CHAPTER 6

HABITAT PREFERENCE AND STATUS OF THE IMPALA IN TEMBE ELEPHANT PARK, SOUTH AFRICA

INTRODUCTION

The impala is a member of the family Bovidae, and it is the sole member of the tribe Aepycerotini. Although efforts have been made to tidy up bovid classification by putting the impala in the same tribe as the gazelles, kobs and most recently the hartebeests, it is so different from other antelope that it clearly belongs in a separate tribe (Estes 1997). Lichtenstein first described it scientifically in 1812 from a specimen collected in the Kuruman district of the Northern Cape Province of South Africa (Skinner & Smithers 1990; Grubb 1993). The impala is distributed widely in the eastern woodland parts of Africa, from northern Kenya all the way south to the northern parts of the KwaZulu-Natal province of South Africa. In the southern parts of its distribution, it extends westwards to the extreme southern parts of Angola (Skinner & Smithers 1990). It is an ecotone species, preferring light woodland with little undergrowth and grassland of low to medium height (Estes 1997). In all regions, the impala is highly residential and it seldom moves more than 10 km from the centre of its home range (Kingdon 1997). Cover and the availability of surface water are essential habitat requirements for the impala. Although it is rarely found more than 8 km from water in the dry season, the impala can survive without drinking water with access to green vegetation (Skinner & Smithers 1990; Estes 1997; Mills & Hes 1997).

Based on its diet, the impala is classified as an intermediate feeder, being an animal with a diet that consists of 30 to 70% monocotyledonous and dicotyledonous plant material but always < 20% fruits (Gagnon & Chew 2000). The ability of the impala to utilise both monocotyledonous and dicotyledonous plant material gives it an unusually varied and reliable food source and makes it highly adaptable to different areas. The impala includes more grasses in its diet during the summer, and gradually shifts to more shrubs and bushes as the season becomes drier. The shift in its diet is not only linked to the season, but it is also influenced by the available habitat. Consequently, the impala can also thrive in areas where the natural vegetation has degenerated because of overgrazing or bush encroachment (Estes 1997; Kingdon 1997). The habitat of ungulates provides them with food, water and cover and the feeding styles of each species are therefore of primary importance in determining their preferred habitat (Van Rooyen 1990).

The impala is gregarious but shows regular changes in social organisation and the males are only territorial during the annual rut. Outside this period, the males congregate in bachelor herds and the females occur in breeding herds. Territorial males have exclusive mating rights and females entering a male's territory are herded by him and are aggressively defended against other males. After the rut the territorial system deteriorates and males form bachelor herds or join the breeding herds (Skinner & Smithers 1990; Anderson 1997).

Knowledge of the habitat preference, ecological requirements and conservation status of large herbivores is basic to any management programme for a reserve, and a pre-requisite to determine stocking densities and possible translocations (Dekker *et al*. 1996). Stocking density is the area of land allocated per animal unit (Tainton 1999). In conservation areas, one of the primary objectives is to maintain viable populations of all the indigenous species present. The control of impala numbers is a major consideration when trying to maintain both habitat and species diversity. A sound knowledge of the diet and factors affecting it are also crucial to understanding ungulate ecology and management (Van Rooyen 1990). The fact that most species are linked to major vegetation types helps in understanding their distribution patterns (Pienaar 1974).

In the present study, we tested the hypothesis that the impala responded to the variables in its physical habitat in proportion to its availability within the Tembe Elephant Park. If the impala showed a preference of use for certain vegetation types, then the suitability of different areas for the impala can be determined by evaluating the physical characteristics of the preferred vegetation types. More accurate stocking densities can then also be determined based on the habitat preferences and diet of the impala. The objective of the present study was therefore to gather information on the habitat preference and conservation status of the impala within the park. This information is crucial for the effective management of the impala population in the park, as well as for future reintroductions of the impala to neighbouring areas.

METHODS

The methods presented below are restricted to the broad outlines of the methods employed. For a more detailed description of the methods, please refer to the general methods in chapter 3.

Habitat preference

Road counts of the spatial distribution of the impala were done in Tembe from December 2002 to November 2003. The study area was surveyed four times per month for a full year. All the observations were documented on a field form and the closest coordinates of the position of an observed impala was determined by using geographic positioning equipment (GPS). All the data were captured on a computer database for further analysis.

A measure of habitat preference for the impala was obtained by comparing patterns of habitat use with habitat availability within the study area. The Index of Jacobs (1974) was then used to calculate a preference index of use (*P*) for each vegetation type. The preference index only provided a ratio of habitat use to habitat availability and was not based on a statistical test. This was overcome by performing a Chi-square goodness-of-fit test. When a significant difference in use versus availability was detected, a Bonferroni *Z*-statistic was used to determine which vegetation types were used more or less often than expected by constructing 95% simultaneous confidence intervals around the proportion of the impala recorded in each vegetation type (Beyers *et al*. 1984; Allredge & Ratti 1992; Pienaar *et al*. 1992).

Population status

An aerial survey that was done in October 2003 was used to determine the current population status of the impala in Tembe. The overall aim of the survey was to derive trends and estimates of the large herbivore populations in Tembe that would be useful for management decisions and would stand as a record of abundance for future trend analyses. Total aerial counts and transect distance sampling counts were used to estimate the number of impala in Tembe and to calculate trends in the population from 1993 to 2003 (Matthews 2004).

RESULTS

Habitat preference

In all, 818 observations of impala were recorded during the study period. It was most often found in Open Woodland (42.7% of observations) and *Acacia borleae* Shrubland/Bush Clump Mosaic on clay (29.8%), less often in Sand Forest/Grassland Mosaic (10.3%), Closed Woodland/Thicket Mosaic on sand (9.7%) and Closed Woodland on clay (4.8%), and least often in Hygrophilous Grassland (1.7%), Sparse Woodland (1.0%) and the Muzi Swamp (0.1%). The impala was never found in Old Lands (Table 6). The Chi-square goodness-of-fit test for the overall data set showed

Table 6. Vegetation types in Tembe Elephant Park, South Africa, their respective sizes (km²), proportion of the available habitat, proportion of use by the impala and preference index of use by the impala from December 2002 to November 2003.

Number	Vegetation type	Size (km²)	Percentage of available habitat (*A*)	Percentage of use (*U*)	Preference index (*P*)
1	*Acacia borleae* Shrubland/Bush Clump Mosaic on clay	2.3	0.7	29.8	0.977
2	Closed Woodland/Thicket Mosaic on sand	51.8	15.0	9.7	-0.353
3	Closed Woodland on clay	8.7	2.5	4.8	0.479
4	Hygrophilous Grassland	6.7	2.0	1.7	-0.150
5	Muzi Swamp	3.4	1.0	0.1	-0.900
6	Old Lands	0.6	0.2	0.0	-1.000
7	Open Woodland	91.5	26.6	42.6	0.376
8	Sand Forest/Grassland Mosaic	164.8	47.8	10.3	-0.785
9	Sparse Woodland	14.4	4.2	1.0	-0.762

a significant difference (χ^2= 1256.254; $p \leq 0.05$; $df = 8$) in use versus availability for the different vegetation types in Tembe. The preference index of use of vegetation types by the impala in Tembe indicated vegetation types 1, 3 and 7 as being preferred for use, vegetation types 2, 5, 6, 8 and 9 as not being preferred and vegetation type 4 as being used in the same ratio as its proportional occurrence (Table 7).

Population status

During the total aerial count, 460 impala were recorded in 69 groups. Based on the distance sample estimate this indicated a population of 1331 individuals, which is the current estimate for the impala population in Tembe (Matthews 2004). Population trends appear to indicate an increase in the impala population from a total aerial count of 69 individuals in 1993 to the 460 in 2003 (Figure 13).

DISCUSSION

Habitat preference

The impala in Tembe showed a preference of use for the *Acacia borleae* Shrubland/Bush Clump Mosaic on clay, the Closed Woodland on clay and the Open Woodland. The Hygrophilous Grassland was used in proportion to its availability within the park while the Closed Woodland/Thicket Mosaic on sand, Muzi Swamp, Sand Forest/Grassland Mosaic and Sparse Woodland were not being used often and no observations of the impala were ever recorded in the Old Lands.

The *Acacia borleae* Shrubland/Bush Clump Mosaic on clay occurs next to marshy areas and clay-based thickets associated with the Muzi Swamp. In structure this vegetation type varied from areas of dense vegetation to thickets that were associated with termitaria. Moreover, perennial pans were found interspersed throughout these clay areas (Matthews *et al*. 2001). Of all the observations of the impala, the second highest number (29.8%) was in this vegetation type but it only comprised 0.7% of the total available habitat.

The Closed Woodland on clay occurs on clay-rich duplex soils that are normally associated with the bottomlands of the dunes and the edges of the Muzi Swamp. Perennial pans were also found throughout this vegetation type and it contained few grass species. Since the impala is dependent on the availability of drinking water, and is seldom found far from it, the presence of perennial pans in these vegetation types were most likely the reason for their preference by the impala in Tembe (Skinner & Smithers 1990; Estes 1997).

Table 7. The preference of use for the vegetation types in Tembe Elephant Park, South Africa by the impala from December 2002 to November 2003 (α = 0.05; k = 9; $Z_{1-\alpha/2k}$ = 2.75)

Vegetation type*	Percentage of habitat	Chi-square contribution	Confidence interval	Habitat use
1	0.7	1209.7	$0.254 \leq p_1 \leq 0.342$	Prefer
2	15	1.9	$0.069 \leq p_2 \leq 0.125$	Not used
3	2.5	2.1	$0.027 \leq p_3 \leq 0.069$	Prefer
4	2.0	0.1	$0.005 \leq p_4 \leq 0.029$	No pattern
5	1.0	0.8	$-0.002 \leq p_5 \leq 0.004$	Not used
6	0.2	0.2	$0.000 \leq p_6 \leq 0.000$	Not used
7	26.6	9.6	$0.378 \leq p_7 \leq 0.474$	Prefer
8	47.8	29.4	$0.074 \leq p_8 \leq 0.132$	Not used
9	4.2	2.4	$0.000 \leq p_9 \leq 0.020$	Not used
Total	100	1256.2	-	-

*Vegetation type numbers correspond with Figure 5 in chapter 2, and Table 6.

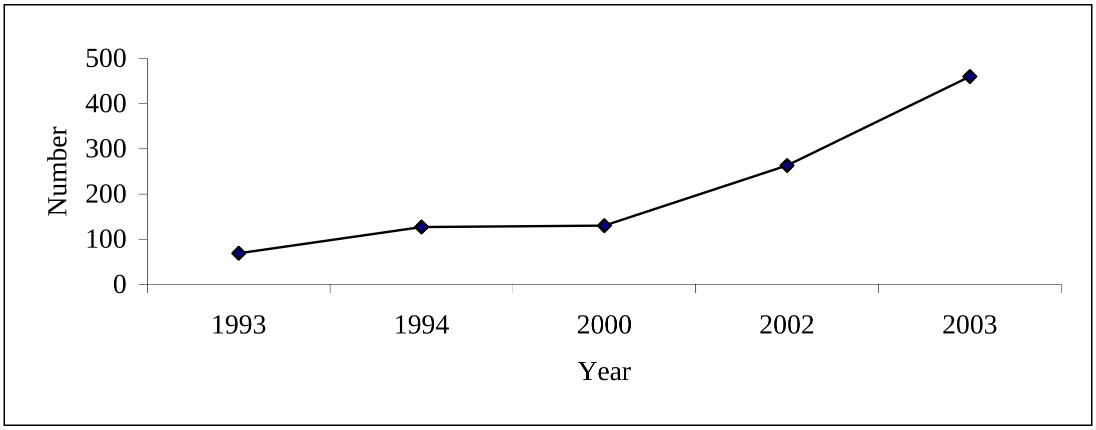

Figure 13: Aerial survey of the impala as based on total counts conducted in Tembe Elephant Park, South Africa from 1993 to 2003. Source: Matthews *et al*. (2004).

The Open Woodland was the second largest vegetation type in Tembe and occurs on the dune crests, slopes and interdune depressions throughout the park (Matthews *et al*. 2001). This vegetation type was characterised by a good grassy layer interspersed with a few tall trees of approximately 8 to 10 m in height. This vegetation type had the highest occurrence of the impala in Tembe (42.7%). Grass species abundant in the Open Woodland included several species with a high grazing value such as *Andropogon gayanus*, *Panicum maximum* and *Digitaria eriantha* (Van Oudtshoorn 1999; Matthews *et al*. 2001). Abundant trees in this vegetation type included *Albizia versicolor*, *Strychnos madagascariensis*, *Combretum molle*, and *Terminalia sericea* (Matthews *et al*. 2001). Most of these species are common in the diet of the impala elsewhere, and most likely also the reason why they prefer this vegetation type in Tembe (Skinner & Smithers 1990).

The Hygrophilous Grassland had a grassland structure with only scattered trees or thickets and occurs adjacent to the Muzi Swamp as well as in marshy areas associated with sand. Abundant plant species in the Hygrophilous Grassland were the grasses *Imperata cylindrica, Eragrostis lappula, Dactyloctenium geminatum, Panicum genuflexum* and *Eragrostis heteromera* and the shrub *Acacia nilotica* (Matthews *et al*. 2001). None of these grasspecies present has a high grazing value and therefore the grasses are generally poorly utilised by grazers (Van Oudtshoorn 1999).

The Closed Woodland/Thicket Mosaic on sand occurs on the dune crests, slopes and interdune depressions throughout Tembe and could be distinguished based on plant density, which in most cases varied from closed to semi-closed crown gaps and a canopy that varied from approximately 8 to 12 m in height. The Muzi Swamp have a grassland structure with no abundant trees or thickets and comprised of reed beds of the extensive Muzi Swamp system that crosses the eastern side of Tembe and extends northwards to Maputo Bay in Mozambique. The Sand Forest/Grassland Mosaic was the largest vegetation type in Tembe and was mostly associated with dunes. This vegetation type was structurally classified as a forest that was interspersed with grassland (Matthews *et al*. 2001). Abundant grass species included species with a low grazing value like *Andropogon chinensis*, *Perotis patens*, *Diheteropogon amplectens* and *Aristida stipitata* subsp. *spicata*. The grasslands there were open with little to no trees and shrubs. It gradually acquired a more open woodland character further away from the Sand Forest.

The Old Lands comprised only 0.2% of the total available habitat in Tembe. Since the proclamation of the park more than 10 years ago, these areas have recovered to the point that they are not distinguishable in the field anymore. This, and the absence of water was most likely the reason that the impala was never recorded in the Old Lands despite the fact that impala are usually associated with a heavily utilised herbaceous layer (Wentzel *et al.* 1991). The ability of the impala to utilise both monocotyledonous and dicotyledonous plant material makes it highly adaptable to different areas. The impala also have the ability to shift its diet according to the season and the available habitat (Estes 1997; Kingdon 1997). In Tembe, vegetation types with an intermediate density was consistently selected for use by the impala over dense vegetation or vegetation with an open grassland structure.

Population status

The population of the impala in Tembe is currently estimated at 1331 individuals. This can be considered more reliable than past estimates although it might be higher than the actual number (Matthews *et al*. 2001). The impala is today more widely distributed and occurs in greater numbers in a wider range of habitats than ever before. It forms the basis of game farming wherever it occurs and has been translocated extensively into areas beyond its natural range, where it is out-competing other species (Skinner & Smithers 1990; Anderson 1997; Friedmann & Daly 2004). The control of impala numbers is thus a major consideration when trying to maintain both habitat and species diversity. The impala population in a given area should therefore be controlled in order to prevent the overutilisation of the habitat. The influence of the impala on its preferred habitat should also be monitored, especially where less abundant species share these habitat preferences.

The long-term ecological capacity for the impala is 300 animals for 1000 ha of optimal impala habitat, or 0.3 impala/ha (Fürstenburg 1997). In Tembe, 10 250 ha of preferred habitat (vegetation types 1, 3 and 7) are available. This equates to an estimated maximum recommended stocking rate of 3075 impala based on habitat availability. The impala is, however, dependent on water and is rarely found more than 8 km from surface water (Mills & Hes 1997). Tembe, being situated in the drier central regions of Maputaland, have few permanent waterholes and water for animals are mostly available in the form of perennial pans found interspersed throughout the clay areas. The Muzi Swamp is the only natural source of permanent water present in Tembe throughout the year (Matthews *et al*. 2001). A high density of the impala around water will inevitably lead to veld degradation. In order to keep the impala population in Tembe at its current level, 466 individuals will have to be removed annually, based on an expected population growth rate of 35%, whether this is through predation, culling, live capture for translocation or other causes (Bothma *et al*. 2002).

Since most harvesting programmes disrupt animal herds, it should be done at a time that will have the least effect on reproduction. Animals should not be disturbed just before, during or immediately after the lambing season (Bothma 2002). The impala breeds seasonally, with a restricted mating season during the rut in autumn. The onset of the rut is in May, with most mating between full moons (Skinner & Smithers 1990; Van Rooyen 1990; Estes 1997). Lambs are born within a restricted period of a few weeks during the months of November to January after a gestation period of 194 to 200 days. The young are weaned and able to survive without their mothers by 4½ months (Skinner & Smithers 1990). The best time to harvest would therefore be during June and July. Apart from being the least disruptive on reproduction, this will have the added advantage of reducing the impala population before late winter when food is in short supply. Because of the fact that the impala is highly residential and seldom moves more than 10 km, harvesting should be confined to areas with visible habitat degradation.

REFERENCES

ALLREDGE, J.R. & RATTI, J.T. 1992. Further comparison of some statistical techniques for analysis of resource selection. *Journal of Wildlife Management* 56: 1-9.

ANDERSON, J. 1997. Impala *Aepyceros melampus*. In: G. Mills & L. Hes (Eds), The Complete Book of Southern African Mammals (pp 271 – 273). Struik Winchester, Cape Town.

BEYERS, G.R., STEINHORST, R.K. & KRAUSMAN, P.R. 1984. Clarification of a technique for analysis of utilization-availability data. *Journal of Wildlife Management* 48: 1050-1053.

BOTHMA, J. du P. 2002. Harvesting wild animals. In: J. du P. Bothma (Ed.), Game Ranch Management, Fourth edition (pp. 358 – 381). Van Schaik, Pretoria.

BOTHMA, J. du P., VAN ROOYEN, N. & DU TOIT, J.G. 2002. Antelope and other smaller herbivores. In: J. du P. Bothma (Ed.), Game Ranch Management, Fourth edition (pp. 149 – 175). Van Schaik, Pretoria.

DEKKER, B., VAN ROOYEN, N. & BOTHMA, J. du P. 1996. Habitat partitioning by ungulates on a game ranch in the Mopani veld. *S. Afr. J. Wildl. Res.* 26: 117-122.

ESTES, R.D. 1997. The Behavior Guide to African Mammals. Russel Friedman Books, Halfway House.

FRIEDMANN, Y. & DALY, B. (Eds) 2004. Red Data Book of the Mammals of South Africa: A Conservation Assessment. CBSG Southern Africa, Conservation Breeding Specialist Group (SSC/IUCN), Endangered Wildlife Trust, South Africa.

FÜRSTENBURG, D. 1997. Impala *Aepyceros melampus*. *Game and Hunt* 3: 6-7, 31.

GAGNON, M. & CHEW, A.E. 2000. Dietary preferences in extant African Bovidae. *Journal of Mammalogy* 81: 490-511.

GAUGRIS, J.Y., MATTHEWS, W.S., VAN ROOYEN, M.W. & BOTHMA, J. du P. 2004. The vegetation of Tshanini Game Reserve and a comparison with equivalent units in the Tembe Elephant Park in Maputaland, South Africa. *Koedoe* 47: 9-29.

GRUBB, P. 1993. Order Perissodactyla. In: D.E. Wilson & D.M. Reeder (Eds), Mammal Species of the World: A Taxonomic and Geographic Reference, Second edition (pp. 403). Smithsonian Institution Press, Washington DC.

KINGDON, J. 1997. The Kingdon Field Guide to African Mammals. Academic Press, San Diego.

JACOBS, J. 1974. Quantitative measurement of food selection. *Oecologia* 14: 413-417.

MATTHEWS, W.S. 2004. Large herbivore population estimates for Tembe Elephant Park: October 2003. Unpublished report, KwaZulu-Natal Nature Conservation Services.

MATTHEWS, W.S., VAN WYK, A.E., VAN ROOYEN, N. & BOTHA, G.A. 2001.Vegetation of the Tembe Elephant Park, Maputaland, South Africa. *South African Journal of Botany* 67: 573-594.

MILLS, G. & HES, L. 1997. The Complete Book of Southern African Mammals. Struik Winchester, Cape Town.

PIENAAR, D.J., BOTHMA, J. du P. & THERON, G.K.1992. Landscape preference of the white rhinoceros in the southern Kruger National Park. *Koedoe* 35: 1-7.

PIENAAR, U de V. 1974. Habitat-preference in South African antelope species and its significance in natural and artificial distribution patterns. *Koedoe* 17: 185-195.

SKINNER, J.D. & SMITHERS, R.H.N. 1990. The Mammals of the Southern African Subregion. University of Pretoria, South Africa.

TAINTON, N. M. 1999. Veld Management in South Africa. University of Natal Press, Pietermaritzburg.

VAN OUDTSHOORN, F. 1999. Guide to Grasses of Southern Africa. Briza Publications, Pretoria.

VAN ROOYEN, A.F. 1990. The diet, habitat selection and body condition of impala *Aepyceros melampus* and nyala *Tragelaphus angasi* in Zululand. M.Sc. (Zoology) thesis, University of Pretoria, Pretoria.

WENTZEL, J.J., BOTHMA, J. du P. & VAN ROOYEN, N. 1991. Characteristics of the herbaceous layer in preferred grazing areas of six herbivore species in the south-eastern Kruger National Park. *Koedoe* 34: 51-59.