CHAPTER 3

HABITAT USE

Methods

Elephant distribution is affected by ecological and population variables. Habitat analysis includes the determination of the availability, the degree of utilization and the preference for each habitat type by the elephants (White & Garrott 1990).

As the concept of habitat is so controversial (Garshelis 2000; Klingelhoeffer 1987), only the vegetation types will be considered as habitat in this study. The measurement of the availability of each vegetation type in the MER was assessed from the digitised polygons of each vegetation type of the Arcview vegetation map of the MER. A section of 527.8 km^2 covering the western side of the MER that was intensely used by elephants, was selected to represent the availability of vegetation types. All polygons named in the MER vegetation map as Sand Forest (SF) and Sand Thicket (ST) were treated as forest.

The number of locations obtained in a particular vegetation type for each animal was assumed to correspond with the percentage of time spent in that vegetation type and as such could be used as a relative measurement of vegetation type use. All locations were displayed on the digitised map using Arcview GIS.

The number of locations in each vegetation type was counted and vegetation type preference was calculated by assuming that if one vegetation type was preferred, more locations in that specific vegetation type were recorded than could be expected on the basis of the area occupied by this vegetation type within the home range of a given animal. If a vegetation type is preferred, one or more of the remaining vegetation types would have been avoided because of the time constraints (White & Garrott 1990). Thus, the Chi-squared test proposed by White & Garrott (1990) and Wonnacott & Wonnacott (1990) was used to test for the goodness of fit of utilized vegetation type to available vegetation types as well as if the elephant vegetation types utilisation was affected by seasons. Preference Indices (PI) have been determined for all five elephants as described below (White & Garrott 1990, Wonnacott & Wonnacott 1990) (see Table 7).

A preference index (PI) >1 suggested that the vegetation type was preferred; if 1>PI>0.5, the preference for the vegetation type was neutral and PI<0.5, the vegetation type was considered to be avoided.

Plant biomass and vegetation cover was taken from DCB (2000), Haandrikman (1998) and Vriesendorp (1998) and included into the MER vegetation map. Excel spreadsheet computer calculations were used to calculate the local time in Mozambique from GMT elephant locations data. After this, the time spent in a particular habitat type was calculated. Distance and speed travelled were determined from successive locations, which formed part of one cycle of tracking[5].

A paired T-test (Zar 1984) was used to test for differences between daytime/night and dry/rainy vegetation preference. A Wilcoxon Matched Pairs Test (Motulsky 1995) was used to test if the roaming speeds through the vegetation types were influenced by the time of day. T-test was used to test for difference on habitat preference by sex of elephant.

Results

Vegetation type preference

The vegetation types were not randomly used by elephants as would be expected on the basis of area covered by each vegetation type (see Table 10B). Elephants preferred Forest and Futi riverine vegetation types, whilst the use of grasslands and woodland were relatively neutral or with a low preference (for more details see Tables 8 & 9 and Fig. 10).

The preference for vegetation types by the male was similar to that of the females (T-test, T=-0.26, df=16, p>0.05). However, the male did use woodlands outside the MER more frequently than the females, mainly during the rainy season (Tables 10, 11 & 12).

[5] The PTT's have a 24/48 hour on/off duty schedule. One cycle is a period of time that PTT's were continually transmitting the signal during the 24 hours.

Table 7: Preference Index calculation based on White & Garrott (1990) and Wonnacott & Wonnacott (1990) methodology. This example is related to the elephant Female 6455 tracked from February 1998 to August 1999.

Habitat type	**Area (km^2)**	πo	**Observed frequency**	**Expected Frequency**	χ^2	**p**	**$1{,}96\sqrt{p(1-p)/n}$**	**π (95% CI)**	**PI = p / π o**	**SD**
Forest	146.570	0 .278	24.000	24.186	0.001	0 .276	0 .094	0 .182-0.370	0 .993	0 .338
Woodland	122.210	0 .232	39.000	20.184	17.649	0 .448	0 .105	0 .344-0.553	1.931	0 .453
Hygrophilous grassland	162.290	0 .307	11.000	26.709	9.274	0 .126	0 .070	0. 057-0.196	0 .410	0 .228
Futi vegetation	21.520	0 .041	12.000	3.567	20.142	0 .138	0 .072	0. 065-0.210	3.366	1.756
Maputo flood plain	17.050	0 .032	0.000	2.784	2.810	0.000	0.000	0. 000-0.000	0.000	0.000
Woody grassland	16.570	0 .031	1.000	2.697	1.097	0 .011	0 .022	0. 011-0.034	0 .355	0 .710
Tidal wetland	17.250	0 .033	0.000	2.871	2.843	0.000	0.000	0 .000-0 .000	0.000	0.000
Mangroves	13.040	0 .025	0.000	2.175	2.149	0.000	0.000	0 .000-0 .000	0.000	0.000
Others	11.300	0 .021	0.000	1.827	1.863	0.000	0.000	0 .000-0 .000	0.000	0.000
Total	527.800	1.000	87.000	87.000						

Where:

πo is the probability if **Ho** is true (area of the habitat type/total area of all habitat types)
Expected frequency = **πo** in a specific habitat type **x** total observed frequency
p=Observed frequency/n
n=Total frequency
$\pi = p \pm 1.96\sqrt{p(1-p)/n}$
PI = preference index
$SD = 1.96\sqrt{p(1-p)}/\pi o$

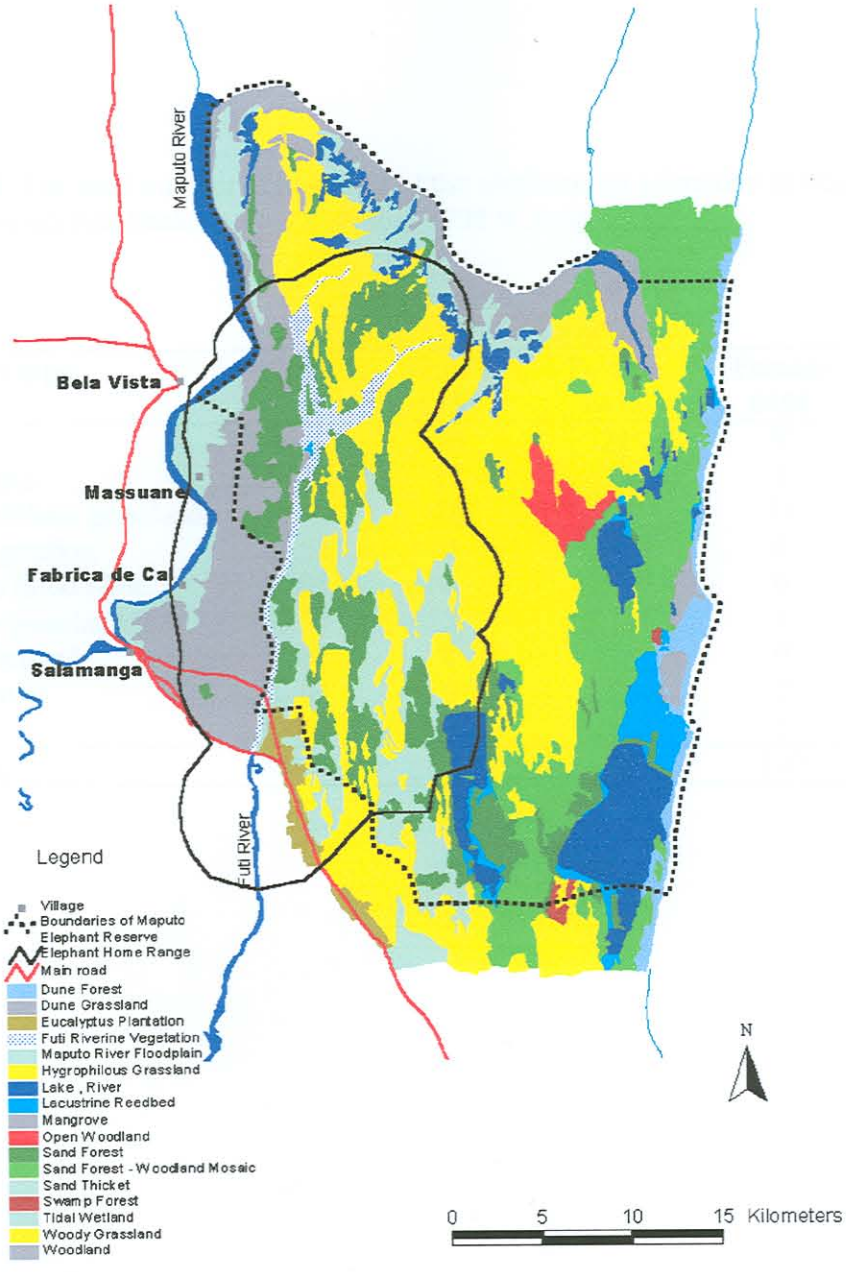

Figure 10: Vegetation types in the Maputo Elephant Reserve. The bold black line delineates the collective home range of the five elephants tracked from February 1998 to August 1999.

Table 8: The total number of locations of the elephants as a function of vegetation type based on satellite tracking from February 1998 to August 1999.

		Locations				
Habitat type	**Area (km^2)**	**Female 6454**	**Female 6455**	**Female 6456**	**Female 6457**	**Male 6458**
Forest	146.57	70	24	50	33	42
Woodland	122.21	22	39	3	7	42
Hygrophilous grassland	162.29	38	11	35	69	20
Futi vegetation	21.52	0	12	8	11	6
Maputo flood plain	17.05	0	0	0	0	2
Woody grassland	16.57	2	1	1	3	2
Tidal wetland	17.25	0	0	0	0	0
Mangroves	13.04	0	0	0	0	0
Others	11.30	9	0	5	1	1
TOTAL	527.80	141	87	102	124	115

Table 9: The number of locations of the elephants as a function of vegetation type based on satellite tracking from February 1998 to August 1999 during the dry season (May to October of each year) and rainy season (November to April of each year).

		Locations									
		Female 6454		Female 6455		Female 6456		Female 6457		Male 6458	
Habitat type	**Area (km^2)**	**Dry**	**Rainy**	**Dry**	**Rainy**	**Dry**	**Rainy**	**Dry**	**Rainy**	**Dry**	**Rainy**
Forest	146.57	42	28	16	8	33	17	23	10	32	10
Woodland	122.21	0	22	28	11	1	2	2	5	9	33
Hygrophilous grassland	162.29	30	8	10	1	20	15	54	15	16	4
Futi vegetation	21.52	0	0	9	3	6	2	9	2	3	3
Maputo flood plain	17.05	0	0	0	0	0	0	0	0	0	2
Woody grassland	16.57	1	1	0	1	1	1	3	3	2	2
Tidal wetland	17.25	0	0	0	0	0	0	0	0	0	0
Mangroves	13.04	0	0	0	0	0	0	0	0	0	0
Others	11.30	5	4	0	0	3	2	0	1	0	1
TOTAL	527.80	78	63	63	24	64	38	88	36	60	55

Table 10A: Preference indices and Chi-squared test results (A) calculated as methodology described in the methods section (see Table 7 and 8).

				Habitat type								
Elephant	**$\chi 2$**	**Df**	**P**	**HG**	**FOR**	**WG**	**M**	**WOL**	**FV**	**TW**	**FPL**	**OTHERS**
Female 6454	60	8	<0.001	0.876	1.788	0.452	0.000	0.674	0.000	0.000	0.000	2.981
Female 6455	57.83	8	<0.001	0.411	0.930	0.366	0.000	1.936	3.383	0.000	0.000	0.000
Female 6456	52.85	8	<0.001	1.116	1.765	0.312	0.000	0.127	1.924	0.000	0.000	2.290
Female 6457	60.82	8	<0.001	1.810	0.958	0.771	0.000	0.244	2.176	0.000	0.000	0.377
Male 6458	28.20	8	<0.001	0.566	1.315	0.554	0.000	1.577	1.280	0.000	0.538	0.406

Table 10B: The avoided, neutral or preferred vegetation types as a function of the identity of the five elephants. If in the table A, the preference index (PI) was more than 1, the respective vegetation type was considered as preferred in the table B; if 1>PI>0.5, preference for the vegetation type was considered neutral and PI<0.5, the vegetation type was considered avoided in the table B. Vegetation types are: Hygrophilous grassland(HG), Forest (FOR), woody grassland (WG), woodland (WOL), Futi vegetation (FV), Tidal wetland (TW), Mangrove (M), Maputo flood plain (FPL), OTHERS (including sand forest mosaic, eucalyptus plantation and lacustrine reedbed).

Elephant	**HG**	**FOR**	**WG**	**M**	**WOL**	**FV**	**TW**	**FPL**	**OTHERS**
Female 6454	Neutral	Prefer	Avoid	Avoid	Neutral	Avoid	Avoid	Avoid	Prefer
Female 6455	Avoid	Neutral	Avoid	Avoid	Prefer	Prefer	Avoid	Avoid	Avoid
Female 6456	Prefer	Prefer	Avoid	Avoid	Avoid	Prefer	Avoid	Avoid	Prefer
Female 6457	Prefer	Neutral	Neutral	Avoid	Avoid	Prefer	Avoid	Avoid	Avoid
Male 6458	Neutral	Prefer	Neutral	Avoid	Prefer	Prefer	Avoid	Neutral	Avoid

Table 11A: Preference Indices (PI) and Chi-squared test results for the dry season calculated as methodology described in the methods section (see Table 7 and 9).

				Habitat								
Elephant	**$\chi 2$**	**df**	**P**	**HG**	**FOR**	**WG**	**M**	**WOL**	**FV**	**TW**	**FPL**	**OTHERS**
Female 6454	56.3	8	<0.001	1.251	1.939	0.408	0.000	0.000	0.000	0.000	0.000	2.994
Female 6455	42.1	8	<0.001	0.516	0.915	0.000	0.000	1.919	3.504	0.000	0.000	0.000
Female 6456	38.5	8	<0.001	1.016	1.857	0.498	0.000	0.067	2.299	0.000	0.000	2.189
Female 6457	64.2	8	<0.001	1.996	0.941	0.000	0.000	0.098	2.508	0.000	0.000	0.000
Male 6458	25.6	8	<0.001	0.867	1.921	0.000	0.000	0.648	1.226	0.000	0.000	0.000

Table 11B: The avoided, neutral or preferred vegetation types by the five elephants. If in the table A, the preference index (PI) was more than 1, the respective vegetation type was assumed as preferred in the table B; if 1>PI>0.5, the vegetation type was neutral and PI<0.5, the vegetation type was considered avoided in the table B. Vegetation types are: Hygrophilous grassland(HG), Forest (FOR), woody grassland (WG), woodland (WOL), Futi vegetation (FV), Tidal wetland (TW), Mangrove (M), Maputo flood plain (FPL), OTHERS (including sand forest mosaic, eucalyptus plantation and lacustrine reedbed).

				Habitat					
Elephant	**HG**	**FOR**	**WG**	**M**	**WOL**	**FV**	**TW**	**FPL**	**OTHERS**
Female 6454	Prefer	Prefer	Avoid	Avoid	Avoid	Avoid	Avoid	Avoid	Prefer
Female 6455	Neutral	Neutral	Avoid	Avoid	Prefer	Prefer	Avoid	Avoid	Avoid
Female 6456	Prefer	Prefer	Avoid	Avoid	Avoid	Prefer	Avoid	Avoid	Prefer
Female 6457	Prefer	Neutral	Avoid	Avoid	Avoid	Prefer	Avoid	Avoid	Avoid
Male 6458	Neutral	Prefer	Avoid	Avoid	Neutral	Prefer	Avoid	Avoid	Avoid

Table 12A: Preference Indices (PI) and Chi-squared test results for the rainy season calculated as methodology described in the methods section (see Table 7 and 9).

				Habitat								
Elephant	**$\chi 2$**	**df**	**P**	**HG**	**FOR**	**WG**	**M**	**WOL**	**FV**	**TW**	**FPL**	**OTHERS**
Female1	30.700	8	<0.001	0.413	1.600	0.506	0.000	1.508	0.000	0.000	0.000	2.966
Female2	18.000	8	<0.001	0.136	1.200	1.327	0.000	1.979	3.066	0.000	0.000	0.000
Female3	16.600	8	<0.001	1.284	1.611	0.000	0.000	0.227	1.291	0.000	0.000	2.458
Female4	9.310	8	<0.001	1.355	1.000	2.654	0.000	0.600	1.361	0.000	0.000	1.297
Male1	47.400	8	<0.001	0.237	0.655	1.158	0.000	2.591	1.338	0.000	1.126	0.849

Table 12B: The avoided, neutral or preferred vegetation types by the five elephants. If in the table A, the preference index (PI) was more than 1, the respective vegetation type was assumed as preferred in the table B; if 1>PI>0.5, the vegetation type was neutral and PI<0.5, the vegetation type was considered avoided in the table B. Vegetation types are: Hygrophilous grassland(HG), Forest (FOR), woody grassland (WG), woodland (WOL), Futi vegetation (FV), Tidal wetland (TW), Mangrove (M), Maputo flood plain (FPL), OTHERS (including sand forest mosaic, eucalyptus plantation and lacustrine reedbed).

				Habitat					
Elephant	**HG**	**FOR**	**WG**	**M**	**WOL**	**FV**	**TW**	**FPL**	**OTHERS**
Female1	Avoid	Prefer	Neutral	Avoid	Prefer	Avoid	Avoid	Avoid	Prefer
Female2	Avoid	Prefer	Prefer	Avoid	Prefer	Prefer	Avoid	Avoid	Avoid
Female3	Prefer	Prefer	Avoid	Avoid	Avoid	Prefer	Avoid	Avoid	Prefer
Female4	Prefer	Prefer	Prefer	Avoid	Neutral	Prefer	Avoid	Avoid	Prefer
Male1	Avoid	Neutral	Prefer	Avoid	Prefer	Prefer	Avoid	Prefer	Neutral

The preference for vegetation types was affected by season (see Tables 11B & 12B) .

Distances between successive locations were larger in areas with a low percent of cover (grassland and woodland) than in the forested areas (see Table 13). Elephants, moved relatively slowly through vegetation types with a high biomass and plant cover (see Fig. 11). The time of day did not influence habitat use (Table 14). Significant differences were found between day and night time roaming speeds (Wilcoxon Matched Pairs Test, T=15; N=14; $p< 0.05$) (see Fig. 12).

Discussion

The habitats of the MER are not used randomly by elephants (Ntumi 1997, de Boer *et al*. 2000) as was also pointed out by Douglas-Hamilton (1972), Leuthould (1977a, 1977b), Owen-Smith (1988), Western & Lindsay (1984), and Laws, Parker & Johnstone (1975) in other Parks of Africa. A possible explanation for this phenomenon is that animal behaviour changes according to changes in the physical environment (temperature, rainfall) (Leuthould 1977b), the presence of habitat resources (including food, water and refuge from weather extremes) (Owen-Smith 1988) and quantity and quality of food (Leuthould 1977b). On the other hand the pattern of habitat use noted in MER also may be ascribed to: i) unequal number of successful locations obtained during the study; ii) unequal tracking period per elephant iii) the short period of elephant tracking and iv) differences in the areas of each habitat.

Small woody grassland (WG) patches adjacent to the more preferred habitats (forested areas) had significantly more elephant locations, which gave rise to high preference indices for woody grassland (WG) during the rainy season (see Table 12). Based on the characterisation of tropical forage quality described by Iason & Van-Wieren (1999) forested areas in the MER should offer a high food quantity (DCB 2000) but a lower food quality than the grasslands and woodlands. Thus elephants may accept the low food quality of forests in return for food quantity and an increased safety from disturbance (see Western & Lindsay 1984).

Although the preferences for vegetation types were not affected by sex of the tracked elephants in the present study the Futi riverine vegetation was more preferred by females, whilst the woodland was more preferred by the male. The Futi riverine vegetation comprises tall and green *Phragmites australis*, *Juncus kraussii* and green riverine forest composed by *Ficus sycomorus* (see details in Chapter 1). Has also high herbaceous biomass (Table 13). Probably, due to the high herbaceous biomass and high herbaceous percent of cover, the females may spend more time searching for food and seeking refuge. Some of the woodlands are close to the populated Salamanga and Massuane and to the agricultural fields in this area. The higher preference for the woodland close to agricultural fields by the male may be due to him raiding crops during the rainy season. It should be noted that this statement is based on observations on only one male and that his foraging behaviour may not be representative of that of all males in this population.

I could not discriminate between time devoted to feeding, foraging and resting by elephants in each habitat. A short distance between successive locations in the forest as well as the negative correlation observed between biomass, percentage cover and roaming distances may be the consequence of increased feeding, foraging or resting behaviour.

Elephants may select forest to balance the maximisation of forage intake with minimisation of risks, or to minimise exposure to intense sunlight and associated high ambient temperatures. The following explanations for this apparent behaviour may be formulated.

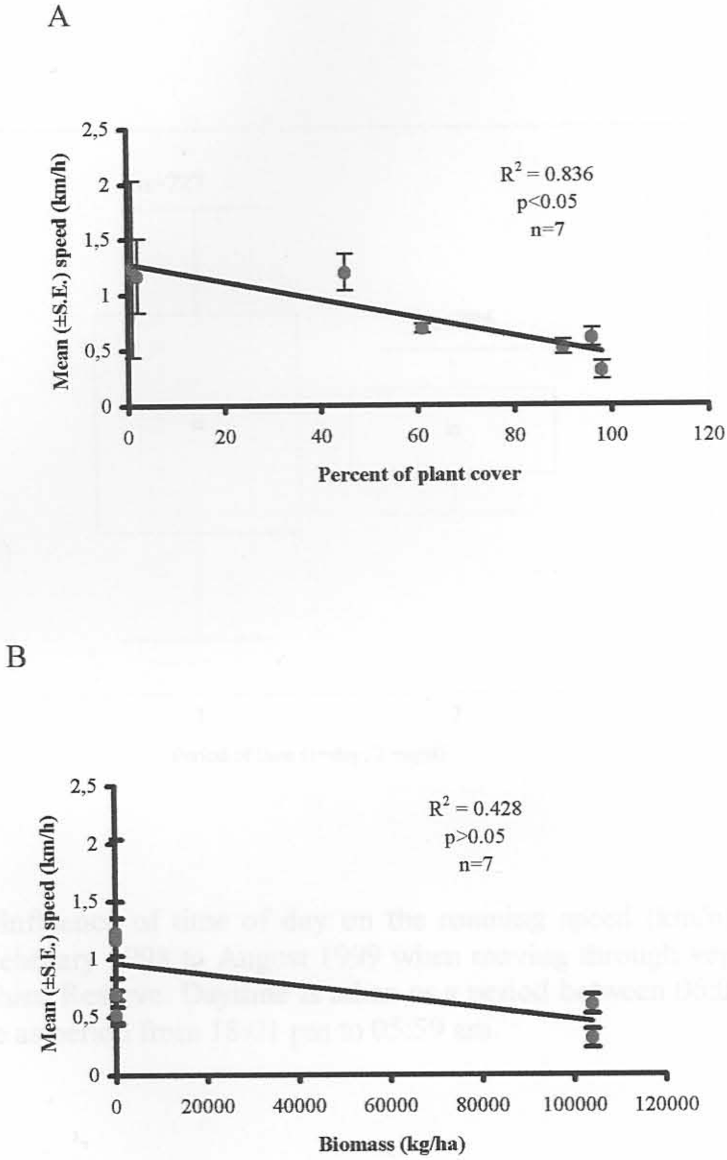

Figure 11: Mean roaming speed (Km/h) as a function of percent plant cover (A) and plant biomass (B). The analysis is based on the raw values estimated by DCB (2000) for Hygrophilous grassland, Sand forest, Sand thicket, Woody grassland, Woodland, Maputo River floodplain and Futi vegetation (see Table 13).

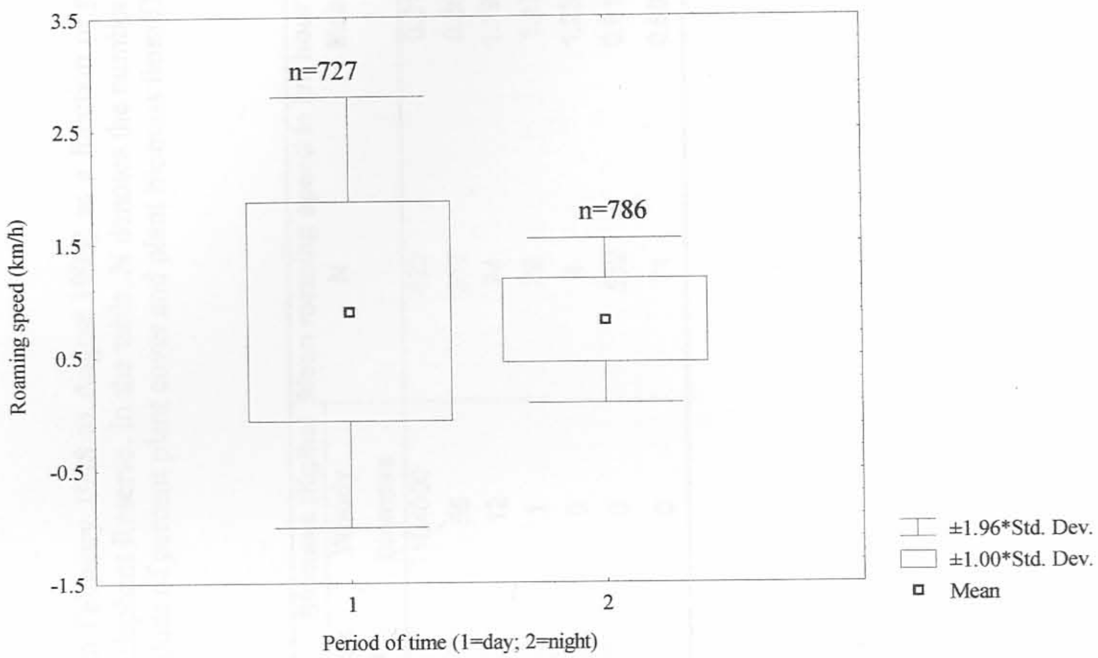

Figure 12: The influence of time of day on the roaming speed (km/h) of the tracked elephants from February 1998 to August 1999 when moving through vegetation types in the Maputo Elephant Reserve. Daytime is taken as a period between 06:00 am and 18:00 pm and nighttime as period from 18:01 pm to 05:59 am.

Table 13: Mean roaming speed (km/h) of the tracked elephants from February 1998 to August 1999) as a function of percent plant cover and plant biomass of the main vegetation types of the Maputo Elephant Reserve. In the table, N denotes the number of locations in the respective vegetation types. The analysis is based on the raw values of percent plant cover and plant biomass from DCB (2000).

	Percent of cover		Biomass (Kg/ha)		Mean roaming speed in km hour^{-1}		
Vegetation type	Herbaceous layer	Woody Layer	Herbaceous biomass	Woody biomass	N	Mean	S.E
Sand Forest	65	98	200	104000	422	0.31	0.011
Sand Thicket	80	61	800	55	317	0.69	0.041
Woodland	51	45	600	12	74	1.195	0.164
Woody Grassland	78	2	1100	1	26	1.17	0.334
Maputo River Floodplain	99	1	1500	0	4	1.234	1.407
Hygrophilous Grassland	90	0	1600	0	552	0.518	0.068
Futi Riverine Vegetation	96	0	3000	0	71	0.604	0.082

Table 14: The mean ± S.E. day and night time roaming speed in km hour^{-1} of the tracked elephants from February 1998 to August 1999 by the main vegetation types of the Maputo Elephant Reserve. In the table, **n** denotes the number of locations in the respective vegetation type.

Vegetation type	**Mean ± S.E. (n) roaming speed in km hour^{-1}**	
	Day time (06:00 – 18:00)	**Night time (18:01 – 17:59)**
Hygrophilous grassland	0.432±0.045 (282)	0.608±0.131 (270)
Forest	0.803±0.443 (343)	0.577±0.144 (396)
Woody grassland	2.985±2.744 (9)	0.600±0.329 (17)
Woodland	1.020±0.610 (24)	1.036±0.413 (50)
Futi vegetation	0.663±0.318 (29)	0.550±0.181 (42)
Tidal wetland	0.122±n/a (1)	0.659±0.654 (2)
Maputo flood plain	0.241±n/a (1)	1.565±1.207 (3)

Foraging reason

Elephants, like other animals, cannot obtain their essential nutrients without simultaneously exposing themselves to increased risks to their predators (Altman 1998). Thus, an adequate foraging strategy adopted by elephant would result not only in short-term effects but also in long-term consequences, such as the change of their foraging habits or their preferences.

The metabolic requirements of mammals increases with body mass to the power of 0.75 (Iason & van Wieren 1999). In contrast, the capacity of the gastrointestinal track increases linearly with body mass (Iason & van Wieren 1999). O'-Reagain & Goestsch (1996) have demonstrated that quantity of food ingested depends on the height of the herbage, the greenness and its digestibility. The more digestible a forage is, the higher quality is and the lower the percentage lignin it has (Iason & Van Wieren 1999).

Bell (1971) pointed out that larger animals could tolerate a lower forage quality. Mammals with a smaller body size are more selective, which increases diet digestibility but results in a negative relationship with intake rate because of the greater time required. Therefore, selectivity appears to be constrained by the costs of searching for and discriminating between forage resources (Wallis de Vries *et al.* 1994).

Chemical analysis revealed that generally, grasses have a high percentage NDF (Neutral Detergent Fibre), low percentage lignin, high percentage nitrogen and low percentage condensed tannin (Van Wieren 1996). Vegetation studies conducted in the MER by Tello (1973), Hatton (1995), Maria (1998), Vriesendorp (1998), Haandrikman (1998), Chuma (1999) and DCB (2000) revealed that the sand forest and sand thicket (composed mainly of dicotyledons) have a high percentage of browse and biomass while grasslands (mainly monocotyledons) have a high percentage of grasses and low total biomass. Elephant diet studies (Correia 1995, Mafuca 1996 and Banze 2000) in the MER noted that a large part of the diet consisted of dicotyledons. To be able to take in sufficient volumes of browse, high volumes of woody material with high lignin values and of low digestibility have to be ingested.

Apparently, a lower food quality was taken by elephants in the forest in an effort to increase total intake. The quantity-quality balance of the diet of elephants influences their food choice differently in each season. With a reduced availability of forage in the open areas and the forest providing green browse during the late dry season, elephants spend more time in the dense forests. Here they are able to find shade and also to forage on woody species under the canopy (Dublin 1996). But in the early wet season, inundated grasslands in the MER become green, increasing forage biomass and quality. According to Dublin (1996), elephants select primarily on the basis of forage quality but may be limited in their choice by the amount of food available within their range. The reported preference for forests during the dry season could be aimed at increasing forage biomass while the open areas (hygrophilous grasslands) with high forage quality were preferred during the wet season.

Refuge seeking

The foraging reason does not explain why elephants avoid forests close to Lake Piti and in the south of the MER along the Futi River. It also does not explain why elephants forage in the reedbeds of the MER. Probably, the home range of the elephant may not be limited only by food resources but by social, behavioural, physiological and/or other factors as Stern (1998) pointed out for elephants elsewhere.

Since elephants return to preferred habitats, resources within the revisited habitats should be reduced, eventually showing signs of vegetation damage (Stern 1998). However, there are no significant signs of elephant damage in the forests in the MER (Haandrikman 1998, Vriesendorp 1998). Because of the high biomass, the forest has a high percentage cover (DCB 2000) and thus, habitat selection may be dependent on cover. Large groups of elephants in open areas may be associated with a more defensive elephant behaviour (Western & Lindsay 1984). Breaking into small groups when they enter the forest could therefore be an immediate response to the artificial disturbance. In fact, during the elephant capture operations (1996, 1998) and the aerial survey (1999), we observed that the helicopter forced large groups of elephants feeding on the grasslands to break into small herds that fled into the forest.

Based on the elephant defensive behaviour and immediate response to the disturbance, I suspect that the grasslands and sand forest mosaics of eastern MER are probably less preferred by elephants in the MER for three main reasons: i) most of these areas are open, ii) are more accessible by roads, and iii) have fewer control posts, which could induce a higher poaching pressure.

Low cover in these habitats reduces refuge potential and poachers prefer open areas where antelopes can be caught more easily (personal observation).

Poaching in the MER by people from Maputo has been reported mainly from open areas and occurs during the night (Chambal 1996) and it is not directed at elephants. Only five small elephants have been poached during the last five years (personal observation).

During the last ten years poaching for antelopes has become more severe in the MER and has probably stressed the elephants which may have changed their preference from open areas (Tello 1973) to the sand forests (de Boer *et al*. 2000). Those observations could support the refuge seeking, which influence elephants' behaviour observed during this study and the differences on habitat use on day/night times (see Chapter 3, result section).

Physiological reasons

Leuthold (1977b) pointed out that climatic factors affect thermoregulatory behaviour, activity patterns and movements. Sunshine and temperature, wind and rain may act simultaneously and produce a variety of effects. As a general response to high temperatures, many ungulates seek shade and remain inactive during much of the day (Sikes 1971; Leuthould 1977b). According to Brooks (1961) cited by Leuthold (1977b), in cases where no shade is available wind can be used for cooling.

The enormous ear pinnae of African elephants facilitate cooling. Ear fanning rates are correlated with ambient temperature, and the temperature of the blood leaving the ear is cooler than that of the blood entering it (Buss & Estes 1971 cited by Owen-Smith 1988). Randall *et al.* (1997) refers to use of behavioural mechanisms for thermoregulation when the elephants move to a part of the environment where heat exchange with the environment favours attaining optimal body temperature. Regular daily temperature records from the MER do not exist. Mean monthly temperature recorded at Changalane post (Matutuine District) does not show significant changes from 1970 to 1999 (see Appendix 3) that can explain changes in elephant preference, from open areas (Tello 1973) to sand forest (Ntumi 1997, de Boer *et al*. 2000). The relatively high roaming speed during a day (Fig.12) may not be supported by those changes in mean temperature.

With the limited information available we may speculate that space and habitat use by elephants of the MER is affected by human disturbances (de Boer *et al.* 2000) induced by burning and poaching. Regular fires may reduce plant cover and biomass and convert forested areas into open grasslands. These open areas are prone to fire and poaching which force elephants to move to the forested areas (west of MER), where fires are at low intensity and there is high biomass, water and better game scout control.

Conclusion

The preferred habitat of the elephants of the MER has high biomass and high percentage of cover. The avoided ones are open and situated at east part of the MER where human disturbances are common. But, forested areas that are preferred by elephants have low biomass quality than avoided grasslands by elephants. However, the observed negative influence of plant biomass and the percent of cover on the elephant roaming speed appears that elephants may select forests by balancing the maximisation of intake and minimisation risks.

I can conclude then, that with the limited information available, habitat use by elephants in the MER is affected by human disturbances such as that induced by burning and poaching at east of the MER.