CHAPTER 3: BAOBABS AND ELEPHANTS IN THE KRUGER NATIONAL PARK.

INTRODUCTION

This chapter is based on the information presented in a paper by Whyte *et al.* (1999), and a report by Whyte *et al.* (1996).

Some of the negative impacts of high densities of elephants on boababs elsewhere in Africa have been documented. Leuthold (1977) reported that as a result of elephant exploitation in Tsavo National Park (Kenya) the boababs had almost been exterminated. Once abundant, too few were recorded to include in his analysis of elephant damage to the Parks' tree species. A decline was also recorded in baobabs in Ruaha National Park (Tanzania) between 1976 and 1982. This decline was halted by 1989 which was attributed to by the poaching of most of the Park's elephant bulls (Barnes *et al.* 1994). In Mana Pools National Park, 29% of a sample of 124 baobabs was killed by elephants between 1984 and 1988 (Swanepoel 1993a; Swanepoel & Swanepoel 1986). These impacts have been associated with elephant populations considered to be at high densities, but in KNP there is some evidence that even at the relatively low densities at which the elephant population has been held, they may have been partly responsible for a gradual decline in the baobab population.

In Africa the baobab is unique and unmistakable. Carbon dating has put larger specimens at over 3 000 years old (Coates Palgrave 1977). He described the trees as "comparatively short (10 m to 15 m in height) but grotesquely fat – the boles in large specimens reaching 28 m in circumference", and because of its unique characteristics, they are "surrounded by a wealth of African legend and superstition (e.g. that God had planted the tree upside down)". Trunks of older trees are gnarled, dented and grooved. They are also often hollow and these characteristics lend themselves to use by a variety of species for roosting and nesting. The only known natural nesting sites of both the Mottled spinetail *Telecanthura ussheri* and Böhm's spinetail *Neafrapus boehmi* are in hollow baobabs (Harwin 1989; Maclean 1993; Sinclair & Whyte 1991). Other species which favour baobabs for nesting are the northern race of the Cape parrot *Poicephalus robustus suahelicus* and the Mosque swallow *Hirundo senegalensis* (Maclean 1993). As other species are dependent upon boababs, these trees are considered a "keystone" species, and as such must form an important component of KNP's biodiversity maintenance policy (Whyte *et al.* 1997).

The objective of the original report (Whyte *et al.* 1996) was to examine the demography of the baobab population in KNP with a longer-term objective of establishing a monitoring programme through which the causes of mortality of these trees might be identified.

Age determination of baobabs has proved problematic. Guy (1970) found that in known age baobabs of up to 127 cm in diameter core samples yielded estimates of age accurate to within two per cent. He did not assess the value of the technique for larger trees. In 1980/81 Gertenbach (pers. comm.[1]) extracted cores from baobab trees in KNP in an effort to relate growth rings to climatic (rainfall) cycles. However, the trunks' centres were too porous and sections could not be obtained by means of a core. The thin outer layers of the trunks were also too thin for use in correlations of growth layers with long-term rainfall patterns. The age that baobabs may potentially achieve is thus not known. Measures of the girth of these trees are flawed as an age determination technique, as these trees are known to contract as a result of moisture loss during droughts (Guy 1970). For instance a baobab tree measured by David Livingstone in 1853 and by Guy in 1966 had shrunk by some 11% (Guy 1970).

Nothing is known of long term recruitment and mortality rates for baobabs. Nel (1988) estimated the Kruger National Park baobab population at 20 000 trees, but was of the opinion (Nel pers. comm.) that "over the past decade" (1986 -1996) more than 1 000 of these trees had died. Between 1993 and 1995 alone, 151 freshly dead baobabs were recorded during aerial censuses (Whyte & Wood 1994b; 1995). Although it is known that drought alone can be responsible for baobab mortality, it is thought that baobabs' susceptibility to drought is exacerbated through bark stripping by elephants which may increase moisture loss.

STUDY AREAS

This study focused on three areas which can all be considered high-density baobab areas but which have been subjected to different elephant densities over different periods of time. Two of these areas occur in the northern KNP (Figure 5) while the third (Messina Nature Reserve) falls outside the KNP about 120 km to the west. These three areas are:

[1] Dr W.P.D. Gertenbach, Department of Wildlife Management, Kruger National Park.

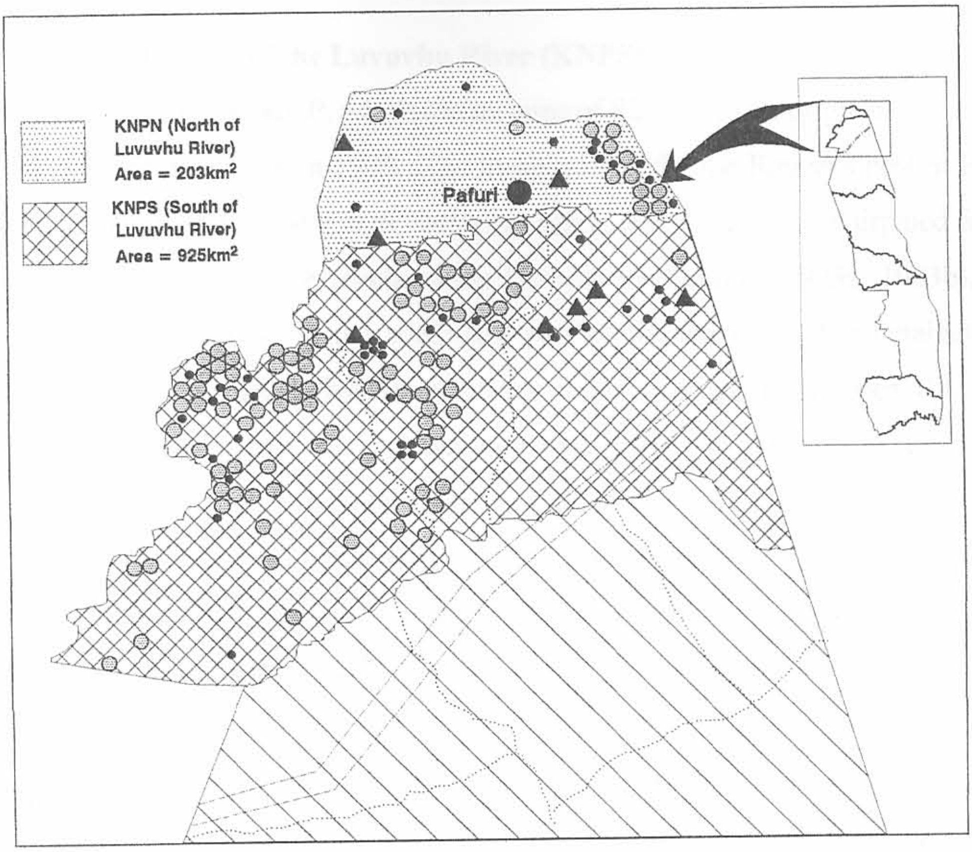

Figure 5: The Kruger National Park study areas. Localities of baobabs that had died are shown by: ◎ in 1993 (n = 95), • in 1994 (n = 48), and ▲ in 1994 (n = 48).

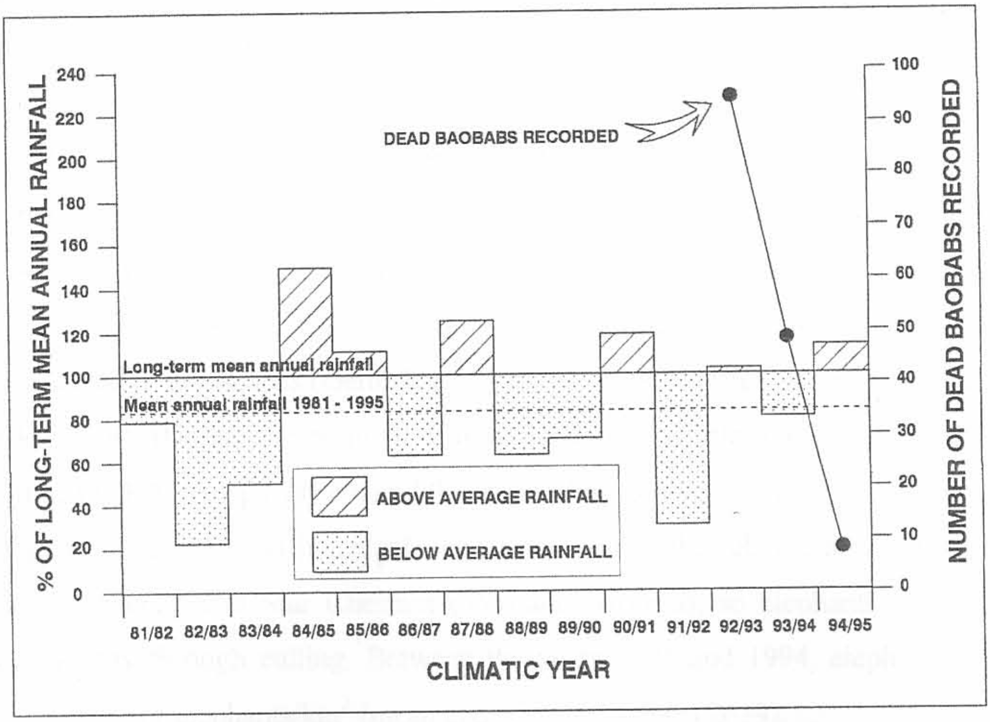

Figure 6: Rainfall measured at Pafuri between 1981 and 1995 and dead baobabs recorded between 1993 and 1995.

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Kruger National Park south of the Luvuvhu River (KNPS)

The study area in this part of KNP, which has an area of 925 km^2, was originally proclaimed as the Shingwedzi Game Reserve in 1903. The mean rainfall for the Ranger's post at Pafuri is 420 mm and it lies at an altitude of 250 m above sea level. Elephants were extirpated from the area at some unknown time before proclamation (Stevenson-Hamilton 1903a; 1903b), but in 1905 elephant spoor was found in the south-east part of this area near the Letaba/Olifants confluence and it was estimated that 10 elephants then occurred in the area (Stevenson-Hamilton 1905). In 1926 this area was included in the KNP upon its proclamation as a national park. In 1931 elephants started to recolonise the baobab area of the KNP according to ranger's reports (Stevenson-Hamilton 1931). The elephant population of the area subsequently increased until 1967 when culling campaigns were initiated to maintain the total population of KNP at around 7 000 individuals. Between the years 1985 and 1994, elephant densities ranged from 0.14 to 0.81 elephants/km^2 (mean and S.E. = 0.356 ± 0.2001). The KNP landscapes (Gertenbach 1983) of this study area are nos. 15, 16, 23, 25, 26, 27, 28, 32 and 34 (See Figure 4). Baobabs occur in all of these landscapes. Unfortunately, cull records are inadequate to allow the designation of numbers of elephants culled to each of these areas.

Kruger National Park north of the Luvuvhu River (KNPN)

This area of 203 km^2 did not initially form part of the KNP at its proclamation in 1926, but was only added in 1969. Rainfall and altitude are similar to those of the KNPS. It is unlikely that any elephants have been present in the area since the decline of the town Schoemansdal, described as the elephant hunters' Mecca, which thrived between 1846 and 1867 (Pienaar 1990; see Chapter 4). It is likely that by this time and probably from even before, these hunters were hunting elephants to the north of the Limpopo River in Zimbabwe (then Rhodesia) and Mozambique. The KNP landscapes (Gertenbach 1983) of this study area are nos. 16, 25, 26, 27 and 28 (See Figure 4). Baobabs occur in all of these landscapes. After the proclamation of the KNPN as part of the KNP, elephants entered the area in low numbers. It was perceived to be an area of ecological sensitivity and botanical importance due to the relative abundance of rare trees such as the baobab and Star Chestnut (*Sterculia rogersii*), so elephants were kept at relatively low density through culling. Between the years 1985 and 1994, elephant densities ranged from 0.03 to 0.77 elephants/km^2 (mean and S.E. = 0.305 ± 0.2639).

Messina Nature Reserve (MNR)

The MNR was proclaimed in 1976 as a baobab reserve. It is 4 471 hectares in extent and is situated 5 km south of the town of Messina in the Northern Province of South Africa. It lies at an altitude of 600 m above sea level and the mean annual rainfall is 299 mm. As with the KNPN area, it is unlikely that any elephants have been present in the area, at least since the establishment of the town of Schoemansdal in 1846.

This reserve falls within Acocks' (1988) Veld Type Number 15 (Mopaniveld).

METHODS

Baobab data

The KNP data used to indicate size classes of the trees come from the studies of Whyte *et al.* (1996) and from Nel (1988). The MNR data were from Steyn (1990).

Baobabs were located while travelling along roads in a vehicle. In KNP distribution is often clustered and many trees can be accessed on foot. In the clusters sampled, all trees were examined. While travelling in the vehicle or moving between trees on foot, a diligent search for smaller trees was conducted by slow movement and careful scanning, but the obscure nature of small baobabs probably resulted in under-sampling of this class. Data were obtained from all trees found. Data were recorded from 220 boababs in KNPN and from 204 boababs in KNPS in July 1995 and January 1996. For each of these (alive and dead) girth was measured at breast height (GBH) to the nearest cm. A photograph was taken of each tree and its position was plotted using a Global Positioning System (GPS) to allow for certain recognition on subsequent surveys.

During the 1993, 1994 and 1995 aerial (helicopter) censuses of the KNP elephant and buffalo populations (Whyte & Wood 1994a; 1994b; 1995), the numbers and approximate localities of dead baobabs which had died within the past year, were recorded on the census maps. (Such trees are easy to recognise as within a few months of dying, they collapse into a heap of pulp which is initially a fairly yellow colour. The pulp of trees dead for a longer period turns grey).

Elephant damage

Damage to bark of baobabs remains visible for a very long time. Some early European visitors to the KNP area carved their names with dates on these trees as far back as 1890 and are still clearly after 110 years. If elephants were utilising baobabs 100 or even 200 years or more ago, it could be expected that the scars would still be clearly visible. Nel (1988) differentiated between "old" and "new" elephant damage to the bark of baobabs. Old damage was that which he could recognise as elephant damage, but which had healed to a point where it had regained the colour and texture of old bark. He estimated that this process took about seven years.

Whyte *et al.* (1996) only examined fresh damage in the KNPN and KNPS regions of the KNP as their study was specifically aimed at acquiring a better understanding of the factors affecting baobab mortality. "Old" damage which had healed completely was assumed to no longer be a factor affecting the trees' chances of survival, and an assessment of the severity of "new" elephant damage only was conducted.

The amount of damage was recorded as either none, slight (some utilization but shallow and tree not ring-barked), moderate (utilization shallow but tree ring-barked), severe (tree ring-barked: utilization affects the shape of the trunk), very severe (utilization dramatically affects the shape of the trunk).

RESULTS

Dead boababs

Nel (1988) estimated KNP's baobab population at around 20 000 individuals, and is of the opinion (pers. comm.) that in the 15 years up to 1995, more than 1 000 (5%) of this initial population had died. The majority of the mortality occurred before 1993 (which was the last of the serious drought years) but unfortunately the numbers and localities of these dead trees were not recorded. However, between 1993 and 1995, a further 151 dead trees were recorded of which 95, 48 and eight were noted in these three years respectively (Whyte & Wood 1994a; 1994b; 1995). No fresh mortalities were recorded in 1996. Mortality therefore declined from 0.48% in 1993 to 0.24% in 1994, 0.04% in 1995 and 0% in 1996 which may be related to the higher rainfall which fell towards the end of the period (Figure 6). The localities of the dead trees are shown in Figure 5.

Of the 220 baobabs examined in KNPN during the most recent ground survey, four (2.0%) were dead, while in KNPS , 11 (5.4%) of the 204 trees examined were dead. The difference in these proportions was not significant ($\chi^2 = 2.98$; $p > 0,1$). No dead trees were recorded in MNR.

Population structure

The size structure of the baobab populations (Figure 7) from the three areas differed significantly (Kolmogorov-Smirnov 2-sample polynomial tests for KNPS vs KNPN ($p = 0.0002$), for KNPN vs MNR ($p = 0.001$) and for KNPS vs MNR ($p = 0.0002$). In the MNR a very high proportion (50%) of trees in the sample had a circumference of < one metre. Similarly the KNPN sample had a high proportion of younger trees though with a much smaller proportion of trees in the first age class than in the MNR.

There were clearly more trees in the middle size classes (4 - 9m circumference) in all three areas, which suggests that for some period in the past, recruitment and/or survival rates were better than at present (Figure 7).

Elephant damage

As there are no elephants in the MNR, no damage was recorded. In the KNPN, 169 (76.8%) of the 220 trees sampled were either undamaged or showed only slight damage with 51 (23.2%) trees in the more severely damaged classes (Figure 8). In the KNPS however, a significantly ($\chi^2 = 20.86$; $p < 0.001$) higher proportion of trees were recorded in the more severely damaged classes as 113 and 91 of the 204 sampled were recorded in these two categories respectively.

DISCUSSION

Population structure

The distribution of the size classes in the MNR sample is indicative of a very healthy population with a high proportion of young trees and decreasing proportions into the larger (older) size classes. In the KNPN, the size class distribution suggests that the age structure of this population also favours higher proportions of younger trees than in the larger size classes. The KNPS sample however, shows an opposite trend, with a reduced proportion of trees in the younger classes (< 6m). For the 30 years prior to the present study, the KNPS supported a higher density of elephants than the KNPN. The pattern recorded in these three areas conforms closely to the results of three surveys conducted in the Ruaha National Park (Barnes 1980, 1985; Barnes *et al* 1994). Barnes *et al.* (1994) reporting on the three surveys wrote that *"The 1976 size distribution indicated a healthy population with more young than old trees. By 1982 there*

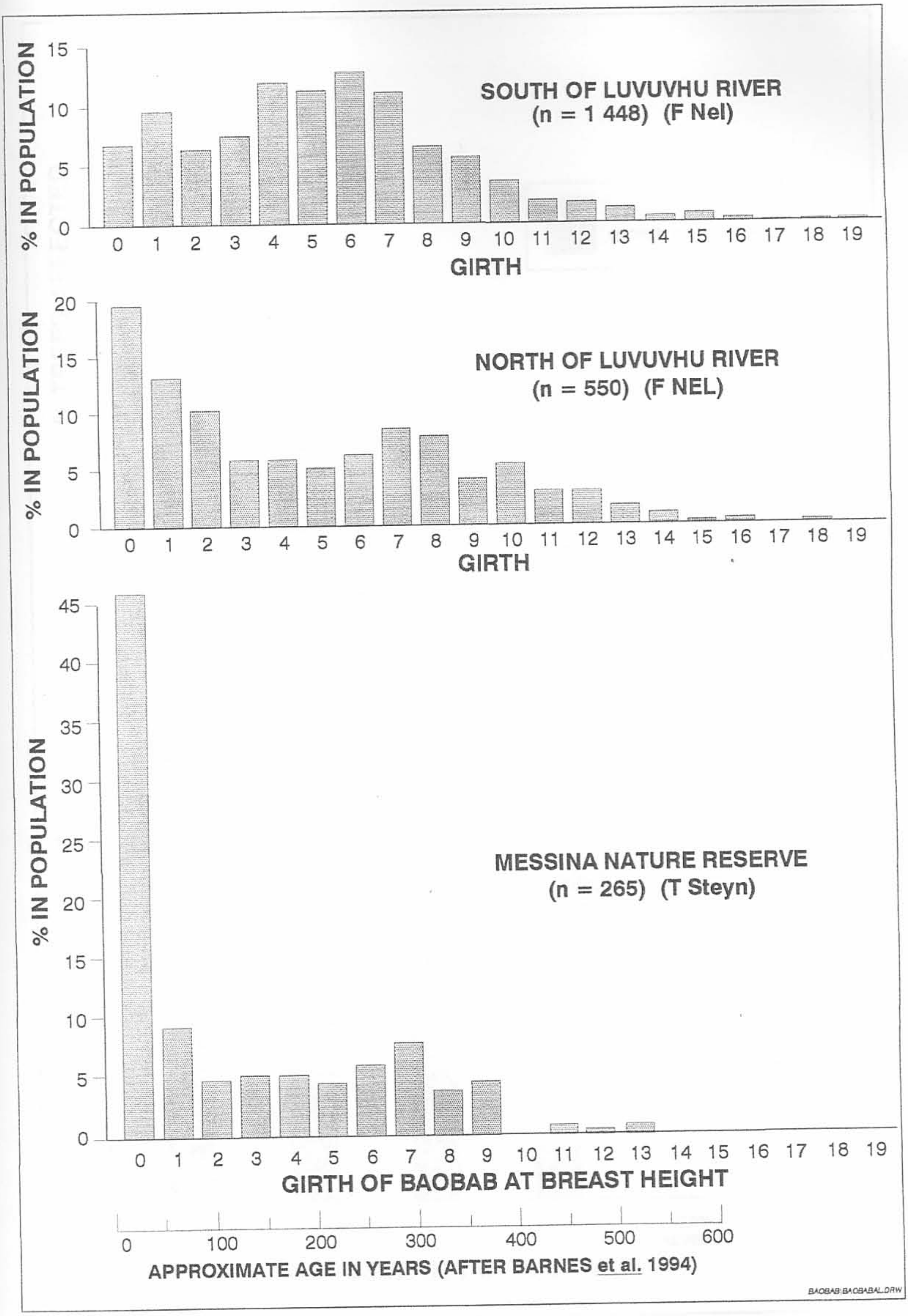

Figure 7: Size structure of the baobab populations of the three study areas and the age estimation method of Barnes *et al.* (1994).

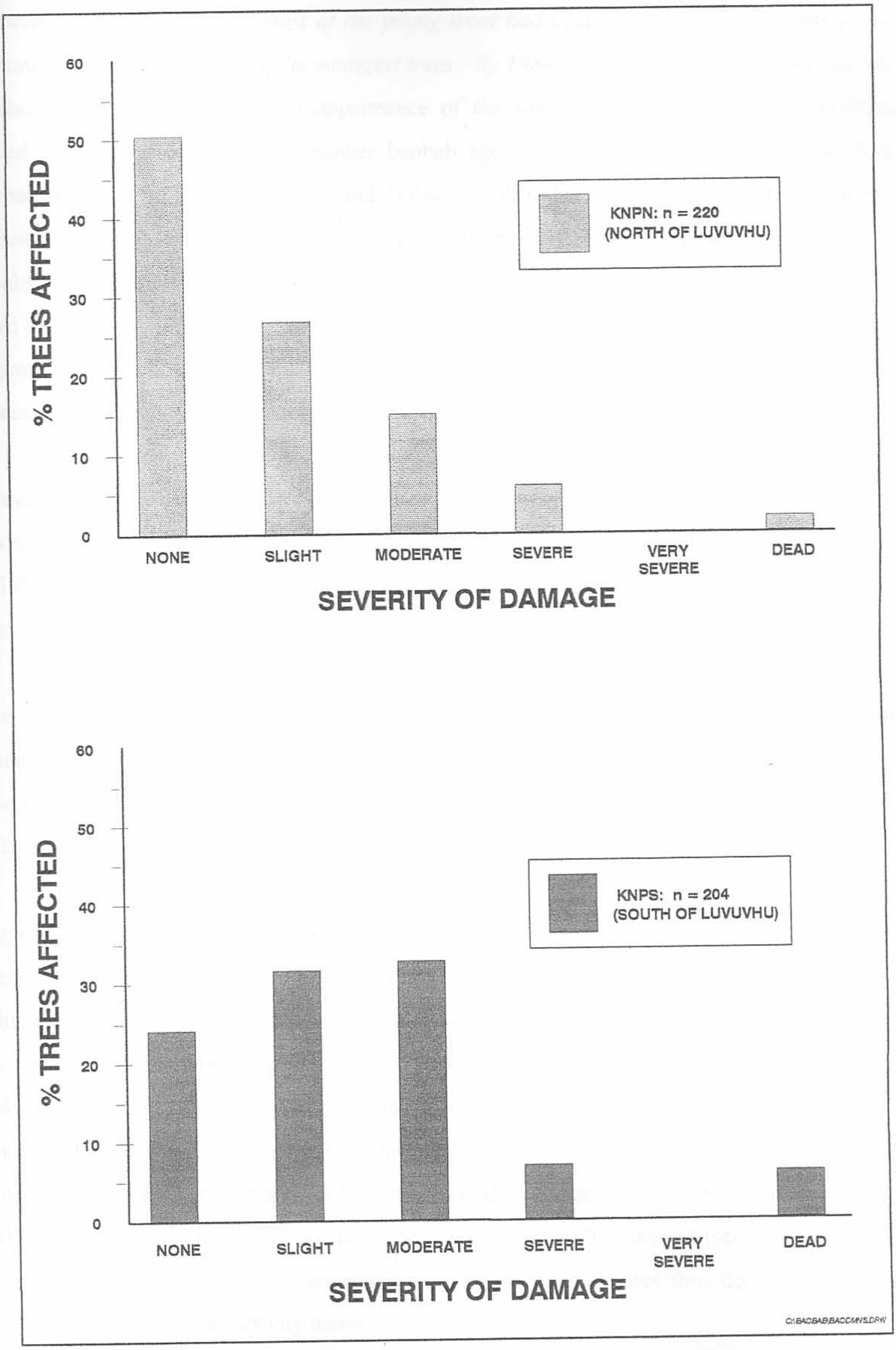

Figure 8: Classes of elephant damage to baobabs in the two study areas (KNPN and KNPS) of the Kruger National Park.

had been a dramatic change: most of the young trees had disappeared. This was due to the elephants' preference for eating the youngest trees. By 1989 there was a further change in size distribution, with the complete disappearance of the smallest class". Swanepoel (1993a) showed a similar decline in the younger baobab age classes in Mana Pools National Park (Zimbabwe) between 1984 and 1988 and Wilson (1988) also reported a lack of recruitment attributable to elephants in certain other African countries. Differences in the age structures of boababs in the three study areas may thus be the consequence of elephant damage which was shown to be significantly greater in KNPS than KNPN. Though the complete disappearance of the younger age classes has not occurred in KNPS, it is clear that recruitment is being suppressed and that a similar process is now in an earlier stage in KNPN.

However, in spite of the disappearance of the youngest size class, Barnes *et al.* (1994) could show no significant difference between the population structures recorded in Ruaha in the 1982 and 1989 surveys. They attributed this to a 60% decline in the Park's elephant bull population due to heavy poaching between 1977 and 1984.

Barnes' (1980) model of elephant predation on baobabs suggests that while an elephant population is static (not increasing), a baobab population will decline but not to the point of extinction, but that when the elephant population is increasing, extinction would be the end result.

The greater proportion of trees in the middle size classes (4 m to 9 m circumference) which are evident in the samples from all three of the study areas (Figure 7) suggest of a period in the past in which recruitment/survival rates were relatively high. This may be related to human presence in the area in the late Stone Age by the San people (up to 300 AD) and thereafter by Bantu (Cooke 1969; Eloff 1990a). Human habitation could have discouraged the presence of elephants, particularly if they had actively hunted them (see Chapter 4). This in turn could have improved recruitment/survival rates of baobabs. Based on Barnes *et al.* (1994) baobabs in these middle size classes (4 - 9 m GBH) would be between 170 and 370 years old (see Figure 7). The ages of the trees in the period of increased recruitment/survival rates thus do not match the periods of increased human activity mentioned above.

The method of Barnes *et al*. (1994) implies a linear relationship between age and GBH, while Swanepoel (1993b) showed that, at least in the Zambezi Valley, this is not the case and that growth rate varies between trees of differing GBH. Swart (1963) estimated a baobab with a girth of 14.36 m as to be 900 – 1100 years old, while the method of Barnes placed this tree in the 550 - 600 year old class.

The age determination techniques for baobabs (using GBH) are thus not consistent, and the suggestion that man's impact on elephants in turn influenced baobab recruitment/survival rates can not be supported.

Elephant damage

Pienaar (In litt.[2]) suggested that baobabs heal almost entirely, new bark being laid down *"under the outer layer of fibrous woody pulp. Within months to a year or so these trees will boast an entirely new and smooth layer of bark over their gnarled trunks when the outer fibrous debris sloughs away, and all the evidence of the debarking that remains is a ring-like scar of thickened bark at a height of 2.5 to 3 metres from ground level"*. Nel (1988) however suggested that it took around seven years for the bark of a baobab to heal after being stripped by elephants. Either way, this means that if damage is older than seven years, it is not possible to estimate when such bark stripping may have occurred. While a considerable proportion of the boababs in KNP showed evidence of "old" bark stripping (Nel 1988), the fact that no estimate of the age of the damage is possible means that this can not be used as an indication of the historical presence of elephants.

CONCLUSIONS

The majority of known baobab mortalities in KNP occurred between 1981 and 1994 during the extended dry cycle (drought) to which the Lowveld was subjected. Some trees are known to have died with very little or no visible elephant damage (Scott Ronaldson, pers. comm.[3]). Drought is clearly one of the major agents of mortality for baobabs. However, baobabs damaged (debarked) by elephants may have an increased vulnerability to drought due to increased moisture loss from the stem areas left unprotected.

It is known that elephants at extremely high densities are capable of major impacts on baobab

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populations. The rapid disappearance of these trees from Tsavo East National Park in Kenya (Leuthold 1977) is one example, and the disappearance of the youngest size classes in Ruaha (Barnes *et al* 1994) is another. In the absence of elephants (as in MNR), recruitment rates can be very high, while in KNPN the exclusion of elephants for more than 100 years has resulted in a recruiting population. Elephant damage is much less prevalent in KNPN than in KNPS. In the KNPS area where elephants have been present for longest, recruitment rates are lowest in spite of the elephant population having being maintained at a relatively low level through culling.

While it is as yet unclear whether baobab recruitment rates at current elephant densities are sufficient to maintain a stable population, it is likely that an increasing elephant population would have greater impacts (Barnes 1980). It seems reasonable to expect that due to their current confinement in KNP, elephant ranging or feeding patterns will have changed. This may have resulted in an increased pressure on baobabs. However, it seems more likely that if at any time in the past 500 to 1000 years elephant densities were significantly higher than those current in KNP, baobabs would be unlikely to occur at their current densities. Is this evidence that elephants have been at a lower density for an extended period? Other evidence presented in the Chapter 4 also supports this postulation.