

CHAPTER 7

POLICY REVIEW PHASE 2B:

AN INTEGRATED UNDERSTANDING OF GROWING ELEPHANT POPULATIONS AND THEIR MANAGEMENT EMERGES

In the events and discussions held from 1996 to 2005 stakeholders, managers and scientists raised concerns about the potential impacts of growing elephant population in South Africa's national parks. Four main concerns were expressed:

- The impacts of animals which leave parks through fencebreaks by elephant
- Human-elephant conflict in the areas neighbouring parks.
- Changing appearance of landscapes
- Impacts on the structural, functional and compositional biodiversity of ecosystems within parks.

The full content and context of these concerns is synthesised below. As the causal mechanisms for the last two concerns are linked these will be discussed together.

Fence breaks and their consequences

Though in South Africa elephants are mostly confined within 'hard' boundaries, these do not always serve to keep them within protected areas. On KNP's western boundary fencebreaking by elephants peaks in February and March – the marula season – as they seek out these trees and their favoured fruit beyond the borders of the park. Elephants also leave the park in the dry season in search of water and bulls in musth will travel large distances in search of oestrous cows. KNP researchers have reported a strong correlation between areas and periods of high elephant population densities and the number of fence breaks. The cost of fence breaks is counted not only in the expense of maintenance but in the potential for other species to leave the park – predators which escape may kill livestock, and there is a risk of buffalo, kudu, wildebeest and warthog spreading livestock diseases such as theileriosis, brucellosis, bovine tuberculosis and foot and mouth disease. Foot and mouth disease is of the greatest economic concern. Though control measures are in place, such as risk zonation, and regular inspection and vaccination of livestock within the buffer zone, four outbreaks of foot and mouth have occurred in the area to the west of KNP since 2000, all of which were associated with fence breaks which allowed buffalo to come into contact with cattle¹⁷. Should there be an outbreak of foot and mouth disease outside the control zone, South Africa would lose its foot and mouth free status for international trade in animal products, a scenario with serious economic implications for the entire country.

There are a number of factors which contribute to breaches of the fence on the western boundary of KNP or which make it easier for elephant to do so. In an attempt to contain elephant more successfully, KNP have installed electric fences but these are interfered with by illegal immigrants entering South Africa via KNP, or by locals who enter the park to poach, or to harvest wood, thatching grass, honey or medicinal plants. Theft of solar panels and batteries provide

further obstacles to the maintenance of an effective boundary. It is then easy for elephants to walk over the fence, often ripping up large sections as they move along.

Human-elephant conflict

Even without the problems of fence-breaking by people or elephants, the western boundary of KNP is crossed by a multitude of streams and drainage lines, making it impossible to have a continuous and consistent fence system. Elephants which are able to leave the park through, over or around the fence, then find themselves as unwelcome guests on the lands of neighbouring communities. Here they often cause damage to crops, water installations and dwellings. Though crop losses in these areas are attributed to many animals which are more frequent visitors than elephants – such as rodents, bush pigs, monkeys and baboons – the effect of a single elephant on a single occasion can be devastating. Elephant raids occur most often just before harvest, and can destroy an entire crop in one night. Elephants are also a threat to human life and are difficult to chase away²². The social cost of human-elephant conflict rises as children stay home from school and adults spend their nights in their fields to guard crops. Household chores such as collecting water and firewood are disrupted, and daytime productivity is affected by nights spent without sleep.

Confusion over the jurisdiction of provincial versus KNP authorities with regard to animals found outside the park, the slow response by authorities, and a lack of capacity for dealing with human-elephant conflict exacerbates the problem and the community's sense of helplessness. All these factors potentially contribute to the cost of human-elephant conflict in fostering negative attitudes among communities toward parks and conservation.

Elephants, biodiversity and landscape change

The greatest controversy within the scientific aspect of the debate, since the flux of nature paradigm gained precedence, has been the potential impact of elephants on biodiversity.

The scale of elephant's role and impact within ecosystems is relative to their great size, strength and mobility. An adult male consumes about 180kg of food a day²³ and needs to drink approximately every 48 hours. In the wet season, elephants are mostly grazers – feeding on the highly palatable grass species which resurge after the first spring rains. In winter, when the savanna grasses die back, elephants switch to browsing, eating leaves and branches, stripping bark and occasionally even taking roots of trees. Elephants are selective feeders at the plant species level – therefore different impacts are observed for different tree species found within the same area. Elephants fell or uproot trees, sometimes feeding on branch tips or roots, but on other occasions walk away without feeding – suggesting that some tree pushing may be a male social display unrelated to feeding. Elephants may travel great distances in search of food, but are limited in their movements by their need for water – the greatest impacts on vegetation are therefore usually observed in areas close to water.

The scale and extent of elephant influence has led to them being referred to as **keystone species** and **system engineers** of savanna ecosystems. Elephants serve a number of important ecological functions: creation of paths and clearings, configuration of riverbeds, formation of waterholes, seed dispersal, germination facilitation, litter production, nutrient dispersal, nutrient cycling, and

preventing bush encroachment in grasslands²⁴. The absence of elephant from landscapes in which they used to occur can thus cause a loss or change in ecological function, structure and diversity.

Disturbances, such as those created by elephant feeding activities, help to enhance **heterogeneity** and thus generate conditions for a variety of species to coexist. However, if disturbance is too frequent or too extensive, it is likely that progressive landscape change will occur over time and ultimately lead to a loss of heterogeneity and diversity.

The main influences of elephant on vegetation become visible as a **change in plant species composition** (loss or gain of species or a combination) and a **change in vegetation structure**, usually manifest as a reduction in tall trees and/or a change in the tree/grass ratio. It is mostly the potential impacts of elephant on the abundance of woody plants, and particularly big trees, which has led to concerns about growing elephant populations in South Africa's national parks. In KNP, fixed point photographs and fence line contrasts have been used to demonstrate the influence of elephant on vegetation. Photographs taken at the same points since the late 1970s show taller trees steadily diminishing in abundance. Of the 60 sites monitored 49 sites experienced a net decrease in the abundance of tall trees (greater than 5 metres). Tall trees are a component of both structural and functional diversity – vultures and other birds require sufficiently large trees for nesting and tall trees are essential habitat for 40% of bird, 15% of small mammals, 6% of amphibians, and 5% of reptile species in KNP. A large number of insect species also inhabit tall tree canopies⁹.

The loss of trees also has implications for the **aesthetic qualities** of the savanna landscape²⁵. Large trees such as marula (*Sclerocarya caffra*), baobab (*Adansonia digitata*), knobthorn (*Acacia nigresens*) and kiaat (*Pterocarpus angolensis*) form part of the 'sense of place' attributed to the lowveld landscape by tourists and locals alike. Should the rate of loss of mature trees not be matched by the establishment of seedlings in the same or other patches over time, there could be a complete **conversion of savanna to shrubland or open grassland**, a deteriorating habitat for many other species, and ultimately also for elephant. Diminishing food resources will eventually lead to a decrease in the population growth rate of elephant. Should this happen suddenly, such as through a devastating drought, it could lead to a **population crash** for elephants and other browsers.

Changes of this nature have been reported for other parks in Africa which have decided not to intervene in growing elephant populations. Often brought into the debate as examples of 'ecological disasters' are **Chobe** National Park in Botswana, **Amboseli** and **Tsavo** East National Park in Kenya, **Hwange** in Zimbabwe, and the **Rwindi Plain** in DRC. Local changes have been dramatic – at Rwindi and Tsavo dense thickets and woodland were transformed to open grassland and 7000 elephant subsequently starved to death at Tsavo in a drought that spanned two years. Elephant impacts have resulted in almost complete removal of the mature riparian forest at Chobe, and at Amboseli species such as lesser kudu, bushbuck, and gerenuks are no longer found in the park, with giraffe now only recorded as occasional vagrants¹⁸. Some have used these examples to suggest that allowing elephant population growth to take its natural course is choosing the inevitable scenario of reducing our national parks to 'elephants and dust'.

Others argue that the changes brought about in these parks have been exaggerated, being severe but extremely localised in their extent. At Chobe and Hwange woodlands were transformed into shrublands in areas close to water but the plant species that were affected are widely distributed. At Tsavo riparian woodlands have regenerated following the die-off of elephants²⁵. It is also not considered appropriate to extrapolate from experiences in parks with very different soils, climate

and vegetation in order to predict outcomes for South Africa's landscapes and elephant populations.

One aspect which is comparable is that observed changes in vegetation over the last few decades need to be viewed in the context of centuries of ecosystem change. Severe human impacts of the previous two centuries have left a legacy in the vegetation which established at the time. The vegetation, particularly big trees, recorded historically in KNP and in Chobe's riparian forest, was able to establish due to the absence of elephants together with low densities of other herbivores as a result of ivory and other hunting and the introduction by European settlers of rinderpest. The phenomenon of '**megaherbivore release**' – which results in changes to ecosystems due to the absence of elephants – is used to argue that the changes observed with increasing elephant densities are merely a return to a situation that existed prior to elephant removal.

With increasing populations of elephants and other browsers a decline in canopy cover over time is to be expected, and is evidenced in KNP by the loss of woody vegetation which has persisted through almost three decades of elephant population control. Changes in ecosystem attributes over time are also a reflection of the flux of nature. Though the low levels of herbivory experienced toward the end of the 19th century were due to a catastrophe of human origins, establishment during episodic windows of opportunity seems to be a general feature of woodlands subject to wide variability in rainfall, fire frequency and herbivory²⁵.

Unacceptable and irreversible ecosystem change

But if change is natural and expected, why is so much concern expressed by scientists and stakeholders about potential landscape change in KNP and other national parks?

It is generally accepted that past elephant impacts on vegetation in Africa must have been variable and patchy. Parts of the landscape would experience periods of high impact leading to reduced woodland and more grassland. Elephant would then move on to other areas providing opportunity for woodland 'recovery'. The African landscape would then consist of a mosaic of patches of different stages of elephant impact and vegetation 'recovery'. A general principle is that the reduction of woodland (to shrubs and/or grassland) by elephant occurs much faster than recovery in their absence²⁰.

There is now concern that the **shifting mosaic of high and low elephant impacts** has been homogenised by providing permanent water throughout parks and by preventing the migrations that allowed vegetation the time and opportunity to regenerate. Whether changes (to shrub thicket or grassland) have adverse ecological consequences depends not on their local severity but on their extent²⁵. Sustaining the mosaic and the biodiversity it holds requires a range of elephant impacts to be maintained across space and time. At low elephant densities, disturbance-sensitive species thrive, at high density, disturbance-tolerant species thrive. But in parks where populations are confined or find no need to migrate in search of water, elephant densities remain at high levels all the time creating ever-expanding patches of highly impacted vegetation, which could spread to cover a large fraction of the available area. The likelihood of this occurring is relative to the size of a park, but more importantly to the existence of **refuges**²⁵ – areas that provide protection from the impacts of both elephants and other factors which limit regeneration.

The risk of permanent loss of species is now much higher than ever before, due to diminishing habitat for rare species as a result of human development, which is soon to be compounded by the

effects of climate change. The risk and **acceptability of change** needs to be assessed relative to human values and perceptions. Both the definition of biodiversity loss and the **reversibility** of ecosystem changes are relative to human needs and timeframes. For example, it may be decided that biodiversity loss is not of concern if species lost are abundant elsewhere. Similarly, whether changes are termed irreversible depends on one's time frame – ecosystem processes, particularly those involved in woodland dynamics, extend well beyond the timeframe of most relevance to individual humans, and in many cases can span several human lifetimes.

Predicting the outcome of interacting variables: fire, climate, elephants and other herbivores

Predicting what kind of impacts are likely, and when and whether a particular elephant population size or distribution poses a threat to biodiversity or other values, is subject to various sources of uncertainty.

There is general agreement that high densities of elephant can lead to short-term modification or loss of savanna woodland. However, in the long term several scenarios are thought to be possible. Species could become locally extinct, constituting irreversible change that could also result in elephant deaths on a large scale. Alternatively, elephant populations could be self-regulating, with decreasing food availability resulting in declining fertility and increased mortality, and causing any elephant induced changes to be short term and cyclical²⁶.

The effects of previous management interventions on the age structure of elephant populations could determine whether they will be able to avoid a catastrophic crash by timely density-dependent reproductive responses. Any relatively young population will show eruptive growth²⁷ and is likely to overshoot its key resource, causing a crash and elephant deaths by starvation.

Driving variables in savannas include nutrients, moisture, fire and herbivory – not only by megaherbivores but by insects, rodents and antelope. It is believed that most of the important changes in savannas are event-driven. In particular it is the co-occurrence of two or more events which is able to bring about a fundamental shift in ecosystem state. Disturbances which occur together have an effect which is far more severe than the simple addition of their individual impacts – a factor which is an important source of complexity and uncertainty in ecosystem management.

Fire, for example, is an important factor in the mortality of tall trees. Though bark stripping by elephant or other animals such as porcupine does not kill trees, trees subject to this type of damage are more likely to die in fires. Elephant impacts in general may also increase the frequency of tree-damaging fires as the amount of grass fuel increases in more open woodland²⁸. It is thought that fire in conjunction with elephant impacts may have resulted in the loss of large trees in KNP between 1960 and 1989²⁹. There are also interactions with rainfall – trees damaged by elephants are more likely to die during drought than wet years. Debarking of trees may also make them more susceptible to damage by wood-boring insects.

But some of the negative impacts attributed to elephants could also occur in their absence. Though it is elephants that kill large trees, it is smaller animals such as bushbuck, impala and rodents that eat seeds and seedlings and prevent the recruitment of young trees. The problem which could lead to a conversion of savanna to shrubland or grassland is not only the loss of big trees but the combination of this with a lack of recruitment from smaller size classes to replace

them. Other agents, such as fire and browsers – particularly impala – play a role in delaying or preventing the establishment of large trees²⁵.

The issue of regeneration is then key, but again a number of uncertainties arise: Processes governing regeneration include the actions of elephants, browsers, fire and climate variability and predicting whether regeneration will occur requires reliable specification of how these factors interact within specific ecosystem contexts. Elephants prefer some species over others and their influences are played out through the complex interaction of plant attributes (e.g. mode of reproduction, ability to sprout), plant community processes (e.g. plant succession, competition between plant species) and ecosystem drivers (fire, drought, other herbivores). The outcome of these interactions can manifest differently in vegetation at different scales, and with different management histories. It is therefore often difficult, in specific situations, to separate elephant effects on vegetation from other disturbance drivers such as fire, drought and other herbivores⁹.

Predicting the outcome of management scenarios for elephants and other factors is thus difficult. Reversing effects brought about by elephants may involve factors other than elephants. For example, though elephants were largely responsible for removing large tracts of riparian forest in Chobe, evidence suggests that it is currently impala that are preventing regeneration of *Acacia*¹⁸. Interventions to control elephants therefore do not carry the assurance of reversing the changes that they brought about.

What then are the management options?

Though there is some disagreement as to the extent, acceptability and likelihood of potential negative impacts of growing elephant populations, the most heated aspect of the debate has continued to be the ethical acceptability, appropriateness and effectiveness of various management options.

All participants agree that there is a limited range of management options for reducing the potential negative impacts of elephants on landscapes and biodiversity – should management be necessary. These are:

- Do nothing – with or without additional information collection
- Expand elephant habitat
 - o Increase the size of parks
 - o Create corridors linking parks and thus create metapopulations
- Habitat restriction within parks
 - o Close water points permanently or cyclically
 - o Fence vulnerable vegetation to exclude elephant
- Reduce birth rate by contraception.
- Translocation of elephants to establish new populations or enhance existing populations in new conservation areas.
- Increase mortality to reduce population growth rate and/or size
 - o Introduce biological control through predators and disease
 - o Allow hunting and fail to control poaching
 - o Culling (blanket or selective) control in the form of predators or diseases

This first priority of management is to address ecological and biodiversity goals. However there are also economic (options to protect local livelihoods and ensure disease control) and social

(options to protect and benefit communities) objectives to consider. There are also many issues that must be taken into account when weighing up the different options²⁰:

- *Environmental issues:*
 - o Consequences for compositional, structural and functional biodiversity.
 - o Long term effects on elephant: social structure, behaviour, health/welfare, genetic diversity, population dynamics.
- *Social issues:*
 - o Need to consider affected communities, local stakeholders, potential for provision of benefits where possible.
- *Economic issues:*
 - o Impact of chosen strategy on local and national livelihoods and revenue generation, e.g. potential intended and unintended effects on tourism.
- *Political issues:*
 - o Implications for the rest of SADC, transfrontier parks and international trade
 - o The need to take into account the potential influence of lobby groups.
- *Ethical issues:*
 - o These relate to both the choice of management option and the principles governing its implementation. Ethical dimensions include impacts on elephants, other species, biodiversity and victims of human-elephant conflict.
- *Legal issues:*
 - o Compliance with international conventions and national legislation.
- *Feasibility:*
 - o Is it possible to meet the technical, physical, legal, financial, logistic and infrastructure requirements for implementation?
- *Institutional and park image:*
 - o Impact on branding, media, tourism and donor funding.

Do nothing (laissez faire)

One option for managing elephant populations is to not manage them. Known as a *laissez faire* policy this allows for natural population fluctuations, and has been adopted by countries such as Kenya in recent decades. It has also been the policy implemented by default for South Africa's national parks since 1995.

Rationale:

- Elephant population growth rate will decrease in response to decreasing resource availability before irreversible or unacceptable habitat change results.

Advantages:

- Avoid an immediate decision and thus the potential negative reactions resulting from more active management approaches.

Concerns:

- Risk of loss of biodiversity if no natural limitation of populations occurs. There has been no evidence of density-dependent or independent regulation of population growth in KNP since the moratorium on culling.
- Potential negative reaction of tourists to changing landscapes.

Ethical concerns:

- Participants at the indaba expressed the concern that population die-offs resulting from habitat degradation and starvation may be more traumatic for elephants than culling.

Habitat expansion: metapopulation dynamics within megaparks

The development of transfrontier parks is expanding the size and connectedness of southern Africa's protected areas and elephant ranges. Metapopulation dynamics is a population management option which is more than just range expansion but explicitly addresses how elephants use of space and resources affects their dispersal behaviour and population dynamics.

Rationale:

- Restoration of natural migration and dispersal processes by linking protected areas and removing factors such as fencing, water holes and human settlements will enable elephant populations to limit their own density more effectively³⁰. The megaparks so created will need to encompass or link areas where elephant populations tend to increase (sources) and areas where their numbers decrease (sinks), thus creating a metapopulation. When elephants are able to move freely between these areas it allows 'surplus' animals to be soaked up by the sinks. Restoration of meta-population dynamics can best be achieved through the development of a network of mega-parks across ecological gradients. One of the most important gradients is water availability. Without year-round water supplies elephants tend to move between distinct wet and dry season ranges – this seasonal migration gives relief to vegetation from the impacts of high elephant densities.

Advantages:

- Ethically acceptable from an animal welfare and animal rights perspective.
- Compatible with a minimum interference conservation ethic as it mimics natural processes to limit populations.
- Provides opportunity for habitat regeneration if elephants leave for long periods.
- Increases the range of elephants.

Limitations to implementation:

- Establishing corridors between parks will require relocation of human settlements.
- Potential for human-elephant conflict in the vicinity of corridors.

Questions about effectiveness:

- Success in limiting populations and impacts depends on a number of assumptions about elephant movements and habitat preferences. It remains to be seen whether elephants will use corridors and move into new areas.

Habitat restriction within parks: closing water points

It is believed that in KNP the 'water for game' programme has increased the dry season range of elephants. Removal of water points began in KNP in 1996 and is still in progress.

Rationale:

- Removing many of the artificial water sources located in areas away from rivers will limit elephant foraging range in the dry season and could limit the extent of impacts on susceptible tree species that grow primarily in upland areas. In addition an increase in calf mortality will decrease population growth rates.

Limitations to effectiveness:

- KNP is still well supplied with natural water sources - perennial rivers and pools in seasonal streams provide fairly widespread water. Two thirds of artificial water sources have already been removed and removing the rest will not restrict elephants' dry season range by a great deal.

Limitations to implementation:

- Visitor expectations regarding game viewing at water holes are a factor that constrains removal of all water points. Tourist experience will be negatively affected by crowding at remaining waterholes in the future.

Create artificial refuges for vegetation through fencing

Rationale:

- Rare and endangered vegetation at high risk from elephant activities is protected from any impacts of elephants by fencing. This is already successfully used in Addo Elephant National Park where certain endemic plant species are now only found in areas from which elephants and rhino have been excluded. Fencing to create botanical reserves is also used in Tembe Elephant Park and Phinda Resource Reserve.

Limitations to implementation:

- Expense of installing and maintaining fences, therefore most appropriate for small areas of highly threatened endemic vegetation.

Concerns:

- Detracts from wilderness qualities of park.
- Potential loss of ecological benefits from presence of elephants and other wildlife.

Contraception

Manipulating fertility in elephants was not even an option prior to the 1990s and elephant contraception in wild populations is still a developing technology. Two methods of elephant contraception have now been tested in South Africa – steroids and immunocontraception.

Steroids:

Contraception occurs by means of hormonal control through the surgical insertion of oestradiol (oestrogen) implants. Trials were undertaken in KNP from 1996 to 1998 by a team of researchers from the Institute for Zoo and Wildlife Research in Berlin, but were ultimately abandoned due to the technique's adverse effects on sexual behaviour³¹. As the cows are kept in a state of chronic "false oestrus" this incorrectly signals to the bulls that they are sexually receptive – bulls are thus continuously attracted to the cows and attempt to mate, causing ongoing disruption to the herd.

Immunocontraception:

A more promising technique involves immunising cows with a foreign protein (porcine zona pellucida). This leads to the production of antibodies which hinder fertilisation. Two field trials were conducted in KNP from 1995 to 2000, with success rates of 60% and 80%. A trial began in Makalali Private Game Reserve in 2000, which has thus far demonstrated that in the short-term the method is effective in preventing pregnancies, reversible, harmless (no adverse health effects have been observed) and safe during pregnancy and with no negative effects on calf raising³². No

behavioural side effects have been noted other than increased heat incidence, and there has been no change in the social status of the treated cows. A new one-shot vaccine has been developed that is effective for 12 months. The vaccine is delivered by darting and there is thus no need to immobilise the cows.

Rationale:

- Limiting elephant reproduction by preventing conception will prevent population from increasing and could even reduce the population over the long term.

Advantages:

- Economically viable, could attract international sponsorship.
- Vaccine locally manufactured.

Limitations to effectiveness:

Incapable of reducing population size in the short term.

Limitations to implementation:

- Costs in long-term could be prohibitive for large populations. Cows need to be darted repeatedly; expenses include helicopter flights, veterinary expertise.

Concerns:

- There is currently insufficient historical data on the method's effectiveness, reversibility, and long-term impacts on health and social behaviour of cows.
- Preventing births will destabilise the age structure of breeding herds.
- There will be a loss of genetic diversity over time.
- There could be impacts on the social behaviour and wellbeing of the cows and herds.
- There are health concerns for cows over the long-term; uterine fibroids are common in unmated female elephants in zoos.
- In captive elephants sterility has been shown to occur with repeated use.
- Ethical concerns due to the level of interference in natural processes and elephants' natural lives, particularly the right to reproduce.

Allied concerns:

- Some view contraception as wasteful – in that it involves spending resources to effectively forgo the potential to derive useful products from a renewable resource (that could be yielded from lethal methods of population control).

Translocation

Translocation has been practiced in KNP alongside culling since 1978 and has continued since the moratorium on culling. Initially only juveniles orphaned by culls were relocated but the absence of socialisation by the matriarch-dominated herd and large bulls resulted in problems with delinquent behaviour – young bulls are now only introduced to areas where older bulls are already present. From 1993, techniques and equipment were developed for the capture of entire herds as well as large bulls, and elephants are now only relocated in family groups.

Rationale:

- Translocation reduces local elephant densities by removing elephants from an area of high density to establish new populations or increase existing populations in new elephant conservation areas.

Advantages:

- Increases the range of elephants.

Limitations to implementation:

- Highly specialised and thus expensive procedure, requiring heavy duty cranes, trucks and containers, well-trained capture and transfer teams, and veterinary expertise and supervision.
- As a result of translocation in the past most areas in southern Africa which can accommodate elephants now have them. There is now very limited land available which can accommodate relocated elephant, thus not considered to be a large-scale or sustainable solution for reducing large elephant populations.

Concerns:

- Capture and transfer process, and removal from familiar social and physical environment, is stressful for elephants.
- Potential for human-elephant conflict in new areas.

Increase mortality by introducing biological control

This is currently not an option under consideration, as elephants have few predators other than man, and are attacked by few diseases.

Increase mortality by allowing hunting or failing to control poaching

This is currently not an option under consideration, as both methods are in conflict with the current conservation values of SANParks.

Increase mortality by culling

Culling has the longest history of all the elephant management interventions proposed, but this history is coloured by controversy and protest. Culling has been used extensively in the past, not only in KNP but elsewhere in eastern and southern Africa. However, the only countries that have practiced culling in recent decades are in southern Africa – Zimbabwe, Namibia and South Africa. In KNP, the technique and principles of the practice have evolved over time in response to ethical concerns and improved knowledge and technology. In recognition of elephant's strong social bonds the practice of culling adults and capturing calves was abandoned in favour of herding off and then culling entire family groups. Darting elephants with Scoline, which resulted in death through paralysis, was suspended in 1990 as it is now considered inhumane. From 1990 to 1995 culling was conducted by means of a brain shot delivered from a helicopter.

Rationale:

- In the past in KNP and elsewhere the rationale behind culling was to remove 'surplus' animals and thus keep the population within the ceiling proposed to limit the impact on vegetation. A blanket culling approach aimed only to reduce the size and not alter the structure or local density of the population, though from 1985 onward the location of the entire annual cull was rotated through four regions of KNP in an attempt to introduce a form of population fluctuation. The concept of a fixed carrying capacity has since been abandoned. However, culling was proposed as a management option by the 1999 KNP plan and the SANParks report to the Minister, though within the context of a desire to

create a range of elephant impacts within a particular park, not to maintain the static population of the past. At the current high population densities across the park culling is now being proposed as a means to achieving areas of low elephant density and thus to create refuges for vegetation to recover from elephant impact.

Advantages:

- Only option which is currently available to reduce the population in the short term.
- Sale of by-products can finance costs of management.
- Potential for economic benefits to local communities from consumptive use and employment in the processing of by-products.
- Due to its long history of use in KNP the capacity and skill already exists for effective implementation.

Concerns:

- Ethical concerns for animal welfare and animal rights.
- Potentially traumatic for entire populations, as elephants in cull areas may be able to signal their distress to other elephants over large distances using infrasound.
- Removal of entire family groups removes older females from the population over time causing a loss of cultural information and disruption of social networks.
- Suggestions by some stakeholders that affected elephants may suffer a form of social trauma affecting both physiology and behaviour, and analogous to post-traumatic stress disorders of modern human society.

Allied concerns:

- Threat of tourism boycott and prolonged legal action by animal rights groups.
- Impact on image of SANParks and South Africa, leading to avoidance of national parks and other local destinations by international tourists.
- Concerns about consumptive use creating dependencies and expectations amongst neighbouring communities which will limit the choice of future management options for parks.

Questions about effectiveness in reducing impacts:

- Culling at 'economic' carrying capacity (e.g. the previous KNP target of 7000 elephants) may keep elephant populations at a density at which food remains abundant and is thus able to support a maximal growth rate. This sustains the need for a high level of management intervention making culling a self-perpetuating practice.
- Over time a blanket (non-selective) culling programme reduces the average age of the population creating an unstable age structure which, if released from culling, enters an eruptive population growth phase which is likely to overshoot the resource.
- Culling may not achieve the goal of reducing impacts on vegetation if population movements in response to a cull result in higher densities in cull blocks. It has been suggested that in KNP culling stimulated local population growth rates, probably through intrapopulation migratory patterns.
- Stress and trauma suffered by surviving elephants could have behavioural effects, such as aggression, which increase impacts.
- Blanket culling does not target the cause of undesirable impacts on vegetation – if these are largely due to one segment of the elephant population (bulls) in certain parts of the park (areas remote from natural water sources) at a particular time of the year (dry season).

Addressing human-elephant conflict and improving community perceptions of conservation

Management options should, to an extent, be considered separately for the goal of reducing human-elephant conflict versus that of reducing negative environmental impacts. Though it is assumed that any management options which succeed in reducing elephant population densities in areas close to human settlements will also reduce the incidence of elephants breaking fences and straying from parks onto agricultural land, there are also a number of options unrelated to elephant population density which are available to reduce human-elephant conflict and the resultant poor perceptions of conservation by neighbouring communities:

- Improving, maintaining and patrolling barriers between elephants and people such as electric fencing, sisal barriers, trenches and the use of chemical repellents and deterrents (for example chillies are highly unpalatable to elephants and provide a powerful deterrent when burnt), disturbance shooting, firecrackers and traditional methods.
- Employing guards from within the community.
- Finding ways to address the problems of people tampering with fences in order to access the park.
- Land use planning to create buffer zones between cultivated land and protected areas.
- Improving communities' and authorities' capacity for dealing with human-elephant conflict.
- Creating ways for communities, who bear the costs of potentially dangerous and destructive wildlife neighbours, to benefit from their proximity to protected areas, and from Damage Causing Animals which are found on their land. This includes the option of consumptive use should culling be implemented as a management option. Some stakeholders have pointed out that the issue of improving benefits for communities neighbouring protected areas like KNP can also be considered independently of the elephant management question and the controversial subject of consumptive use.

Ethical concerns

A range of ethical frameworks have been applied to the elephant management debate and particularly the issue of culling. Different ethical frameworks derive from different values and assertions about the moral standing of elephants and thus the constraints that humans should impose on their behaviour toward elephant, and the appropriate rights that should be accorded to individual elephants relative to human interests and the interests of ecosystems as a whole.

Ethical positions about elephant management options range from the assertion that elephants have the right to life and the right to reproduce, to concerns about the effects of the stress or trauma of contraception, culling or translocation on both affected and unaffected animals, particularly given elephants' strong social bonds, to simply applying a principle that culling should be carried out in as humane a way as possible, both for the elephants killed and those left behind. Some stakeholders have expressed the view that culling is unethical and inhumane and should never be used; others that culling is acceptable only as a last resort and to prevent irreversible biodiversity loss.

Though other methods are not without ethical concerns, culling has received the most attention in this regard – it has been suggested that the ethical implications of other management options requires further analysis.

Context-specific management decisions

The appropriateness of a particular management option is relative to the goals and context of a park. It is likely that different management options will be appropriate for short-term versus long-term management goals and that combinations of options will be used. The most important aspects of context which influence the goals and thus methods of elephant management are:

- Desired State of a specific park – what vital attributes stakeholders agree are most important to maintain.
- Soils, vegetation, climate, regeneration strategies of woody plant species.
- Management history – culling, fire management, water supply.
- Size, shape, heterogeneity of protected area.
- Existence of rare and endemic vegetation types or species.
- Social, political and economic context.

Adaptive management

There is still much that is uncertain about elephants and their impacts on their habitat. Any and all management interventions are an opportunity to reduce this uncertainty and learn by doing.

Scientific uncertainties will remain until the longer term consequences of high elephant densities have actually been observed. Delays will occur in the reproductive responses of elephant populations to increasing densities and reduced resource supply and the duration of these delays is difficult to predict. Similarly, recruitment of trees in savannas may only occur at intervals of a decade or longer, and will be affected by rainfall, fire frequency, seed predation and browsing of seedlings²⁵.

For decision-making in conditions of uncertainty it is considered appropriate to invoke the precautionary principle. But precaution could be applied to the elephant debate in two contrasting ways:

- To reduce the risk of biodiversity loss, elephant numbers can be kept generally low.
- To avoid killing elephants and the risks and concerns this entails, action can be delayed until it has been observed that losses to biodiversity do actually occur before population stabilisation through resource limitation takes place.

A third alternative is to apply both options, thus ultimately establishing the consequences of each option and reducing uncertainty by determining where the thresholds of system response and recovery from elephant impacts lie. This will involve allowing changes to progress toward extremes in selected places, through an adaptive management approach²⁵.

Designing suitable adaptive systems is a means to enable the policy and decision-making process to avoid the paralysis resulting from differences in scientific opinion.

Finally, planning of management interventions must consider actions and outcomes at a range of ecological (and ultimately also social and economic) scales. Actions applied at one spatial scale could have unexpected and unwanted consequences at smaller or larger scales. Similarly, actions designed to meet short-term goals could ultimately prevent long-term objectives for the same or other spatial scales from being met.