SAVE THE ELEPHANTS

ELEPHANT RESEARCH

—A·P·N·R—

LOOKING AT THE VEGETATION

At this time of the year when dry grass and leafless woody species dominate the veld, we tend to apprehensively look at the feeding habits of elephant. As we wait for more rain to nourish the earth, let us take the time to look at what we know and to carefully consider what we still need to learn about the vegetation.

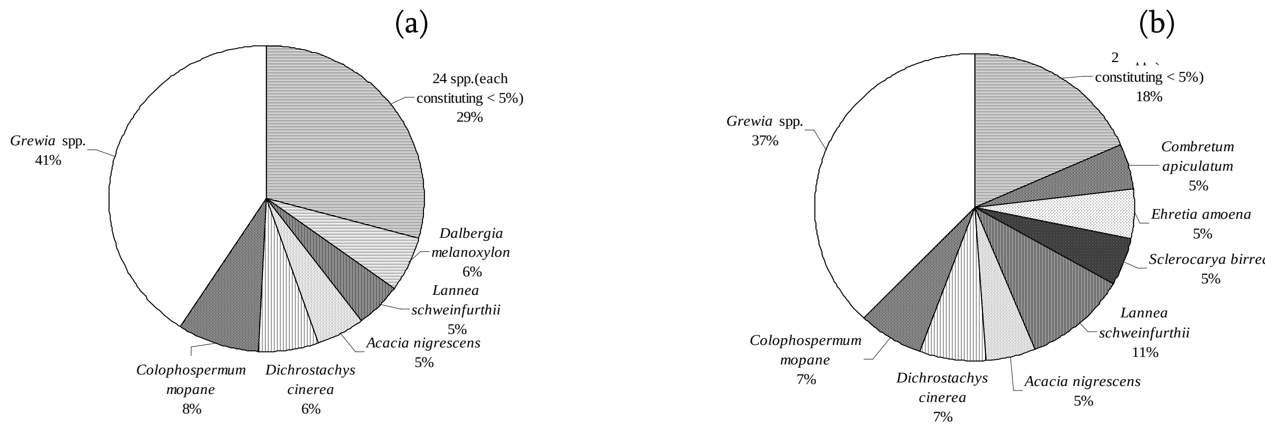
Previous findings

When I conducted my field work for two consecutive years within the Association of Private Nature Reserves (APNR) during the dry season, I was looking at distinctions in the feeding behaviour of elephant bull groups and family units. Each social unit was quantified separately as bull groups and family units were found to select different woody species in Chobe National Park (Stokke & du Toit 2000). The high density of elephants in Chobe, coupled with the differences in body size between bulls and cows probably gave rise to the dissimilar diets of each social unit. Resource partitioning between the sexes could be one way of meeting nutritional requirements during periods of resource limitation.

My results show that both bull groups and family units utilised only 9% of the 5 780 individual woody plants that were available to them. A dry season dietary shift to browse was confirmed by carbon isotope analysis of faecal samples where a diet dominated by woody browse in the dry season (80%), reached near equal proportions of grass:browse by the wet season. During the dry season elephants, irrespective of social structure, frequently ate a narrow range of 6-8 woody species. *Grewia* species were the principle food to both family units and bull groups as this set of species had the highest relative dietary contribution when compared to other utilised species (refer to the figure below). When considering which plant species are favoured by elephants, one has to also take their availability and not only their acceptability into account. Five woody plant i.e. *Albizia harveyi*, *Colophospermum mopane*, *Dalbergia melanoxylon*, *Dichrostachys cinerea* and *Lannea schwienfurthii* were identified as plants favoured by both types of social unit. In addition, bull groups favoured *Sclerocarya birrea*. These six woody species together with *Grewia* spp. were utilized during 72% and 70% of all feeding events by bull groups and family units respectively.

Although similar in terms of plant species composition, the diets of bull groups and family units differed in the plant parts ingested. Bulls accepted plant species and plant parts high in calcium content while family units utilised parts high in sugar and low in fibre content. The results suggest that energy intake and digestibility might govern the diet choices of family units.

Calcium may be of particular importance to bulls because of their large skeletons and longer growth curves when compared to females. Furthermore, calcium is important to tusk formation and although tusk growth is continuous for both males and females, the mean tusk weight for males over 50 is six times greater than for females of similar age (Laws 1966).

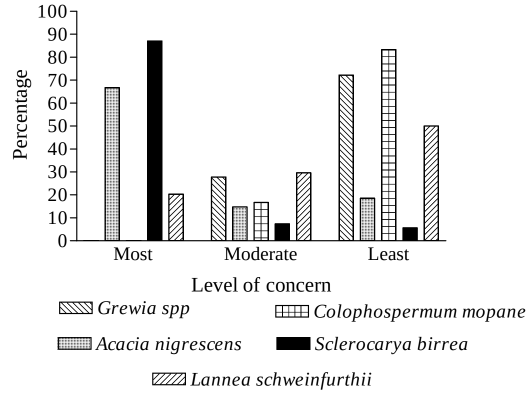


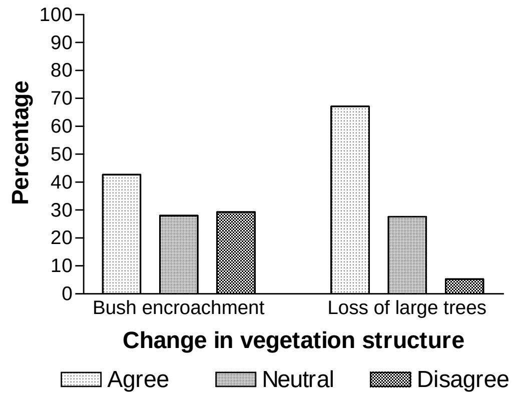
Relative dietary contributions of woody plant species that were utilised by (a) family units and (b) bull groups of elephants during the dry season period of resource limitation.

Your input from the questionnaires

These results are based on 76 questionnaires that were completed by APNR landowners. *Grewia* spp. and *Colophospermum mopane* were identified as woody species of least concern to landowners while *Acacia nigrescens* and *Sclerocarya birrea* were of greatest concern to the respondents. Other plant species of possible concern to the respondents, with regard to elephant utilisation, included *Acacia gerradii*, *Acacia mellifera, Acacia tortilis, Albizia amara, Albizia harveyi, Boscia albitrunca, Combretum apiculatum, Combretum imberbe, Commiphora* spp., *Dalbergia melanoxylon, Diospyros mespiliformis, Lannea discolour, Lonchocarpus capassa, Manikara mochisia, Pterocarpus rotundifolius, Schotia brachypetala, Sterculia rogersii, Xanthocercis zambesiaca.* These species were however infrequently listed by respondents. The majority of landowners thought that the vegetation structure had changed over time with bush encroachment increasing and tall trees being lost to the system.

The fact that *Grewia* species have been shown to be the principle forage species of elephant in the APNR implies that elephant may have a positive role to play in the control of bush encroachment (a successionary process that some scientists believe will speed up with the increase in atmospheric carbon and 'greenhouse' gases). The impact of elephants on *Acacia nigrescens* and *Sclerocarya birrea* needs to be evaluated. A number of methods have been proposed to minimise the risk of damage to such aesthetically important species including the wiring of tree trunks to prevent bark stripping, the packing of stones around the base and the placement of bee hives in trees (I. Douglas-Hamilton pers. comm.). The question then needs to be asked: if the impact upon these species can be minimised, what remains of the 'elephant problem'?





The proportion of questionnaire respondents most concerned, moderately concerned or least concerned about the utilisation of woody species by elephants. The second figure depicts respondents' opinions on the changes in the vegetation structure.

Points to ponder

Before considering where all this information leaves us, I would like to discuss a few concepts which often govern our way of thinking.

Although concepts such as 'carrying capacity' have been used to manage wild herbivores since the early nineteenth century (Leopold 1933), carrying capacity remains a mathematical abstraction rather than a measurement of sustainable population size (Macnab 1985). This is especially true when measured within variable environments where carrying capacity can fluctuate by an order of magnitude between extreme seasons or years. Carrying capacity can therefore not be viewed as a measurement of long-term equilibrium density but can at best reflect a short-term potential density as a function of resource availability (McLeod 1997). Furthermore, a distinction should be made between 'economic carrying capacity' and 'ecological carrying capacity'. The former refers to the density of stock that provides maximum sustained yield to range managers and farmers. The latter is the average density a population assumes over a long period and since the density of animals is higher than at economic carrying capacity, the pressure of grazing and browsing is heavier and the long-term composition of the vegetation is different

(Caughley 1983). Thus while stock-farming aims at optimum production for optimum utilisation, ecological systems are maintained through natural selection which are often in operation because of inevitable changes in the vegetation as herbivore populations increase towards saturation levels and then decrease as they become limited by food resources.

Culling in the Kruger National Park took place in accordance with a target density of one elephant per square mile (0.4 elephants/km^2) which was maintained for 27 years (1967-1994) (Whyte 2001). This figure was originally suggested on the basis of elephant densities that were believed to exist in the Kruger and Hwange National Parks when vegetation damage was first perceived. Subsequently accurate counts have shown that elephant densities in Hwange were about 2.5 times this figure (Owen-Smith 1988). It should also be remembered that even at low densities of elephant, utilization of preferred species will still occur. Pellew (1983a) found that mature *Acacia tortilis* trees were being lost at a rate of 6% per annum despite an elephant density of 0.2 elephants/km^2. Furthermore, it remains uncertain whether declines in certain tree or animal species as a result of elephant utilisation have not been balanced by increases in other formerly rare species. Although reports from Tsavo in Kenya documented a decline in other browsers after the near elimination of *Commiphora* thickets by elephants, increases in open country grazers were also reported. Hence reductions in species diversity as a result of changes in the vegetation caused by elephants are undocumented (Owen-Smith 1988). There are at present no authentic reports of an irreversibly degraded natural ecosystem caused by elephant over-utilisation (Sinclair 1983).

In most parks the vegetation structure and composition has developed in the absence of elephants over a 70-100 year period. Elephants within most protected areas are in a phase of increase from low densities caused by excessive ivory hunting at the turn of the previous century. Although the vegetation is being modified by expanding elephant numbers, we are still unsure whether long term food production for elephants is being increased or decreased or whether the vegetation is not merely reverting to prehistoric times when elephants were unaffected by human hunting (Owen-Smith 1988).

Changes in the vegetation structure should not always be perceived as detrimental to the system. Habitats and natural populations are not static and as an ecologist, one realises that change has and will always be an integral component of ecosystem functioning. Pre-emptive culling to maintain a given state may also pre-empt the operation process of natural selection that have shaped the characteristics of the species (Owen-smith 1988). There is an increasing understanding amongst ecologists that keeping a system static for too long could eventually lead to a cumulative loss of resilience and stability with an increasing probability of catastrophe (Walker 1981, Holling 1973, Holling 1995). Elephant-induced vegetation change can also be beneficial especially for smaller species of herbivore. Taller, palatable woody species pushed over by elephants frequently respond to breakage by recoppicing. This increases the quantity of food available to other browses (Bell 1981). More nutrient rich vegetation can also be induced by elephant utilisation as repeated heavy browsing of plants can depress their contents of deterrent chemicals (Bryant, Chapin & Klein 1983). Lastly, *Acacia* seedling establishment does not occur under mature tree canopies. Elephants potentially promote the replacement of mature trees by opening the canopy with a consequential greater density of regenerating saplings (Pellew 1983a).

Where to from here?

What we do know is that large elephant populations can reduce the ability of future populations of elephants to survive droughts which will cause populations to be more susceptible to episodic mortality during such times. If dispersal is prohibited through fences or water-stabilising programmes, then episodic overexploitation of the vegetation can occur. The effects of drought will effect juvenile recruitment because of reduced calf survival and delayed conceptions while only minor increases in adult mortality will occur (Owen-Smith 1988). It is important to remember that if the constraints of dry years are removed, the recovery in wet years is more likely to overshoot (Laws 1981). Furthermore, culling invariably results in an increased birth rate because food supply per head is raised (Caughley 1983).

Annual aerial censuses have indicated that elephant numbers within the APNR have increased in recent years to a density of approximately 0.4 elephant/ km^2 (I.J. Whyte pers comm.). The increase is thought to represent an influx of elephants from the KNP following the removal of the western boundary fence in 1993 (Joubert 1996). Further increases in elephant numbers are expected because the APNR population adjoins a so-called high elephant density zone within the KNP, where elephant numbers are allowed to increase following the termination of culling operations in 1994 and the implementation of a new elephant management policy (Whyte *et al.* 1999). According to this policy the KNP has been divided into six zones where different elephant densities will be maintained. In low density zones, elephants will either be translocated or culled if other alternatives can not be found and if elephant impact has exceeded thresholds of potential concern. Coupled with the removal of a large number of waterholes this policy has the following potential advantages (Owen-Smith 1988): (1) dispersal as a response to the depletion of habitat resources is encouraged (2) surplus individuals removed within the low density zones are selected by natural mechanisms operating within the population (3) population densities in the high density zones can adjust more naturally according to food resources and climatic cycles (4) the population structure is not artificially distorted within the high density zones. (5) aesthetic features of landscapes are not compromised in the botanical reserve zones while elephants within the high density zones are not subjected to the side-effects of culling or translocation operations (6) spatial diversity is enhanced which enables species sensitive to elephant impacts to take refuge in the low density zones.

I suggest that under natural circumstances, any localised over exploitation of woody vegetation within the APNR would be prevented by dispersal. Contrary to the problems facing elephant populations within small private nature reserves, the APNR represents a reserve of approximately 1800 km^2 and furthermore borders on the KNP with a size of 18 992 km^2 (Whyte 2001), which itself has recently become part of an even larger Transfrontier Conservation Area (Braack 2000). Since the removal of the western boundary fence between the APNR and the KNP, the APNR is likely functioning as a dispersal sink (Owen-Smith 1983). Although not yet documented, I expect bulls to emigrate from the KNP more frequently than family units, as bulls are known to cover larger areas than family units and are generally the first to colonise new areas (Hall-Martin 1992). The vegetation structure and composition can thus be expected to change as more and more elephants utilise the APNR. While elephants should disperse once their resource base becomes heavily utilised, the extensive network of artificial water points within the APNR may interfere with this process. The KNP is currently decreasing the number of artificial water points there (Whyte 2001) while waterholes in the APNR are spaced no further than 2 km apart (Stalmans *et al.* 2003). Consequently, elephants may remain in the proximity of the APNR's many water sources during the dry season instead of seeking out areas offering them more suitable food resources. I suggest that in the long run, landowner's concern for woodlands would best be resolved by the systematic removal of waterholes. It makes ecological sense that in the dry season elephants tend to congregate near perennial rivers and more persistant water sources, thereby diminishing their impact at a landscape scale. In the wet season when water is freely available, their impact will be more evenly spread across the landscape. The impact of elephants on the woody vegetation should be lower in the wet season because woody species don't constitute such a large proportion of their diet. Furthermore, impacted woody species would be most likely to recover in the growing season as well as during the coming dry season when elephants would, under natural circumstances, tend to move away from these impacted areas in search of water. Artificial water points thus potentially decrease both spatial and temporal variability (Walker & Goodman 1983). Natural cycles of local over utilization of the vegetation due to high densities of herbivores around ephemeral water sources are consequently not followed by recovery periods once animals are forced to disperse to more permanent sources of water.

If management decisions are to be based on the concept of carrying capacity, ongoing monitoring and continual reassessment are required before implementation in environments such as the APNR. De Villiers (1994) concluded that food availability was more than adequate and indicated a mean carrying capacity of 4.7 elephants /km^2 in which the study area (the Klaserie and Timbavati Private Nature Reserves) could carry at least twice the elephant density (0.35 elephants /km2) at the time of the study. It would also be important to realise that with the removal of the boundary between the APNR and the KNP, the elephant population within the APNR can't be viewed in isolation. The incorporation of various adjacent reserves into the Greater KNP Biosphere would also necessitate recalculations to obtain more updated indications of possible carrying capacity. Defining carrying capacity levels for elephants, which are capable of large-scale movements, which have not yet been established within the APNR, would thus seem superfluous. It is apparent that insights into patterns of movement and population growth rates within the APNR are of significance to all the above, including the concerns of landowners and managers.

When considering the vegetation the most important step would be to determine the percentage of trees killed per annum and whether recruitment by surviving saplings and seedlings can maintain the tree population (Owen-Smith 1988). If this is monitored over a sufficiently long period, we could potentially predict changes in species composition and structure over time. The condition of the system can thus be assessed although this gives little or no insight into the numerous underlying processes that affect the status of the components (mature trees and elephants) in an ecosystem (Caughley 1983, Sinclair 1983, Owen-Smith 1988). Without knowledge of the causal effects of changes in the vegetation, removing elephants could merely slow down the rate of decline of mature trees with no recovery. For example Pellew (1983b) found that burning and giraffe culling would encouraged mature canopy recovery more efficiently in the long-term than measures to reduce tree mortality (elephant culling). He concluded that if continuity of a mature canopy is desired, then continual recruitment is essential.

Too often management decisions are based on subjectively preconceived ideas of what natural processes should take place in the absence of a clear understanding of the intricate interrelationships between the various components. Rational strategies can only be achieved by setting up long-term monitoring sites that specifically test cause-effect relationships (Joubert 1983). To achieve this a monitoring system would need to be put into place which would not merely track changes but look at causal effects by creating control areas which separate the effects of elephants from those due to climatic cycles, fire, soil properties and other herbivores which potentially could prevent recruitment of seedlings (browsing by impalas) or retard recruitment into mature height classes (browsing by giraffe). The only way in which these objectives can be met is by exclusion experiments (Sinclair 1983, Mallan 1992). Elephant impact on woody species has and is currently being monitored at 90 sites annually within the APNR along fixed transects (25m X 25m) within each of the major vegetation types (M.J.S. Peel pers. comm.). Adjacent to these transects, close enough to ensure similar vegetation types and edaphic factors, a plot with an Armstrong fence could be erected to exclude all types of herbivore. Another plot fenced with an electrified fence (operated by a solar panel) and set at a certain height would exclude larger herbivores such as elephant and giraffe but still allow us to monitor the impact of other ungulates on seedling survival. On all three plots edaphic and climatic variables should be carefully monitored and vegetation surveys conducted on a regular basis.

I would like to conclude by encouraging us to move away from descriptive analyses on interannual variations in the vegetation because climatic and edaphic and other external factors are not properly controlled for (Johnson *et al.* 1996). Given the little that we know the wisest strategy appears to be to move cautiously with all interventions as Miller (1983) said. Personally I agree with Caughley (1983) when he stated:

"I am intrigued by ecological processes, delighted by the dynamics of both plant and animal populations, and impressed by the adaptive solutions that evolution has bestowed upon them. These days I can watch these processes at work relatively unfettered in only a few places, and most of those places are designated parks. I warm to a national park according to how much it differs from an efficient farm, a cultured botanical garden, or a well-run zoo. Where Bell* is likely to reach for his Mauser, I am likely to wait and watch a little longer, perhaps because I have more faith in ecological processes and in the robustness of their solutions…."

*Caughley here refers to one of his scientific colleagues.

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