CONSIDERATIONS FOR THE COMPILATION OF AN ELEPHANT MANAGEMENT POLICY

HISTORY OF THE KNP ELEPHANT CULLING POLICIES

IAN WHYTE

In 1967, annual aerial censusing of the population as well as population control (culling) were initiated. This signalled the start of the "Management era" during which the policy was to hold the population at a level of around 7 000.

The historical development of the culling policy

The artificial control of elephant numbers in the KNP had been discussed among staff as far back as at least the early 1940's. During the 1950's and early 1960's there was a growing feeling among some biologists in Africa that elephant numbers should be controlled to prevent habitat change. Beuchner *et al.* (1963) concluded that in Murchison Falls National Park (Uganda) 4.5 - 5.5 elephants/mile^2 was exceeding the carrying capacity and that "their numbers must be regulated to avoid damage to the vegetation and for the future welfare of the population of elephants". Similarly Glover (1963) felt that for Tsavo National Park (Kenya) "one elephant/mile^2 is apparently the highest stocking rate possible..." and that "If the habitat is to be preserved in its present form for all of the animals in the Park, then the numbers of elephants will have to be controlled".

These feelings were shared by the KNP's biologists who also felt that it may become necessary to limit elephant population growth in the KNP. This feeling was expressed by Pienaar (1960). "*The desirability of elephant control measures on a more general basis, which may become necessary in the near future, is a much more sensitive problem and will only be successfully solved after attention has been paid and information has been acquired regarding the actual numbers of elephant in the South, the number of breeding herds, herd composition, seasonal movements, ... as well as aspects such as how and where control should be applied*". In conclusion Pienaar (1960) made (among others) the following recommendations regarding the management of the elephant population:-

1. *That the collection of the information mentioned above be regarded as a matter of urgency. An aerial census was suggested as the best means of obtaining the information.*

2. *That in the light of the above information, an elephant population level be prescribed for the Southern District.*

3. *That all surplus elephants be destroyed annually through culling operations - preferably in the boundary areas and with due respect for outstanding individuals.*

4. *That during normal years, elephants be denied the strip along the Crocodile River as well as a belt along the western boundary.*

5. *Quantitative culling be applied elsewhere with great caution, if necessary".*

On 30 November 1965 a symposium was convened in Pretoria by the National Parks Board of Trustees (hereafter referred to as "the Board") which many South African biologists of the time attended. The symposium focused on "over-protection". Papers delivered at this symposium were on General Principles (Knobel 1965), Ecological Regions of the KNP (Brynard 1965), Problem Areas (van Wyk 1965), Reproduction and Biological Control (Fairall 1965), Control by diseases and Parasites (van Niekerk 1965), Animals, Areas & populations, Desirability of Culling and Methods (Pienaar 1965), Byproducts (Labuschagne 1965) and Publicity (van der Merwe 1965). The recommendation of this conference to the Board was that the numbers of seven species be artificially controlled by means of culling. The species involved were elephant, buffalo, hippo, giraffe, wildebeest, zebra and impala (Raad van Kuratore vir Nasionale Parke 1967). At its next meeting the Board decided that the culling of these species should take place (National Parks Board of Curators 1966).

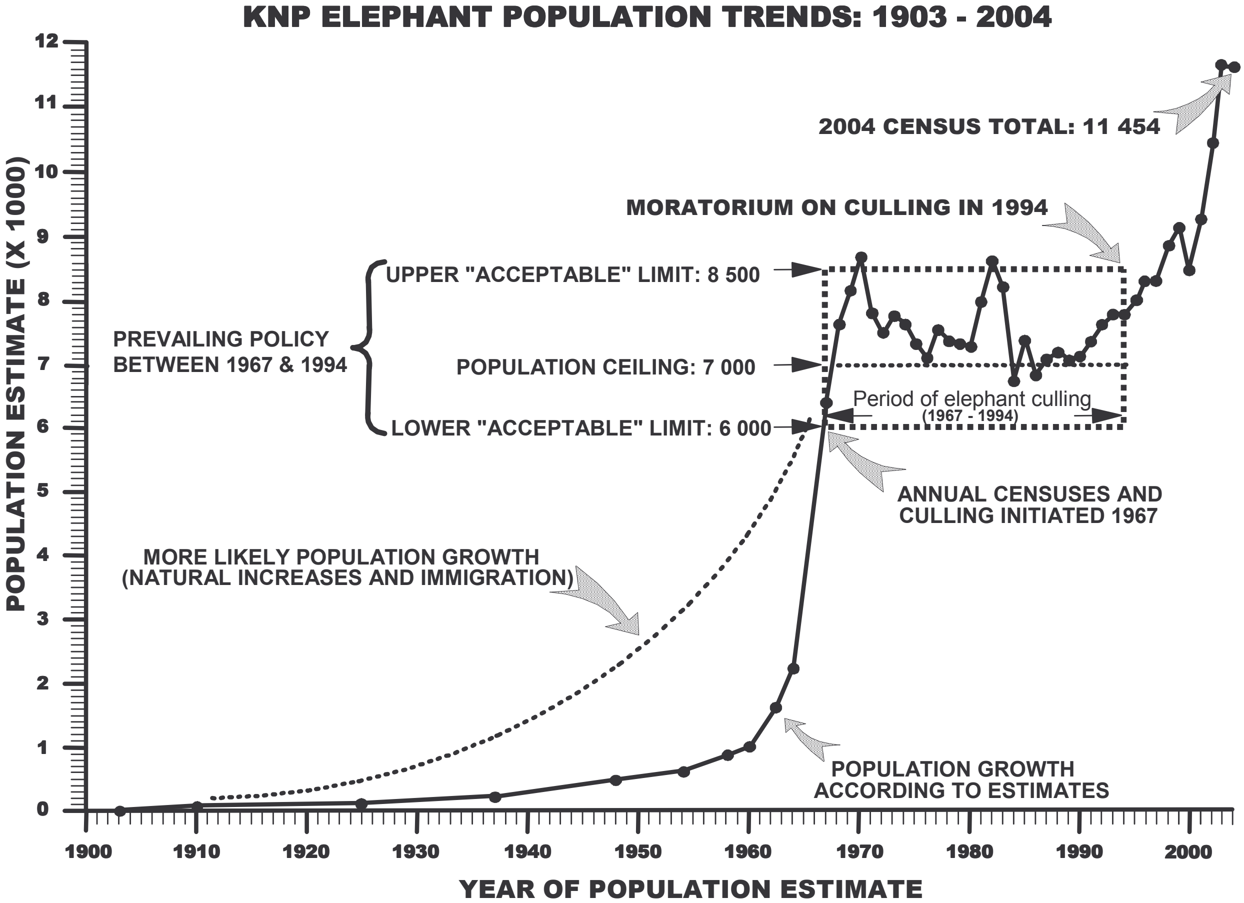
Reporting on the census results of 1964, Pienaar *et al.* (1966) concluded that "It would appear that theoretically a carrying capacity of 1 - 4 elephants per square mile, depending on the existing vegetation, available water supplies and size of the area, holds for the majority of elephant habitats in Africa", and van Wyk & Fairall (1969), from the results of their research on the impact of elephants on the vegetation of the KNP, concluded that "... the highest number of elephants which could be carried .... would be 0.75/mile^2 (i.e. 6 000 elephants) if the total destruction of the vulnerable areas near water is not to result".

Pienaar (1996) also stated that this coincided with results obtained during the first helicopter census in 1964, "... 1 139 elephants occurred in the Letaba River and its main tributaries (namely the Ngwenyene, Tsende, Shipikane, Makhadzi and Mbyashishe). This was apparently the preferred habitat of these animals ...... in which they stayed during the recolonisation years until they approached a natural saturation point before they, in ever increasing numbers, began to disperse northward and later southward... Because the recolonisation of the Letaba-Tsende area, which can be considered as prime elephant habitat, could occur without hinderance or human interference, it must be accepted that the elephant density per unit area during the continuing process of dispersal would give a very good indication of a self-imposed (ie natural) saturation level for elephants in this habitat. A planimetric calculation of the area of this original elephant homeland yielded an area of 1 030 mile^2 - that is one elephant per mile^2". From this and the findings reported by van Wyk & Fairall (1969), the Director of the National Parks Board (Mr Rocco Knobel) recommended to the Board at an ordinary meeting held on 17 June, 1968, that the recommendation contained in Annexure "B" of the agenda with respect to the culling of elephant and buffalo in the KNP be adopted. The Annexure read as follows: "Until the water provision program has been finalised in its entirety, both the elephant and buffalo populations of the KNP should be held at their current level...". At this time the latest estimate for the elephant population (1967 census) was 6 586. This recommendation was adopted by the Board. Although it is obscure when or for what reasons it was changed, this figure was later rounded to 7 000.

This then was the level (7 000) at which management attempted to hold the population. The policy was adhered to until 1995 when a moratorium was placed on culling heralding the post-management era, though the last culls took place in 1994.

The change in elephant population during this period is illustrated in Fig.1.

Figure 1. Projected trends in the KNP elephant population after implementation of the new elephant management policy



In order to assess the implications of implementing the proposed new elephant management policy on the elephant population, a spreadsheet model was developed to simulate the trends in the respective zones and also for the KNP as a whole (Whyte 2001, 2004).

A simple spreadsheet model was constructed to calculate the number of elephants to be removed from each zone based on the management strategies listed for each of the six elephant management zones (Whyte *et al.* 1997, 1999). The starting point (Year 1) was the data derived from the aerial census of 1999. The populations in the botanical zones were reduced to and held at the prescribed density of one elephant per 2.85km^2, those in the low-impact zones were reduced by 7% per year, while those in the high-impact (unmanaged) zones were increased by 7% per year. The projections were based on three assumptions:

i. That the elephants recorded in the respective management zones will remain in these zones and will not move into adjacent zones;

ii. That population growth rates will remain a constant 7% per year;

iii. That to achieve a 7% reduction in a population which is growing at 7% per year, a total of 14% of the animals recorded in that zone should be removed each year;

The numbers of elephants to be removed from the respective zones' populations are given in Table 1. Since the prescribed limits for the botanical zones were exceeded by far, a large number of animals must be removed from these two zones. It is assumed that all of the excess elephants in the botanical reserves are removed in the first year while in the low-impact zones a 7% reduction is made. This gives a total of around 950 elephants to be removed in the first year. This large quota results in a small total population decline after the first year, but once the excess in the botanical zones has been removed, the quotas for removal decline rapidly and the KNP population begins to increase.

If the assumptions given above were to hold true, the population trends and the trends in the numbers of elephants to be removed can be projected into the future. These are shown in Figure 1. Once the excess elephants have been removed from the botanical zones, the number to remove drops significantly in the second year (from 963 to 540). In subsequent years the management option for each zone is maintained until a hypothetical TPC is reached in the year 22. The number to be removed declines as the population declines. After 22 years the number to be removed has declined to just 170, while the KNP population as a whole has increased to around 19 000.

Once a TPC has been reached and the management options for the high- and low-impact zones is reversed, the number of elephants to be removed once again increases dramatically due to the high numbers of elephants in the high impact zones which now need to be reduced (Figure 2). This also results in a decline in the overall population which persists for about 20 years. At this time, the number of elephants in the "new" high-impact zones has built up to a level where the 7% increase exceeds the number to be removed from the "new" low-impact zones and population begins another growth cycle. This will continue until another TPC is reached sometime in the future. In this way, significant population fluctuations will be induced, not only in the individual HEIs and LEIs, but also in the KNP as a whole. It is believed that such fluctuations will significantly contribute to the overall biodiversity of the KNP.

Table 1: Hypothetical population reduction quotas for the respective elephant management zones of the Kruger National Park in the year if the new elephant management policy were to be implemented (census totals are from 1999).

Management Zone	Total counted in 1999	Limit	Total to be removed	Bulls to be removed	Br. Herds to be removed
Northern Botanical Reserve	901	550*	351	53	298
Northern Low Impact	1720		241	36	205
Northern High Impact	2665		0	0	0
Central High Impact	1524		0	0	0
Southern Low Impact	2001		280	42	238
Southern Botanical Reserve	341	250*	91	14	77
Total	9 152		963	144	819

* The limits for the botanical reserves (1 elephant per 2.85km^2) are specified in the management policy.

** The respective quotas for bulls and breeding herds are 15% and 85% as these are the ratios at which they occur naturally.

References

WHYTE, I.J. 2001. *Conservation management of the Kruger National Park elephant population*. PhD. Thesis. University of Pretoria, Pretoria.

WHYTE, I.J. 2004. The ecological basis of the Kruger National Park's new elephant management policy and expected outcomes after implementation. *Pachyderm* 36: 99-108.

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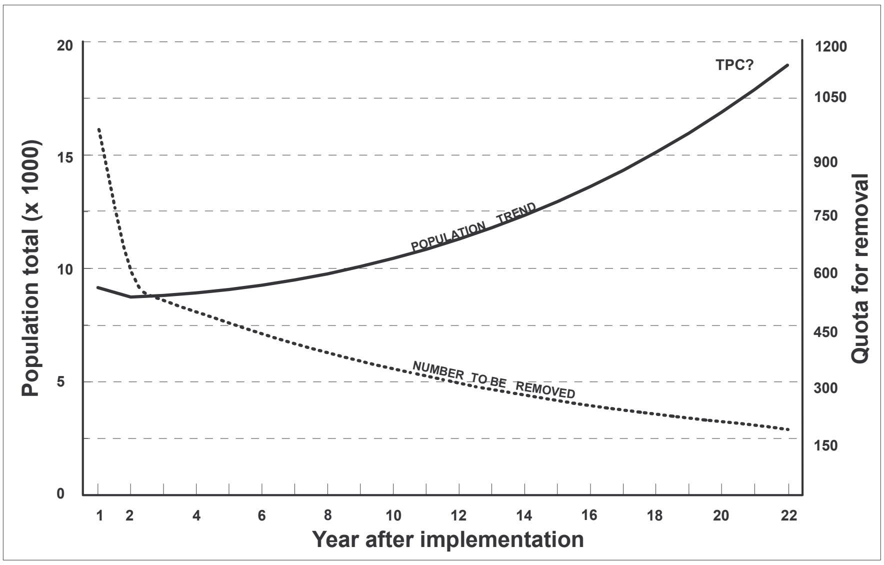

Figure 1: Expected elephant population trends and numbers to be removed from the population after implementation of the new management policy until a TPC is reached after a hypothetical period of 22 years.

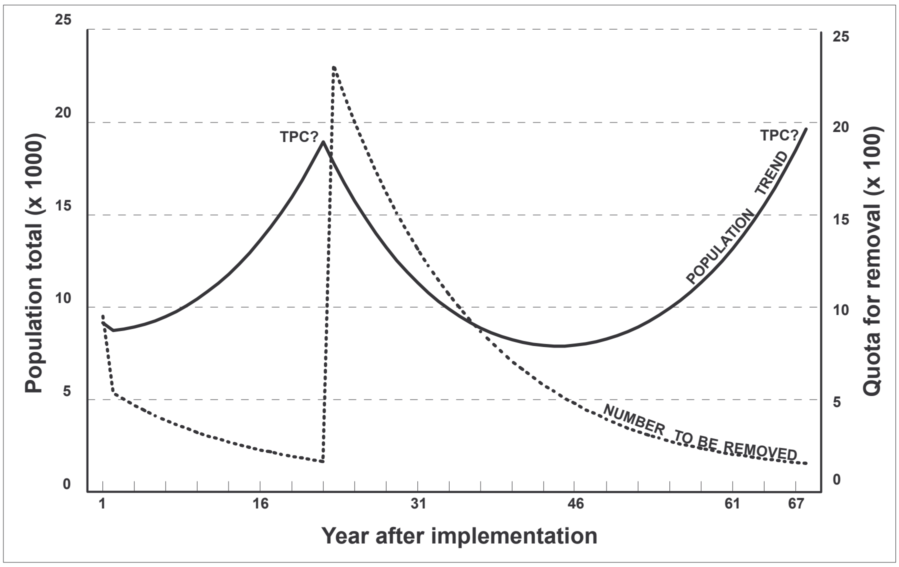

Figure 2: Expected elephant population trends and numbers to be removed from the population before and subsequent to reaching a TPC at which time the management option for the zones was switched (see text).

SUMMARY OF KRUGER NATIONAL PARK'S CURRENTLY PROPOSED ELEPHANT MANAGEMENT POLICY

ANGELA GAYLARD, SCIENTIFIC SERVICES KNP.

Introduction

While KNP's previous elephant management policy was based on a perceived carrying capacity for elephants, the new policy focuses on the *extent* and *intensity* of elephant impacts on biodiversity. The policy is based on four fundamental ecological principles:

- That ecosystems are not static, but rather that fluctuations of conditions and population responses are an inherent and desirable attribute of the Lowveld ecosystem that contribute to its biodiversity. A range of elephant impact intensities, achieved through different densities of elephants in different areas at different times, is thus also natural and desirable.
- That elephant are important agents of habitat modification and thus contribute to biodiversity (Intermediate Disturbance Hypothesis).
- That elephant populations which are confined, but whose growth is not limited through management, can increase in number until negative impacts on the system's biodiversity result.
- That elephants should not be viewed in isolation, but as one component of a broader, integrated system. The fundamental basis of this policy proposal is not to manage purely for the benefit of the elephant population, but to manage elephant *impact* in conjunction with other ecosystem process (such as fire) to promote biodiversity in general.

Outline of the policy

The currently proposed elephant management policy in KNP suggests that it be divided into six zones. These are two botanical reserves, two high elephant impact zones and two low elephant impact zones. Elephant impacts within these zones will be audited by means of "Thresholds of Potential Concern" (TPC's). These TPC's are limits of ecological change specified by expert available scientific knowledge, and should not be exceeded if undesirable change to the ecosystem is to be prevented. The designated elephant impact for each zone will be allowed until there are indications that one or more of the TPC's have been reached. In the high elephant impact zones the population will be allowed to increase until one or more TPC's are reached. It is expected that the population in these zones will increase at around 7% per year. In the low elephant impact zones the population will be decreased (through live removals or culling) until one or more of the TPC's have been reached. This decrease will be achieved through the reduction of the populations within these zones by 7% per year. In the Botanical Reserves, moderate elephant impacts will be allowed until one or more TPC's are reached. Since the Botanical Reserves will be established to protect important plant species that are particularly vulnerable to elephant impact, there are specific TPC's to monitor declines in these plant species.

Once TPC's are reached in any of the impact zones, the management actions applied in those zones will be swapped. For example, high elephant impact areas will be treated as low elephant impact zones and their populations systematically reduced, while the elephant populations of the low elephant impact zones will be allowed to increase. It is reasoned that this will provide a measure of temporal heterogeneity in elephant impacts.

TPC's

Scale	Theme	TPC
Regional (KNP)	Woody cover Numbers of Trees> 5m	30% ↓; non-linear↑ 50% ↓; non-linear↑
Landscape (impact zones & vegetation units)	Woody cover Numbers of trees >5 m	80% ↓; non-linear↑ 80% ↓; non-linear↑
Local (plant comm, pan, sodic patch)	Woody cover Numbers of trees>5 m	100% ↓; unlimited↑ 100% ↓; unlimited↑

Selection of elephant management zones

The boundaries of the respective elephant management zones have been defined so as to roughly conform to the known boundaries of elephant clans as defined by Ian Whyte's doctoral study. This is to allow elephant management to proceed without disrupting the natural home ranges of these clans. The boundaries have also been defined so as to ensure that the four major zones (excluding the botanical reserves) are of a similar size. Elephant densities will be monitored annually during aerial censuses and elephant movements in and out of the area will be monitored through the ongoing movement study using radio-collared animals.

Responsibility for decision-making

Decisions as to appropriate actions for the management of elephants in the respective zones should be made through an annual appraisal by senior management and research staff of the results of the respective biodiversity monitoring projects and the annual elephant census results.

Options for reducing elephant numbers in low impact zones

The preferred future methods for elephant population control should be non-lethal, but where these options are not feasible, culling will have to remain an option. Possible non-lethal options for the management of elephants are:

1. Translocation: Only adult bulls or animals in intact family units should be translocated.
2. Contraception: Contraception technology at present does not yet offer a viable method of population control in elephants.

A critical aspect of this policy is that it represents Strategic Adaptive Management. This essentially means that the policy is set up within a framework that will allow for maximum learning which can be fed back into future management decisions by focusing monitoring, auditing and research issues appropriately. In addition, it conforms to current ecological advances by representing a move away from the species-based focus of past management policies, towards ecosystem management of key ecological processes.

VALUESCAPES IN ELEPHANT MANAGEMENT – LEARNING NECESSITATES DIVERSITY

HARRY BIGGS

This paper aims at moving societal reaction from the simplistic "damned if we do and damned if we don't" responses to elephant culling, to a more nuanced understanding of the complexity of ecosystem management, and to the recognition of the need for a variety of approaches, if there is to be any hope that biodiversity imperatives will succeed.

No elephant management action (including *laissez-faire*) has any universally justifiable basis, and a clear conflict of values emerges between differing interest groups jostling to secure moral high ground. Philosophical grounds for ecosystem management and even for population management are as yet poorly explored in society, relative to the (often anthropomorphic) focus on animal rights at the individual level. Other interest lobbies (such as those punting maximum-yield sustainable utilization i.e. "farming with elephant"; or those promoting contraception, the latter lobby driven at least partly by exciting technological challenges funded under the banner "we avoid killing") further confound the value landscape. Yet conservation agencies have been essentially charged with ecosystem management since the IUCN opted in the late eighties for the ecosystem approach. This decision rested on a belief that it would yield the best overall biodiversity outcome, and came without a guarantee that all other value systems would be concurrently upheld. In fact, it is argued that ecosystem- and individual-level ethics are at times incompatible.

The legal mandate of SANParks is guided strongly by new biodiversity and protected area legislation, legislation which imposes direct accountability. Furthermore, the SANParks mission statement is explicit about sustainable utilization and benefits, and with some neighbouring communities plagued by elephant damage, there appears to at least be synergy between certain values. But the wider rift remains: if SANParks is to satisfy animal rights values, there exists a serious risk (many claim a certainty) of degraded biodiversity outcomes, and hence almost certain legal challenge in terms of the accountability framework. In order for SANParks to maximize biodiversity options, it may well need to use methods (culling; or restriction of surface water, the latter operating through infant mortality) abhorrent to animal rightists who believe they have constitutional grounds (rationality and proportionality) for legal challenge. Hence the dictum "damned if they do and damned if they don't" coined by an NGO at the recent elephant indaba. This paper suggests the 'truths' and values underlying these simplistic notions are considerably more complex.

Ecosystem management in the last twenty years displays increasing acceptance that these systems are complex and adaptive. Complexity implies the existence of several underlying drivers (herbivory e.g. grazing and browsing by elephant; fire; moisture, including its effect on range condition and distance to drinking water; etc.) which interact continuously, and the effects of which it is impossible to entirely disentangle. There may be multiple combinations of causes for any given outcome. Systems, especially African savannas where elephant live, are generally undergoing continual change, yet are confined for longer periods within a broader 'state' (such as open woodland). Furthermore, the overall responses often (in contrast to earlier understanding) follow non-linear curves, which implies that they display distinct thresholds when for instance, a system relatively suddenly changes its state (e.g. from open woodland to closed scrubland) after years of sustaining gradual effects from a disturbance such as herbivory. System behaviour is often also characterized by lags between stimuli and effects. Humans and their social and economic effects are now seen as simply part of the overall socio-ecological system, hence bringing further values, only partly related to biodiversity values (e.g. wilderness; material value) to the table. As a whole, the system is adaptive, which means that it responds in self-organising ways (for instance "bush encroachment" seals off grazing in damaged areas), and the 'health' of the self-organisation processes is determined largely by the heterogeneity (or variation over space, as typified by a variety of species and by a rich mosaic landscape) of the system. Ecosystem managers today aim at maximizing resilience, meaning the ability to withstand system flips into undesirable states. It is generally believed that allowing irregular smaller disturbances (e.g. patchy fires) often precludes larger undesirable changes (such as catastrophic fires) and hence promotes system resilience. Management leading to homogenization of habitat over vast extents or complete parks is believed to lead to poor resilience. Elephants are key agents of change, and are now known to promote or suppress biodiversity levels, under different circumstances and viewed at different scales. A holistic overall understanding of their effects has yet to be developed, though many useful partial understandings exist, which is also why results can sometimes appear contradictory.

How is SANParks to behave? Driven by fundamental values of ecosystem and biodiversity management, to be coupled with tourism values and values supporting benefits to local communities, it has to be true to these value systems to achieve its mission. Inevitably, this will at times bring it into conflict with certain other value systems, which it may strive, but only where possible, to partly appease. In the absence of complete knowledge and in changing environments, structured versions of adaptive management are considered most appropriate. SANParks therefore has to adopt an adaptive risk-based approach, and in ecosystem terms has to hedge its bets by multiple probing strategies. The ability to learn fast enough as human pressures and global environments change, is the single most important key to survival and persistence of the biodiversity mission. The only way to stand a chance of learning fast enough, is to adopt multiple approaches, even through some of them, risking local loss (as in the celebrated Wisconsin lake examples). Viewed against this background, all forms of management are experiments, and the current "single-experiment" approach to elephant (simply letting numbers rise everywhere, all the time) over all elephant-inhabited areas of southern Africa, is an extremely vulnerable one, measured against all value systems except a fatalistic one where animal rightists will be briefly satisfied till predicted mass die-offs may materialize. A far more resilient and hopeful approach is to indeed test out different paradigms and approaches within the SANParks value mantra, and so give ourselves as biodiversity managers a reasonable chance of achieving our mission as we learn and adapt. We will need to justify this legally and societally by spreading awareness of both the values we espouse, and the way in we currently see ecosystem function, our insurance policy being our investment in a heterogeneous but adaptive approach. In this way we will likely retain our biodiversity complement and have the knowledge to persist.

Appendix 1

A longer list of values which have bearing on national parks, and some of which will have potential bearing on elephant management. Many necessarily overlap. Much of the material is drawn from "The Full Value of Parks. From Economics to the Intangible" 2003. Eds: D. Harmon & A.D. Putney. Rowman & Littlefield Publishers, Oxford.

Biodiversity/environmental values – see SANParks list as currently being expanded

The other nine SANParks corporate values (transformation, service excellence, professionalism, initiative, equity and justice, discipline, respect, honesty and integrity, transparency and open communication)
Material value – as discussed at values meeting e.g. biological stock; ecosystem services
Intrinsic value – a value, believed by some to exist independent of humankind
Intangible values, one typology being:

- Recreational values
- Spiritual values
- Cultural values
- Identity value – linking people's identity to the landscape
- Existence value
- Artistic value

Aesthetic value
Educational value
Research value
Peace value – fostering regional peace and stability
Therapeutic value – as successfully argued in the St Lucia debate
Two "darker" (more cynical?) values came out of some recent analyses:
Utility value as "spare land" for other uses when required!
Prestige or fashion value – a country showing that they too have impressive parks
Wilderness values
Permanence value – knowing it will be there later
Bequest value – for future generations
Co-operative governance value (in a South African bioregional context)
Re-coupling value – re-establishing awareness of peoples' dependency on nature
Human safety value – inside and outside Parks
(Negative) value of damage-causing animals – direct and indirect
Compliance with legislation or treaties
Restoration value
Africanism cf Eurocentricity
Animal rights
Animal Anti-cruelty
Realism & Feasibility value

Appendix 2

Three major candidate management tools and their value relations

While this table treats interventions in isolation, it is recognized that for value-based reasons, many or all of these may be implemented in different places at different times.

Obviously there are many assumptions [I use the most regular ones cited in debates] underlying each assignation of a value in the second and third columns. Often the same value can ultimately appear in both, because the world is complex and dynamic. It is assumed all three are intelligently applied by modern standards e.g.contraception and culling taking into account spatial relations as determined by the heterogeneity paradigm. The smaller font indicates a lesser influence.

Tool/strategy	**Values underlying this**	**Values violated by this**
Laissez-faire	Wilderness Non-intervention No active killing necessary	Biodiversity Material value Human safety/incurred damage Recreational & Tourism?
Contraception	Avoids killing May limit 'environmental damage' and hence support biodiversity value Tourism Human safety	Biodiversity?(age-class/reproductive/psychological/physiological) Wilderness Co-operative governance (in some contexts) "Naturalness"
Culling	Biodiversity/heterogeneity Naturalness of 'hunting' Sustainable utilisation Tourism Human safety	Involves killing Wilderness Tourism (boycotts)

THE KNP ELEPHANT CHALLENGE : SOME ANIMAL HEALTH AND SOCIO-ECONOMIC CONSIDERATIONS

ROY G. BENGIS

Introduction

African elephants are a highly successful and intelligent species with few natural enemies except man. Elephants can access and utilise most strata of vegetation, and because they are hindgut digesters, they can process large volumes of poor quality forage and extract marginal nutrients. This and the fact that they can dig pits for water and that they are highly mobile makes them resilient to climatic extremes such as drought.

They are generally blessed with high reproductive and recruitment success and steady population growth frequently results in overabundance in finite fenced protected areas.

Elephants are not susceptible to most of the fatal ungulate diseases, although anthrax and EMC (mouse virus) sporadically cause localised mortalities in elephant on a small scale. Elephants have also never been implicated as disease reservoirs for contagious livestock diseases, and therefore do not constitute a primary animal health risk to the agricultural sector.

Fences

Elephants are however an indirect animal health risk factor, in that they are the most important fence-breaking species in our multi-species National Parks and game reserves. Fences are broken to access water, highly desirable trees and natural fruits as well as agricultural crops. Peaks of fence breaking activities occur in February / March (marulas and ripening agricultural crops) and in the winter dry season months. The Kruger National Park western and southern boundary fences are animal disease barrier fences, which were erected to prevent the spread of endemic contagious diseases from wild ungulates to livestock. Elephant breaks result in conduits through which important disease –carrying species such as buffalo, wildebeest and warthogs can move into the neighbouring communal and commercial agricultural areas. These movements frequently result in outbreaks of foot and mouth disease (FMD), theileriosis, malignant catarrhal fever (MCF) and African swine fever (ASF) with significant morbidity and mortality amongst livestock. In addition, there is a public health risk because buffalo also carry two chronic and erosive cattle diseases, which are contagious to humans, namely bovine tuberculosis (BTB) and brucellosis. Humans are at risk if they drink raw unpasteurised milk from infected cattle, which is unfortunately normal practice in many communal areas. Other causes for concern are that the loss of the structural integrity of fences also results in crop raiding by a variety of wild species, as well as predation on livestock by vagrant large predators.

Over the past 10 years, the KNP elephant population has almost doubled, and this has placed increased pressure on the fences. The number of elephant- associated fence breaks has increased significantly in certain areas, and this also places increased pressure on the fence maintenance resources and personnel. There appears to be a strong spatial and temporal correlation between elephant densities (especially bulls) and the number of fence breaks.

Management implications

Barrier fences are the first line of defence to control the spread of foot and mouth disease from buffalo to cattle. During the past five years, the exodus of vagrant buffalo through elephant damaged fences has been directly linked to two foot-and-mouth disease outbreaks in communal cattle adjacent to the KNP. These outbreaks resulted in calf mortalities, loss of milk and beef production, and loss of draught animal power for agricultural activities (due to painful hooves). In addition, strict local movement control of cloven-hoofed livestock and their products resulted in the loss of commercial trading opportunities. In the most recent outbreak in Letaba district, west and north of Phalaborwa, where FMD spread from the buffer zone into the surveillance zone, it was necessary to expand control measures. These expanded measures included a total movement ban on cloven hoofed animals and their products as well as certain other agricultural produce, mass vaccination in and around the outbreak area, and the erection road block control points as well as additional cordons and barrier fences. The control of this current outbreak, which started in July, 2004, is costing the tax-payer an average of R6 million per month. In the worst-scene scenario, if FMD spreads outside of the current control zones into the commercial agricultural areas, South Africa may stand to lose its current FMD zonation status with resultant loss of international trading opportunities for agricultural products. This could cost the country millions of Rands in lost foreign earnings.

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A MONITORING PROGRAMME TO DETECT CHANGES IN BIODIVERSITY IN KRUGER NATIONAL PARK – ATTRIBUTING CAUSALITY IN A SYSTEM WITH MULTIPLE DRIVERS.

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Introduction

Biodiversity conservation is one of the important reasons for the proposal of high and low elephant density zones in the Kruger National Park (KNP). To evaluate change in biodiversity in these zones, it is essential to have a record of species present and to be able to detect reliably when a species has disappeared over a defined time scale. It also implies the monitoring of biodiversity to its full extent of composition, structure and function, as defined by Noss. The challenge to biodiversity surveys is thus to detect a loss of functional and species diversity. Species surveys are surveys time consuming and expensive and therefore not entirely a practical approach in such a large conservation area. The success of observing or capturing a species known to occur in a specific area is also not guaranteed, and unsuccessful observation can thus not be assumed to indicate species loss. With this in mind we have developed a monitoring programme that will deliver a habitat quality index for functional groups of small mammals, vertebrates and birds. As habitat quality is strongly linked to landscape functional integrity (Ludwig et al. 2004) this aspect will also be covered.

Method

The survey design was based on gradsect sampling (Margules and Austin 1991). This implies the selection of transects which contain the steepest environmental gradients in an area. By overlaying geology with rainfall, a total of 205 sites were selected in the KNP. These sites will cover similar environmental domains in the high and low elephant density zones, to insure that changes that are recorded in either zone are not landscape related. At each site a survey will consist of a minimum of two 200 x 5m transects (in a very uniform, flat landscape) to six transects in a landscape with well-developed relief, to cover the land units from crest to valley bottom.

The survey evaluates landscape functional integrity over a distance of one meter every 20m using the method of Tongway and Hindley (2004). This gives an index of soil infiltration, nutrient cycling and stability as well as the number of vegetation patches per area. The habitat survey renders information on the vegetation structure and density both woody and herbaceous. The density of specific habitats such as logs, holes, and rocky outcrops is further recorded. Lastly the density of observed animal activity in the form of tracks, faeces or foraging is recorded. This habitat information is processed to give a habitat quality index for the functional groups of species that may occur in the KNP. Species surveys will be undertaken in some of the selected sites to verify whether the predicted species occur there. The landscape function information will help explain the absence of predicted species.

Loss of biodiversity will eventually be evaluated as loss of complementarity over time, thus taking the possibility of change in habitat or species on the smaller scale into account.

Conclusion

Using this approach we hope to detect changes due to herbivore impacts as well as those related to other drivers such as global climate change, changes in fire regime or changes in landscape function.

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THE FEASIBILITY OF CURRENT OPTIONS FOR THE MANAGEMENT OF WILD ELEPHANT POPULATIONS

IAN J. WHYTE

Published as: *WHYTE, I.J. 2004. The feasibility of current options for the management of wild elephant populations. In: Proceedings of an expert consultation on the Control of Wild Elephant Populations. Pp 14-16. Utrecht University Library, Utrecht, The Netherlands.*

There is now ample evidence to show that in National Parks or game reserves in which elephants are adequately protected from illegal killing (poaching), their numbers will increase to the point where they begin to have negative impacts on biodiversity. Initially this may only affect the structural diversity of habitats, but as elephant numbers continue to increase, some other species will be lost from the system. Generally, the process is one in which woodlands are changed to grasslands (Bourlier & Hadley 1983; Leuthold 1977; Dublin, Sinclair & McGlade 1990), and so ultimately, species that are dependant upon woodland habitats (even some large mammals) can be extirpated (Western & Gichohi 1989).

The decision as to whether elephant numbers in any given reserve should be limited or not, should therefore be based on the management priorities set for the reserve (see Fig 1). If biodiversity is not a priority, then elephant management may not be as important an issue, but if the maintenance of species diversity is the stated priority, then something will ultimately have to be done to limit the elephant population to a level at which their impacts will not have negative consequences for these other species. If the management priorities for such reserves have not been clearly defined, then management will at best be muddled and directionless.

If biodiversity has been defined as the management priority, what are the options available for managing elephants? For any species, whether they be mosquitoes or elephants, there are only three basic options – translocation, contraception (both of which are non-lethal) and culling. While the non-lethal options may seem to be ethically more acceptable, they too have their problems.

Figure 1: Management loops

Loop 1: No biodiversity concerns; no elephant management

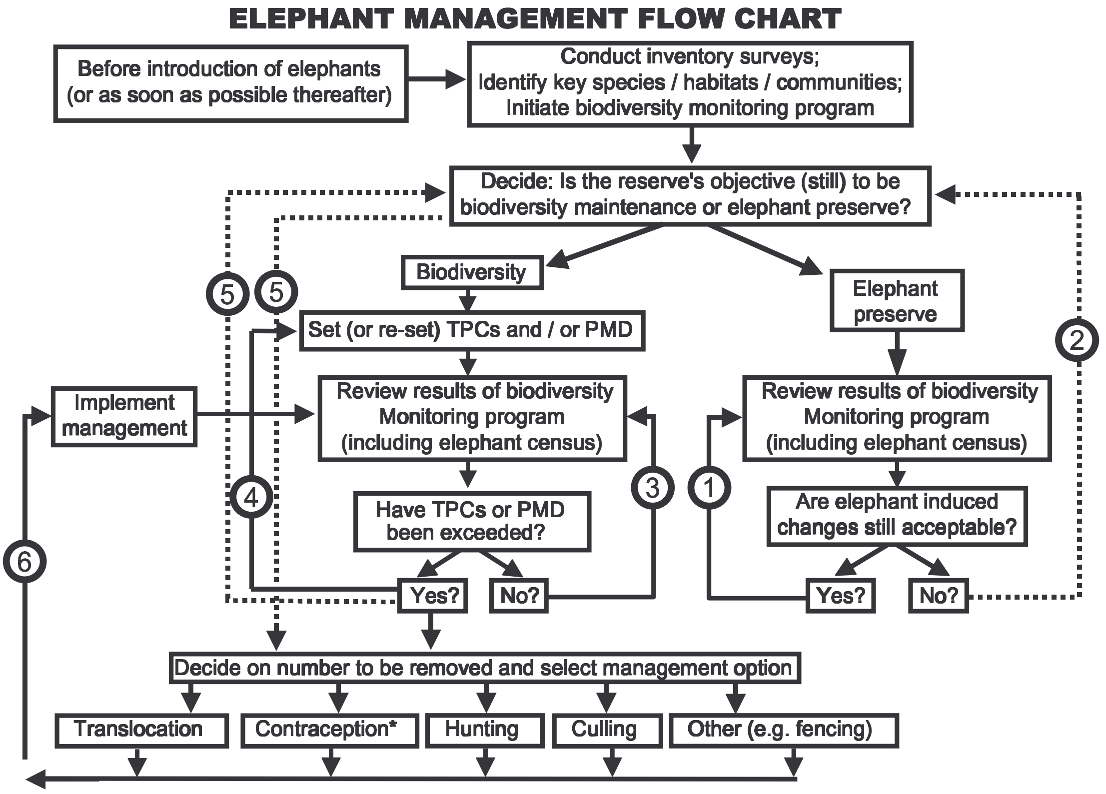
Loop 2: Reconsider the elephant / biodiversity decision

Loop 3: Biodiversity concerns but impacts do not yet exceeded Threshold of Potential Concern (TPC) or elephant population does not yet exceed Preferred Management Density (PMD)

Loop 4: Biodiversity concerns and impacts exceed TPC or elephant population exceeds PMD. Reset TPC or PMD?

Loop 5: Reconsider the elephant / biodiversity decision

Loop 6: Elephant management loop



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Translocation:

Opportunities for translocations are now extremely limited as there is little space left into which elephants can be moved (Garai *et al.* 2004). Most areas in Southern Africa that can potentially accommodate elephants now have them, while those that still can (e.g. Limpopo National Park in Mozambique), will not be able to accommodate the numbers that need to be moved. While this method may well be the most acceptable from an ethical viewpoint, there are some ethical questions, as it can seldom be established with certainty whether family units are moved intact or whether some are left behind (Whyte & Fayrer-Hosken In Press). The effects that this may have on those moved and those left behind are not yet well understood.

Contraception:

Current contraception technology is of limited value for controlling large populations (Whyte, van Aarde & Pimm 1998). While the use of porcine zona pellucida (pZP) vaccines have been shown to be an effective contraceptive in small elephant populations (Fayrer-Hosken *et al.* 2001), oestrogen (oestradiol-17ß) implants caused behavioural aberrancies and post-treatment affects that were considered unacceptable (Whyte & Grobler 1998). But for both of these techniques, the logistics preclude their use in large populations. In order to stabilize an elephant population, 75% of all breeding females must be constantly under treatment (Whyte, van Aarde & Pimm 1998). In a normal population, this equates to around 35% of the population total. These animals all require "boosters" or replenishments at specific times, which means that each animal must be individually locatable, and each one must therefore be fitted with a radio collar. This all pushes the costs (economically and logistically) to a level that is beyond that affordable by most conservation agencies. There are some developments which may change this situation.

Sterilization is another form of contraception. Its major drawback is that it is not reversible, which means that a population under regulation using this technique would be severely at risk from either a poaching or disease epidemic. Its ability to recover would be greatly impaired if most of its adult females (or males) had been permanently sterilized.

This level of interference in a large national park also poses many unanswered moral questions - the longer-term side effects on structure and behaviour in a contraceived population are also poorly understood (Whyte & Fayrer-Hosken In Press).

A final problem with all contraception techniques is that they cannot reduce a population over the short term. Elephants are long-lived animals, so once a population has been stabilized by contraception, there will be a time lag before natural mortalities will eventually begin to reduce it.

Culling:

Culling is the third option and it is the only one that can currently solve the problems of over-abundance in a large population.

Culling is an extremely emotive subject, particularly when it is applied to elephants. While to some the culling of elephants may be anathema, it is usually seen by those concerned with the maintenance of biodiversity as a necessary evil – one which unavoidably must be used in situations where the two non-lethal options (translocation and contraception) are not implementable.

The advantages of culling are that in large populations, the over-population problem can be successfully addressed (except where a population may be so large that even this option is not logistically implementable). Also, the processed by-products of a cull (meat, hides, ivory, etc.) may be sold which can be profitable. This can provide conservation activities (such as anti-poaching) with much needed funding.

The disadvantages are that there is a certain amount of disturbance to related groups that may be nearby at the time of the cull. The degree of disturbance will depend on how close they are and will be worst when a larger group needs to be split. However this disturbance is almost identical in nature to a translocation operation.

As with translocations, there will be impacts on the family and bond group members that are left behind. These impacts come from the disturbances of the operation itself and from the longer-term effects of the loss of bond group/family members.

But the major ethical question surrounding culling remains: Is it ethical to kill elephants? Some westernized cultures may find culling ethically unacceptable. But whose ethics should apply? To a rural African with little access to protein, an average westerner, or an animal rights person, ethical elephant management will mean very different things.

While there will be many who will believe that culling may not be ethical, it must be clearly understood that this option has to be weighed up against the losses of whole populations of other species. Loss of a species from a system will have its effects on biodiversity and the system's food webs, and in extreme cases, may even mean the extinction of a species. These losses of species from a reserve will occur if elephant numbers are not limited in some way. In a modern world that realizes the importance of biodiversity, is it ethical to allow species to be lost from a system when prevention is possible?

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PROJECTED TRENDS IN THE KNP ELEPHANT POPULATION AFTER IMPLEMENTATION OF THE NEW ELEPHANT MANAGEMENT POLICY

IAN WHYTE

In order to assess the implications of implementing the proposed new elephant management policy on the elephant population, a spreadsheet model was developed to simulate the trends in the respective zones and also for the KNP as a whole (Whyte 2001, 2004).

A simple spreadsheet model was constructed to calculate the number of elephants to be removed from each zone based on the management strategies listed for each of the six elephant management zones (Whyte *et al.* 1997, 1999). The starting point (Year 1) was the data derived from the aerial census of 1999. The populations in the botanical zones were reduced to and held at the prescribed density of one elephant per 2.85km^2, those in the low-impact zones were reduced by 7% per year, while those in the high-impact (unmanaged) zones were increased by 7% per year. The projections were based on three assumptions:

i. That the elephants recorded in the respective management zones will remain in these zones and will not move into adjacent zones;
ii. That population growth rates will remain a constant 7% per year;
iii. That to achieve a 7% reduction in a population which is growing at 7% per year, a total of 14% of the animals recorded in that zone should be removed each year;

The numbers of elephants to be removed from the respective zones' populations are given in Table 1. Since the prescribed limits for the botanical zones were exceeded by far, a large number of animals must be removed from these two zones. It is assumed that all of the excess elephants in the botanical reserves are removed in the first year while in the low-impact zones a 7% reduction is made. This gives a total of around 950 elephants to be removed in the first year. This large quota results in a small total population decline after the first year, but once the excess in the botanical zones has been removed, the quotas for removal decline rapidly and the KNP population begins to increase.

If the assumptions given above were to hold true, the population trends and the trends in the numbers of elephants to be removed can be projected into the future. These are shown in Figure 1. Once the excess elephants have been removed from the botanical zones, the number to remove drops significantly in the second year (from 963 to 540). In subsequent years the management option for each zone is maintained until a hypothetical TPC is reached in the year 22. The number to be removed declines as the population declines. After 22 years the number to be removed has declined to just 170, while the KNP population as a whole has increased to around 19 000.

Once a TPC has been reached and the management options for the high- and low-impact zones is reversed, the number of elephants to be removed once again increases dramatically due to the high numbers of elephants in the high impact zones which now need to be reduced (Figure 2). This also results in a decline in the overall population which persists for about 20 years. At this time, the number of elephants in the "new" high-impact zones has built up to a level where the

7% increase exceeds the number to be removed from the "new" low-impact zones and population begins another growth cycle. This will continue until another TPC is reached sometime in the future. In this way, significant population fluctuations will be induced, not only in the individual HEIs and LEIs, but also in the KNP as a whole. It is believed that such fluctuations will significantly contribute to the overall biodiversity of the KNP.

Table 1: Hypothetical population reduction quotas for the respective elephant management zones of the Kruger National Park in the year if the new elephant management policy were to be implemented (census totals are from 1999).

Management Zone	Total counted in 1999	Limit	Total to be removed	Bulls to be removed	Br. Herds to be removed
Northern Botanical Reserve	901	550*	351	53	298
Northern Low Impact	1720		241	36	205
Northern High Impact	2665		0	0	0
Central High Impact	1524		0	0	0
Southern Low Impact	2001		280	42	238
Southern Botanical Reserve	341	250*	91	14	77
Total	9 152		963	144	819

* The limits for the botanical reserves (1 elephant per 2.85km^2) are specified in the management policy.

** The respective quotas for bulls and breeding herds are 15% and 85% as these are the ratios at which they occur naturally.

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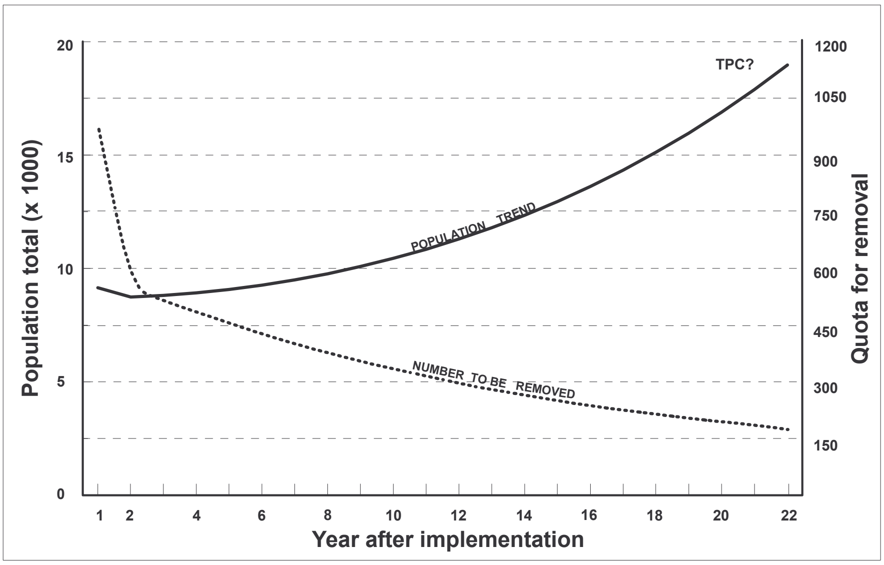

Figure 1: Expected elephant population trends and numbers to be removed from the population after implementation of the new management policy until a TPC is reached after a hypothetical period of 22 years.

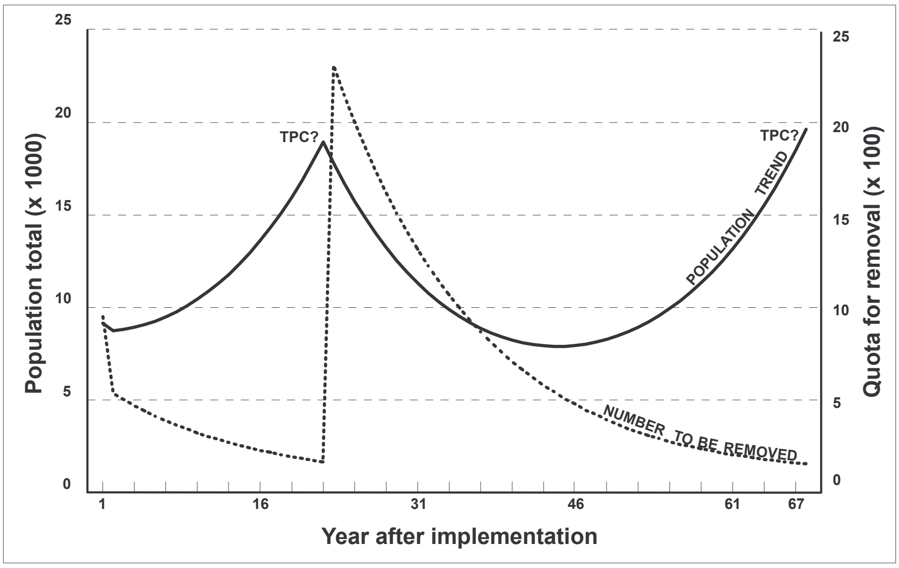

Figure 2: Expected elephant population trends and numbers to be removed from the population before and subsequent to reaching a TPC at which time the management option for the zones was switched (see text).

COSTS OF CULLING

BASED ON INFORMATION SUPPLIED BY: I WHYTE, H BENEKE, M COETZEE AND T VAN WYK.

The costs of culling elephants given are based on estimated figures. Full scale culling last took place 16 years ago in 1994. This estimate is based on an annual cull of 800 elephants, over a period of 5 months a year, over the winter period – i.e. 100 working days.

The estimated costs do not include annualised figures for the cost of major refurbishment of equipment and de-mothballing of existing facilities. This may be a significant expense and will need to be determined. Decisions on the actual ownership of newly refurbished facilities, as well as the positioning thereof must still be made.

The full complement of personnel (as previously used) to operate the total facility (abattoir, and processing units) has been considered. Depending on the specific configuration of SANParks owned and operated, and community owned and operate facilities in the final configuration the costs here may differ considerably.

SOME ESTIMATED COSTS OF FUTURE ELEPHANT CULLING OPERATIONS

Cost of Capital Not Included

Operating Cost Of Processing (E.g. Canning) Not Included

OPERATING COSTS (Based on an annual cull of 800 elephants)	**Yearly costs**
Helicopter costs (200 hours @ R2 200 per hour)	440 000
Transport truck @ 62 200 per month	311 000
Trailer for transport truck @ R21 000per month	105 000
Tractor (x2) costs @ R38 826 per month each	388 260
Trailer (X2) @ R620 per month each	6 200
Mobile crane @ 21 160 per month	105 800
Ground crew transport @ R10 600 per month	53 000
Staff salaries (if all staff are SANParks)	3 009 000
Operating costs -Salt, spices, cleaning materials, PPE etc.	100 000
Abattoir costs: water, electricity etc.	420 000
Abattoir maintenance	360 000
TOTAL:	**5 298 260**
INCOME (Based on an annual cull of 800 elephants)	
(300 kg deboned meat/elephant)	
Meat products @R4-R11 /kg ("average R5.00")	1 200 000
Hides (Ave 200kg/ele: last sold at R60 /kg dry salted)	9 600 000
Carcass meal (not calculated)	
TOTAL:	**10 800 000**

UTILISING THE "TRIPLE BOTTOMLINE" PRINCIPLES IN EVALUATING COST- BENEFITS OF MANAGEMENT ACTION

RIA MARSHALL, VIDA BOTES

Rationale for Management Action

The rationale for taking management action in the case of elephants within the South African national parks is firmly based on an evaluation of the risks posed by no elephant management action or a laissez-*faire* approach. The combined effect of these risks can be estimated by determining the likelihood and consequences of the individual elements.

There is still healthy debate on the individual likelihood of potential risks identified. It is unlikely that this will ever be concluded as the biodiversity system is complex, and accurate modelling and prediction unlikely. Evaluating the impact of any positive or negative experience or action can only be done from a specific value system. Unless this value system is shared by the range of stakeholders, it is unlikely that the perception of total risk exposure by the different stakeholders will be the same.

In the specific area of conservation, the Values espoused by SANParks are clear. Despite the fact that the uncertainty as a result of the complexity of the system, as well as the opinions of different scientist scans only lead to acceptable ranges of likelihoods, it is possible to determine the impact (or impact range) that SANParks will be exposed to, should no management action be taken on the matter of elephant numbers in conservation areas.

Taking management action will change the total impact that is likely to be experienced by SANParks, however, the management actions themselves need to be evaluated to determine the viability of the specific action. This will be done in terms of the costs and benefits directly obtained from the action, as well as the predicted changes of the total risk impact of elephants in the park.

When the specific set of actions that comprises the management plan for a specific park in SANParks has been proposed, it will be necessary to do a valuation of the change that this plan should deliver on the risk impact and weigh this against the cost/benefits of management plan. Establishing a predicted value for a management action is not an exact science, and it is dependant on at least the:

- Value system of the organisation embarking on the management action;
- Ability to predict the outcome of a specific action; and
- The ability to realise any predicted value.

Triple Bottom Line Concept

Considering the impact and results of an organisation through objectives that is beyond that of the pure financial objective has been accepted within the management sciences. The Global Reporting Initiative (GRI) is one of the best known standards-setting bodies, although there are a number of these competing bodies directed at developing and disseminating international standards for reporting. These bodies are part of the overall movement for social and ethical accounting, auditing and reporting (SEAAR) (Norman, MacDonald 2003). No attempt is made in the GRI to rank organisations, but minimum acceptable standards and reporting formats are given.

The concept Triple Bottom line was coined in 1997 by John Elkinton in a book '*Cannibals with Forks- The triple Bottom-line of 21st Century Business".* It has become very popular and has been adopted by corporations, governments and activist groups.

TBL, as do many of the SEAAR movement initiatives, focus primarily on the reporting of social and environmental performance in addition to the financial reporting. It assumes that the measurement of the social and environmental bottom lines can be done objectively and that relatively un-controversial formulas can be used to report on these.

Models for application of TBL

Although the term TBL may be seen as misleading, or even impossible to implement (Norman and MacDonald, 2003), as it requires the usage of qualitative judgements that depends on a specific value set, it does emphasize that any organisation should be accountable for meeting all three of the objectives- financial, social and environmental.

The TBL principles can be used explicitly in calculating investment opportunities and screening companies based on their reporting of performance against social and environmental accountability factors. TBL is used in three manners:

1. Translate all the factors into a single currency and compare the total aggregate. The aggregate is often a financial value, and requires the translation of qualitative evaluations into a quantitative format. The mechanism used to do this is that of risk evaluation, and is as such dependant on the accuracy of the underlying information. It also requires that the valuation of the "seriousness" of a specific negative or positive consequence is judged explicitly and consistently by the organisation, and its stakeholders.
2. Use one of the factors as the mechanism to rate the performance of a specific management action or investments based on minimum requirements, and rank the other factors to guide decision-making. In many industries any project or management action will be judged on financial terms (e.g. hurdle rate) and then considered in terms of its social or environmental attractiveness.
3. Combine some of the factors through explicit weighing factors to inform decision-making. This mechanism is underlying many of the tender evaluation processes used in South Africa where social responsibility measures are used with the financial rating of a specific project or investment.

The drivers for "valuation" of specific bottom-line is specifically dependant on the values that exist within the organisation, as well as the stakeholders influenced by a specific project or management action. It may not be possible to "offset" the positive or negative consequences if these occur in the different "bottom-lines".

Valuation of Cost/Benefit of Elephant Management actions

Any management decision made in SANParks must be made in a responsible manner. This means that such a decision must be accountable in financial, social and environmental terms.

Financial Accountability

The Public Finance Management Act requires SANParks, and its officials to be accountable for the financial management decisions made. These decisions must be deemed to be economic, efficient and effective. In addition to this the total cost of ownership must be considered and the longer term effects and liabilities of decisions such as operating cost and maintenance must be included in a decision.

Environmental accountability

In the SANParks context environmental accountability can be evaluated both in terms of the Conservation Values espoused by SANParks and the more standard environmental aspects governed by NEMA.

The SANParks Conservation Values and their potential usage in decision-making support is the focus of much current debate (Rodgers, Biggs 2005). The biggest challenge in utilising these values is that it may not be the underlying values of all the stakeholders.

All potential management actions will need to be evaluated in terms of the potential environmental impact. In this case it may be possible to translate the costs that will be needed to ensure that any such concerns is dealt with and state it explicitly as operating costs and capital costs, as is the case.

Social accountability

Social accountably of the different management issues may very controversial. SANParks values clearly articulate that it supports sustainable utilisation. However, the actual policy guidelines for such utilisation have not been unpacked and accepted within the organisation. The community based natural resource management (CBNRM) guidelines provides a framework to evaluate different initiatives. SANParks must also comply with procurement policies that clearly articulate its support of BEE and SMME development.

The constitution, NEMA and the Protected Areas Act require a participatory style that empowers all stakeholders. This requires that all stakeholders have a stake in the decision making process and must be given an opportunity or constructive input in decisions that concerns them. The process followed takes the requirement of social accountability into consideration, but the actual costs and benefits to the communities involved must be determined, and should inform management decision.

Social benefits and costs must be evaluated and a minimum requirement set for evaluation of suitability of specific elements of the proposed elephant management plan. These benefits must be true benefits, and in addition to this the benefits must be sustainable over the long term. One of the potential areas to consider is that of agreements with communities to own and operate facilities required to process elephant products such as meat, worked elephant hides and elephant hair.

Conclusion

Any potential management action or intervention must be evaluated to ensure that it is fully accountable. In the Case of SANParks, and especially with regards to any management action so clearly in the spotlight as the Elephant Management Plan, it is essential that this be done in a transparent and responsible manner. Rationality of any management action must be proven as part of the process of developing and submitting a plan for approval.

It is not foreseen that the financial evaluation will be very difficult, although the necessity to consider the longer term implications and liabilities of specific options must be kept in mind. Costs needed to ensure that environmental standards are maintained should also be included.

Development of a system to evaluate the compliance of management actions and interventions in terms of the Conservation Values of SANParks is well under way.

Evaluation of the social benefits and costs- and the resultant “bottom-line” will be very important and will require significant focus. Community participation and involvement is a key element in the process of establishing an Elephant Management Plan for SANParks. However, the principle that communities benefit from these management plans in a sustainable manner must be applied.

Trade –offs between the different bottom lines is extremely difficult and will be difficult for SANParks to motivate as a responsible and rational action. A fully evaluated management action or intervention must meet minimum requirements in all three of the “bottom lines” to be acceptable as a viable solution.

CONTRACEPTION OF AFRICAN ELEPHANTS USING PORCINE ZONA PELLUCIDA VACCINE - BASIC PRINCIPLES

HJ BERTSCHINGER, AK DELSINK, JF KIRKPATRICK, D GROBLER, JJ VAN ALTENA, R SLOTOW

Introduction

The use of antigens to control of fertility is known as immunocontraception or immuno-fertility control. A number of antigens have been employed in the past with varying degrees of success. The most commonly used antigen has been porcine zona pellucida (pZP) proteins to control fertility of females. Zona pellucida proteins isolated from ovaries of pigs (pZP) have been shown to be effective for the immunocontraception of horses (Kirkpatrick *et al.* 1995; Kirkpatrick & Turner 2002) and a range of wild and zoo herbivores (Kirkpatrick *et al.* 1996; Naugle *et al.* 2002; Shideler *et al.* 2002). In these species the vaccine was shown to be safe and, where tested, also reversible.

Mechanism of action

In order to understand how pZP vaccine works as a contraceptive we need to look at the process of fertilisation of the egg by a sperm. This is explained in Fig 1 (A-C). Blocking of all sperm receptor sites relies on antibody concentrations that are sufficiently high to achieve this and should the concentrations fall below a critical level, which happens over time, the cow will once again be fertile. pZP only targets the zona pellucida of the cow and has no direct effect on behaviour. Because the cow does not fall pregnant she will continue to show an oestrous cycle that is 15-17 weeks long. This means that she will come on heat 2-3 times a year.

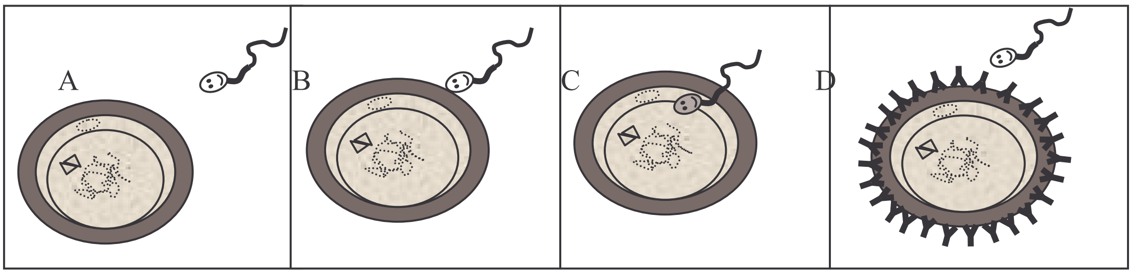

Fig 1: A - When the egg (oocyte) is ovulated into the Fallopian tube it is surrounded by a capsular layer known as the zona pellucida capsule.

B- Before fertilisation can take place the sperm binds to one of thousands of receptor sites on one of the zona proteins. The sperm then undergoes the so-called acrosome reaction.

C - Only once the sperm has undergone the acrosome reaction can it penetrate the zP-capsule and then a single sperm fertilises the egg.

D - The antibodies formed in response to the pZP vaccine recognise and cover all sperm receptors on the ovulated elephant egg. The binding of sperm is blocked as is fertilisation and thus pregnancy

Fayrer-Hosken *et al.* (1999) showed homology between porcine and elephant zona pellucida proteins. This meant that antibodies to pZP proteins should recognise the elephant zona pellucida and with high titres elephants could be contracepted with the vaccine. The first field studies to contracept African elephant cows with the pZP vaccine were carried out from 1996 to 2001 in the Kruger National Park in two trials. The first trial resulted in a 56 % (n=19) efficacy rate while during the second 80 % (n=10) of cows were successfully contracepted (Fayrer-Hosken *et al.* 2001).

Application in the field and results

Since the Kruger Park trials the vaccination protocol has changed in that we now make use of modified Freund's for the primary and incomplete Freund's adjuvant for the booster vaccinations. Vaccinations are all delivered remotely with dropout darts either from the ground or a helicopter. A total of 58 cows have been vaccinated in five private game reserves.

Makalali is the only private reserve where the project has been running long enough to provide data on the efficacy of the vaccine and possible effects on behaviour (Delsink *et al* 2004). Twenty-three cows have been vaccinated. The protocol employed for most of the cows was a primary vaccination followed by two boosters at 3-4 weeks intervals during the first year. A single annual booster for each cow followed this. Darting was performed from the ground during the first two years of vaccination but in 2003-2004, 17 and 21 cows were darted from the helicopter. At no time was immobilisation of animals necessary to perform vaccinations. Total time taken for helicopter vaccination was about 30 min and the herds settled down much quicker (1-2 days) then if darted from the ground. The success rate has been encouraging to say the least. Ten cows have passed the 53-month inter-calving period of the reserve with no early calving indicating 100 % reproductive control so far.

The elephants at Makalali have been monitored intensively almost on a daily basis (Delsink *et al* 2004). To date, no anomalies in terms of aggressive or indifferent behaviour with regards to nursing time, nursing behaviour and calf proximity have been noted. No change in the cows' social hierarchy has been noted.

Implications for elephant management

Population control methods for African elephants in smaller parks are limited. The options are translocation (few takers), hunting and culling (not suitable for small populations) and contraception. The research has shown that pZP vaccine can be used successfully and safely to contracept small populations of free-ranging elephants. What is more, it can be applied selectively on an individual cow basis, which, once a population has been stabilised, will allow individual animals to calve from time to time.

Potential for application to larger populations

Although the procedure has to date only been implemented in smaller populations (< 100 individuals, we have the technology and experience to recommend the use of the procedure in larger populations. This is possible using a mass-darting approach, rather than darting individually identified elephants. Identification would take place on the basis of family or clan ID, and then as many adults over 12 years old will be darted with the vaccine. The use of paint-darts will help to identify cows already darted. It is feasible to dart 80 % or more cows within a group from a helicopter with a darting time of about 30 seconds per female. Some animals are bound to be missed when darting is repeated but a rate of about 60 % should be achieved in a continuously vaccinated population. The only constraint for the contraception of large populations would be resource limitations.

Future research

This year we plan to test two different types of vehicles with the pZP vaccine. The first is the so-called one-shot vaccine. The dart in this case contains three different portions of vaccine: a fluid portion which constitutes the primary vaccination; a pellet that dissolves after about 3-4 weeks and provides the first booster and a second pellet that dissolves after 6-8 weeks and provides the second booster. This means that during the first year only one dart per cow is required. Following this an annual booster will be necessary to maintain immunity and contraception. The second is a slow-release liposomal formulation, which provides a contraceptive effect for a period of five years or longer after a single vaccination. Cows will be recaptured four months after vaccination to test antibody titres as well as T-cell immunity response. The latter will provide more accurate information as to possible permanent sterility effects of the vaccine. Although there are no indications of this thus far in immunised elephant cows, this test will provide a final answer to the often-asked question.

Conclusions

In conclusion we feel that it is important to emphasise the following points:

- The pZP vaccine can be used successfully to contracept African elephants
- The Vaccine is safe during pregnancy and has no negative effect on birth or calf raising
- It has no side effects other than occasional lumps at the site of vaccination
- It is reversible
- Other than an increased incidence of heat no behavioural side effects were seen
- Administration of the vaccine is carried out remotely by darting and does not require immobilisation

Key Publications

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ESTIMATED COSTS OF USING CONTRACEPTION TO MANAGE THE ELEPHANT POPULATION OF KRUGER NATIONAL PARK.

P.E. BUSS

Introduction

Kruger National Park (KNP) has adopted a policy of managing for maximum indigenous biodiversity through intermediate levels of spatial and temporal disturbances within ecosystems. It is accepted that elephants are important agents of disturbance and positively contribute to biodiversity. However, excessive disturbances at high densities will negatively affect biodiversity and it is in this light that the cost of controlling elephant populations through contraception is discussed. In the current KNP elephant management policy, it believed that the use of contraception in managing elephant populations is restricted to maintaining medium elephant densities in the two botanical reserves (Whyte 2004). Estimating the costs of using porcine zona pellucida (pZP) contraception to manage elephant populations throughout the KNP is a theoretical exercise, and is not in line with present elephant management policies. Current knowledge and techniques in contraception do not allow for reductions in population size in the short to medium-term and, therefore, alternative methods are required if elephant numbers are to be reduced in the low-elephant-impact zones and botanical reserves of KNP (Whyte et al. 1998, Whyte 2004b). There are concerns that the logistical complexity of a contraception programme in a large population of elephants makes it impractical. There are also a number of questions regarding the medium to long-term behavioural and physiological effects of contraception that need to be investigated before a contraception programme should be considered (Grootenhuis et al. 2004, Heesterbeek et al, 2004).

Estimated cost of vaccinating reproductively active females

To control the elephant population in KNP, 75% or more of the reproductively active females will have to be incorporated into a contraception programme (Whyte et al. 1998). Of the 11454 elephants counted in the census of 2004, approximately 5326 animals (46.5%) are breeding females (Whyte, I. pers. comm., Whyte 2004a). Table 1, gives the estimated costs of administering one dose of pZP vaccine to each animal. The vaccine will be delivered by dart using a helicopter as a darting platform. A 100% vaccination programme will include all 5326 females. However, it can be predicted that not all animals will be located, some of the darts will not deliver the vaccine successfully and the contraception will fail to be effective in a percentage of females. The values for each of these variables are not known, and still have to be determined through further research and testing of systems. Therefore, it is assumed for this costing exercise, that if all female elephants located are darted, and the unknown values for these variables are accounted for, 75% or more of the animals will be effectively contracepted.

The number of hours that it will take to locate the elephant breeding herds in KNP is based on the number of hours that are commonly flown by helicopter each year to complete the elephant census. Darting animals with the vaccine will involve splitting up breeding herds into smaller more manageable family groups, identifying the female animals and determining which of these are old enough to be reproductively active. Only once this has been done, can these animals be darted with the pZP vaccine.

In the costing (Table 1) it has been assumed that the total number of vaccine doses required is equivalent to the total number of reproductively active females. In reality the number required will probably be significantly higher than this. A number of darts will miss their target, as it is difficult to age elephants accurately from the air it is reasonable to expect that some females that are not yet able to breed will be darted, and due to similar difficulties in sexing younger animals a percentage of males will be vaccinated. This increase in the number of vaccine doses required will be offset to some degree by the number of reproductively active females not found.

Table 1. Estimated costs of administering one dose of pZP vaccine to each reproductively active female elephant in KNP.

Helicopter	**Cost (rands)**	**Units**	**Total (rands)**
Operating costs of an EC-120 helicopter per hour	2400	160	384000
Fuel delivery	5000	1	5000
Vaccines			
Cost of vaccine per dose	120	5326	639120
Cost of a dart	60	5326	319560
Cost of a dartgun	8500	1	8500
Cost per explosive charge	1	5326	5326
Personnel			
Cost of helicopter pilot per hour	222	160	35520
Cost of a veterinarian per hour	111	160	17760
Cost of a veterinary technologist per hour	65	160	10400
Cost of a veterinary assistant per hour	50	160	8000
Miscellaneous			
Accommodation per night	600	20	12000
S & T per person per day	65	80	5200
Vehicle	13000	1	13000
		Total	1463386

The rates per hour for personnel have been calculated from their current cost-to-company. It is believed that the vaccination programme can be accomplished by four people; a helicopter pilot, veterinarian, veterinary technologist and veterinary assistant. However, as individuals become fatigued they may have to be relieved and replace by similarly skilled people. The veterinarian will be responsible for the darting of the animals, ensuring correct storage and handling of the vaccine, and for monitoring the welfare of all animals affected by the process. A veterinary technologist will be responsible for the preparation of the darts, laboratory procedures, the maintenance of equipment, and the collation and storage of data. A veterinary assistant will be required as the third person in the helicopter to assist in locating the breeding herds, monitoring which animals have been darted and keeping of records.

At present, effective contraception in elephants requires that three doses of pZP vaccine be administered at three week intervals in the first year, and then annually thereafter (Bertschinger, H. pers. comm.). Table 1 shows the costs associated with administering a single dose of the vaccine to at least 75% of breeding females. In the first year, as the process will have to be repeated on two further occasions, the costs will be approximately three times those illustrated. At this point, a further assumption must be highlighted. It is believed that elephants cannot be effectively marked when receiving a dose of vaccine, so that they can be identified when subsequent doses are to be administered. Any form of permanent ink or paint applied to the skin of an animal by the dart at the same time as vaccination is unlikely to be visible three to four weeks later. This is due to the fact that elephants frequently have mud and dust baths which will obliterate the markings. The use of radio collars is not a realistic option, as each animal will have to be immobilized so that they can be fitted. The increase in the amount of resources, capacity and time required will significantly increase the costs, and the risk of injury or death in the treated animals. At this time it is not even certain that such an exercise, due to its complexity, is logistically possible. Due to these limitations in identifying individuals, it is assumed that of the animals receiving an initial vaccine dose, sufficient animals will be relocated and administered second and third doses, to result in the contraception of at least 75% of reproductively active females. Elephants, following the initial three dose vaccination, will require a single annual booster dose. This interval may be increased to two years as suggested by Kirkpatrick (2004); however, this still needs to be confirmed.

The development of a vaccine that needs to be given only once in the first year, will eliminate the need for multiple vaccinations, and reduce the initial costs of vaccinating animals. Another option is a slow-release mechanism that can be administered once, and that is relatively effective for several years. Both options are currently being investigated (Kirkpatrick & Rutberg 2001).

The costing, as reflected in Table 1, does not take into account increases in costs each year due to inflation. It also, does not make provision for the fact that each year; a certain number of young female animals will become reproductively active for the first time. The exact number will depend on the percentage of older females that have been effectively contracepted and are no longer producing calves, and the duration the vaccination programme has been active. These new female animals will require an initial three doses of vaccine. How these animals will be differentiated from other females in the population that have been contracepted for a least one year and, therefore, only required a single booster dose is a logistical problem still to be solved.

Conclusion

An estimate of the costs involved in administering one dose of pZP vaccine to at least 75% of actively reproductive female elephants in the KNP has been presented. A number of variables that will impact on the numbers of elephants treated and the resources required, cannot be quantified without further research, vaccination trials or modeling. Therefore, the effects of these variables on the costs of such a programme, have not been included. A clear indication of the scale of the costs involved has been given, and an indication of how these might be reduced in the future. The costs of such a vaccination programme will be incurred each year for as long as it is used to manage the elephant population. They are not wholly or partially recoverable as is possible when other techniques in population control, such as translocation or culling, are used. This costing has been a theoretical exercise, and does not indicate that SANParks is about to embark on a contraception programme to manage the elephants in KNP.

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THE SANPARKS ELEPHANT DEBATE: A REVIEW OF WHAT HAS HAPPENED IN THE PAST AND SUGGESTIONS OF HOW TO PROCEED.

GUS MILLS

Introduction

Elephants are a keystone species that play an important role in ecosystem dynamics. Although there is much that is known about the dynamics of elephants in ecosystems, especially at the spatial scale, little is known about the long-term temporal relationships between elephants and ecosystems. Therefore the long-term management of ecosystems with elephants is a subject of much conjecture and uncertainty.

Within SAN Parks elephants occur in parks of different sizes with Kruger being the largest and Mapungubwe currently the smallest. Although a uniform policy for the management of elephants throughout SAN Parks is being sought this is may not be the most practical way forward as the question of scale is paramount.

The elephant debate and the development of a new policy for Kruger.

At a public debate held in May 1995 SAN Parks undertook to review its policy for the management of elephants in the KNP. A series of meetings and workshops with a wide range of stakeholders including the IUCN African Elephant Specialist Group, The International Fund for Animal Welfare (IFAW), and managers in Kruger Park followed. The new policy was born out of these meetings and presented to the public in 1996 at a meeting at Midrand and through a document circulated at the time (Hall-Martin & Novellie 1996). In February 1997 a workshop to discuss the maintenance of biodiversity was held in Skukuza and attended by a wide variety of scientific experts both national and international, leading to the finalised policy document being formulated at a meeting of SAN Parks staff on 17 March 1997. The finalised policy document was placed on the Internet for further public scrutiny and was also presented at another public meeting in Nelspruit on 31 October 1998. Almost unanimous public support was given at this meeting, with the only objection coming from the small animal rights group FALCON. Accordingly SAN Parks approved the policy on 12 March 1999. Six years later the policy has still not been implemented and another round of meetings has been implelemted; i.e. the Elephant Indaba held at Berg-en-Dal in 2004 and now the Scientific Meeting to be held in March 2005.

The way forward and objectives of the scientific workshop

I would hope that at least with regard to Kruger, the starting point at the Scientific Meeting will be the acceptance of the management policy and that the debate will centre around the implication of this policy. It will be counter productive if we have to go back to discussing the role of elephants in ecosystems and a review of what we do and do not know with respect to Kruger and whether we need more data before we can implement a policy. The aspects that will be important to discuss will be the way in which water distribution should be factored into the various zones (Owen-Smith 1996), the monitoring program and TPC's that should be implemented and the manner in which the population would need to be managed to achieve the desired management strategy. Once this has been achieved, the discussion should then turn to how this policy can be modified to embrace the situation in smaller parks.

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Factors affecting an elephant management policy

Lindsey Gillson

A post-normal approach to science is appropriate when facts are uncertain, systems complex, values are diverse, stakes are high and decisions are urgent. Kay *et al.* have developed a heuristic framework for integrating a plurality of legitimate perspectives.

Key Publication

KAY, J.J., H.A. REGIER, M. BOYLE & G. FRANCIS (1999) An ecosystem approach for sustainability: addressing the challenge of complexity. *Futures* 31: 721-742

UNDERSTANDING ELEPHANTS AS AGENTS OF HETEROGENEITY IN KRUGER

JOHAN T. DU TOIT

It is generally accepted by ecologists that elephants are keystone megaherbivores in African savanna ecosystems. Due to the visible impacts they have on vegetation including mature trees, it is typical for stakeholders to express concern when elephant populations are in the eruption growth phase. Inevitably, however, for any savanna herbivore population that it is immune to predators (as elephants are, if man is excluded as a predator for now), some kind of dynamic equilibrium will be reached between animal numbers and the abundance and accessibility of key food resources during dry periods. So why worry? The problem is that: (1) people don't like seeing elephants dying of starvation and vegetation being denuded, as would be the case if the elephant population were allowed to reach density dependence;

(2) managers interfere with the system by introducing waterpoints and fences;

(3) the area within a national park may not be big enough to allow an elephant population to self-regulate, and the surrounding matrix may be transformed by human landuse, causing compression within the park;

(4) managers typically prefer managing wildlife rather than leaving it alone. Finally

(5), there is a politically and economically justifiable argument that a large elephant population represents a sustainable source of meat, skins, ivory and trophy fees, which could all contribute to the flow of ecosystem goods and services that a wildlife area should provide in order to justify its existence. So, the question emerges: do we know the "right" density of elephants for any particular landscape? The answer is a resounding "no".

If the managers of a national park such as Kruger are adequately convinced, empowered, confident, and honest enough to tell the world that the elephant population will be held at somewhere near half of the estimated carrying capacity of the system through harvesting for maximum sustainable yield, then the impact of elephants on biodiversity is mostly irrelevant. But if culling is applied as a management tool to serve the objectives of biodiversity conservation, then prior understanding is required of the relationship between elephant population density and biodiversity in each landscape. That understanding does not exist, and in my opinion it is naïve to propose that culling can be used within an experimental design to reach that understanding.

Management implications

The response time of any experimental treatment in a plant-herbivore system involving elephants is measured in decades, during which constant treatment and control conditions must be maintained throughout. The probability of that being achieved in Kruger is low, because new park management regimes will come and go, government policies will change, and international pressure against culling will mount. If the project has to be aborted before any meaningful results are obtained then all is lost.

I propose that Kruger establishes a broad-based research programme with multiple subprojects, all designed within a framework (Pickett *et al.* 2003) built around elephants as agents of heterogeneity (Fig. 1). Using simulation modeling, field experiments, and comparative analyses based on meta data-sets compiled from previous studies across African savanna ecosystems, an adequate understanding of key interactions could be quickly reached (at least within one decade). Elephant impacts in Kruger are patchy already due to variations in distance to water. Hence, after controlling for soil type and catenary position, it should be possible to establish a replicated set of study sites across an elephant density gradient in each landscape. Researchers from SANParks and various universities should then conduct simultaneous studies on the responder variables (see Fig. 1) across all sites, using creative research designs (e.g. by erecting herbivore exclosures, planting common gardens of tree seedlings, simulating elephant impacts, manipulating soil nutrients, fumigating selected termitaria, etc, etc). If the overall project theme is "elephants as agents of heterogeneity" and regular networking meetings are held, peer-reviewed publications are produced and circulated, and a SANParks team manages the overall project under the direction of an internationally respected scientific steering committee, then science and management will both win. If the emerging scientific evidence provides a compelling argument for elephant culling in Kruger, then SANParks will have a solid scientific platform to work from. If no justification can be found for culling, then much will have been saved and credibility will have been gained. The BONIC project in Chobe (Vandewalle 2003; Skarpe *et al.* 2004) provides an example that SANParks could follow, to promote both capacity building and integrated research on the elephant "problem" in Kruger.

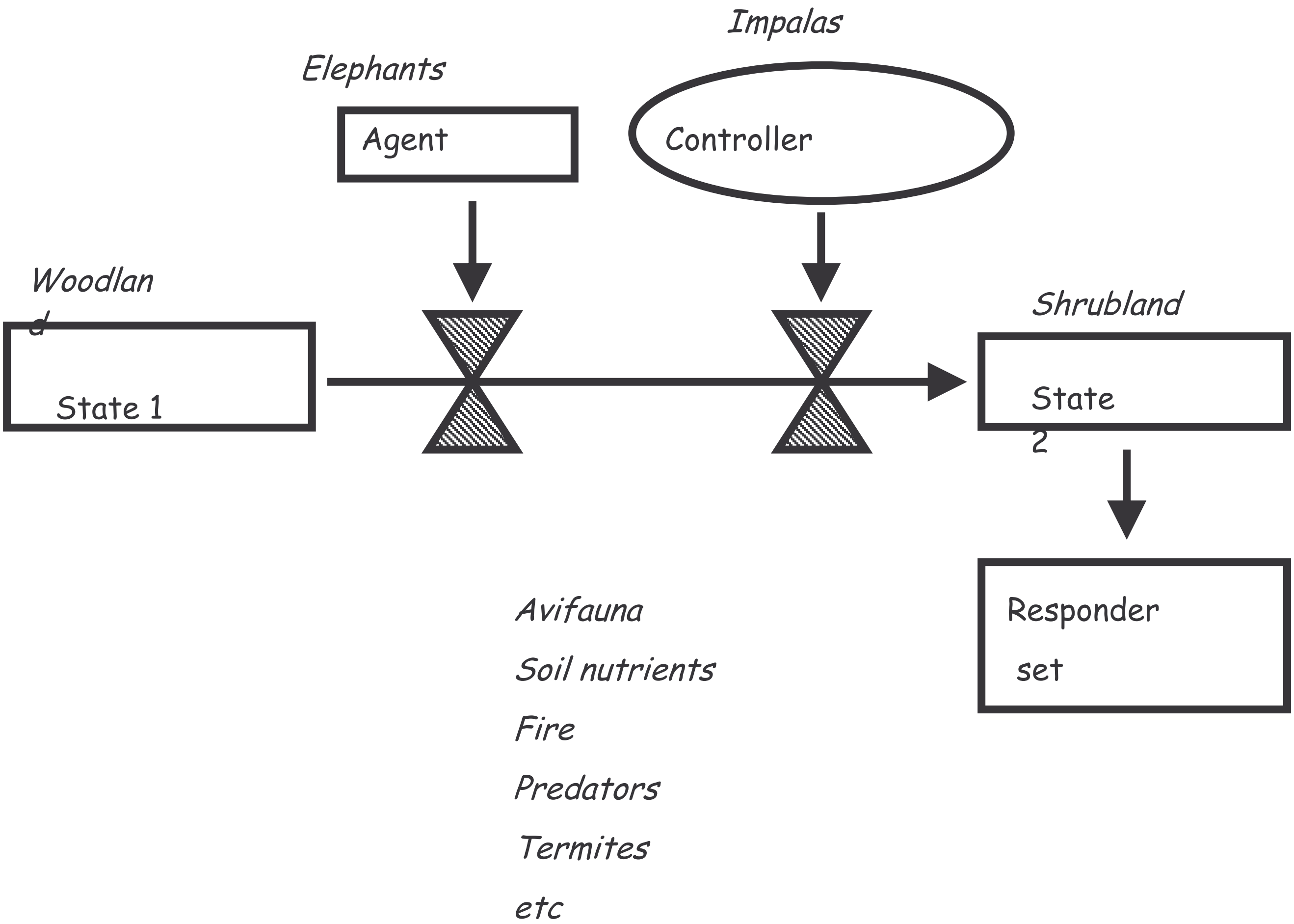

Figure 1. Conceptual framework (based on Pickett et al. 2003) in which elephants are agents of heterogeneity, being responsible for changing a substrate (vegetation) from one state (e.g. woodland) to another (e.g. shrubland). The probability of this change occurring within any specified period depends on the density of elephants (first bowtie), and on various controllers that influence the transition in either way. In this case, as has been found in Chobe (Skarpe et al. 2004), impalas are controllers (second bowtie) in that they regulate the regeneration of seedlings of woodland trees, and therefore accelerate the transition. When vegetation changes from one state to another it is to be expected that numerous variables will respond, which could collectively result in an increase or decrease in biodiversity. This framework could greatly assist in the design of multiple subprojects to investigate the ways in which elephants influence heterogeneity, and therefore biodiversity, in Kruger.

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WESSA'S ROADMAP FOR NEGOTIATING THE ELEPHANT CUL-DE-SAC PROVIDING THE BASIS OF THE EXECUTIVE SUMMARY TITLED THE ROLE OF SCIENCE IN SANPARKS DECISION MAKING

TONY FERRAR AND ANDREW ROSSAAK

Background

WESSA represents informed public opinion on environmental and conservation issues.

Our conservation policies are firmly based on scientific knowledge and are accessible in the public domain. They are intended for practical application and are sensitive to the needs and ethical norms of society.

Our views are generally in line with those of the World Conservation Union of which we are a founder member and whose policies we have helped to formulate over the years, especially in respect of southern African issues.

WESSA has, throughout its 75-year history, advocated the active management of Protected Areas and sustainable use of natural resources where economically and socially justified. This broad and inclusive policy has been successfully applied in southern Africa to entire Protected Area systems as well as to individual wild animal and plant species.

In Protected Areas, the need to manage towards carefully stated, interconnected objectives is recognised. Implementation is easier said than done. Management objectives often conflict with one another and there is always inadequate information to be sure of any intended outcome. In the face of such uncertainty 'adaptive management' is the norm; a system that involves repeated monitoring and review of scientific evidence, field observations and the 'informed guesswork' on which decisions are based.

Management objectives are linked within a dominance hierarchy. This means that the broader objectives for things such as evolutionary processes, landscapes and ecosystems have priority over narrower objectives, such as for a particular plant community or animal species. In such cases, sound management priorities must not be jeopardised by the spotlight of public interest highlighting a particular charismatic species.

The predominant objective of SANParks is to conserve biodiversity within South Africa through the management of a comprehensive and nation-wide system of Protected Areas. This simply stated objective is also deceptively complex. It has to be applied *in situ* and at various levels or scales, from that of a whole landscape, to that of a single population of an endangered species. The SANParks biodiversity mandate generally excludes functioning at levels as low as the individual plant or animal, or that of the gene. At these levels, institutions such as the National Botanical (Biodiversity) Institute and zoological institutions have responsibility for conserving biodiversity *ex situ*.

Indicators for resolving the KNP elephant problem

WESSA recognises the nature and complexity of the elephant problem in Kruger and the decision-making difficulty it presents. Like all interested and affected parties WESSA has inadequate information to recommend an immediate solution. Recently WESSA held a discussion forum in Nelspruit to help inform the interested public, and much of what follows is derived from those discussions and from subsequent reflection and consultation.

WESSA believes that scientific information and understanding should dominate the decision-making process because the conservation of biodiversity is, in principle, a scientific endeavour. Economic and ethical/cultural issues are important but can only play a secondary role as they will tend to be more varied and inconsistent and are based on personal rather than universal values.

Kruger has applied the principles of 'Management by Objectives' fairly openly over the last ten years. This has been done probably more clearly, energetically and 'correctly' than in any other large reserve in Africa. In a shrinking world of spiralling human pressure and predicted climate change it is difficult to argue for any alternative paradigm of management where it can be afforded. To stand by and let nature take its course into the unknown, when the human impact on these no-longer-pristine systems, outweighs even that of elephants, is not defensible. MBO implies learning as much from your mistakes as from your successes. It applies equally well to situations of uncertainty as it does in highly informed circumstances. It requires correct identification of vital signs, continuous monitoring, record taking, archiving and analysis. It requires careful reflection in the light of all this accumulated knowledge until insight and wisdom emerge. Then it requires the boldness to make tough decisions in line with clearly stated goals.

In expecting the elephant management decision to be informed mainly by scientific understanding, WESSA is concerned that confusion and disagreement exist as to what the data mean and what solutions should apply. In particular, in the decade since culling was halted in Kruger, there appears to be little evidence that ten years of expensive research and monitoring has produced any significant increase in understanding of the problem. Is this so? Have there been any habitat or behavioural studies comparing the 10 years prior, to the 10 after the halt of culling? There are stark differences of opinion between individual scientists. There are other differences between scientists generally, and decision makers. If this is a fair reflection of reality, is it scientific failure or decision-making failure? We think it is probably a bit of both.

It is noteworthy that during the ten-year moratorium on culling, the Kruger Management Plan was extensively reviewed and major changes implemented. Artificial game water supplies and fire management practices were changed radically. Potentially, both have a similar scale of impact on biodiversity to that of elephant 'overpopulation'. The elephant management policy was also revised but was *not* implemented. Is this so? And if so, then why?

The Nelspruit debate left a sense of confusion in respect of the scientific interpretations of contending groups of researchers. Those with management responsibility (state employees) tend to present evidence in favour of culling while external researchers tend to suggest the opposite. External researchers, it must be said, avoid having to live with the consequences of providing wrong advice. Both groups have their biases, often associated with their sources of finance and the explicit or implicit strings attached. KNP scientists are just as likely to be biased by their need to justify their salaries and track record. It is quite normal within institutional cultures to subtly encourage scientists to 'prove' a particular management decision as sound and beneficial.

As with the government scientists, external research and monitoring in Kruger is financed by the public – mostly with donors' or taxpayers' money. It is also in the nature of science and scientists, to have difficulty communicating with the lay public. Many scientists naively believe they alone are truly objective and should only be accountable to their scientific peers. Unfortunately, like the rest of us, they are paid pipers, and we all dance unwittingly to specific tunes. One thing seems evident, you and I, as shareholders of *SANParks Inc.* are being let down, possibly along with the donors and NGOs. We need to be reassured that this is not so.

What are the alternatives?

For the purpose of *significantly reducing Kruger's present elephant density*; practical alternatives to culling do not exist. The more acceptable and benign options offer small chances of success, but only for the purpose of 'stabilising' a population within limits. The range extension option, presented by the creation of the Greater Limpopo TFCA, has very limited chances of providing the extra space within an acceptable time frame. If and when it does, it will only postpone or transfer the problem, not solve it. The irony of this very politically driven option is hidden in the nature of the Mozambican landscape. To make the intended range expansion even temporarily workable, artificial water-points will have to be developed to hold elephant populations away from the settled Limpopo River. This is an old road that SANParks has travelled before and we all know the pitfalls it has led to. Should we be exporting these failed ideas to our disadvantaged neighbour?

Promising contraceptive technologies such as immuno-suppression do exist. These have demonstrated an ability to slow population growth-rates without apparent side effects, but only among small, contained populations. These populations are already socially disrupted and abnormal. This technology has some way to go before the side effects have been properly tested. Potentially serious behavioural changes could be expected. The technology also appears to have very limited potential for free-ranging or large populations the size of Kruger's. The most vociferous promoters of the application of this technology in Kruger, are those who one-way or another, stand to benefit from the huge amounts of money that would have to be raised to apply it.

Kruger is unique in Africa as the only really large Protected Area that is fenced. Although the fences are coming down, it remains for all practical purposes, enclosed. No matter what plans there are to remove more fences, it seems likely to remain effectively isolated along most of its perimeter, if not by wire then by either people or politics. The fact of enclosure has huge consequences for management. Kruger's elephants have lost not only their main predator and agent of disturbance (and therefore of habitat relief) namely man, but have also lost their ability to move out, a highly developed and important survival mechanism in Africa's dynamic ecosystems. Solutions to similar problems in Chobe or Tsavo do not necessarily apply to Kruger.

If the consequences of enclosure are not enough, the increasing human use of resources at the park's borders will also escalate exponentially. Land-cover will change radically or be destroyed, thus enhancing isolation and its 'island-effect'. On top of this we can expect global climate change, which some scientists have predicted may reduce biodiversity in southern Africa by as much as 65%. For park managers one thing is certain, the future for parks is going to get rougher and more uncertain. This means increased need for well informed and far sighted management. Non-interference will increasingly be a recipe for conservation disaster.

The enclosed Kruger Park also carries a major tourism industry with huge investments in infrastructure, both within and outside the Park. This reality means that management options probably *do not* include letting nature take its course, especially *if that course were to threaten local tourism.* This, in turn, means that the management objectives for the Park include an aesthetic (or commercial) component, whether this is stated as such or not. In effect, there is a *de facto* rule: "What visitors want to see, must be protected."

Socio-economic and ethical issues

This paper is not going into the heart of the ethical debate. It is sufficient to say WESSA has always advocated high ethical standards, based on universal rather than personal values. Consumptive use (killing individual plants or animals at rates that are sustainable) is legitimate. But it must be done humanely and based on real need and good science. The decisions to use species consumptively must be openly and honestly justified to all interested parties. In this debate it is deplorable that conservation spokespeople refer to planned sustainable use as being aligned with the causes of extinction, when this is obviously not the case. Their case is supposedly based on moral grounds but their sensational language reveals their moral frailty as well as their economically spoilt perspective towards those less fortunate than themselves.

The role of neighbouring communities is crucial in levelling the ethical playing field in this debate. Their statements in the Nelspruit forum two months ago were clear and humble and without pretence. They spoke with all the compassion and respect for wildlife more readily associated with their affluent westernised cousins. They simply asked for a fair deal when it comes to bearing the costs of living near the wilderness as they do. Not crumbs from the top table, but an honourable invitation to a regular square meal. We in WESSA know that this is official policy in Kruger but we also know it is far from satisfactory in its implementation.

The road ahead

A decision, whether or not to reduce the elephant population in Kruger, is impossible to avoid. The people or institutions taking it (SANParks and their Minister) are damned if they do and damned of they don't. We, who represent the most concerned and informed citizens in our country, are stuck in a cul-de-sac with over 10 000 increasingly pressurised elephants, and we have to find a way out.

The decision will be taken. All of us must help SANParks, our country actually, to find a way forward, out of the trap. Not for the selfish vindication of our personal beliefs, not just for the benefit of elephants, but for the good of Kruger and the whole Protected Area system of southern Africa. This is clearly a task for all the wisdom and expertise our conservation community can muster. But beware the seduction of mobilising public support for emotive issues. We, the public, kept mining out of Kruger and out of St Lucia, and we eventually helped to keep a million speculators off Table Mountain. Surely we can solve this problem with our imagination and our proven willpower?

But this one is different as far as public sentiment is concerned. The temptation to mobilise the public around an emotive issue will backfire. People identify much more with elephants than with the obscure concept of biodiversity. In this case we must be able to support the right decision through clear and honest scientific argument.

If science is to be used as the main basis for making decisions then it is useful to invoke certain principles of decision-making that apply in complex arenas with deficient information. One is the well-known 'precautionary principle', much used in the EIA process. This states in effect that the course of action taken should always be that of least regret – the decision that holds least risk of irreversible failure – the one that forecloses least on future options. In the management of natural resources this does not necessarily mean, do nothing. In Kruger, where culling was an established practice for 26 years we still have future options that are possibly not available to the ecosystems of Amboseli or Chobe. Although commentators reflect on those 26 years almost with horror, there is little evidence we know, of any negative impact on the elephant population or on the human/elephant interaction, which incidentally is naturally one of predator and prey. A thorough debate on the application of the precautionary principle to Kruger's elephant problem is merited.

We have talked of the apparent failure of science and/or its application, and about the unavoidable bias that clouds every researcher's results. Park management science is no longer the mystic preserve of khaki-clad field ecologists. Ecology has become one of the most complex and limitless applications of science on earth. The exponential growth of knowledge and computing power has made it impossible for the civil-servant-field-ecologist to keep up with the best, without constant exposure to critical external review.

There is a strong case for their work to be managed and evaluated by more objective and independent structures to counteract the limitations and bias imposed by their institutional setting. The main purpose of such restructuring would be to resolve the disagreements between scientists and to communicate the relevant results clearly, to management and to the public. Review workshops and consultants have come and gone through Kruger and still there appears to be confusion. Millions have been spent on research and monitoring over the years. If we cannot glean clear guidelines from this investment something radical must be done. If it is no problem to raise a few million dollars to translocate a couple of hundred elephants to new homes, we should be able to find the money to properly interrogate this body of work.

Management suggestions

WESSA suggests an elaboration of this process to provide a transparent and defensible solution in the longer term. It starts with the assumption that the only insurance against taking a truly bad decision, is to have the best possible scientific back up as to why the decision is taken. The need for greater objectivity in research and hopefully better agreement between researchers is obvious. This cannot come from Kruger or the Kruger scientists alone. They, like their external colleagues, have their biases. Neither is sufficiently objective. Similarly, the opposite end of the scale is equally inappropriate; it should not be put to the popular vote. The public is hugely uninformed and vulnerable to emotional appeals and media hype.

This is a hugely complex decision for which we will never have sufficient information. Because it threatens to tarnish our long record of world-class achievements in conservation, it deserves the most thorough process of review we can provide. It must rank up there with a first order Environmental Impact Assessment for systems of highest sensitivity. But the EIA process is no silver bullet. It is legislated for, somewhat rigid and designed primarily for industrial development. It therefore does not have the right sensitivity, and is vulnerable to bureaucratic bungling and legal sleight of hand.

WESSA suggests the selection of a council of independent scientifically competent experts, acceptable to the majority of interested parties (such as those represented in this gathering). These experts should then develop their own Terms of Reference by participatory means – including, if necessary, public debate – to review and interpret the available scientific information. The council will be tasked with making a recommendation to the decision makers that would have the prior support of a majority of the interested and affected parties. There will never be consensus but this is a mechanism for finding support from the majority. South Africa is a world-leader in conservation management. We have learned and experienced a great deal from noteworthy successes and failures. We have a world-class solid foundation to build on, without fear or favour. The road ahead must show we are not loosing our way and with it our reputation.

The role of science in SANParks decision making

Tony Ferrar

It is accepted that there are many factors other than science that inform high level decision making, even on scientific issues. The points that follow are made in recognition of this reality. It is also suggested that invoking sound scientific argument is one of the most politically safe and technically sound options when complex or risky decisions are at issue.

- SANParks primary objective is to conserve biodiversity through PA management
- Science should dominate as the basis for management decisions because biodiversity conservation can only be assessed in terms of scientific criteria
- 'Management by Objectives' is the only practical way to achieve biodiversity targets
- The last 10 years monitoring and research should have thrown more light on current problems than is apparent among scientists today
- Application of science (Research & Monitoring) is neither independent nor objective; it cannot avoid influence by individual, institutional and sponsorship perspectives
- The result is, lack of cohesion, clarity and insight from this huge scientific effort
- 'Many many millions' of public money has been spent on Research & Monitoring and still we have no clarity – how do we avoid admitting this has been wasteful?
- Kruger is 'one-of-a-kind' – by its combination of size, enclosure and development, within and outside its borders. Management solutions for other areas will mostly be irrelevant to Kruger, although scientific findings from such areas may be invaluable.
- Additional uniqueness is present in the access that local communities have to legal and moral instruments that empower them to exercise their rights.
- Resulting from all the above, a decision of immense significance is unavoidable. Whatever it is, it will have major national and international consequences.
- Something more effective and more permanent than this scientific review process is required
- **WE RECOMMEND** a truly independent scientific review process, or council, be established (e.g. under auspices of SANBI) to evaluate the results of biodiversity-related research and monitoring, where issues of particular difficulty or of national significance arise. Our powerful new NEMA legislation requires this high level of oversight to give real authority to future decisions. Certainly, such decisions can only get more complex, more contentious and more in need of the most experienced and reputable scientists available.

ELEPHANTS AND THEIR MANAGEMENT IN THE KRUGER NATIONAL PARK

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Introduction

Managers and scientists at the Kruger National Park face a challenging task. They have inherited a system constrained through extensive hunting, the ivory trade, rinderpest, sleeping sickness and past management decisions (see Prins & van der Jeugd 1993; Whyte 2001; du Toit *et al.* 2003). Add to this historical complexity the impact of more recent events such as the redistribution of water (Gaylard *et al.* 2003) and we can only speculate on the consequences for the ecosystem. This exacerbates the current management challenge within such a highly heterogeneous and confined area (du Toit *et al.* 2003).

Stabilising natural systems through management has the perceived benefit of generating predictability. However, by their very nature, savannas fluctuate across space and through time (*e.g.* May 1977; Dublin *et al.* 1990). For managers this complicates the task of targeting stability, especially when this is judged in terms of the local losses or gains of species, a goal sometimes used as a surrogate for biological diversity. At first glance the Kruger's latest management plan (Whyte 2004) takes cognisance of the dynamics of savannas. In reality, however, its targets are predefined and rely on predictable outcomes of their plan (also see Gillson & Lindsay 2003).

We identify with the need for Kruger to manage their system, since the limitations imposed by space carry over into time (see Likens 1987). Managing the outcome of these limitations, however, hardly takes cognisance of the underlying causes. We argue that the challenge Kruger faces encompasses more than the "elephant problem". In spite of this our presentation highlights our understanding and misunderstanding of the some of the issues related to this elephant colloquium. Our approach is to provide content to a number of relevant statements.

Scientific support for our understanding of Kruger's "elephant problem" is limited

Almost 65% of the 293 scientific references on elephants in Kruger relate directly to reproductive physiology, general physiology, nutrition, morphology and anatomy, history, distribution and the ivory trade. Spatial dynamics (0.7% of all papers), population dynamics (3.8%) and elephant-environment interactions (6.1%) receive little attention. Half of the 18 studies on the interactions between elephants and their environment focussed on one or two plant species. Papers underlying management (translocation, culling *etc.*) account for 15% of papers.

SANParks mandate is to maintain biological diversity within the Kruger (Whyte 2004). Therefore, the small number of studies in which elephant-biodiversity issues have actually been addressed within the Kruger concerns us. These include studies of elephant spatial dynamics, population dynamics and elephant-environment interactions.

Our understanding of the impact of elephants on biodiversity is biased by interpretation

Elephant feeding may inflict structural changes on individual plants, which may further influence single-species dynamics, plant densities and vegetation communities (*e.g.* Dublin *et al.* 1990). These changes gave rise to concerns of the negative effects elephants may have for other components in the system (Laws 1970; Cumming *et al.* 1997; Whyte *et al.* 2003). The argument is founded in the perceived consequences of high elephant densities for other species. This argument is often used as justification for the artificial reduction of elephant numbers (*e.g.* Cumming *et al.* 1997; Whyte 2004).

We have collated information from over 200 studies published on the consequences of elephant presence for the environment (Guldemond & Van Aarde in review). These studies were conducted at 74 study sites over a period of four decades. We used standard meta-analytical methods when analyzing 34 studies with sufficient statistical information. Our results indicate that over short time periods (< 5years) elephants have a significant effect on individual plants. These effects, however, disappear with an increase in the time period over which the study was conducted.

Most response parameters for plants were based on indices of damage and population estimates, while other components were usually studied at the community level. Our results suggest that elephants, irrespective of densities, do not significantly reduce species diversity. Only 12 peer-reviewed studies specifically reported on elephant-plant interactions from Kruger. Unfortunately only one of these provided sufficient statistical information for us to use. Based on studies from across Africa we conclude that science does not provide satisfactory evidence that elephants had a lasting negative effect on either animals or plants.

To consider long-term effects we have to distinguish between lower and higher order responses. Here we need to separate individual structural damage by elephants from changes induced by them at the ecosystem level. This is further confounded by the complexities that may stem from positive and negative feedback mechanisms, delayed responses, non-linear dynamics and the interaction of local, regional and global events (May 1977; Pimm 1984; Olff et al. 2002). Simply put – elephants do not act in isolation, and the responses to them are not uniform.

Landscape selection has a role in management decisions

Much of Kruger's proposed elephant management plan hinges on creating zones of different elephant impact. The intention is to achieve this by differences in elephant densities that are induced and maintained by culling (Whyte 2004).

In heterogeneous landscapes, elephants will use some landscapes more than others (Omphile & Powell 2002). This suggests that favoured landscapes will be associated with high elephant densities, whereas those that are less preferred harbour fewer individuals. Following an ideal free distribution (Fretwell & Lucas 1970) animals select resources that are better suited to their survival and reproduction (Lessels 1995). The "suitability" of a patch may depend on intra-specific competition within the patch (Fretwell & Lucas 1970). As density increases, competition will also increase and elephants should increasingly make use of landscapes that were previously less preferred – this may shift landscape preferences or reduce selection.

Our assessment of data on the location of elephants using Kruger's yearly helicopter counts suggests that landscape selection does occur. At the time of the surveys, such selection was not influenced by the increase in elephant density over the ten years since the cessation of culling. An overall increase in elephant numbers increased densities on both preferred and avoided landscapes (CERU analysis in progress). This suggests that manipulating densities, as proposed in the recent management plan, may not have the desired results. Indeed elephants should continue to disproportionately use preferred landscapes. Clearly, a proper understanding of landscape selection in response to density is needed to better understand the response of elephants to future management actions.

Local dispersal may nullify the intended outcomes of management

The purpose of culling elephants was to reduce numbers. A reduction in numbers may conceivably have reduced the effect of elephants on vegetation. For practical purpose yearly culls took place within one of four management regions for the final ten years of culling. The objective to protect vegetation from the effects of elephants through their reduction in numbers within predefined areas is debatable (see Whyte 2004).

In the year immediately following culls, elephant numbers declined due to the cull (van Aarde *et al.* 1999; Whyte *et al.* 2003). The following year, however, trends were reversed with more elephants within the previously culled management zones than expected from population growth alone (van Aarde *et al.* 1999; Whyte *et al.* 2003). This suggests that region-specific culling induces inter-regional movement.

Immigration has been demonstrated with the removal of the fence line between Kruger and Sabie-Sand Game Reserve (Whyte 2004). The elephant population within Sabie-Sand Game Reserve grew faster than natural rates, inferring the immigration of more than 500 elephants. Indeed the elephant counts for the neighbouring Klaserie/Timbavati complex, which supported a much larger elephant population, suggest there may have also been immigration from the Kruger, all be it at a much lower rate (see Whyte 2004). In fact, immigration of animals into the Kruger has clearly been documented for the early 1900s (Whyte *et al.* 2003). Colonisation rates were also recorded northwards from the confluence of the Letaba and Olifants Rivers at 7.3km/year, and southwards at 5.4km/year. We conclude that elephants readily reoccupy areas from which individuals have been artificially excluded, or indeed areas from which elephants have been removed.

Furthermore, Kruger stands to become part of a much larger regional conservation area. Dispersal induced by such developments will have consequences for the perceived impacts of elephants on vegetation within the Kruger. This provides an opportunity to design a series of studies that will address the mechanisms underlying elephant spatial dynamics. These include the consequences of the opening and closing of artificial water points, dropping the fence line with neighbouring conservation areas and the implementation of other management actions.

Home range use is related to landscape fragmentation/ water supplementation

In Kruger the reduction of artificial water points accessible to animals from 325 to 141 effectively reduced the area within an 8km proximity to artificial water from 89 to 63% of the Park's total area. The distribution of water, like landscape fragmentation, influences home range areas elsewhere (Stokke & du Toit 2002). Typically during the dry season elephants also concentrate their activities around water, causing a localised impact on vegetation (Ben-Shahar 1993, de Beer *et al.* in review).

Our analysis (Grainger *et al.* in review) showed a significant exponential decline in range area with an increase in landscape heterogeneity, some of which may be induced by artificial water points. Consequently, the intensity of landscape use may be higher in small ranges with a relatively large number of water points. The lack of a direct relationship between closure rate and proximity to artificial water should be considered in further actions. The influence of water point distribution on movement patterns and population variables also deserve consideration. Habitat selection and water requirements are not mutually exclusive.

Water availability may influence survival

In elephants, natural mortality is primarily the result of drought (Moss 1988; Dudley *et al.* 2001), while disease also plays a role (*e.g.* anthrax; Lindeque 1989). Water, its availability and distribution, may limit elephant populations. For instance, our recent assessment suggests that in Kruger survival of young and juvenile elephants (individuals <12 years of age) may be positively related to rainfall in the year of birth (CERU unpublished data). Based on this nearly twice as many newborns survive in years with >500 mm of rainfall than years with less.

Our finding is not surprising since rainfall influences the dynamics of a large number of large herbivores in African savannas (Coe *et al.* 1976; East 1984; Gaillard *et al.* 2000; Ogutu & Owen-Smith 2003; Dunham *et al.* 2004). We also know from the work of Moss (1988) that extensive droughts increase calf mortality and reduce conception in elephants. Dudley *et al.* (2001) suggested that the duration of a drought, rather than the intensity of a drought, explains mortality best in elephants.

Aerial surveys imply a rapid population increase for Kruger's elephants

The desire to manage Kruger's elephants stems largely from their continuing increase in numbers – this growth is implied from SANParks' yearly total counts. Arguably, this growth implies an increase in elephant-biodiversity conflict that may be ameliorated by reducing elephant numbers artificially. A decision to limit elephant numbers clearly stands to be affected by the interpretation of the existing population trends deduced from aerial counts. In this context, it is worth addressing the fundamental question – how many elephants are there in Kruger?

We intuitively expect aerial counts of Kruger's elephants to produce population estimates with high accuracy and precision. However, it is impossible to measure these values from single total counts (Norton-Griffiths 1978). Furthermore, total counts require a great deal of time and money, and involve a certain amount of bias. These include inaccuracies perpetrated by individuals that are either missed or double-counted. Such biases in counts can, however, probably best be dealt with by interpreting census information in terms of accuracy and precision. Currently we have no measurements of the accuracy or precision for counts from Kruger. CERU's simulation exercise, based on strip censuses of objects distributed randomly or clumped at densities similar to those recorded in Kruger, suggests that accurate values can be obtained through the covering of 55 to 95% of the area (CERU unpublished results). Based on this simulation, we have no reason to question the accuracy of Kruger's counts. After all, these counts come from coverages greater than those given above. Precision as a measure of the closeness of repeated estimates, and therefore as a measure of the confidence of the estimates, needs further investigation. Given a clumped distribution and survey intensities greater than eighty five percent our confidence intervals range from 8–13%. Elsewhere few elephant surveys report confidence limits and those that do normally yield confidence limits wider than 10% of the estimate (Morley in review) – this therefore compromises the deduction of trends in numbers.

Presently elephants densely populate Kruger. This differs from two centuries ago when few elephants occurred in the region (see Whyte 2001). Since the early 1900s numbers have increased, though this growth was checked for a relatively short period of 27 years when elephants were culled. This population increase has proceeded at rates approaching maximum growth for elephants (van Aarde *et al.* 1999). The decade following the cessation of culling was followed by a rapid increase of 4.1±0.7% per year. A breakdown of these numbers into different periods suggests that, for the 5-year period since 2000, the rate of increase was double that recorded for the preceding 5-year interval. These differences are particularly significant as the rate recorded for the last five years are well beyond the biological capacity of elephant populations with a stable age distribution (see Hanks & McKintosh 1973; Calef 1988).

This apparent discrepancy may be ascribed to one of several factors: 1. The Kruger population may not be a closed population and elephants have moved into the Park from elsewhere. This would account for an increase in numbers beyond those expected from the yearly differences in birth and death rates. Thus, population growth is influenced by immigration; 2. Population growth rates deduced from counts may be inflated by observer bias. We know for instance from work conducted elsewhere that aerial surveys for relatively small populations underestimate numbers, which may artificially inflate the estimated growth rate (Whitehouse *et al.* 2001; Morley in review); and 3. The biases in aerial counts are different each year, as environmental conditions differ even when time of year is controlled for (Caughley 1974; 1977). Such census biases are capable of masking changes in population sizes between years (Redfern *et al.* 2002).

SANParks currently estimates population growth rate by inference from changes in the number of elephants recorded between consecutive total counts (Whyte 2001). This method is limited because it requires a high confidence in yearly counts. Total counts should meet this requirement, but we are unable to calculate their precision. In spite of this, it is noticeable that only 2 of the 15 counts since 1990 yielded lower values during year $t+1$ than during year t. This is surprising as aerial counts generally yield levels of precision greater than 10%, suggesting that it is unlikely to detect a continuous rate of increase <10% year after year. The accuracy and precision of Kruger's reported elephant counts clearly deserve further attention.

As a group CERU is currently developing a rapid elephant population assessment (REPA) technique. This method aims to overcome the pitfalls of using standard counting techniques to estimate population growth. Instead, it relies on collecting data on the sexes, family groupings, and ages of elephants. Using this information, REPA has the potential to return realistic information on the age of first calving, calving intervals, population growth rate and survivorship within elephant populations. We are critically reviewing the technique and are optimistic it will become an alternative method of determining growth rate in large, free-ranging elephant populations. Certainly, the REPA technique returned reliable results when tested on populations with known individual life histories, such as those in Amboseli and Addo (CERU unpublished results). We are also using REPA on several southern African populations. Once developed the application of REPA will improve the efficiency and precision with which to derive population trends for Kruger's elephants. It will also provide reliable information on the age-specific demographic variables that stand to be affected by management or environmental events.

Concluding remarks

The perceived consequences of elephants for biological diversity in the Kruger have little scientific support. Considering only species or species richness as surrogates for biodiversity is wrong. Biological diversity is the outcome of a large number of biotic and abiotic processes. Elephants are one of many agents that influence biological diversity. Managing only elephants does not address the issues surrounding the maintenance of biological diversity as a primary conservation objective.

We contend that biological diversity is best maintained by allowing for the processes that drive local colonisation and extinction. These call for landscape heterogeneity and linkages across sufficient space. It also asks for discontinuity of factors forcing biological diversity. Unfortunately, the spatial scales that provide such dynamics may stretch beyond the areas catered for by existing conservation areas. Ideally, we should aspire to increase conservation areas and to link existing conservation areas into networks where such dynamics can be played out. If not available, such an ideal may be mimicked at smaller scales. For instance, this can be achieved by insuring a diversity of elephant densities within Kruger. Here it makes sense to use the metapopulation metaphor (Hanski & Ovaskainen 2003) to motivate options that induce a range of elephant densities. This allows Kruger's management to shift its focus from the asymptotic paradigm, which until now reinforces long-term stability in numbers and diversity as a management target.

Conceptualizing elephant management is in dire need of a paradigm shift (summarized in Wu & Loucks 1995; Briske *et al.* 2003). This shift should be from a perceived 'balanced nature' to accepting non-linear and unpredictable lower order dynamics, stabilised by higher-order processes. This is referred to as metastability (Wu & Loucks 1995). For example, when we allow for scale-dependant processes (Western *et al.* 1989; Lewin 1986) such as dispersal and metapopulation dynamics, elephants may establish sink or source populations through range expansion into other areas and potentially limit their local densities. This could also allow temporal alleviation of 'high' elephant densities and initiate 'recovering periods' for other parts of the affected system.

We contend it is premature to instigate elephant management without an adequate knowledge base. Furthermore, the management on Kruger's elephants will remain inconclusive due to bias in interpretation of the underlying scientific information. Kruger's management objectives must be dictated by relevant and innovative *in situ* scientific research.

Acknowledgements

We would like to acknowledge SANParks for logistical and technical support for our elephant research in Kruger National Park. Financial support was provided by the International Fund for Animal Welfare, National Research Foundation, Peace Parks Foundation and the US Fish and Wildlife Service.

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SOME CONSIDERATIONS REGARDING THE MANAGEMENT OF THE KRUGER NATIONAL PARK ELEPHANT POPULATION

SCJ JOUBERT

Stabilization of the population

At the elephant indaba it was stated that the management of the KNP elephant population was no longer a 'numbers game' the implication being that the population would be managed according to environmental (habitat) guidelines. This 'sounds good' as the rational approach to take. However, in practice the management of the population will inevitably boil down to *how many* elephants can reasonably be carried, on a sustainable basis, by the available habitats. At a rough guess the ultimate number is eventually going to pan out at about 7 000 to 8 000.

If the above is correct and the present population is in the region of 13 000 it means that it would need to be reduced by about 5 000 to 6 000. To give the vegetation a fair chance to recover it would, however, be wise to reduce the population to below its carrying capacity, say 4 000 to 6 000. This would imply a reduction of some 7 000 to 9 000 elephants!

The motivation that called for the elephant debate arose over the past few years as the impact of the elephants on their habitats became all the more obvious and in areas even dramatic. If this statement is true Sanparks finds itself in the position where

- the elephant population has already exceeded its limits and damage to its habitats has become obvious;
- if the population is not reduced and maintained at is present level its impact will become even heavier (further impact on an already impacted system), and
- the situation calls for an immediate reduction of the population or the consequences for the KNP can become grave (if not already the case).

At a 6-8% annual rate of increase a population of 13 000 is capable of increasing by roughly 800 to 1000 animals per annum (by the end of this year the population can be around 14 000).

The processing plant at Skukuza would find it difficult to cope with a quota equal to the annual increase. What then, is the KNP going to do to achieve the reduction? The situation may offer the opportunity of providing neighbouring communities with some of the meat, private entrepreneurs may be interested in some of the products (e.g for mines , forest stations, construction teams, etc). What about the ivory, hides, entrails, etc?

Whatever exercise is decided upon it would have to conform to strict hygienic standards, would have to comply with the highest standards of humane culling, cause the least disturbance to the rest of the population, be ecologically accountable and *leave no room for public dissent.* In every respect the entire operation, including and especially the culling, *would need to be under the direct control of Sanparks!*

Whatever you do, please ensure that the hunting fraternity do not get any form of foothold – even on the Hoheisen properties which were added to the KNP via the National Parks Foundation on condition *that they be managed as an integral part of the KNP.*

Habitat analyses

The only reasonable and rational reason for the management of the elephant population rests on the impact the elephant have on their habitats and, by implication, on associated animals. However, very little evidence of this was presented at the Indaba. Some yes, but very little. In this respect I believe that Sanparks were let off very lightly.

This aspect has two sides to it, viz

- there is more than sufficient data at Skukuza to prove a point. It just needs to be analysed and interpreted. What does, however, concern me is that the collection of invaluable data has been scaled down in recent years and this would urgently need to be placed on track again. I also believe that the vegetation research side is totally under-staffed and needs to be bolstered as a matter of priority. Much of the work could probably be done by post-graduate students.
- The other aspect is the criteria, or thresholds of potential concern (TPC's), set for guiding the management of the elephant population. Clearly, elephant are highly selective for both particular plant species and also for favoured vegetation communities. I do not see that either of these is specified in the elephant management plan published in Koedoe. If it has not received further attention this should be done very thoroughly without further delay and be implemented in the monitoring and evaluation of the elephant/habitat situation.

Research and monitoring programme

I have alluded to this in my previous comments and do not want to belabour the point. However, the more I think of it the more convinced I am that the elephant is merely an integrated part, albeit an important part, of a larger picture. The elephant Indaba has placed the KNP under a large magnifying glass and under critical scrutiny. Right now everything is quiet but once the culling starts there is likely be some reaction. Irrespective of the support received from higher authorities the support base of the people who patronise the KNP should remain the most important consideration.

To retain the support base of the visitors it is essential that the integrity of the KNP remains intact. For this reason may I, once again, suggest that you take this opportunity of reviewing the total research and monitoring programme of the KNP. I am of the opinion that there is enough reason for it to be done.

UNDERSTANDING INDIVIDUALS IN ORDER TO MANAGE POPULATIONS.

ROB SLOTOW

I have a wide range of concerns about the proposed elephant management strategy for KNP, but I am unsure as to which elements will be addressed in the workshop. Taking the approach that we need to understand the role of elephants in the ecosystem as the prime aim of the workshop, I believe that there is one key element to each of the ecology and management which I see as critically important, and to which I can bring a unique perspective.

Ecology

Populations comprise unique individuals that vary in both their exploitation of and contribution to the environment in which they occur. I believe that a major flaw in the logic and understanding underlying the current elephant management policy of KNP is the population level approach to the problem.

Although there may be up to 14 000 elephants in KNP, these comprise elephants that differ greatly in their behaviour, and thus in their impact (for want of a better word) on the vegetation (and thus on underlying diversity).

At a broad level, male and female elephants are different ecological species. This has been demonstrated in a number of studies at a range of levels, including ranging, movement rates, habitat selection, and foraging selection (e.g. tree size or height). We have data that reinforces this across all scales.

Further, within males and females there is a range of variability in behaviour. Not all males elephants are the same, and not all females are the same. This variability translates into a complexity of ecological input which has previously been ignored. This complexity is not only manifest in small isolated populations, but is clear in data from KNP as well – for example: why is the range of one female group small, and the range of another group large (and may in fact incorporate completely the range of the first group). Another example is that we have data indicating variability in tree species selection among male elephants within the same range.

If the proposal is to manage elephants as an ecological process, we have to ensure that we manage the variability that they bring as individuals. A management intervention cannot be planned and designed at the population level, but has to be conceived at the individual level. For example, removal of the group of females that have a small range will reduce the intensity of impact relative to removal of the group of females with the larger range. This will decrease heterogeneity of impact, but at the same time decrease the average intensity of impact. The reverse, removal of the females with a larger range will increase the heterogeneity of the impact and increase the level of intensity of the impact.

There are extensive data that indicate the heterogeneity of response of individuals, which can be used to model heterogeneity in the ecological inputs of the population as a whole, and what removal of specific elements of the population would do to the ecological inputs.

Management implementation.

When we examine elephants at the individual level, we understand the heterogeneity of the role in the ecosystem in both space and time. In order to manage effectively and sustainably we have to implement management that effects processes at this level. The logical end-point of the above argument is that management has to be implemented at the level of the individual.

Although this might at first seem naive in terms of the reality of management intervention, the problem is actually one of planning capacity in the first instance, and resource allocation in the second. The first component requires a commitment from the management team to incorporate scientific principles into implementable plans. The second requires a commitment from executive to allocate the necessary resources for sustainable management.

In terms of practicality, one obviously cannot manage every individual in a population of 14 000 elephants. However, it is very simple to manage common units below that of the population as a whole, but that incorporate general behavioural patterns based on their average (median or CV etc) of behaviour for that group. In the most simple circumstance, males should be separated from females in both the planning and implementation of any intervention. This may seem simplistic, and obvious, but the current plan does not really exploit this difference in elephants, and which can easily affect ecological inputs. The examples provided above illustrate this point at different levels of required knowledge. If we know the range of female groups, we can selectively remove a specific female group to achieve a spread of heterogeneity that matches the planned ecological role of elephants. At another level, if we selectively thin the male population across all age groups, we will reduce the impact of males on large trees (as this will decrease their displacement activity of attacking trees – but that is a whole story in itself). At a finer level we would need to know the foraging behaviour of males and selectively remove those that for example, target Baobabs or Marulas. In the extreme, if you shoot every male elephant that feeds on Marula, you will soon (in evolutionary terms) select that behaviour from the population!

Population growth and control

I will also have a range of ideas about how individual information is relevant to population growth and control. I also have ideas on implementable solutions to control population growth, especially the extremely viable route of contraception. We are currently contrasting population management through contraception and culling, and the long-term consequences of this for management. I am not sure if it is appropriate for the workshop to explore these ideas, but will certainly bring them to the workshop.

MANAGEMENT CHAPTER – DRAFT SUMMARY/SYNTHESIS

DAVID CUMMING , ANGELA GAYLARD. GUY CASTLEY AND IAN WHYTE

With contributions from:
Harry Biggs, Johan du Toit, Tony Ferrar, Lindsey Gillson, Janie Hauser and Hilary Langer, Matthew Klasen and Jessica Winans, and Gus Mills

1. INTRODUCTION

Elephants are ecosystem "engineers" and, depending on their numbers, have the potential to influence habitat structure and biodiversity at several levels and scales. Environmental legislation in South Africa, and elsewhere, requires that state protected areas maintain and protect biodiversity. The primary objective of the SANParks workshop is to explore the current state of our understanding of elephant – habitat interactions and more specifically their impacts on biodiversity in protected areas. A secondary objective is to explore the implications of that understanding (or lack of it) for parks management plans and how SANParks might deal with the issue of expanding elephant populations.

This "Summary Chapter" attempts a brief synthesis of the material that has been submitted thus far for the "Management Chapter" and examines the implications of material presented in earlier chapters on populations, vegetation, fire and water. Note, however that the *summaries* for earlier chapters are not yet available and pertinent key points may well have been missed.

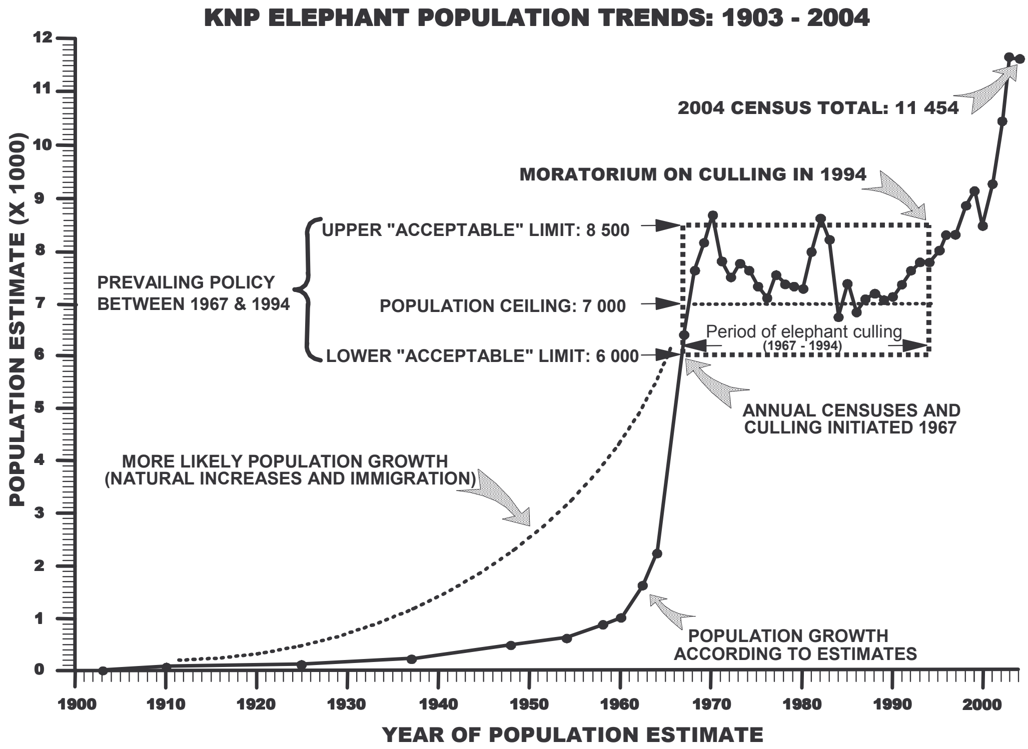
Because many submissions for the workshop assume that science should be pre-eminent in decisions about elephant management it is desirable, at the outset, to consider some aspects of decision making for natural resource management (Section 2 below). The chapter then attempts a summary/synthesis of the twelve contributions received that relate directly to the "Management Chapter". It also draws on some aspects of earlier chapters under the "Ecological components" section.

1.1 Historical context to the "elephant problem"

As result of over-hunting during the 1800s there were fewer than c. 7,000 elephants in southern Africa (i.e. south of the Kunene-Zambezi Rivers) in 1900, with less than c. 200 in South Africa. Today there are approximately 250,000 elephants in southern Africa with most populations still growing at close to 5% per annum or close to the maximum growth rate for the species. Savanna elephant populations in East Africa presently appear to be recovering but the now separate species populations of Central and West Africa are not recovering. This section largely focuses on the "elephant problem" in Kruger but the discussions should also include the current dilemma that other (smaller) national parks and indeed private reserves are facing.

Elephants re-entered Kruger Park along the Olifants River in 1905 after an absence of about 20 years. They took another 40 years to reach the southern and northern boundaries of the park with a remarkably slow average dispersal rate of 5 -7 km per year. In 1965 concerns about "over-protection" of certain species in the park surfaced and a symposium was held to examine the issues. In 1966 the Parks Board decided to limit the numbers of seven large herbivore species. By 1967 the elephant population had reached 6,500 and culling started in the south of the park. Between 1967 and 1994 the management objective was to hold the elephant at about 6,500 (i.e. about 1 elephant/sq. mile) through annual culling. The biological basis of the "One elephant/sq. mile" rule was clearly given by Pienaar (1966) as the density at which the central elephant population in the Olifants-Letaba catchment reached saturation point and started to disperse more rapidly into the rest of the park. The subsequent growth and management of the elephant in KNP is summarized in **Fig. 1**. A moratorium on culling elephant was introduced in 1994 and is still in place despite a management plan to contain the elephant population eruption in KNP having been adopted in 1998.

Fig. 1. Changes in the elephant population of Kruger National Park from 1900 to 2004



and points of major changes in the management of the population

Elsewhere in South Africa some elephants survived into the 20th Century only in the Tsitsikama forest and the Addo area. A decade after the attempt by Major P J Pretorius to eliminate the Addo elephant failed a national park (Addo Elephant National Park, AENP) was established in 1931 to contain them. Since its protection and subsequent containment within an elephant proof, Armstrong-fence the Addo elephant have grown at a rate of almost 6% per year and are now in excess of 420 animals. The impact of a large population of elephant in a confined space has been clearly demonstrated with the loss endemic plant species in areas used by elephant. However, the elephant in AENP have facilitated population growth of other species (e.g. kudu, black rhino). To date park expansion has to some extent mitigated the impacts of increasing elephant numbers but there will be a time when no further land can be added to the park. The small herd in Tsitsikama dwindled to extinction during the 1980s. Elephants are now widely distributed in numerous small national parks, reserves, and private properties in South Africa. Calves captured in culling operations formed the founder stock for many areas but since techniques for translocating entire family units were developed in the early 1990s whole family groups have been relocated. Most, if not all, of the smaller protected areas now face the problem of how to manage expanding populations.

The notion of "one elephant per square mile" as a stocking rate for elephant also emerged in East Africa in the early 1960s and was used in Zimbabwe where it was partly based on the elephant densities at which marked elephant impacts on woodlands became apparent. Interestingly, it is also the density at which elephants began to disperse more rapidly from Hwange National Park in the early 1950s (Cumming 1981). The density of elephant in the AENP has been as high as 4 elephants / km^2 but over the past 10 years has fluctuated between

2-3.5 elephant / km^2. The density is currently at one of its highest levels but is likely to be reduced soon after additional land is made available to the elephant once fencing is complete. There are also strong arguments that the currently accepted upper limit of 2 elephant / km^2 is unfounded and significantly lower densities, in the order of 0.1-0.5 elephant / km^2 are required in order to conserve the region's biodiversity.

1.2 Drivers of Resource Management Decisions and Practice

Policies, i.e. rules and guidelines for governance, give rise to the laws and regulations that govern society. In an open society the policy and legal framework regulating resource use and management will ideally reflect the values and will of the majority of its citizens. If they don't, as is the case in much of Africa, then informal institutions will often govern resource use. It is the role of elected politicians, through the legislature and various arms of government, to oversee the translation of public opinion and wishes into policy and action.

Resource management plans and actions will generally require consideration of at least six sets of factors (or drivers) that will influence the outcome of most enterprises (Fig. 1). Ecological considerations, which are a major focus of this workshop are but one of these. Each involves a cluster of different actors, value systems and goals and importantly, different criteria on which to judge the success or otherwise of outcomes. These factors will also have to be dealt with at a variety of temporal and spatial scales. It is therefore important to recognize that elephant management issues are firmly embedded in complex social-ecological systems that can also be characterized as complex adaptive systems; systems in which both certainty and predictability are low and where post-normal science is an appropriate analytical approach.

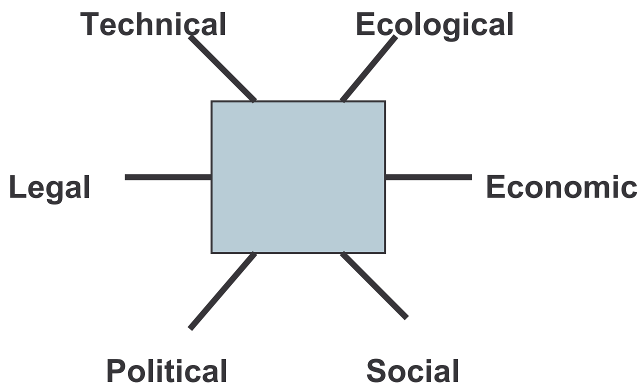


Fig. 2. Major components influencing, or impacting on natural resource management decisions and practice (from Cumming 2000)

2. POLITICAL AND LEGAL COMPONENTS (policies, laws, value systems and ethics)

Value systems in society evolve and adapt. Ninety years ago it was acceptable to kill wild dogs in protected areas to reduce predation on still small herds of "game", today it is completely unacceptable. Similarly, the responsibilities of protected areas have changed over the last century, with an increasing diversity of responsibilities and demands placed on parks and park managers by society (Cumming 2004). Rapid declines in elephant populations in West, Central, and East Africa over the last 25 years, coupled with increasing numbers in southern Africa and changing public opinion, have placed elephant management issues squarely in the public and political domain – nationally, regionally and internationally. It is important to note that even though one may accept that value systems change over time it is highly likely that value systems will differ across a spatial environment at the same time, i.e. the "value" of elephant in Kruger in 2005 may be different to the "value" of elephant in Addo in 2005.

2.1 International treaties and obligations

Two international conventions to which South Africa is a signatory have a bearing on the management of elephants, namely, CITES and the CBD. The Convention on International Trade in Endangered Species (CITES) governs *international* trade in endangered species and their products. In 1989, in response to the collapse of East and Central African elephant populations through poaching, African elephants were listed on Appendix I resulting in a ban on all international trade in elephants and elephant products. In 1997 the elephant populations of Botswana, Namibia, South Africa and Zimbabwe were returned to Appendix II allowing trade in elephant products such as hides but limited trade in ivory. In 2004 Namibia was granted permission to trade in traditionally carved ivory artifacts. Sustainable use of endangered species has been a recurrent bone of contention at the biennial conferences of the parties to the convention but it was accepted, in principle, at the 10th COP, held in Harare in 1997 when elephants were down-listed to Appendix II. The Addis Ababa princioles on sustainable use were adopted by the 13th Conference of the Parties in 2004.

The CBD covers a very wide range of conservation issues. Of relevance to the conservation and management of elephants are those articles dealing with *in situ* conservation in protected areas, sustainable use and benefits to local communities Such benefits need to be put in context. This is referring to direct benefits from use of the actual resource and not an indirect benefit as a result of some other initiative to benefit communities. The argument here is that the benefits valued by one community may differ to those in other areas depending on what types of benefits they may have access to.

The articles (See Annex and extracts from Article 7) clearly support the sustainable use of wild natural resources as a means to achieving conservation and development.

2.2 Regional conventions – SADC protocols.

South Africa is also a signatory to the SADC Protocol on Wildlife Conservation and Management. The protocol makes provision for harmonizing wildlife management policies and practices in the region and places some measure of emphasis on the sustainable use of wildlife, the establishment of transfrontier conservation areas and the development of community based natural resource management. Relevant extracts from the preamble and articles are provided in the Annex to this summary. The SADC Wildlife Protocol demonstrates clear regional support for sustainable use of wildlife resources, the development of transfrontier conservation areas, the associated development of common management practices and legal provisions, and the development of CBNRM programmes.

2.3 National (South African) legal frameworks and mandates

Three acts of parliament have a direct bearing on the conservation of biodiversity, the management of protected areas and the management of elephants within these areas. These are the Biodiversity Act, the National Parks Act and the National Environmental Management Act. These acts contain very clear statements to the effect that protected areas have a responsibility to conserve biodiversity and that sustainable use for the benefit of parks and neighbouring communities is a legitimate component of conservation in national Parks in South Africa.

Current international, regional conventions and national and laws (including those for South Africa) do not rule out the sustainable use option for elephant management in national parks. However, IUCN criteria for strict national parks do rule out consumptive use of animals and plants in national parks and generally this practice has been observed although it is increasingly being questioned (e.g. at the World Parks Congress in 2003). It is important to appreciate that the distinction between extracting animals for live sales as opposed to killing them is an arbitrary and value laden distinction in terms of the protection of biodiversity, ecological integrity, wilderness values, and so on, within a national park.

2.4 Current proposals on elephant management in South Africa

2.4.1 *Kruger National Park*

The KNP policy is based on four underlying ecological principles:

- Ecosystem fluctuations are an inherent and desirable attribute in lowveld ecosystems and spatial and temporal variations in elephant impact would thus be natural and desirable. What is important is to determine what drives these spatio-temporal fluctuations in elephant impact.
- Elephants are important agents of habitat modification and, at intermediate densities, may contribute to maintaining biodiversity
- Confined elephant populations can increase in number to the point where they impact negatively on biodiversity In confined areas in particular it will not just be the density of the elephant that is important but the cumulative impact of these variable densities over time given that they cannot spread their impact across the landscape. Perhaps an exponential elephant impact could be argued in confined areas?
- Elephants should be viewed as one of many components of a broader integrated system and elephant impact should be managed in conjunction with other ecosystem processes to promote biodiversity.

A Strategic Adaptive Management approach will be used to translate these principles into action by dividing the Park into six zones. Two zones will function as botanical reserves, two as high density zones and two as low density zones. Elephant impacts will be monitored and audited by means of “Thresholds of Potential Concern”(TPCs). Once elephant impacts in high impacts zones pass one or more TPCs the zone will switched to a low impact zone and the elephant population reduced. Similarly, once the TPCs for a low impact zone are reached (following annual removals of elephant) it will be switched to a high impact zone and the elephant population will be allowed to increase.

The plan will be appraised annually and corrective, strategic adaptive management action will be taken in keeping with the management plan.

Non-lethal means of reducing elephant populations in selected zones will be preferred but culling will remain an option and be used if necessary.

2.4.2 *Alternative proposals for management of elephant in KNP*

Within the submissions for the workshop are suggestions that (a) the current plan is not realistic or workable (du Toit), (b) that if population densities (and impacts) are going to be manipulated or varied across the park there are more sensitive and workable ways of achieving this (Owen-Smith, in litt.), and (c) that the current population eruption should be left to run its course until such time as there is a better understanding of the impacts of elephants on biodiversity (du Toit).

The major points from these alternative proposals are as follows:

a) The current management plan envisages manipulating elephant numbers in six zones within the park. The likelihood that these plans will be implemented for long enough (decades) to learn much about elephant-biodiversity interactions is remote. In order to gain the required understanding it would be more appropriate to institute a comprehensive research programme along the lines of the recently completed BONIC programme in Chobe National Park and use the conceptual framework of "agents-controllers-responders" based on Pickett et al (2003) as a basis for research and experimental design across the main landscapes in the park. Implicit in this proposal is that elephant growth should not be interrupted while research continues for another decade or so.

b) Since the only present justification for containing elephant population growth at this stage is as a "precautionary risk-containment strategy" (Owen-Smith) then botanical reserves to protect vulnerable plant species would be appropriate with the possibility of disturbance culling in peripheral areas to reduce pressures on boundaries and concentrate animals in the central part of the park.

c) *Lassaiz faire*: Elephants may eventually reach equilibrium with their food resources and therefore no action is required.

The primary intention of the current management plan, and the alternative proposals, is to promote and maintain the heterogeneity and biodiversity of the park.

2.4.3 *Addo Elephant National Park*

Addo ENP holds the second largest elephant population in South Africa and the size of the park has been, and is being, expanded to accommodate increasing numbers.

For detail see management plan in the introduction of this chapter

2.4.4 *Other small reserves (e.g. Venetia, Madikwe, etc.)*

Only one submission covering Venetia was available and this indicated that the level of impact recorded since the recent introduction of elephants was considered to be unacceptable.

2.5 Value systems and ethics

Within South Africa there is a wide spectrum of strongly held opinions and beliefs on how SANParks should manage elephant populations. These tend to divide into two opposing camps such that SANParks finds itself in the position of being "damned if it does and damned if it doesn't" control elephant populations and their environmental impacts. There is thus a need to develop a more nuanced understanding amongst stakeholders of the complexities of ecosystem management and a wider recognition of the need for a plurality of approaches to the conservation of biodiversity and the management of elephants in particular.

The legally mandated agency to manage National Parks has to balance a range of sometimes conflicting values that include biodiversity/environmental values (e.g. material and utility values, existence values, spiritual values, wilderness, cultural values, to name a few), corporate values (e.g. transformation, professionalism, transparency, equity, etc.), sustainability values (maintaining the economic viability of the "Parks enterprise"), public service values (provision of amenities for public enjoyment of protected areas, benefits to neighbours), and so on.

The value relations involved in, or impinging on, major management tools highlight some of the complex interactions between alternative values and value systems as indicated in Table 1 below.

Table 1. An outline of the value relations associated with major elephant management options.

Tool/strategy	Values underlying this	Values violated by this
Laissez-faire	Wilderness Non-intervention No active killing necessary Experimental (Research?)	Biodiversity Material value Human safety/incurred damage Recreational & Tourism?
Contraception	Avoids killing May limit 'environmental damage' and hence support biodiversity value Tourism Human safety Public opinion	Biodiversity? (age-class/reproductive/psychological/physiological) Wilderness Co-operative governance (in some contexts) "Naturalness"
Culling	Biodiversity/heterogeneity Naturalness of 'hunting' Sustainable utilisation Tourism Human safety	Involves killing Wilderness Tourism (boycotts) Naturalness Biodiversity (impacts on habitats while recovering carcasses etc.) Biodiversity (psychological).

An important component of the debate on elephant management is the contribution of animal welfare and animal rights groups. For some activist groups killing elephant, and other mammals, is considered to be morally wrong and the option of killing elephants as a part of ecosystem management action is not condoned under any circumstances. Their activism and access to media resources result in them taking a high profile position in public and political arenas. Their influence is counterbalanced by national environmental and conservation NGOs with a large and active constituency in the country such as WESSA, EMOA, and many others involved in the wildlife and tourism industry in South Africa.

The expressions of African values and judgments on the issue of elephant management, particularly on the issue of culling, have been largely neglected. There is a clear need to rectify this situation and to reliably establish what those values and views may be – particularly from park neighbours.

Scientists conducting research on elephants also have their value systems and world views and these can also have a bearing on their interpretation of research results and their recommendations. Value free research is seldom possible and funding sources can also influence the nature of research and interpretation of results. Scientific paradigms also change and evolve and different schools of thought influence the interpretation of results and advice given to decision makers.

At the heart of the question of whether or not population reductions in protected areas are justified is the problem of distinguishing between arguments based on values (i.e. value judgments) and scientifically or ecologically based arguments. The dichotomy is largely artificial because ultimately the reasons for culling, however well disguised as ecological imperatives and based in sound science will be value judgments. To quote Graeme Caughley (1981)

> *"Is containment of eruption necessary? That is a scientific question and I interpret the evidence available as implying that it is seldom or never necessary. Is*

containment of an eruption desirable? That is not a scientific question. I can boast no qualifications that would make my opinion any more valuable than those of my two immediate neighbors, a garage mechanic on the one side and an Air Vice-Marshall on the other."

We can think of no case in which a purely scientific argument to contain a population eruption is not ultimately based on values. The logical conclusion of this line of argument is that ecological arguments can never be used to justify culling. They can, and should, be used to evaluate the risks that alternative courses of management might hold for reaching desired outcomes – such as the conservation of specific components of biological diversity, or ecosystem states, that society or a landholder may value.

3. Social and Economic Components

Social and economic aspects of park management in relation to the elephant problem have received very little attention and analysis. Aspects that have a bearing on the management of elephants in protected areas include the wider public responsibilities of parks authorities, the financial and economic sustainability of parks, and their social, economic and ecological linkages within the wider landscape within which they are embedded.

3.1 Parks' roles, responsibilities and sustainable use.

The roles and responsibilities of national parks and related protected areas in southern Africa have changed greatly since they were first set aside in the early 1900s as reserves in which to protect "game" (Cumming 2004). Their public obligations increasingly include such matters as the provision of tangible benefits to neighbours, balancing the demands of suitable amenities for greater numbers of visitors while maintaining wilderness experiences, becoming financially independent of the national fiscus, and acting as rural development hubs for an expanding tourism industry. Consumptive, economically viable, sustainable use of some resources (e.g. thatching grass, angling, trophy hunting, live-game sales, and, for a while, elephant products) from national parks has been practiced for decades. Elephants are a keystone species both ecologically *and* economically.

3.2 Financial and economic values of elephants.

The direct financial returns that can be realized from elephants (Table 2) are substantial. In the context of any single national park they may not be huge and are thus easily discounted by opponents of sustainable use. For Kruger National Park the harvest of 700 elephants a year (5% of 14,000) could yield an annual return of c. US $5.3 million (or $278/km^2). In a regional context, however, they represent a considerable resource and the opportunity costs of lost revenue from moratoria on the consumptive use of elephants are significant. Southern Africa presently has a total population of about 250,000 elephants. An annual harvest of 5,000 elephant in the region would, using the figures contained in Table 2, result in a gross annual return in excess of $70 million dollars. That is enough to finance 300,000 km^2 of protected area at $250.00 per km^2 – enough to comfortably finance the entire parks estate of southern Africa. It is doubly significant when one considers that present park budgets in Mozambique are about $5.00 per km^2 while those in Zambia and Zimbabwe are currently in the region of $10.00 per km^2 compared with an operational budget of more than $3,000 per km^2 for Hluhlue-Imfolosi (Cumming 2004).

Table 2. Values of elephant products from a population of 1,000 elephants (Source: Africa Resources Trust). The total returns amount to US$ 377,880 per 1000 animals in the population.

Table 1: Potential Sustainable Returns from 1,000 Elephant						
Management Activity	**% of Pop**	**No.**	**Item**	**Weight kg.**	**Unit Value US$**	**TOTAL US$**
Sport hunting	0.7	7	Fees		25,000	175,000
			Meat	1,000	1	7,000
Culling	4.0	40	Ivory	6	250	60,000
			Skin	70	3	8,400
			Meat	500	1	20,000
Problem Animal Control	0.3	3	Ivory	30	400	36,000
			Skin	120	3	1,080
			Meat	800	1	2,400
Natural (m)	0.2	2	Ivory	50	500	50,000
Mortality (f)	0.4	4	Ivory	15	300	18,000

Another neglected component of the analysis is the value of elephants as a tourist attraction and the level at which that attraction is saturated, i.e. what is the threshold elephant density at which no further value is added in terms functioning as a tourist attraction? Is there a threshold or optimum density beyond which tourists find the level of elephant impacts unattractive? There were suggestions from some at the Elephant Indaba that this factor may influence tourism levels.

3.3 Impacts on neighbours – Problem animals and Disease

Elephants are susceptible to very few of the fatal ungulate diseases and only anthrax and EMC (mouse virus) have caused sporadic, localized deaths. Elephants are not reservoirs of livestock diseases but their propensity to break fences and so allow other disease carrying species to disperse from protected areas makes them an important risk factor in disease control. Elephant fence breaking has, for example, been responsible for outbreaks of foot and mouth disease (FMD), malignant catarrhal fever (MCF) and African swine fever. As elephant densities within fenced protected areas increase so does the incidence of fence breaking. However, elephant densities at Addo have been increasing considerably over the past few years and are at densities higher than in the KNP and there have not been any breakouts. In contrast highly stressed populations and individuals that have been exposed to some intensive management action often break fences (e.g. Marakele, many private reserves). One could argue that culling in confined areas may increase the risks associated with fence breaking so much so that alternative management strategies should be considered in small (<2000 km^2) areas. The costs of disease outbreaks are high – countering a recent outbreak of FMD is costing c. R6 million a month, i.e. apart from the potential losses in export revenues that can result form such outbreaks.

The social cost of fence breaking and crop raiding by elephants in neighbouring high density, small scale farming areas is also high.

4. ECOLOGICAL COMPONENTS

The key issues and areas of interest in the present context are related to the relationship between elephant numbers, distribution and behaviour, their impacts on the environment and desirable ecosystem states or dynamics under different conditions. Secondarily there is also a desire to manage viable populations from a genetic as well as social perspective.

There is currently little if any consensus amongst ecologists on the impact of elephants on biodiversity. Key questions for policy and management decisions, such as "At what elephant densities is biodiversity in any given ecosystem or landscape enhanced or reduced?" remain unanswered. Does the "intermediate density hypothesis" apply to elephant-biodiversity-heterogeneity interactions and if so at what spatial and temporal scales is it applicable? While these interactions remain poorly studied and understood controversy will reign and ecologists are likely to have little useful input to policy and resource management decisions.

Under these circumstances it may well be necessary (and sensible) for decisions to be based on what is known about elephant habitat interactions and to use these as proxies for biodiversity. What *is* known is that elephants fell mature trees and are capable of changing woodlands into shrublands, and of maintaining that state. The elephant density at which this transition may occur varies with rainfall, vegetation type and soil and may be mediated by fire and the distribution of water resources. Approximate elephant/canopy-cover equilibria can be calculated (e.g. Martin 1989). The relationship between elephant density and survival of particular tree species varies greatly with some species disappearing at densities as low as 0.1 elephant/km^2 and others surviving at 5 or more elephants per km^2 (Craig 1989).

By specifying levels of preferred species or preferred levels of canopy cover in particular habitats approximate permissible elephant densities can be set and adjusted under ongoing monitoring regimes. While this simplest of scenarios has been advocated for the last four decades it has seldom been applied in practice for any length of time (which is a lesson in itself!). Given this inability to implement the simplest of elephant - habitat decision frameworks, what is the probability that vastly more complicated decision frameworks will be rigorously implemented? The challenge is "to be as simple as possible but no simpler" (Einstein's words quoted by Holling, 2001)

5. Technical components

Elephant-habitat interactions can be managed directly by manipulating elephant population numbers and structure, or, indirectly by manipulating the behaviour and distribution of elephants, or by using a combination of these approaches. In many cases the key aim of mitigating elephant impacts on habitats or on biodiversity can be reached by manipulating the distribution and availability of water by excluding elephants from particular areas through fencing or by disturbance. This may however, be appropriate in larger "open" systems like the Kruger but it is unlikely that manipulating water in confined systems such as Addo and Marakele will have any effect on elephant distributions. This does not mean that elephant do not respond to surface water and such effects are seen in Addo where the elephant disperse within the thickets after rains using the water in borehole waterpoints infrequently.

5.1 Direct manipulation of elephant numbers.

5.1.1 *Culling*

Two main techniques have been used in the past. One involves using a spotter aircraft and ground team in radio contact with each other and with the pilot. The ground team is guided on to a herd of elephants and, when in position, use heavy calibre rifles and brain shots to kill all of the animals in the herd as rapidly as possible. Experienced teams were able to kill a herd of 50 animals in less than 2 minutes. The other technique involves using drugs administered by means of darts that are fired from a helicopter hovering over a herd of elephants. The latter has been the preferred technique used in Kruger NP while the former was used extensively in Zimbabwe. In KNP carcasses were transported to a central abattoir while in Zimbabwe carcasses were processed in the field. In the hands of experts both techniques could be carried out humanely. Sterilization is also a clinical management option but one that is irreversible

5.1.2 ***Translocation***

With the development of effective techniques for capturing and translocating adult bulls and entire family units the use of live capture as a means to reduce populations or contain an eruption has become a reality. However, given the costs of translocation and the now limited demand (and potential) for elephant restocking in South Africa it is only likely to be a pragmatic option for regulating or reducing quite small populations.

Elephant herds can be driven short distances and in at least one instance more than 150 animals were moved several kilometres from a tsetse controlled hunting area into the Chirisa Game Reserve in Zimbabwe in 1967. The major constraint to moving the animals out of the hunting area was getting animals to cross a fence line even though the fence had been temporally dismantled.

5.1.3 ***Contraception***

Recent advances in the development of immuno-contraceptiion for elephants make this a viable, non-lethal method for containing population growth in small populations. The application of the technique to large populations is presently not considered feasible.

5.2 Indirect manipulation of elephant impacts

5.2.1 ***Water*** (directly from Gaylard's Summary Chapter)

"The presence of surface water plays an important role in focusing elephant impacts in particular parts of the landscape, despite the fact that surface water is relatively abundant in KNP. In addition, despite the relatively short distances (for elephants) between the most isolated surface water in this area, the spatial arrangement of surface water determines the patchiness of elephant impacts on riparian trees. I therefore predict that further closure of boreholes will:

- restore the natural spatial and temporal variability of surface water distribution, thereby
- restoring the natural spatial and temporal heterogeneity of elephant impact distribution
- this heterogeneity of impacts potentially provides spatial and temporal refuges for impact-intolerant species, thereby mitigating against the adverse consequences of elephant impacts for biodiversity.

An important implication of this study is that it also represents an alternative means of decision-making regarding elephant management. The coalescing of piospheres (zones of impact around waterpoints) represents homogenisation of elephant impacts across the landscape. Homogenisation of elephant impacts is an undesirable biodiversity consequence of surface water that is closely-spaced. However, piospheres may also begin to coalesce in landscapes with more isolated water if increased elephant densities force elephants to feed further and further away from water as the vegetation adjacent to water sources is decimated. Monitoring the coalescing of piospheres (rather than the traditional monitoring of elephant numbers) therefore represents an alternative decision-making tool that is in keeping with the paradigm shift away from a species-focus towards managing ecosystem processes for biodiversity. In other words, rather than trying to find a "carrying capacity" for elephants in such a variable environment, monitoring the spread of elephant impacts may provide a better "signal" for determining when elephant populations may have to be reduced to maintain biodiversity."

5.2.2 *Fire*

The interaction between alternative fire management regimes and elephant impacts in Kruger was weak. In more mesic environments, particularly in miombo woodlands, there is a marked interaction. Elephants reduce canopy cover resulting in higher herbaceous fuel loads which, when combined with late dry season fires, contribute to a further reduction in tree canopy cover and inhibit tree recruitment. The "woodland" gets caught in a fire trap.

5.2.3 *Fencing*

Fences can be used to enclose elephant within particular areas or exclude them from others. Key aspects in fence design relate to ease with which elephants may be able to break through them and the levels maintenance required.

5.2.4 Park expansion

There are some situations where the continued expansion of the protected area estate could provide refuge for expanding elephant populations in the short term. Even so these populations will have to consider what other options are best suited to their needs once expansion is no longer an option and such options will need to be highlighted in any plans presented to DEAT and the Minister.

6. WHAT DOES THE MINISTER NEED TO KNOW?

- Likely alternative scenarios and outcomes of differing management regimes
- Costs and benefits of alternative management strategies and the advantages/disadvantages of adopting a diversity of approaches and strategies – "safe fail versus fail safe", minimum regret, etc.
- Reliable information on the value systems and beliefs of his major constituencies regarding the culling and sustainable use of elephants and other species
- Likely risk factors (environmental, political, social, etc.) of alternative management options.

ANNEX – RELEVANT EXTRACTS FROM INTERNATIONAL AND REGIONAL CONVENTIONS

1. The Convention on Biodiversity (CBD)

"Each Contracting party shall, as far as possible and as appropriate:

(a) Establish a system of protected areas or areas where special measures need to be taken to conserve biological diversity

(b) Develop, where necessary, guidelines for the selection, establishment and management of protected areas or areas where special measures need to be undertaken to conserve biological diversity;
(c) Regulate or manage biological resources important for the conservation of biological diversity whether within or outside of protected areas, with a view to ensuring their conservation and sustainable use;
(d) Promote the protection of ecosystems, natural habitats and the maintenance of viable populations of species in natural surroundings;
(e) Promote environmentally sound and sustainable development in areas adjacent to protected areas with a view to furthering protection of these areas;
(f) Rehabilitate and restore degraded ecosystems and promote the recovery of threatened species, *inter alia,* through the development and implementation of plans or other management strategies;
(g) Establish or maintain means to regulate, manage and control the risks associated with the use and release of living modified organisms resulting from biotechnology which are likely to have adverse environmental impacts that could affect the conservation and sustainable use of biological diversity, taking also into account the risks to human health;
(h) Prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species;
(i) Endeavour to provide the conditions needed for compatibility between present uses and the conservation of biological diversity and the sustainable use of its components;
(j) Subject to its national legislation, respect, preserve and maintain knowledge, innovations and practices of indigenous and local communities embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity and promote wider application etc.
(k) Develop or maintain necessary legislation and/or other regulatory provisions for the protection of threatened species and populations;
(l) Where a significant adverse effect on biological diversity has been determined persuant to article 7, regulate or manage the relevant processes and categories of activities; and
(m) Cooperate in providing financial and other support for in-situ conservation outlined in paragraphs (a) to (l) above, particularly to developing countries."

2. The SADC Protocol on Wildlife Conservation – Some extracts from the Preamble to the Protocol

"AFFIRMING that Member States have the sovereign right to manage their wildlife resources and the corresponding responsibility to sustainably use and conserve these resources;
NOTING that Article 5 of the SADC Treaty states that the sustainable use of natural resources and effective protection of the environment is one of the objectives of SADC;
NOTING also that Article 21 of the SADC Treaty designates natural resources and environment as an area of co-operation for SADC Member States;
AWARE that the conservation and sustainable use of wildlife in the SADC Region contribute to sustainable economic development and the conservation of biological diversity;
CONVINCED that the viability of wildlife resources in the SADC Region requires collective and co-operative action by all SADC Member States;"
"BELIEVING that the regional management of wildlife and wildlife products will promote awareness of the socio-economic value of wildlife and enable equitable distribution of the benefits derived from sustainable use of wildlife;"
"DESIRING to establish a common framework for the conservation and sustainable use of wildlife resources in the SADC Region and to assist with the effective enforcement of laws governing those resources;
HEREBY agree as follows:"

Some relevant extracts from Article of the SADC Protocol

"ARTICLE 2, SCOPE: This protocol applies to the conservation and sustainable use of wildlife, excluding forestry and fishery resources".

"ARTICLE 3, PRINCIPLES: Each State Party shall ensure the conservation and sustainable use of wildlife resources under its jurisdiction. Each State Party shall ensure that activities within its jurisdiction or control do not cause damage to the wildlife resources of other states or in areas beyond the limits of national jurisdiction."

"ARTICLE 4, ATTAINMENT OF PRINCIPLES:

1. Pursuant to the attainment of the principles contained in Article 3 of this Protocol, States Parties shall:

   a) ensure co-operation at the national level among governmental authorities, non-governmental organisations hereinafter referred to as NGOs, and the private sector;
   b) cooperate to develop as far as possible common approaches to the conservation and sustainable use of wildlife, and,"

"ARTICLE 5, OBJECTIVES:

1. The primary objective of this Protocol is to establish within the Region and within the framework of the respective national laws of each State Party, common approaches to the conservation and sustainable use of wildlife resources and to assist with the effective enforcement of laws governing those resources.
2. To this end, specific objectives of this protocol shall be to:"
   "f) promote the conservation of shared wildlife resources through the establishment of transfrontier conservation areas; and
   g) facilitate community-based natural resources management practices for management of wildlife resources."

"ARTICLE 8, WILDLIFE MANAGEMENT AND CONSERVATION PROGRAMMES"

"9. States parties shall in recognition of the location of key wildlife resources near international boundaries, promote the development of trans frontier conservation and management programmes."

3. Relevant extracts from the South African Legislation

The preamble to the Protected Areas Act No. 57 of 2003 reads as follows:

> "To provide for the protection and conservation of ecologically viable areas representative of South Africa's biological diversity and its natural landscapes and seascapes; for the establishment of a national register of all national, provincial and local protected areas; for the management of those areas in accordance with national norms and standards; for intergovernmental co-operation and public consultation in matters concerning protected areas; and for matters in connection therewith."

The objectives of the Act are:

(a) to provide, within the framework of national legislation, including the National Environmental Management Act, for the declaration and management of protected areas;

(b) to provide for co-operative governance in the declaration and management of protected areas;

(c) to effect a national system of protected areas in South Africa as part of a strategy to manage and conserve its biodiversity;

(d) to provide for a representative network of protected areas on state land, private land and communal land;

(e) to promote sustainable utilisation of protected areas for the benefit of people, in a manner that would preserve the ecological character of such areas; and

(f) to promote participation of local communities in the management of protected areas, where appropriate

The preamble to the Biodiversity Act No. 31 of 2004 reads as follows:

> "To provide for the management and conservation of South Africa's biodiversity within the framework of the National Environmental Management Act, 1998; the protection of species and ecosystems that warrant national protection; the sustainable use of indigenous biological resources; the fair and equitable sharing of benefits arising from bioprospecting involving indigenous biological resources; the establishment and functions of a South African National Biodiversity Institute; and for matters connected therewith".

The objectives of the Act are:

(a) within the framework of the National Environmental Management Act, to provide for—

(i) the management and conservation of biological diversity within the Republic and of the components of such biological diversity;

(ii) the use of indigenous biological resources in a sustainable manner; and

(iii) the fair and equitable sharing among stakeholders of benefits arising from bioprospecting involving indigenous biological resources;

(b) to give effect to ratified international agreements relating to biodiversity which are binding on the Republic;

(c) to provide for co-operative governance in biodiversity management and conservation; and

(d) to provide for a South African National Biodiversity Institute to assist in achieving the objectives of this Act.

Some relevant definitions under the Biodiversity Act are:

''biological diversity'' or **''biodiversity''** means the variability among living organisms from all sources including, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part and also includes diversity within species, between species, and of ecosystems;

''components'', in relation to biodiversity, includes species, ecological communities, genes, genomes, ecosystems, habitats and ecological processes;

''ecological community'' means an integrated group of species inhabiting a given area;**''ecosystem''** means a dynamic complex of animal, plant and micro-organism communities and their non-living environment interacting as a functional unit;

''sustainable'', in relation to the use of a biological resource, means the use of such resource in a way and at a rate that—

(a) would not lead to its long-term decline;

(b) would not disrupt the ecological integrity of the ecosystem in which it occurs; and

(c) would ensure its continued use to meet the needs and aspirations of present

and future generations of people;

''this Act'' includes any subordinate legislation issued in terms of a provision of this Act;

''threatening process'' means a process which threatens, or may threaten—

(a) the survival, abundance or evolutionary development of an indigenous species or ecological community; or

(b) the ecological integrity of an ecosystem, and includes any process identified in terms of section 53 as a threatening process;

The following amendments to the Protected Areas Act, 57 of 2003 make clear provision for communities to use, on a sustainable basis, biological resources within a park and for protected area authorities to control species that may negatively impact on biodiversity within a park provided such actions fall within the approved plan for the area.

Amendment of section 50 of Act 57 of 2003

19. Section 50 of the principal Act is hereby amended-
(a) by the substitution for the heading to that section of the following heading:
"Commercial and community activities in national park, nature reserve and world heritage site";
(b) by the substitution for subsections (I), (2) and (3) of the following
"(1) The management authority of a national park, nature reserve and world heritage site may, despite any regulation or by-law referred to in section 49, but subject to the management plan of the park, reserve or subsections:
(a) carry out or allow-
(i) a commercial activity in the park, reserve or site; or
(ii) an activity in the park, reserve or site aimed at raising revenue;
(b) enter into a written agreement with a local community inside or adjacent to the park, reserve or site to allow members of the community to use in a sustainable manner biological resources in the park, reserve or site; and
(c) set norms and standards for any activity allowed in terms of paragraph *(a)* or *(b).*
(2) An activity allowed in terms of subsection (l)(a) or *(b)* may not negatively affect the survival of any species in or significantly disrupt the integrity of the ecological systems of the national park, nature reserve or world heritage site.
(3) The management authority of the national park, nature reserve or world heritage site must establish systems to monitor-
(a) the impact of activities allowed in terms of subsection *(l) (a)* or *(b)* on the park, reserve or site and its biodiversity; and

55. (1) South African National Parks must-
(a) manage the national parks and other protected areas assigned to it in terms of Chapter 4 and section 92 in accordance with this Act;
(b) protect, conserve and control those national parks and other protected areas, including their biological diversity; and
(c) on the Minister's request, advise the Minister on any matter conceming-
(i) the conservation and management of biodiversity; and
(ii) proposed national parks and additions to or exclusions from
(d) on the Minister's request, act as the provisional managing authority of existing national parks; and protected areas under investigation in terms of this Act
(2) South African National Parks may in managing national parks-
(a) manage breeding and cultivation programmes, and reserve areas in a park as breeding places and nurseries;
(b) sell, exchange or donate any animal, plant or other organism occurring in a park, or purchase, exchange or otherwise acquire any indigenous species which it may consider desirable to re-introduce into a specific park;
(c) undertake and promote research;

> (d) control, remove or eradicate any species or specimens of species which it considers undesirable to protect and conserve in a park or that may negatively impact on the biodiversity of the park;

The South African legal framework clearly makes provision for the sustainable use and control of elephants within protected areas – including national parks. In this respect it differs from neighbouring countries where consumptive use of natural resources in strict national parks generally follows the IUCN classification for such areas where "use" other than for scientific or management purposes is not permitted.