POLICY

Ecological basis of the new elephant management policy for Kruger National Park and expected outcomes

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Abstract

In 1995, a moratorium was placed on culling elephants in Kruger National Park (KNP) while its elephant management policy was being reviewed. This review resulted in a completely new policy in which maintaining KNP's indigenous biodiversity is the primary objective. Managing for maximum biodiversity will be achieved through principles outlined in the 'intermediate disturbance hypothesis' and by inducing elephant population fluctuations, which it is believed will also play an important role. For these purposes KNP was divided into six zones: two will be botanical reserves in which medium densities of elephants will be maintained, two will be low-elephant-impact zones where elephant densities will be actively reduced through management, while the final two will be high-elephant-impact zones where no elephant management will be conducted and densities will be allowed to increase. Management options for the low-elephant-impact zones and the high-elephant-impact zones will be reversed, once biodiversity monitoring programmes indicate that acceptable thresholds of change have been reached or exceeded. KNP zoning was based on results of research on elephant clan movements. It is believed that zoning along natural clan boundaries will limit movements of elephants between zones once the policy is implemented.

Additional key words: biodiversity, contraception, culling, intermediate disturbance hypothesis, translocation

Résumé

En 1995, on a mis un moratoire sur l'abattage d'éléphants au Parc National Kruger (PNK) tandis qu'on révisait sa politique de gestion des éléphants. Cette révision a abouti à une politique complètement neuve dans laquelle le maintien de la biodiversité indigène du PNK est l'objectif premier. Une gestion qui vise un maximum de biodiversité sera possible grâce aux principes mis en évidence dans l'« hypothèse de perturbation moyenne » et en provoquant des fluctuations de population d'éléphants qui, on le croit, joueront aussi un rôle important. Dans cet objectif, le PNK a été divisé en six zones : deux seront des réserves botaniques dans lesquelles on maintiendra des densités moyennes d'éléphants, deux seront des zones où l'impact des éléphants sera maintenu faible en réduisant activement la densité des éléphants, et les deux dernières seront des zones avec un fort impact des éléphants, où l'on ne pratiquera aucune gestion des éléphants et où leur densité pourra augmenter librement. Les options en matière de gestion dans les zones de faible impact et celles d'impact important seront inversées, une fois que les programmes de contrôle de la biodiversité indiqueront que des seuils acceptables de changement ont été atteints ou dépassés. Le zonage du PNK s'est basé sur les résultats de recherches sur les déplacements des clans d'éléphants. On pense que cette façon de faire limitera les déplacements des éléphants entre les différentes zones une fois que la politique sera mise en place.

Mots clés supplémentaires : biodiversité, contraception, abattage, hypothèse de perturbation moyenne, translocation

Introduction

Between 1967 and 1994, the policy for managing elephants in Kruger National Park (KNP) was to maintain the population at around 7000, allowing it to fluctuate between 6000 and 8500 (Joubert 1986). In late 1994 the reasons for culling and the ethical morality of killing elephants were questioned by an animal rights group, which resulted in a public debate in May 1995. This debate culminated in South African National Parks undertaking to review its policy and to place a moratorium on culling until the review was completed. Meetings and workshops were held to reconsider the policy and recommend appropriate management practices for the future. The review resulted in a completely new policy (see Whyte et al. 1999; Whyte 2001a) in which the primary objective is to maintain KNP's indigenous biodiversity. It is the product of many hours of consultative debate between South African National Parks and a wide diversity of interested and affected people and organizations. While this new policy was published earlier (Whyte et al. 1999), KNP has since been rezoned and that version is now outdated. There was also no attempt to model the expected population trends after the policy was implemented or to determine the number of elephants that may need to be removed from the population. This paper provides an updated version of this policy and examines implications subsequent to its implementation.

Theoretical basis of the new policy

The previous policy (Joubert 1986) was committed to a fairly vague definition of the 'maintenance of biodiversity' through holding KNP's elephant population at a stable level of around 7000 (Joubert 1986), but it did not entirely fulfil this objective. Even at this relatively low density, directional changes were detected that showed that certain plant species were declining (Whyte et al. 2003).

In the new policy, however, KNP now subscribes to the Noss (1990) definition of biodiversity. It therefore emphasizes biodiversity in the widest sense (that is, structure, function and composition across scales from genetic to landscape and even subcontinental) and makes specific mention of fluxes. The theoretical basis of quantifying and managing for biodiversity and flux has its origin in the emergent paradigm relating to heterogeneity (for example, Christensen 1997; Fiedler et al. 1997).

Critical variables in savannahs include nutrients, moisture, fire and herbivory (for example, Wiens 1997). Elephant herbivory is considered particularly significant, as in some studies elephants at high densities have been shown to affect biodiversity negatively (Western and Gichohi 1989; Cumming et al. 1997). If these variables change, an ever-changing mosaic should be the outcome, and the patches that result should be organized in a hierarchy of scales (Wiens 1997). If, for example, many levels of herbivory are naturally superimposed on a fire mosaic, then at certain scales the outcome should be even greater diversity.

The intermediate disturbance hypothesis (Connell 1978; Huston 1979) claims that the greatest species richness (and perhaps overall biodiversity) at any one point is likely to result from intermediate levels of disturbance. At extreme levels of either low or high disturbance, there might indeed be fewer species, but certain species that are not favoured or are absent at intermediate levels would likely prosper. Thus, if the ecosystem can pass through various stages of disturbance in different places and at different times, the patchwork created might support the greatest overall diversity desirable in a natural system, although spatial variation can in many ways substitute for temporal variation and vice versa.

Equally important is the rate of change, as influenced by the pattern and intensity of disturbance—a regime of rapidly increasing disturbance may affect the ecology differently from a slowly increasing one, even if the final intensity is the same.

In recent years there has been increasing belief that most of the important changes in savannahs are caused by events. They may occur only occasionally, when a certain co-occurrence of events brings about a particular shift from one state to another (perhaps an invasion of bush into grassland). Different ecological pressures then prevail, which may stabilize the system in a new state for years or even decades. Current ecosystem theory takes cognizance of the likelihood of the existence of multiple stable states (Dublin 1995) as well as other models from the homogeneity and stability paradigms through to disequilibrium theory (Behnke et al. 1993). Holling (1995) and others suggest that keeping an ecosystem static for too long will invariably lead to catastrophic change if an extreme event occurs, usually because of lack of resilience.

Elephants are one such agent of ecological disturbance. The positive effects that elephants may have are that they open up woodlands, creating habitats for plains or grassland-favouring species; they create microhabitats for organisms requiring shelter under fallen trees and logs; they provide browse by pushing over trees and breaking branches; they distribute the seeds that they pass in their dung; and they can provide water for other species by digging for it in sandy riverbeds. Elephants, as animals with large body size, home range and mobility, and with a propensity for rapid population growth, can affect the environment on a landscape scale. At lower density, they may create a mosaic of medium-scale effects. At the fine scale, elephants feeding on some parts of an individual tree and not others might lead to increased habitat diversity for small vertebrates and invertebrates. Time scales are equally important: longer- and shorter-term fluctuations contribute to the natural flux.

We are now entering an era in which many believe that heterogeneity needs to be not only understood but also encouraged through management in some practical way. The belief is that this management strategy will enhance biodiversity, and at the same time it will provide an opportunity to learn by managing—a crucial element of adaptive management. Although much use will be made of the outcomes to learn more about future elephant management, it should not be seen primarily as an experiment—the options chosen are intended to meet KNP's primary objective of biodiversity rather than constitute any contrived or forceful experiment. 'Thresholds of potential concern' or TPCs (see below) provide an attempt to outline the 'envelopes' of acceptability to management. They are meant to delineate thresholds beyond which, it is believed, the system will have exceeded its inherent elasticity, and from which it may not have the ability to return to a healthy state. These TPCs will be continuously refined as knowledge, experience and hopefully wisdom grow.

The new policy for managing KNP's elephant population

Principles

This new elephant management policy rests on three fundamental principles:

- In accordance with KNP's new vision statement, it is accepted that flux in ecosystems is natural and desirable as this contributes to biodiversity, and that this will probably also hold true for the elephant population.
- It is accepted that elephants are important agents of disturbance and as such create heterogeneity and thus can contribute to biodiversity in accordance with the principles defined in the intermediate disturbance hypothesis (Connell 1978; Huston 1979). This has been demonstrated in Amboseli National Park (Western and Gichohi 1989). In the absence or very low densities of elephants, biodiversity will be negatively affected as no disturbance occurs. Excessive disturbances at high densities will also affect biodiversity negatively. These high and low end-points may also be considered desirable, as it is believed that certain species will benefit from the conditions thus created, provided that these conditions do not occur over a large area for too long.
- It is also accepted that elephant populations that are confined but not managed will increase in number to a level where negative effects on the system's biodiversity will result.

In recognizing the above three principles, the following corollaries have also been considered and accepted:

- To maintain an elephant population at a high level will require culling or translocating more animals than when maintaining the population at a lower level. This has moral or ethical implications.
- Reducing an elephant population from a high level to a lower level will also require culling or translocating more animals than when maintaining the population at a lower level. This has the same moral or ethical implications.

Elephant management options

Options for controlling elephant numbers include two that are non-lethal—contraception (Whyte and Grobler 1998; Fayrer-Hosken et al. 2001) and translocation (Dublin and Niskanen 2003), and the lethal option of culling. These various options were logistically evaluated by van Aarde et al. (1999) and Whyte et al. (1998), and ethically by Whyte (2001b) and Whyte and Fayrer-Hosken (in press).

The new policy states that wherever possible, the elephant population will be managed by non-lethal means, but that where these methods prove inadequate, unfeasible or inappropriate, culling will remain an option. When culling is necessary, the most humane method available will be used.

At the time of writing, the demand for live elephants was limited and the expectation is that annually South African National Parks will be able to dispose of only about 30 animals from breeding herds and 30 bulls through live transfer. As contraception is not yet available as a tool for managing large elephant populations (van Aarde et al. 1999), culling will have to be the method used to dispose of most of the quota. While this limits opportunities for managing the KNP elephant population by non-lethal means at present, this situation will in all likelihood change once the fence between KNP and the new Limpopo National Park in Mozambique has been removed, as proposed. This will offer considerable opportunity for natural recolonization, and it is conceivable that it will relieve some of the necessity for reducing populations in KNP. It must be remembered, however, that Limpopo National Park will offer only a temporary solution, as the number of elephants that it will be able to accommodate also has limits.

Thresholds of potential concern

The new elephant management policy will differ from the old one in that the elephant population will be managed according to measured effects on biodiversity rather than on absolute numbers of elephants. Different management options will be practised in different zones and various aspects pertaining to biodiversity will be monitored. This management option will continue until there is clear evidence that the prevailing density (either too high or too low) of elephants is having a negative impact on some aspect of biodiversity that warrants concern. This point will be known as a 'threshold of potential concern' or 'TPC'. A TPC can be defined as the upper or lower level along a continuum of change in a selected environmental indicator that when reached or exceeded prompts an assessment of the causes that led to the extent of such change. It results in either management action to moderate such cause(s), or recalibration of the threshold to a more realistic or meaningful level.

Such TPCs are initially established at somewhat arbitrary levels, based on the best available knowledge and experience. It is absolutely necessary when deciding to use such TPCs that they be accompanied by monitoring at appropriate intervals, and that there be considerable understanding of the factors causing change in the parameter being monitored.

TPCs have the advantage that management has definite proactive objectives or parameters within which to manage a system, in contrast to previous practices, which reactively managed events or processes to minimize or avoid crises. Nevertheless, TPCs should be constantly challenged as to their appropriateness or validity, and adaptively modified as knowledge and experience increase.

The appropriate TPCs for managing the KNP elephant population (Whyte et al. 1999) have been set widely, which will allow considerable fluctuation in the populations of the various management zones.

Zoning KNP for managing elephant impact

KNP has been divided into six zones, which will receive different treatments in terms of managing their respective elephant populations (fig. 1):

- Two high-elephant-impact zones (HEIs)
- Two low-elephant-impact zones (LEIs)
- Two botanical reserves (BRs)

In the HEIs elephant populations will be allowed to increase (no culling, contraception or live removals) until indications are that one or more of the TPCs have been reached or exceeded. It is expected that the elephant population of these zones will increase at ±7% per year.

In the LEIs elephant populations will be decreased (through culling or live removals) until there are indications that low densities of elephants have induced change to a point that one or more of the TPCs have been reached or exceeded. This decrease will be achieved by reducing the populations in these zones by 7% per year. (It is important to note that contraception is not an option in LEIs as this technique can

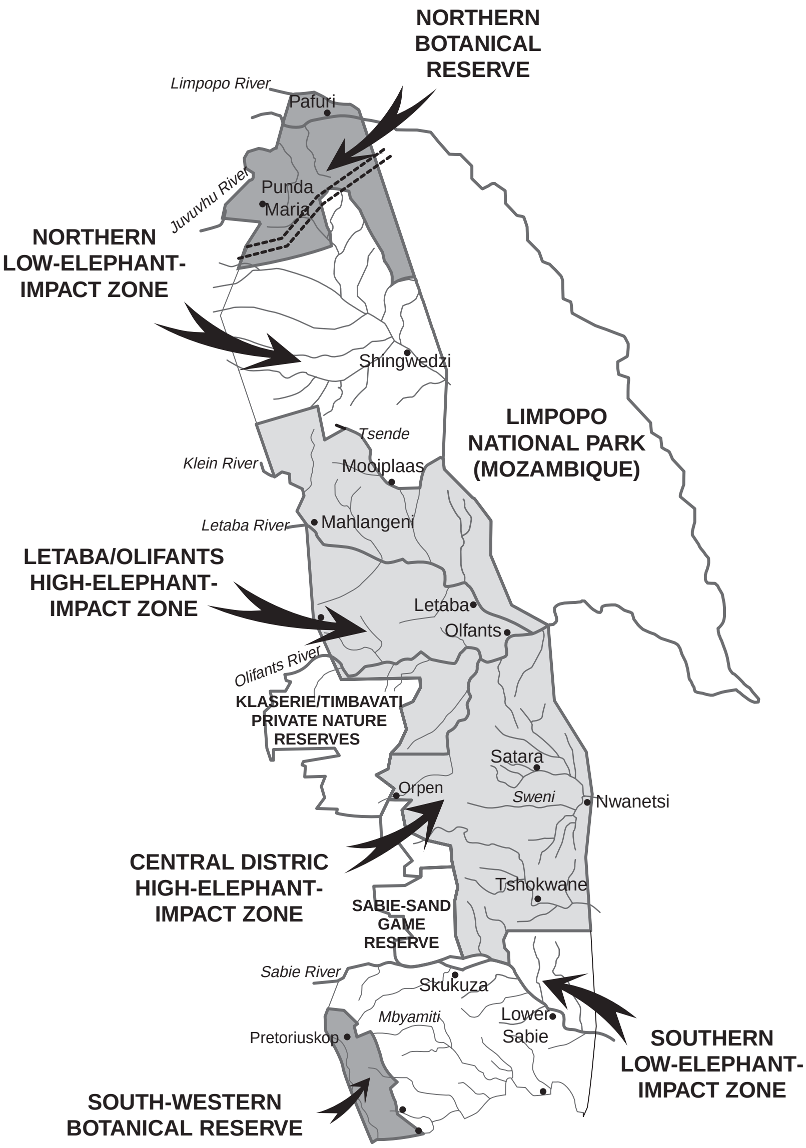

Figure 1. Zonation of Kruger National Park for elephant management as proposed in the new elephant management policy (Whyte et al. 1999).

only stabilize a population, not reduce it.) It is expected that the populations in these LEIs will also be increasing at around 7% per year, so to achieve a 7% decline, 14% of the total recorded in the zone must be removed annually.

The BRs are to maintain medium densities. 'Medium density' is here considered the density prescribed in the previous master plan (Joubert 1986), which was one elephant per 2.85 km^2 (7000 elephants in 20,000 km^2). Populations will be reduced to this density by either culling or translocation, and the density maintained by culling, translocation or contraception. Management of the BRs will be regulated by special TPCs yet to be formulated for these areas. Should one or more of these proposed TPCs be reached or exceeded, elephant numbers will be adjusted (reduced or increased) to bring this into line.

Ultimately, once a TPC has been reached or exceeded in any of the HEIs or LEIs, the management actions applied in these zones will be alternated, and the alternate action will be applied. HEIs will then be treated as LEIs and their populations systematically reduced while the elephant populations of the LEIs will be allowed to increase.

The boundaries of the respective elephant management zones (fig. 2) were defined to conform to the known boundaries of elephant clans. This allows meaningful elephant management without disrupting the home ranges of these clans. Boundaries have also been defined so as to ensure that the four major zones (excluding the botanical reserves) are similar in size.

The two high-impact zones have been placed adjacent to one another in the centre of KNP to establish a large core area of non-management. The two low-impact zones then lie between the high-impact zones and the botanical reserves to obviate the problems of a hard edge between high densities of elephants and the botanical reserves. Once TPCs have been exceeded and the management actions in the respective high- and low-impact zones have been reversed, it is accepted that management problems will have to be addressed.

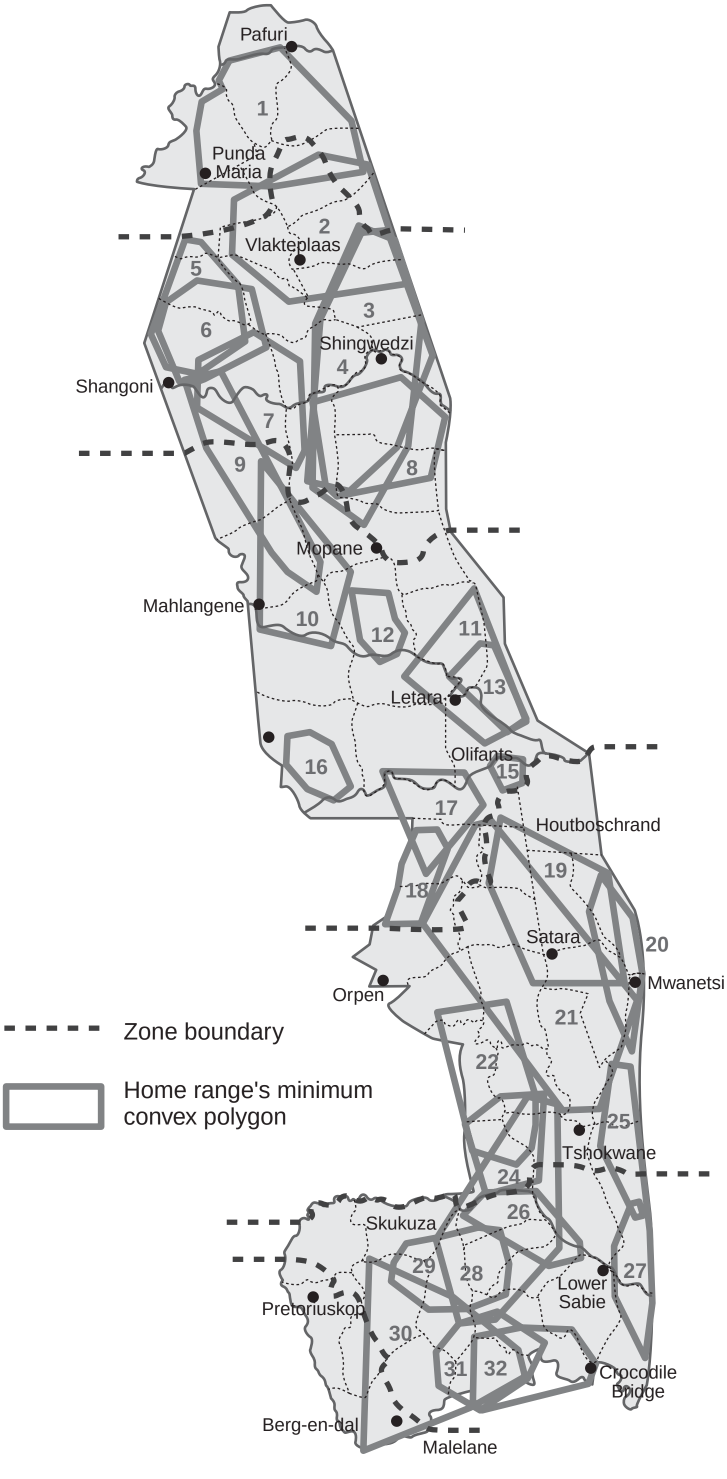

Figure 2. Ninety per cent minimum convex polygons of the home ranges of 29 radio-collared elephant cows in Kruger National Park (Whyte 2001a). Note the boundaries of the elephant-management zones were defined on the boundaries of these home ranges.

It might be expected that by reducing numbers in the two LEIs, the total number of elephants in KNP will not be greatly influenced by increases in the other two zones, keeping the total population at a stable level. However, modelling of the responses of these zones has shown that this will not be the case, and the total KNP population will probably increase dramatically (see section 'Implications of implementing the new elephant management policy' on the next page).

Will the policy work?

One of the crucial questions pertaining to this policy is whether elephants will remain in the designated management zones. Some have suggested that elephants will move from LEIs to HEIs as a result of traumas induced by management. Others suggest that movements will be from HEIs to LEIs as food resources will become increasingly limited when elephant numbers increase. There are two reasons to believe that they will do neither. The first comes from information from home range studies (Whyte 1993). These showed that cow–calf groups in KNP had maintained their home ranges since the start of studies in 1989 and that these groups were unaffected by either culling or change in feeding conditions as a result of patchy rainfall. Ongoing studies on the same animals (Whyte 2001a) confirmed that these home ranges had still not changed after 12 years. The second reason is that the private nature reserves on KNP's western boundary (fig. 1) had very different elephant densities before fences separating these conservation areas were removed in 1993. The Klaserie/Timbavati complex, known as associated private nature reserves or APNRs, had elephant densities similar to those in KNP, while in the Sabie-Sand Game Reserve

Table 1. Population trends in numbers and densities (km^2 per elephant) of elephants between 1993 and 2003 in Kruger National Park and the private nature reserves on its western boundaries

Year	KNP (19,624 km^2)		Sabie-Sand (572 km^2)		APNRs (1266 km^2)	
	Count	Density	Count	Density	Count	Density
1993	7,834	2.50	60	9.53	424	2.99
1994	7,806	2.51	116	4.93	511	2.48
1995	8,064	2.43	202	2.83	526	2.41
1996	8,320	2.36	202	2.83	355	3.57
1997	8,371	2.34	311	1.84	759	1.67
1998	8,869	2.21	429	1.33	617	2.05
1999	9,152	2.14	497	1.15	636	1.99
2000	8,356	2.35	531	1.08	726	1.74
2001	9,276	2.12	601	0.95	824	1.54
2002	10,459	1.88	757	0.76	927	1.37
2003	11,672	1.68	689	0.83	1092	1.16

(SSGR) densities were low (table 1). By mutual agreement, the fence between these reserves and KNP was removed, and the subsequent growth rates in the populations differed markedly. The intrinsic growth rates ($\bar{r}$) between 1993 and 2003 were 0.034 for KNP, 0.088 for APNRs and 0.231 for SSGR. SSGR has experienced a massive population growth, which can only be as a result of an influx from KNP, while that of the APNRs was not far from the 0.66% recorded for KNP during the years that it was fenced entirely (Whyte 2001a). On the other hand, KNP's rather reduced rate over the period would have been the result of the negative influences of culls (n = 552), translocations (n = 657) and emigration into SSGR.

Moss (1988) described that elephant families belonging to a particular home range will defend them from intrusion by other families. The significance of this from the policy's point of view is that where elephants are already established in home ranges, overlap between neighbours is limited. At the time the fence was removed, the APNRs already had established residents while SSGR did not. Movement of elephants from KNP into the APNRs did not occur; a large influx occurred into SSGR, which had 'vacant' home ranges.

There is thus confidence that the elephants will maintain these home ranges in spite of changing densities. If this proves not to be the case and the elephants move from LEIs to HEIs, this will facilitate the policy as the number of elephants to be removed will be reduced, and the desired low and high densities will be achieved with limited management. If, however, the movement goes from HEIs to LEIs, the policy will not work, as all that will have happened is that a source sink will have been created and excess elephants from the source area will have to be removed from the sink. This would then require formulating a new policy.

Implications of implementing the new elephant management policy

To assess the implications of implementing the new management policy on elephant population, a spreadsheet model was developed to simulate trends in the zones and in KNP as a whole. The simple model (Whyte 2001a) calculates the number of elephants to be removed from each zone based on the management strategies listed for each of the six strategies described. The starting point (year 1) was the data derived from the aerial census of 1999. In the model, populations in the botanical zones were reduced to the prescribed density and held there, those in the low-impact zones were reduced by 7% per year, and those in the high-impact (unmanaged) zones were increased by 7% per year. The projections were based on three assumptions:

- that the elephants recorded in the respective management zones will remain where they are and will not move into adjacent zones
- that population growth rates will remain a constant 7% per year
- that to achieve a 7% reduction in a population that is growing at 7% per year, 14% of the animals recorded in that zone will have to be removed each year

The number of elephants to be removed from the populations of each zone is given in table 2. Since the prescribed limits for the two botanical zones are ex-

Table 2. Hypothetical population reduction quotas for the elephant management zones of Kruger National Park as defined in the new elephant management policy, based on the 1999 census data

Management zone	Counted in 1999	Limit	To be removed		
			Total	Bulls	Breeding herds
Northern Botanical Reserve	901	550[a]	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[a]	91	14	77
Total	9152		963	144	819

Census totals are from 1999. Quotas are 15% for bulls and 85% for breeding herds, as these are the ratios at which they occur naturally.
[a] The limits for the botanical reserves are specified in the management policy.

ceeded by far, a large number of animals must be removed. It is assumed that all 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 number 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 hold true, population trends and trends in the number of elephants to be removed can be projected into the future (fig. 3). 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

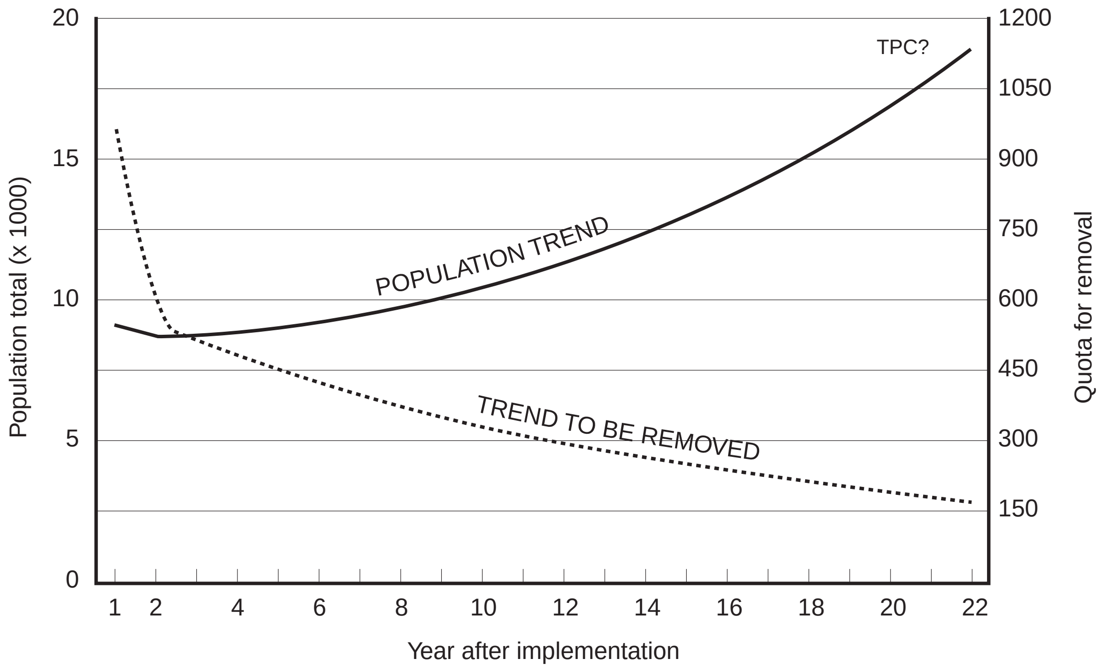

Figure 3. Expected elephant population trends and numbers to be removed from the population after implementation of the new management policy until a TPC (threshold of potential concern) is reached after a hypothetical period of 22 years.

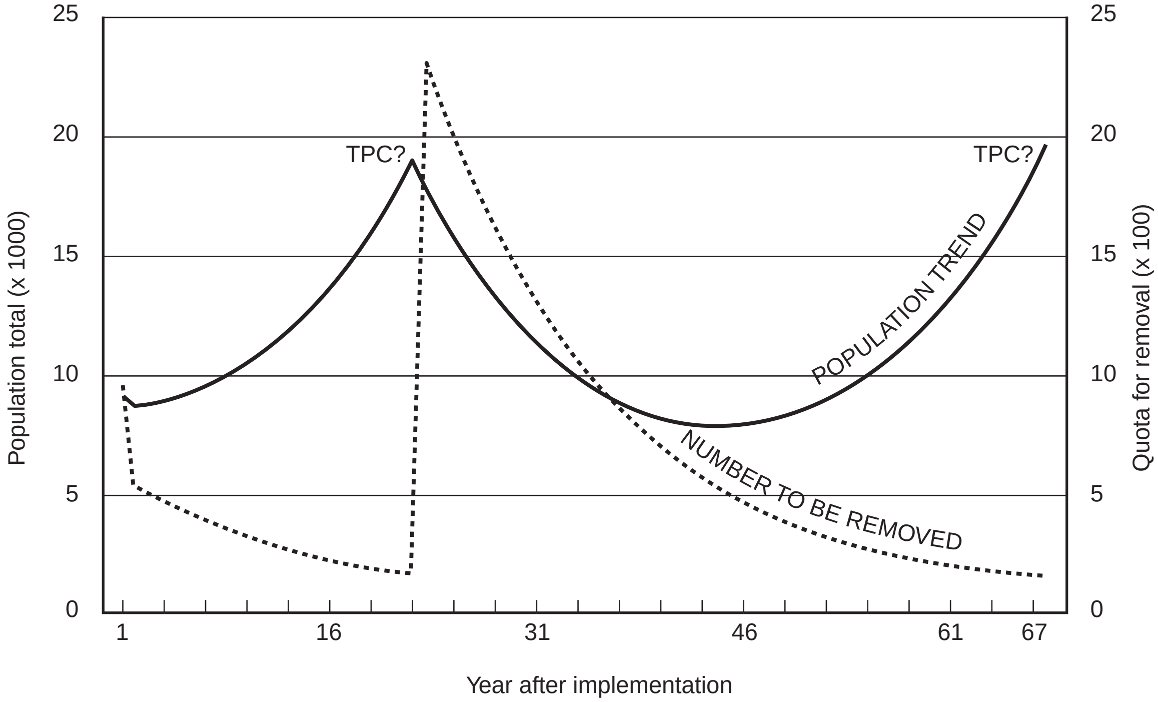

Figure 4. Expected elephant population trends and number to be removed from the population before and subsequent to reaching a TPC (threshold of potential concern), at which time the management option for the zones would be switched (see text).

subsequent years the management option for each zone is maintained until a hypothetical TPC is reached in year 22. The number to be removed decreases as the population declines. After 22 years the number to be removed has decreased to just 170, while the KNP population as a whole has increased to around 19,000.

Once a TPC has been reached and management options for high- and low-impact zones are reversed, the number of elephants to be removed once again increases dramatically due to the high number of elephants in the high-impact zones, which now need to be reduced (fig. 4). 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 newly designated 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 the population begins another growth cycle. This will continue until another TPC is reached sometime in the future.

This management will induce significant population fluctuations, not only in individual HEIs and LEIs, but in KNP as a whole. It is believed that such fluctuations will significantly contribute to the overall biodiversity of KNP.

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