipe is beskryf as suurbosveld, alhoewel die meer ongelyke gedeeltes uit gemengde bosveld bestaan. Die studiegebied is in vier veldtipes verdeel, gekenmerk deur verskillende plantegroeistrukture en spesie-samestellings. Graslengte, laterale sigbaarheid ('n indeks van plantegroei digtheid), boomdigtheid, basale dekking en spesiesamestelling van bome en grasse is vir elke habitat beskryf.

Vyf-en-veertig persent van die studiegebied bestaan uit plato's wat deur kort gras, lae boomdigtheid, hoë sigbaarheid en rotsagtige grond gekenmerk word. Die dominante boomsoorte is *Combretum apiculatum* en *Diplorhynchus condylocarpon*. Die hellings, wat 29% van die totale gebied beslaan, het 'n soortgelyke spesiesamestelling, maar vertoon digter as die plato's. Die valleie is sanderig, gekenmerk deur bome soos *Terminalia sericea* en *Dombeya rotundifolia* maar met 'n soortgelyke plantegroeistruktuur as die hellings. Drie-en-twintig persent van die studiegebied bestaan uit hierdie sanderige laagtes. Die rivier-veldtipe is beperk tot die noordwestelike hoek van die studiegebied en beslaan slegs 3% van die totale oppervlakte. Hierdie gebiede is ruig, met 'n digte basale dekking en lang gras, wat gevolglik swak sigbaarheid veroorsaak. Die dominante bome in die habitat is *Dombeya rotundifolia* en *Grewia monticola*.

Die swartwitpenstrop het 'n duidelike voorkeur vir die plato's in die studiegebied getoon. Die swartwitpense het meestal na die valleie afbeweeg om die waterpunte wat daar geleë is, te benut. 'n Vergrote tuisgebied is aan verhoogde reënval gekorreleer, wat aandui dat die swartwitpense se afhanklikheid vir water 'n beperkende faktor op hulle bewegings mag wees. Die tuisgebied van die swartwitpenstrop is bepaal deur van drie verskillende metodes gebruik te maak en die uitslae is met die van vorige studies vergelykbaar. Die "rekenkundige sentra van aktiwiteit" (arithmetic centres of activity) van die trop is maandeliks bereken en die uitslae toon 'n duidelike groepering van punte in die noord-oostelike hoek van die studiegebied.

Die waarnemings van ander plantvreters in die studiegebied is op 'n kaart aangeteken en die oorvleueling met die swarwitpenstrop se tuisgebied is bespreek. Die moontlikheid dat die swartwitpense die plato's verkies om rooibokbevolkings in die valleie te vermy, is in ag geneem. Die grootste interspesifiese oorvleuling in ruimte- en tydsverspreiding het tussen die koedoes en swartwitpense voorgekom. Hierdie verdraagsaamheid vir mekaar kan verduidelik word deur hulle verskillende voedselkeuses. Terwyl koedoes blaarvretend is, is die swartwitpense hoofsaaklik grasvreters, alhoewel daar in hulle dieët 'n duidelike hoër inname van blare in die winter plaasgevind het. Die grasspesies is geïdentifiseer deur keutels te ontleed en is met dieët-items, beskryf in ander studies, vergelyk.

Sekere aspekte van die bevolkingsbiologie van die swartwitpens is besigtig. Die bevindings van die studie is met inligting aangevul wat uit bestaande literatuur verkry is. Aspekte soos voortplanting, mortaliteit, hiërargie en aktiwiteitspatrone is voorgelê. Die vertoon van dominansie is besigtig terwyl indiwidue hul posisie in die trop bepaal het. Sommige faktore wat mortaliteit beïnvloed, soos jag en wilddiefstal, roofdiere, parasitisme, voedingselement tekorte en intraspesifieke aggressie, is bespreek. Voorplantingsgedrag is nie tydens die studieperiode waargeneem nie weens die oorplasingstydperk en die beperkinge van die studie. Inligting uit ander studies is gebruik. Seisoenale wisseling in die tydsverdeling en aktiwiteitspatrone van die swartwitpenstrop is aangeteken.

Gebaseer op die bevindinge van hierdie en ander studies, is bestuursvoorstelle in twee afdelings bespreek. Die eerste gedeelte handel oor die bestuur van die swartwitpenstrop in die Masebe Natuurreservaat met verwysing tot die na-vrylatingsprogram. Buiten die aanvaarde bestuurspraktyke soos brand en selektiewe uitdunning moet die faktore spesifiek te doen met swartwitpens hervestiging in ag geneem word. Dit sluit in territorialiteit van swartwitpensbulle, tuisgebied grootte, afhanklikheid van water en voorkeure vir plato's.

Die tweede aspek is die teoretiese oorweginge van hervestiging as 'n bewaringsmiddel. Die belangrikheid van noukeurige beplanning voor hervestiging en die kontroversiële saak van genetiese bewaring is bespreek. Die hervestiging van die swartwitpenstrop in die breë konteks van die sosio-ekonomiese voordele vir die gemeenskap is voorgelê. Die belangrikheid van omgewingsbewaring en opvoeding is beklemtoon.

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APPENDIX I

The tree and grass species recorded during vegetation sampling in the study area are listed below. Letters in brackets represent the habitat in which the species was recorded (P = plateau, S = slope, V = valley, R = riverine areas).

TREES

Acacia burkei (S,V,R)
Acacia caffra (V)
Acacia galpinii (V,R)
Acacia karroo (V)
Acacia mellifera (V)
Acacia nigrescens (S,V,R)
Acacia rehmanniana (R)
Albizia harveyi (R)
Albizia tanganyicensis (P)
Bequaertiodendron magalismontanum (S)
Berchemia zeyheri (R)
Burkea africana (P)
Clerodendrum sp. (R)
Combretum apiculatum (P,S,V,R)
Combretum molle (P,S,R)
Combretum zeyheri (P,S,V,R)
Commiphora africana (P,S)
Commiphora mollis (P,S,V)
Commiphora schimperi (P)
Croton gratissimus (P)
Dichrostachys cinerea (P,S,V,R)
Diospyros lycioides (S)
Diplorhynchus condylocarpon (P,S,V)
Dombeya rotundifolia (V,R)
Elephantorrhiza burkei (P,S)
Euclea crispa (V)
Euclea natalensis (R)

Euclea undulata (V,R)

Ficus abutilifolia (P,S)

Gardenia volkensii (V,R)

Grewia bicolor (P,V,R)

Grewia flava (P,V,R)

Grewia flavescens (S,V,R)

Grewia monticola (P,S,V,R)

Grewia retinervis (V)

Kirkia acuminata (P,S,R)

Kirkia wilmsii (P,S)

Lannea discolor (P,S,V)

Maytenus heterophylla (V,R)

Maytenus senegalensis (V,R)

Maytenus undata (R)

Mundulea sericea (V)

Nuxia congesta (R)

Ochna pulchra (S)

Ozoroa paniculosa (P)

Pappea capensis (R)

Peltophorum africanum (P,V)

Pseudolachnostylis maprouneifolia (P,S,V)

Ptaeroxylon obliquum (R)

Pterocarpus angolensis (V)

Rhoicissus revoilii (P,S,R)

Rhus lancea (R)

Rhus pyroides (S)

Rhus undata (S)

Schotia brachypetala (R)

Sclerocarya birrea (P,S,V)

Securinega virosa (R)

Strychnos madagascariensis (P,S,V,R)

Strychnos sp. (S)

Tarchonanthus camphoratus (S)

Terminalia sericea (V,R)

Vitex rehmannii (P,S,V)

Ximenia americana (R)

Ximenia caffra (S,V,R)
Ziziphus mucronata (P,S,V,R)

GRASSES

Andropogon chinensis (S,V)
Aristida adscensionis subsp. guineensis (P)
Aristida congesta subsp. barbicollis (S,V)
Aristida congesta subsp. congesta (P,S)
Aristida mollissima subsp. argentea (P,V)
Aristida stipitata subsp. graciliflora (P)
Bothriochloa radicans (P,S)
Brachiaria nigropedata (P,S)
Brachiaria serrata (P,S)
Cenchrus ciliaris (V)
Chrysopogon serrulatus (S)
Cymbopogon validus (S,R)
Digitaria argyrograpta (P)
Digitaria eriantha (P,S,V,R)
Diheteropogon amplectens (P,S)
Enneapogon cenchroides (P,S)
Enneapogon pretoriensis (P,S)
Enneapogon scoparius (P)
Enteropogon machrostachyus (S,V,R)
Eragrostis gummiflua (P,V)
Eragrostis lehmanniana var. lehmanniana (V,R)
Eragrostis pallens (V,R)
Eragrostis rigidior (P,S,V,R)
Eragrostis superba (P,S)
Eustachys paspaloides (V)
Heteropogon contortus (P,S,V)
Hyperthelia dissoluta (V,R)
Loudetia flavida (P,S)
Melinis repens (P,S,R)

Panicum deustum (S)

Panicum maximum (P,S,V,R)

Perotis patens (V)

Phragmites mauritianus (R)

Pogonarthria squarrosa (V,R)

Schmidtia pappophoroides (V)

Sporobolus africanus (V,S)

Sporobolus conrathii (P,S)

Themeda triandra (S,V,R)

Tricholaena monachne (S,V,R)

Trichoneura grandiglumis var. grandiglumis (P,S,R)

Triraphis schinzii (V,R)

Urochloa oligotricha (= U. bolbodes) (R)