Elephant Management Plan
Kruger National Park
2013-2022

Scientific Services
November 2012

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Authorisation

This Elephant Management Plan for the Kruger National Park was compiled by Scientific Services and the Kruger Park Management of SANParks. The group represented several tiers of support and management services in SANParks and consisted of:

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Mr Rendani Nethengwe	Section Ranger: Houtboschrand
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Mr Steven Whitfield	Section Ranger: Tsokwane
Mr Albert Smith	Section Ranger: Skukuza
Mr Kenneth Muchocho	Section Ranger: Lower Sabie
Mr Evans Mkanzi	Section Ranger: Pretoriuskop
Mr Rob Thompson	Section Ranger: Stolsnek
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Stakeholder Discussions

Associated Private Nature Reserves
Sabie Sands Game Reserve
Limpopo National Park, Mocambique
Makuleke Community
Limpopo Department of Environmental Affairs and Tourism
Mpumalanga Province Tourism and Parks Agency

Recommended:

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Compiler Curriculum Vitae

Sam M. Ferreira has a PhD in Zoology with a focus on restoration and community ecology from the University of Pretoria in 1997. His working experience permeated his studies – from 1984 to 1989 Sam worked as laboratory assistant at the Shortridge Mammal Collection of the Kaffrarian Museum in King William's Town. Over the summer of 1986/87 he spent a year on Marion Island working for the Department of Environmental Affairs and the Feral Cat Eradication Programme. He spent a second year over the summer of 1989/90 at Marion Island coordinating the Seal Research Programme of the Mammal Research Institute of the University of Pretoria. He also coordinated the Richards Bay Dune Forest Restoration Research Programme under the auspices of the University of Pretoria from 1992 to 1997. He worked for the Department of Conservation in New Zealand as Conservancy Advisory Scientist for 7 years from 1997 to 2004 where projects included marine reserve planning, dolphin and bird research, and alien mammal eradications from islands. Sam completed two concurrent post-docs in 2005 and 2006 – one at the Department of Entomology & Zoology at the University of Pretoria on elephant temporal dynamics, and the second at the Department of Statistics of the University of Auckland on modeling large mammal dynamics including elephants, lions, hippos and antelopes. His interests centers on mammal and bird conservation biology with emphasis on temporal dynamics and the factors influencing these. He also has an interest in restoration ecology and the solving of ecological problems. Sam has published 66 peer-reviewed papers, 3 chapters in books, 85 technical reports and presented 40 papers at national and international conferences. Sam is currently working for SANParks as a Large Mammal Ecologist.

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Executive Summary

SANParks wish to manage elephant impacts on biological, cultural, human and stakeholder values. Kruger National Park (Kruger) is a large conservation area, almost 2 million hectares and comprising 37 landscapes that conserve significant biodiversity assets. Kruger forms the key focus of conservation in the lowveld region as well as the Greater Limpopo Transfrontier Conservation Area. The region includes a multitude of landscapes and land uses including rural communities, commercial farming, industry and private ecotourism initiatives. Several different stakeholder interests therefore impact on Kruger. This management plan, compiled in accordance and compliance with the National Norms and Standards for Elephant Management, is a supporting document to the Kruger Park Management Plan submitted to the Department of Environmental Affairs and Tourism in January 2009.

This plan describes the strategic context of elephant management within SANParks as well as key linkages to the vital attributes and management objectives of Kruger National Park as defined in the Park Management Plan. Elephants may impact on several of Kruger's vital attributes, affecting achievement of objectives supporting the desired state of this National Park. In addition, the current elephant population also reflects responses to historical biodiversity and tourism management approaches which inadvertently reduced the limiting factors, some of which are maintained and manifested to this day. The present diversity of expectations, and the need to reconcile objectives, will necessitate several immediate management actions, some of which may be reactive in the short- to medium-term. This plan accommodates such reactive management responses in the spirit of strategic adaptive management and associated "learning-by-doing".

The objectives hierarchy articulated in the Kruger National Park Management Plan guides the specific objectives for the Elephant Management Plan of Kruger. Five key elephant management objectives have been developed for Kruger, with 86 associated management actions to address these. **Objective 1** seeks SANParks to manage elephant impact and human interactions through inducing spatial and temporal variation in elephant use of landscapes by restoring the spatial limitations of the landscape. This should be achieved through 1) minimizing the number of additional water points and dams; 2) mimicking the effect of natural water distribution; 3) expanding land through contracts and agreements; and 4) removing restrictions such as fences. This objective deals with direct influences that elephants have on the landscape and the associated suite of values.

Objective 2 focuses on reactive responses and associated actions to ensure that management accommodates both the consequences of historic biodiversity, elephant and tourism-related management philosophies and the current expectations as articulated in the broad Kruger management objectives. This objective thus strives to ensure that the consequences of historic management actions are minimized by proposing short- to medium-term actions, evaluating risks to other objectives, and implementing actions that do not compromise SANParks' strategic objectives and primary mandate of biodiversity conservation. Actions are reactive and the objective specifically requires robust adaptive management experimental approaches to learn from reactive responses that include primarily localized fencing and removal through translocation and culling.

Objective 3 focuses on the effects that elephants have on stakeholders through aligning SANParks' Elephant Management Plan with co-management and contractual agreements and, where appropriate, revisiting existing and establishing new agreements

with stakeholders and affected parties. These actions focus on assessing concerns and issues of various stakeholders, acting on these, informing stakeholders and evaluating how SANParks' actions affect stakeholders.

International agreements are also catered for through management actions directed at **Objective 4,** namely to align SANParks and Trans Frontier Conservation Area (TFCA) Elephant Management Policies through appropriate bilateral approaches.

Objective 5 is directed at expanding understanding through focused research, namely to evaluate, inform and revise elephant management through collaborative research agreements. This provides for the critical evaluation both internally and externally of SANParks' achievements against the intentions articulated in this Kruger Elephant Management Plan. The actions provide explicitly for the opportunity to generate information as well as to inform, review and accommodate variance in management actions on annual, bi-annual, five-yearly and ten-yearly intervals.

Accountability for overall implementation of this plan lies with the Managing Executive: Kruger National Park while accountability for evaluation is with the Managing Executive: Conservation Services. External review is proposed through a SANParks Elephant Management Advisory Committee that reports to the Minister on two-, five- and ten-year intervals. The Kruger Elephant Management Plan is written for a life-span of 10 years, namely 2011-2020, and should be reviewed by 2020.

Elephant Management Plan: Kruger National Park

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Contents

1. The strategic SANParks context

The public value system around conservation has shifted over time to embrace and encompass a complex array of societal needs and values. SANParks must, where possible and appropriate, balance and integrate various values and viewpoints in support of its national mandate. In the context of elephants, these specifically include values and viewpoints around

- Safety and security – *e.g.* human-elephant conflict issues, damage causing animals, disease outbreak consequences
- Human benefits – *e.g.* tourism, community beneficiation
- Aesthetic and ethical issues – *e.g.* "existence" value of large trees and elephants, the primacy of cultural resources
- SANParks' biodiversity mandate, values and conservation goals including contributions to national targets.

Complexity is SANParks' leading conservation value *i.e.* SANParks respect the complexity, as well as the richness and diversity of the socio-ecological system making up each national park and the wider landscape and context (see Box 1). This requires SANParks to think, observe, sense, probe and respond rather than just rely on traditional mechanistic decision-making tools. SANParks has adopted a strategic adaptive management approach[1] to enable achievement of objectives within the socio-ecological system it has been mandated to manage.

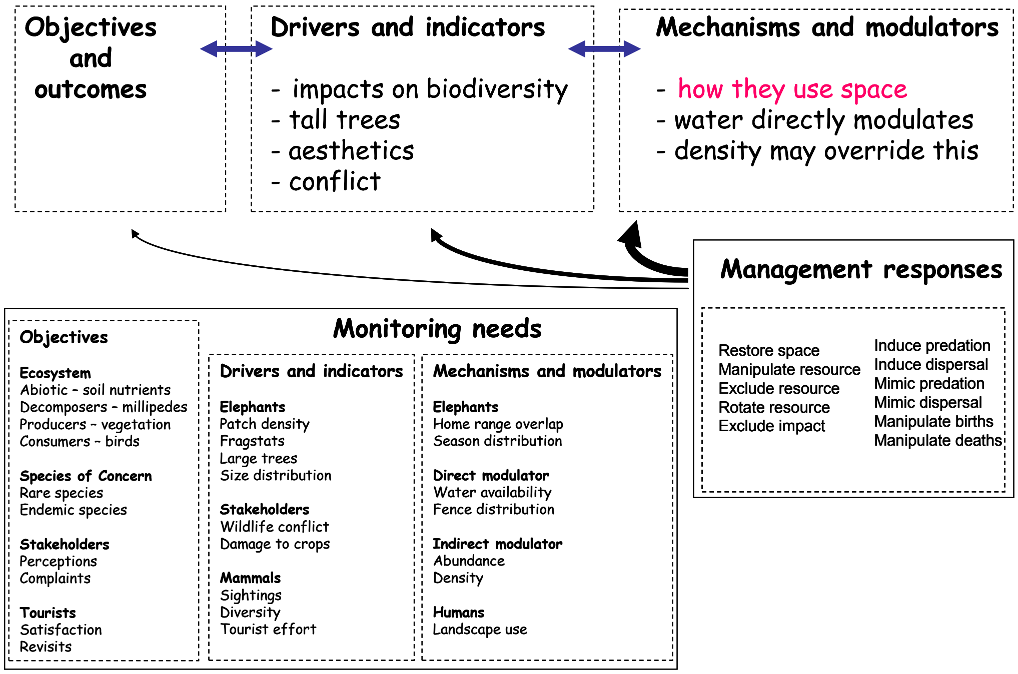
Box 1. SANParks' core conservation values in support of its national mandate[2]

- SANParks respects the complexity, as well as the richness and diversity of the socio-ecological system making up each national park and the wider landscape and context. SANParks respect the interdependency of the formative elements, the associated biotic and landscape diversity, and the aesthetic, cultural, educational and spiritual attributes* and leverage all these for creative and useful learning.
  * Biodiversity (*sensu Noss*) is explained as biotic and landscape diversity and includes structure, function and composition of biotic and all underlying abiotic elements; cultural heritage (*sensu Galla*) includes moveable, immoveable, tangible and intangible assets, even living arts. The word 'natural' is used in the sense expanded upon in the "Guide to the use of values" in SANParks' custodianship framework.
- SANParks strives to maintain natural processes in ecosystems, along with the uniqueness, authenticity and worth of cultural heritage, so that these systems and their elements can be resilient and hence persist.
- SANParks manages with humility the systems under its custodianship, recognising and influencing the wider socio-ecological context in which SANParks are embedded.
- SANParks strives to maintain a healthy flow of ecosystem and cultural goods and services (specifically preserving cultural artefacts), and to make these available, also through access to national parks, thereby promoting enjoyment, appreciation and other benefits for people.
- When necessary, SANParks will intervene in a responsible and sustainable manner, complementing natural processes as far as possible, using only the level of interference needed to achieve its mandate.
- SANParks will do all the above in such a way as to preserve all options for future generations, while also recognising that systems change over time.
- Finally, SANParks acknowledges that conversion of some natural and cultural capital has to take place for the purpose of sustaining its mandate, but that this should never erode the core values above.

In order to effectively select appropriate management responses, under an adaptive management paradigm, SANParks strives to make explicit the links between National Park objectives and their desired outcomes, the drivers and indicators of change, and the mechanisms (and their modulators) of how such drivers cause change (see Box 2).

[1] Rogers 2003
[2] SANParks 2006

Box 2. SANParks' generic approach, applied to elephants, to making explicit linkages from park desired state to management response options[3]



SANParks uses a linkage framework that connects park objectives and outcomes, drivers and indicators of change, mechanisms and modulators of such change. The linkages describe best available understanding and/or jointly derived mental models of such linkages. Effective management responses should focus on the modulators of and mechanisms of change which result in diverse information requirements.

1.1 Elephants in the South African context

South Africa has only 4% of the elephants in Africa[4]. South African populations are better protected and far more intensely managed than elsewhere. In addition, they breed quicker, live longer and use landscapes more intensely than elsewhere[5]. This may have undesirable outcomes for other values, including biodiversity components. Historically, conservationists measured the response of elephant populations to management interventions[6], but not the assumed associated changes in elephant impacts.

Legislatively (see section 1.2 for details), SANParks is directed by the National Environmental Management: Protected Areas Act (Act 57 of 2003) which supports the notion of adaptive management. The prescriptions of this Act are embraced in park management plans prepared for National Parks and submitted to the Department of Environment and Tourism (DEAT). In addition to this Act, the Minister of Water and Environmental Affairs published the National Norms and Standards for the management of elephants in South Africa (Norms and Standards) on 29 Feb 2008 (www.environment.govt.za). The Norms and Standards provides management options to

[3] Adapted from diagram provided by Angela Gaylard, SANParks, Knysna, South Africa & Sam Ferreira, SANParks, Skukuza, South Africa
[4] Blanc *et al.* 2007
[5] van Aarde *et al.* 2009
[6] van Aarde *et al.* 2009, Grobler *et al.* 2009, Bertschinger *et al.* 2009, Grant *et al.* 2009, Slotow *et al.* 2009

control wild elephant population sizes and distribution. The following management options could be use to manage the size of the population, or the composition or rate of growth of a wild elephant population:

- Contraception
- Range manipulation
- Translocation
- Introduction of elephants
- Hunting
- Culling

In terms of the management of the spatial distribution of wild elephant populations, the following direct and indirect management options can be used:

- Contraception
- Range manipulation
- Translocation
- Introduction

The Minister also initiated a scientific consultation process, through the Science Round Table, aimed at reducing the uncertainty associated with various elephant management strategies[7]. The first major output of this process resulted in a scientific assessment of the state of knowledge around elephant – ecosystem – societal interactions (www.elephantassessment.co.za)[8]. The Assessment essentially recognised that elephant impacts must be managed differently in different places and at different times.

1.2 Elephants in the legal context

The natural resources in South Africa are conserved and managed within the context of a comprehensive legal framework which is guided at a high level by the provisions of Section 24 of the country's Constitution. Within the overall framework of the Constitution, there are various pieces of legislation which govern elephant management. These are listed below to indicate their relevance to the preparation of elephant management plans

National Norms and Standards for the Management of Elephants in South Africa (GN 251/GG 30833/ 29 February 2008)

Of most direct relevance are the National Norms and Standards for the Management of Elephants in South Africa which were developed in terms of section 9 of the National Environmental Management: Biodiversity Act, 2004 (Act No 10 of 2004) and came into effect on 1 May 2008. The purpose of the National Norms and Standards for the Management of Elephants in South Africa is to ensure that elephants are managed in the Republic in a way that ensures the long-term survival of elephants within the ecosystem in which they occur or may occur in the future, to promote broader biodiversity and socio-economic goals that are socially, economically and ecologically sustainable and enables the achievement of specific management objectives of protected areas. The norms and standards apply to all protected areas and private land on which elephants occur and require the preparation of elephant management plans, which may be incorporated into either:

[7] Owen-Smith *et al.* 2006
[8] Scholes & Mennell 2009

1. a management plan as contemplated in Chapter 4 of the National Environmental Management: Protected Areas Act, 2003 (NEMPAA), or
2. a biodiversity management plan that has been developed in accordance with section 43 of the National Environmental Management: Biodiversity Act, 2004 (NEMBA)

The National Environmental Management: Protected Areas Act, 2003 (Act No. 57 of 2003)

Of relevance is Section 39 of NEMPAA which deals with the preparation of management plans for protected areas. It specifically provides that a management plan for a protected area should at least contain a coordinated policy framework, planning measures, controls and performance criteria, a program for its implementation and its costing, procedures for public participation, and the implementation of community-based natural resource management as well as a zoning of the area indicating what activities may take place in different sections of the protected area as set out in Section 41(2) of NEMPAA. Section 41 (4) makes provision for management plans to include subsidiary plans. The Minister may approve the management plan or any subsidiary plan in whole or in part.

The National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004)

NEMBA came into operation on 01 September 2004 and provides for the management and conservation of South Africa's biodiversity within the framework of the National Environmental Management Act, 1998 (Act No.107 of 1998; NEMA). Section 43 of NEMBA provides that any person, organisation or organ of state desiring to contribute to biodiversity management may submit to the Minister for his or her approval, a draft management plan for an indigenous species listed in section 56 of the NEMBA or an indigenous species not listed, but that warrant special conservation attention. The biodiversity management plan must be aimed at ensuring the long-term survival in nature of the species or ecosystem to which the plan relates, must indicate who will be responsible to implement this, and must be consistent with the NEMBA, all national environmental management principles, the national biodiversity framework, any applicable bioregional framework, any environmental implementation plans and management plans referred to in Chapter 3 of NEMA, any municipal integrated development plan, any other plans prepared in terms of national or provincial legislation that is affected and any relevant international agreement binding on the Republic of South Africa. NEMBA furthermore provides for the listing of threatened or protected species in terms of Section 56 (1) of the Act. Permits are required to carry out restricted activities involving listed threatened or protected species. This elephant management plan is not a formal Biodiversity Management Plan for a specific species as prescribed by the Biodiversity Act, 2004 (Act No. 10 of 2004). It is a requirement in terms of the National Norms and Standards for the Management of Elephants in South Africa (GN 251/GG 30833/ 29 February 2008) that most likely will have the same effect as a Biodiversity Management Plan.

Threatened and Protected Species Regulations (GN 152/ GG 29657/ 23 February 2007)

The African elephant is listed as a Protected Species in the list of Threatened or Protected Species (GN No R151/ GG 29657/ 23 February 2007). In terms of section 56(1)(d) of NEMBA this means a species which is of such high conservation value or national importance that it requires national protection. The Threatened or Protected

Species regulations (GN No R 152 / GG 29657 / 23 February 2007), promulgated in terms of Section 97 of the Act, is therefore applicable to restricted activities involving the African elephant and permits are required to carry out these activities.

Critically Endangered, Endangered, Vulnerable or Protected Species

Notwithstanding the provisions as indicated in section 45 of NEMBA, these requirements are also highly relevant to matters connected therewith in the publication of lists of critically endangered, endangered, vulnerable and protected species (GN 151/ GG 29657/ 23 February 2007) to avoid the management of elephants in isolation of South Africa's biodiversity that warrants national protection.

Because of the importance of elephant management, SANParks has prepared elephant management plans not as integrated parts of park management plans, but as separate documents. The plans are nevertheless fully aligned with the park management plans, and constitute subsidiary plans as contemplated in Section 41(4) of NEMPAA. They also accord with the National Norms and Standards for the Management of Elephants but are not formal biodiversity management plans as contemplated in Section 43 of NEMBA. In addition, the implications of GN No R151 and GN No R152 have been taken into account in preparing the plans.

1.3 Managing ecological effects of elephants

The management of elephants and their ecological impacts are embedded in the overall SANParks objectives of:

- maintaining, or restoring, ecosystem integrity
- providing benefits to people, and
- taking cognisance of aesthetic and wilderness qualities.

SANParks recognises that ecosystems under their custodianship are constrained through fencing, restricted size, addition of water, and/or missing species. Certain of these ecosystems are also affected by how elephants use landscapes over time and that this could be either too intensely or too sparsely[9], both potentially affecting other values and biodiversity components. In addition, water availability, food availability and people would have historically influenced elephant landscape use[10], while today management can directly (*e.g.* through water provision) or indirectly (*e.g.* contraception) affect the intensity with which elephants use the landscapes available to them.

The ecological effects of elephants vary considerably depending on rainfall, vegetation type, and landscape features[11]. Interpretation of these ecological effects is confounded by length of studies, as well as synergistic effects of fire, other herbivores, drought, wind toppling, soil chemistry and water table[12].

The key mechanism of elephant impact is how intensely elephants use landscapes over time, which is modulated by resource availability and distribution (predominantly food and water)[13]. This is directly affected by water provision, but these effects can be overridden by elephant density effects (see Box 2).

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[9] Gordon *et al.* 2004
[10] Harris *et al.* 2008
[11] Guldemond & van Aarde 2008
[12] Whyte *et al.* 2003, Kerley *et al.* 2009
[13] Owen-Smith *et al.* 2006, van Aarde *et al.* 2006, van Aarde & Jackson 2007

Elephants respond to spatial and temporal resource variation by short- to medium-term movements and/or dispersal[14] and medium- to long-term changes in demography[15]. However, the constraints on protected areas managed by SANParks operate at different scales in different parks and include fencing, water provision and the effect of missing species such as the presence of humans that influenced elephant movements. Such constraints disrupt population regulating mechanisms and how elephants use landscapes. The implications are that:

- Resource manipulation will affect elephant impacts over time and across landscapes; and
- Elephant demographic responses to the distribution of resources may affect birth and death rates through, for example, social and physiological stresses.

This suggests that by restoring or mimicking natural resource distribution, and the historic disturbance effects of humans, SANParks should be able to directly address the spatial and temporal distribution of elephant impact, and may indirectly induce population regulation. However, SANParks takes cognizance of each specific Park's context, scale and constraints, recognizing that this affects management's ability to accommodate lag effects and imposes timeframes for decision-making. In many protected areas elephant populations have responded to a management history that removed key spatial and temporal limitations on elephant spatial use and population sizes. Elephants are long-lived and have a long life-history resulting in anticipated slow spatial and demographic population responses to the management-induced restoration of ecological limitations. As such ecological responses may take time to manifest and result in the desired outcomes, SANParks will be required to manage (a) the mechanisms of ecological effects and (b) the potential lag-effects of the unanticipated outcomes of the variety of historical management approaches and remaining expectations.

1.4 Managing human-elephant interactions

Human interactions with elephants fall into two broad categories, namely

- human-elephant conflict when elephants cause damage to individuals, property and livelihoods, and
- other stakeholder interests such as tourism experiences and various forms of beneficiation.

Management of the effects of elephants on people directly contributes to SANParks' higher level objectives and focuses on (a) managing damage-causing elephants and conflict and (b) managing tourism and stakeholder interactions with elephants.

1.4.1 Managing damage-causing elephants and conflict

Damage caused by elephants to humans and their livelihoods in southern Africa is central to discussion on human-elephant conflict. Nevertheless, the incidence of such conflict is relatively lower in South Africa. Historical incidences of human-elephant conflict were generally recorded in terms of how elephants affect individuals, property and livelihoods[16], but were often not placed within the overall conflict or damage profile of such communities. Even so, elephants typically comprise only a relatively small

[14] Young *et al.* 2009a, Young *et al.* 2009b
[15] Wittemyer *et al.* 2007a, Wittemyer *et al.* 2007b, Trimble *et al.* 2009
[16] Lee & Graham 2006

component of the conflict profile of a community since damage by other wildlife agents such as primates, rodents and even large predators usually exceed that caused by elephants[17].

Management responses are typically reactive and involve several approaches including fencing, removal, destruction and the use of deterrents[18]. SANParks recognizes that managing damage-causing elephants and associated conflicts must focus on both the mechanisms of such conflict and the individual damage-causing animals. Human-elephant conflict typically is an outcome of how elephants and humans use landscapes, which in turn is primarily driven by the distribution of key resources. The key mechanism of damage-causing elephants is linked to how intensely elephants use various landscapes available to them (see Box 2). Furthermore, intensity of landscape use depends on how elephants respond to spatial and temporal resource variation through movements and/or dispersal and ultimately through changes in demography.

The implications of these postulated linkages are that resource manipulation will affect elephant interactions with humans and the damage they cause over time and across landscapes. This means that by restoring or mimicking natural resource distribution, as also proposed for ecological effects, SANParks should theoretically be able to directly reduce a significant proportion of damage-causing elephant interactions and associated human-elephant conflict. However, the restoration of these spatial and demographic limitations carries potential lag-effects which may not reduce immediate damage-causing elephant phenomena and associated human conflict. While SANParks will strive to manage the mechanisms driving incidences of damage-causing elephants and human-elephant conflict, it must deal with the potential lag-effects inherent in this approach and will deal with actual damage-causing incidences on a case-by-case basis according to standard operating procedures associated with the draft Norms and Standards for managing damage-causing animals[19]. The legal jurisdiction of SANParks to proactively intervene when a potential damage-causing animal has left a national park is still unclear. This places SANParks in the difficult position of being potentially liable for any damages caused by such an animal, but not being able to address the problem. Memorandum of Understandings between SANParks and provincial governments clarify this.

1.4.2 Managing tourism and stakeholder interactions with elephants

Tourism forms a key component of SANParks' operations and mandate and SANParks recognizes the intertwined and complex socio-ecological-economic system within which it operates. Assumptions that a key tourist draw-card is the "big five" experience often drives tourism developments[20], including elephants as a key driver of tourist expectations and experiences. Other key stakeholders such as academic partners and institutions, non-government organizations and transfrontier participants are traditionally more affected by governmental policies rather than actual human-elephant interactions.

Management responses to accommodate tourist expectations historically often focused on the principle of bringing the elephant to the tourist. Typically management maintains existing roads and improves sightings by providing additional water resources

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[17] Jackson *et al.* 2008, Unpublished data in Mozambique from Rob Guldemond, University of Pretoria, Pretoria, South Africa and Rudi van Aarde, University of Pretoria, Pretoria, South Africa.
[18] Twine & Magome 2009
[19] DEAT 2009
[20] Akama & Kieti 2003

to attract animals including elephants to existing infrastructure[21]. This action, while economically cost-effective, inadvertently manipulates elephant responses to the distribution of critical resources with undesirable ecological consequences. Again, tourist interactions relate to how elephants (and other animals) use landscapes, which in turn is driven by the distribution of key resources and tourist infrastructure. Tourism experiences, through elephant sightings, are driven by mechanisms dictating where tourists are and how intensely elephants use landscapes. This, in turn, depends on how elephants respond to spatial and temporal resource variation through movements and/or dispersal and ultimately through changes in demography (see Box 2).

It is postulated that by restoring or mimicking natural resource distribution (as already proposed for dealing with ecological and conflict effects) and appropriately redesigning tourist infrastructure, SANParks can create an improved tourist product without placing other objectives at risk. However, the restoration of spatial and demographic limitations for elephant populations carries immediate consequences for tourist experiences since existing infrastructure is costly and time consuming to change. Thus, some artificial water distribution may need to be maintained to accommodate short- to medium-term tourist expectations. SANParks thus wish to ultimately manage mechanisms driving tourist and stakeholder experiences associated with elephants, but also need to accommodate the potential lag-effects through short-term interventions to address the pathology of the past.

1.5 SANParks strategic elephant management directions

The conceptual mechanisms of how elephants influence ecological systems, cause damage to individuals, property and livelihoods as well as influence tourists and stakeholders carry common factors and modulators that alter the influence of these factors. SANParks thus focuses on managing direct mechanisms of ecological, conflict and stakeholder effects by:

- Spatially and temporally altering the distribution of key resources (*e.g.* water distribution);
- Spatially and temporally altering the scale of resource availability (*e.g.* contractually increase size, create linkages and removing fences); and
- Spatially and temporarily altering access to resources (*e.g.* induce elephants to avoid an area indirectly through disturbance or excluding elephants directly through fencing, or mimicking the spatial and temporal limitation of human presence on elephants).

However, when elephant numbers modulate the intensity with which elephants use landscapes, and when lag-effects of elephant responses to the restoration of spatial and temporal limitations contrast objectives and their desired outcomes in the short- to medium-term, SANParks will, at appropriate places, implement:

- Non-lethal induction of spatial and temporal variation in elephant numbers (*e.g.* contraception); and
- Lethal induction of spatial and temporal variation in elephant numbers (*e.g.* culling).

[21] Carruthers *et al.* 2009

SANParks' strategic adaptive management philosophy provides a scientifically robust approach to evaluating and learning about the mechanisms of ecological, conflict and stakeholder effects. In addition, it enables evaluation of whether the management action leads to anticipated change in these effects within the context of SANParks' park-specific desired state and objectives. Monitoring should thus focus on

- aspects of elephant dynamics, namely distribution, ranges, demography and estimates;
- modulators of elephant effects such as water distribution, fencing and human presence;
- aspects of biodiversity that reflect ecosystem objectives;
- aspects of biodiversity that reflected in impacts on rare and endangered species;
- human perceptions and elephant damages that reflect conflict objectives; and
- tourist experiences that reflect on stakeholder objectives.

2. Kruger National Park

2.1 Location and boundaries[22]

The Kruger National Park covers a large and varied area, and lies embedded in an even more varied regional setting, for which multiple historical and geographical descriptions exist. It covers almost 2 million hectares of South Africa's lowveld, bordering Mocambique in the east and Zimbabwe in the north (Map 1). There are a number of contractually included parcels of land which contribute to achieving the vision and overall desired state of this national park as outlined in Table 1 below. Its elongated shape is approximately 350 km from north to south and on average 60 km wide, with rivers providing natural boundaries in the south and north and the Lebombo hills bounding the east. To the west, the park is predominantly bordered by private and provincial nature reserves and many high-density communal areas (Map 2 & 3). Note that only verbal agreements exists between SANParks and adjacent private nature reserves.

Perimeter fencing varies considerably along Kruger's boundaries. Along the southern boundary standard electrified fences are present. Along the western boundary from the Nzikazi River north to Skukuza, a standard game fence provide the boundary. No fences exist between Kruger and the western Private Nature Reserves. From where the Klein Letaba enters Kruger to the Levhuvhu River a cabled veterinary fence delineates the boundary. There are no fence along Kruger's northern boundary and large parts of the fence between Kruger and Limpopo National Park north of the Olifants Gorge has been removed. South of the Olifants Gorge a sturdy cabled fence delineates the boundary. Kruger's fences do not have warning signs as the National Park is well known and delineated. These varying fences do not adhere to the complete Norms and Standards Requirements. It is largely irrelevant given that Kruger National Park forms part of the Greater Limpopo Transfrontier Park with varying land uses surrounding Kruger.

[22] Extracted from SANParks 2008.

Table 1. Private land included, by proclamation, into the Kruger National Park by written permission of the landowner

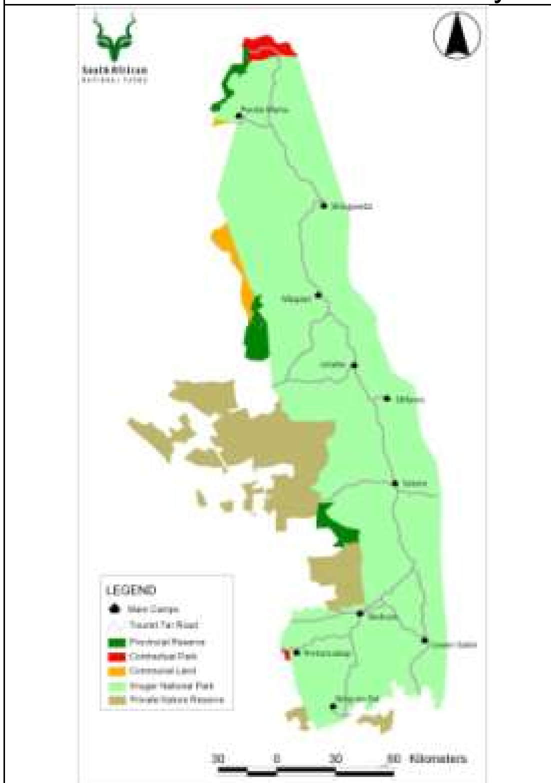
TITLE DEED	FARM	PORTION NO	EXTENT	OWNER	SECTION	GOV GAZ	PROCLA DATE	PERIOD	RESTRICTIONS
T6866/1992	Vlakgezicht 75	Remainder of portion 1	863.8188	WWF of SA	2B(1)(b)	15540	1994/11/03	Remain in force in perpetuity, subject to possible transfer to SANParks.	The management agreement is subject to the lease agreement between the National Parks Trust of SA and Sound Props 1311 Investments (Pty) Lts.
T30743/1991	Lilydale 89	Portion 0	3919.6874	WWF of SA	2B(1)(b)	15540	1994/11/03	Remain in force in perpetuity, subject to possible transfer to SANParks.	None.
T30743/1991	Remainder of Kempiana 90	Portion 0	3960.5422	WWF of SA	2B(1)(b)	15540	1994/11/03		
T30743/1991	Remainder of Morgenzon 199	Portion 0	2114.3169	WWF of SA	2B(1)(b)	15540	1994/11/03		
T30743/1991	Spring Valley 200	Portion 0	3838.1499	WWF of SA	2B(1)(b)	15540	1994/11/03		
	Makuleke 6	Portion 0	22733.636	Makuleke	2B(1)(b)	19927	1999/04/16	50 years from 16 April 1999 with an option to renew.	None.

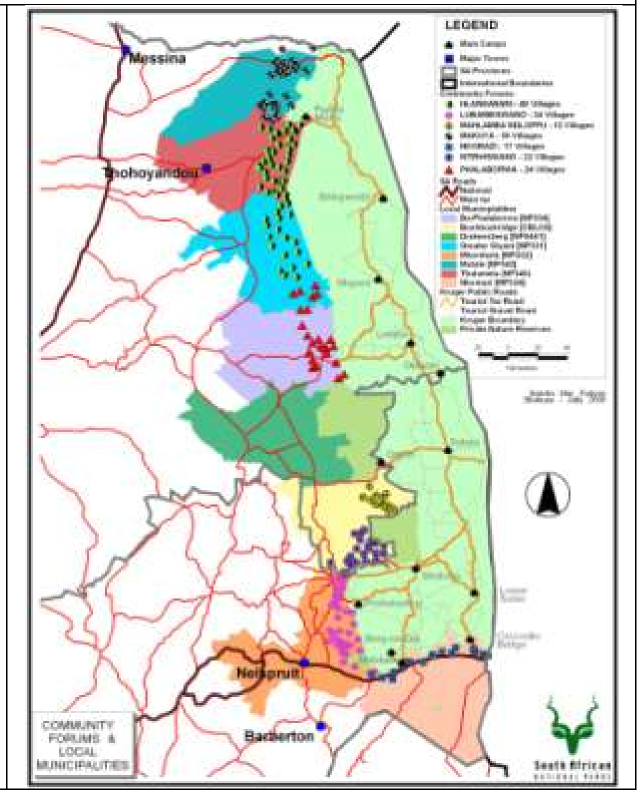
The scale of Kruger as well as ecological realities makes it unrealistic to comply with the fence requirements of the Norms and Standards that tent to pertain to small reserves specifically in South Africa.

Map 1. Kruger National Park and its neighbours[23].

[23] Extracted from SANParks 2008.

Map 2 & 3. Classification of neighbours associated with Kruger National Park as well as community forums and local authorities[24].





2.2 Characteristics of Kruger National Park[25]

Kruger lie in the low-lying savannas of north-eastern South Africa, with elevations from about 250 m to a small section over 800 m. Kruger's climate is tropical to subtropical with high mean summer temperatures and mild, generally frost-free winters. Rainfall, delivered mostly through convective thunderstorms, is concentrated between October and April. A rainfall gradient stretches from an annual mean of about 750 mm in the south-west, to 350 mm in the north, although strong inter-annual and roughly decadal cyclic variations exist, with drought considered endemic.

The basic geological template comprises a western granitic half, characterised by distinctive catenas, and an eastern clayey basaltic and rhyolitic half, with some important smaller intrusive, sedimentary or recent sandy zones. The extreme north of Kruger is unique due to its diverse assemblage of rock formations. Seven major perennial or seasonal rivers cross the park, and especially the western half of the park's terrestrial landscape is heavily dissected by drainage channels on undulating land. Kruger's patterns of geology, soil, fire and rainfall, and its convergence zones are regional to local factors which are emphasized in the *vital attributes* section below.

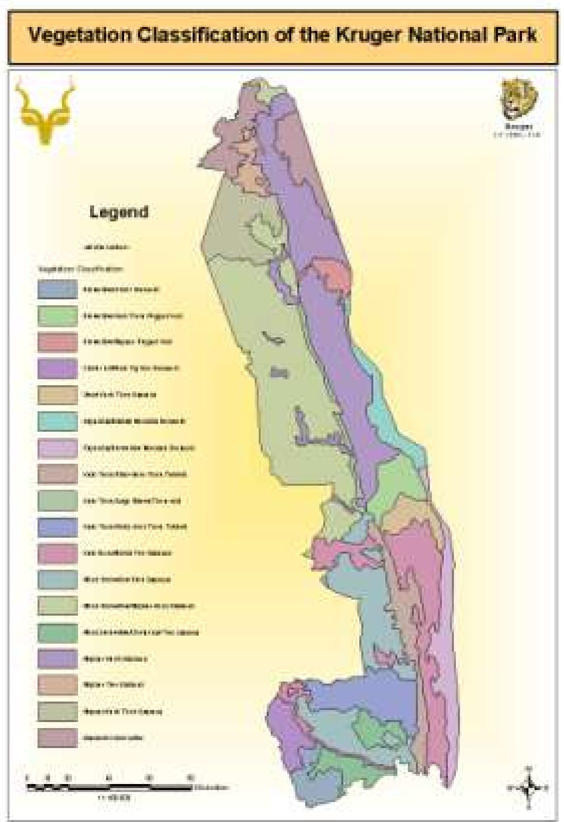
Numerous classification systems exist to divide the park into various vegetation, physiographic and natural history zones, and composites of these. There are close on 2000 plant species in the park, including about 400 trees and shrubs, and 220 grasses. At a very coarse level, the vegetation can be considered as falling into one of three

[24] Extracted from SANParks 2008.
[25] Extracted from SANParks, 2008.

zones. A lower nutrient, higher rainfall well-wooded area occurs in the southwest and important trees are bushwillows (*Combretum* species, especially *C. apiculatum*), knobthorn (*Acacia nigrescens*), tamboti (*Spirostachys africana*) and marula (*Sclerocarya birrea*). The southeast lies on basalts with palatable productive grasslands and some trees such as knobthorn, marula and leadwood (*Combretum imberbe*). The northern half of the park is, broadly speaking, dominated by mopane (*Colophospermum mopane*) with more fertile open grasslands on the eastern basaltic half, and more undulating landscapes with woodlands including bushwillow trees (*Combretum* spp) in the north-western quadrant (Map 4). Fauna is very diverse, with about 150 species of mammals (Table 2 provide estimates of selected mammal species), including many large charismatic predator and grazing species, roughly 50 fish, just over 500 bird, 34 amphibian and 116 reptile species. In addition, there are about 375 alien species, mostly plants, although mostly with restricted distributions and densities.

Many of these are captured in species of special concern lower level plans of Kruger National Park with specific conservation issues, with key species in Kruger being black rhino, wild dog, pepper bark tree, wild ginger and Swazi impala lily. A justification framework helps prioritize these and other species which also require action, and trade this off against the modern need for overall ecosystem conservation.

Map 4. Vegetation of Kruger National Park[26].



[26] Extracted from SANParks 2008.

Table 2. Estimates for animal abundances in Kruger National Park. We provide 95% CI ranges where available and indicate the method, 5-year trend and year of last estimate[27]. nc – not counted. Methods: r – registration studies, b – block counts, d – transects using distance sampling, t – total counts, g – guestimate usually from ranger experience, p – photographic mark-recapture, c – call-up surveys, s – sample surveys using fixed width transects. Trends: u – unknown, i – increase, d – decrease, 0 – non-directional. We round values larger than 10 to the nearest 5, and larger than 50 to the nearest 10. * - indicate species for which reported techniques are not ideal.

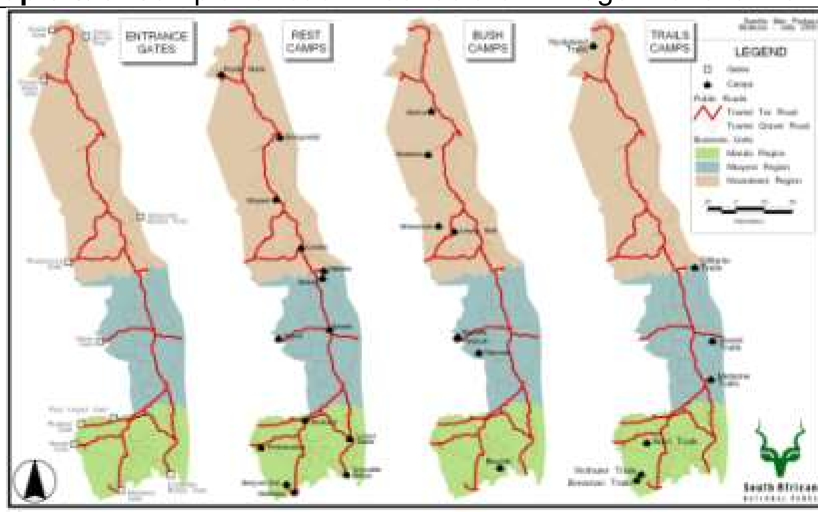
Species	Estimate	Species	Estimate
Aardwolf*	nc	Leopard	1000 g,u,2009
Baboon*	nc	Lichtenstein Hartebeest	50 g,u,2009
Bat-eared fox*	nc	Lion	1620-1750 c,0,2006
Black rhinoceros	590-670 b,i,2009	Mountain reedbuck	150 g,u,2009
Blue wildebeest	6400-13100 d,0,2010	Nyala	300 g,u,2009
Buffalo	37130 t,i,2010	Ostrich	nc
Burchell's zebra	23700-35300 d,i,2010	Porcupine*	nc
Bushbuck*	500 g,u,2009	Reedbuck	300 g,u,2009
Bushpig*	nc	Red Hartebeest	-
Cheetah	120 p,u,2009	Roan antelope	90 g,u,2009
Common Duiker*	nc	Sable antelope	290 g,u,2009
Crocodile	4420 t,i,2009	Sheep	-
Eland	460 g,u,2009	Spotted hyena	2000-5340 c,u,2008
Elephant	13750 t,i,2010	Steenbok*	nc
Gemsbok	-	Tsessebe	220 g,u,2009
Giraffe	6800-10300 d,I,2010	Vervet monkey*	nc
Goats	-	Vultures*	nc
Greater kudu	11200-17300 d,0,2010	Warthog	3100-5700 d,0,2010
Hippopotamus	3100 t,u,2008	Waterbuck	3100-7800 d,0,2010
Impala	132300-176400 d,i,2010	White rhinoceros	8700-12700 s,i,2010
Jackal*	nc	Wild dog	120 p,u,2009
Klipspringer*	nc	Nc	nc
Kori bustard*	nc	Nc	nc

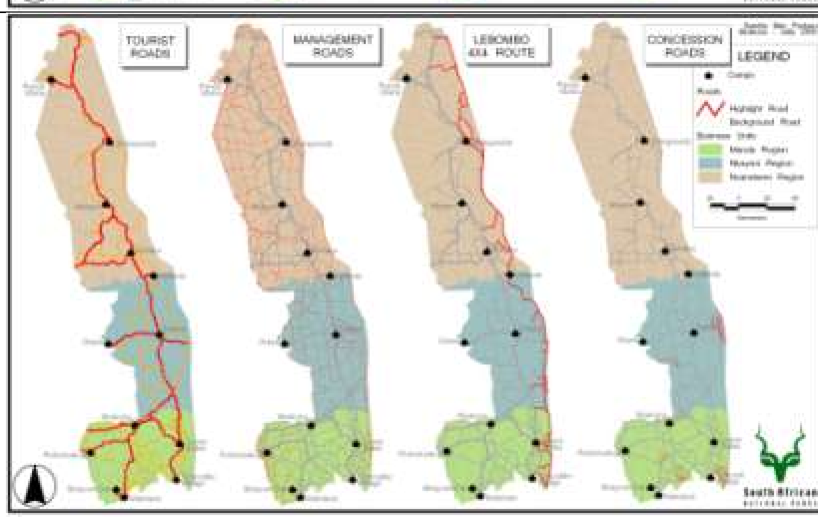
Kruger acts as a *de facto* hub of economic, especially tourism, development in the lowveld region (Maps 5 & 6). The Kruger National Park offers a variety of tourist accommodation and currently has 12 main rest camps, five bushveld camps, two bush lodges and four satellite camps; a total of more than 4 500 beds. There are also seven luxury lodges that have been granted concessions. It is one of the world's most popular

[27] SANParks 2011

public entry game parks and receives in excess of 1 million visitors per year. Malaria has a potentially negative impact on tourism, but is currently under tight control. The KNP provides some employment opportunities, a market outlet, and source of business custom for local communities, and stakeholder meetings in these communities always voice the desire to share structures (such as marketing channels), decision-making, and benefits. Adjacent land uses impact in various ways on the KNP and have to be incorporated in management considerations. Even though relationships between the park and immediate neighbours have been improving since 1994 there is still need to continuously discuss contentious issues and work towards a common purpose. Land claims may threaten management block sizes and/or management options within the park. Provincial borders and the limited jurisdiction of SANParks outside Kruger affects the efficiency with which management options can be exercised. Damage causing animals, employment issues and insufficient interaction affect neighbour-relations and require special attention.

Map 5 & 6. Camp and road infrastructure in Kruger National Park.[28]





[28] Extracted from SANParks 2008.

2.3 Vital attributes[29]

The above illustrate that Kruger National Park comprises state-owned property and contractual land owned by local communities. It is located in the north eastern part of South Africa and is the largest National Park at over 19 000 km^2. Zimbabwean rural land abuts Kruger in the north while the Limpopo National Park in Mozambique abuts the park in the north-east. In the south-east a mixture of rural and ecotourism land-uses in Mozambique are found next to Kruger. South of Kruger commercial sugarcane farms are the dominant land use, while the western boundary has a mixture of rural and ecotourism land-uses.

Kruger is a semi-arid savanna, underpinned by extensive variations in geology and climate. This promotes spatial heterogeneity and biodiversity reflected in 37 different landscape types that comprise the park. Multiple rivers, perennial, seasonal and small streams, cross Kruger primarily in a west-east direction. The Sabie and Crocodile Rivers are the most diverse in South Africa. Biological diversity is high and several species have Kruger as a stronghold in South Africa. Kruger is home to major cultural resources of societal interest and contains significant wilderness areas that are roadless.

Even though five different language communities abut Kruger, many forms of adjacent land-use promote biodiversity conservation and prevent Kruger from being an island. However, the surrounding landscape does also include a mosaic of less conservation-friendly activities. While the matrix of Kruger and its surrounds is complex, the biota, ecological processes and cultural heritage sites are mostly intact.

Kruger's early management history went from exploitative (carnivores were removed to enhance hunting game numbers) to command-and-control when conservationists embraced the balance of nature paradigm and tried to keep systems stable. The balance of nature paradigm was replaced by the flux of nature paradigm when conservationists realized that spatial and temporal heterogeneity enhance biodiversity which in turn enhance resilience of the socio-ecological system which modern day conservation practice has embraced. Under this last paradigm, Kruger's current management philosophy is one of strategic adaptive management focusing on learning-by-doing.

Kruger does not function ecologically, economically or socially in isolation from the region. It is a focal point of the Greater-Limpopo Transfrontier Conservation Area, is the hub of tourism in the Lowveld and a magnet for foreign exchange. To support such demands, Kruger has a well-developed infrastructure, human capacity and a long history of research and management. This is recorded in well-designed databases which provide insight and the foundation of management decisions.

The park is protected by strong national legislation and carries widespread national and international sentiment. This ensures strong political support and assurance of the long-term survival of Kruger.

2.4 Kruger National Park Management objectives

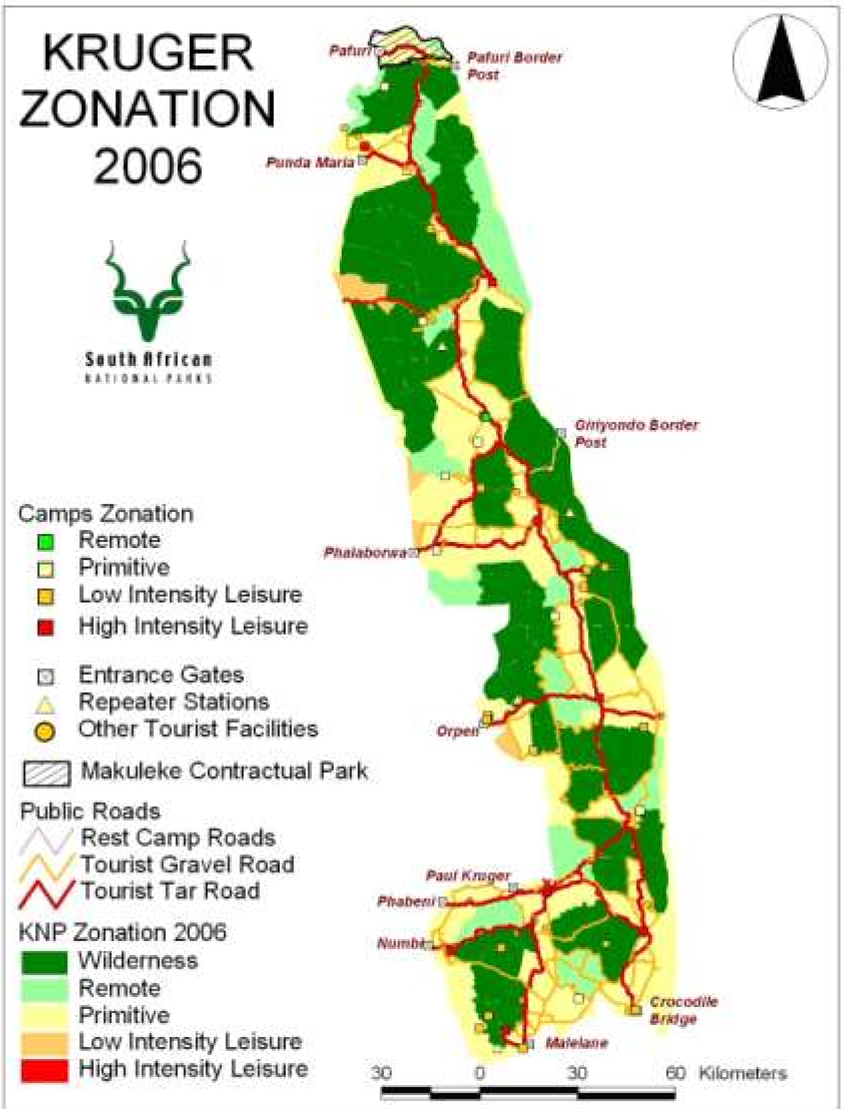
The summarized key attributes outlined above direct the desired state and park management objectives, which are explicitly articulated to overcome threats to and ensure persistence of vital attributes[30]. Kruger is not isolated from private and public conservation land to the west and some parts of the fence between Kruger and the Limpopo National Park have been dropped. This is reflected in objectives leaning towards large-scale ecosystem functioning and a variety of people and stakeholder

[29] SANParks 2008
[30] SANParks 2008

objectives promoting human benefits and constituency building to achieve the desired state (see Box 3, Map 7). Elephants are a key system driver that may affect achieving these objectives on ecological, tourism as well as social fronts. Following SANParks' strategic directive in Section 1, elephant management objectives will focus on managing the cause of elephant interactions and effects on biological and stakeholder objectives.

Several actions that may be associated with elephant management make use of actions for other programs specified by the Kruger National Park Management Plan (see below), or contribute to actions required by other programs within the Kruger National Park Management Plan. This Elephant Management Plan is thus a logical extension of the overall Park Management Plan.

Map 7. Zonation of Kruger National Park[31].



[31] Extracted from SANParks 2008.

Box 3a. High level Objectives of Kruger National Park[32]

KNP Mission

In keeping with the SANParks mission, to maintain biodiversity in all its natural facets and fluxes, to provide human benefits and build a strong constituency and to preserve as far as possible the wilderness qualities and cultural resources associated with the Park

* see footnotes to this mission statement in section 1.1.1

Biodiversity and Ecosystem Objectives

To understand and manage the KNP as part of the lowveld savanna and its river catchment areas in such a manner as to conserve and restore its varied natural structure, function and composition over time and space, and its wilderness qualities, through an approach integrating the different scales and types of objectives.

Integrating Objectives

(= sustainable utilisation if defined broadly and holistically, e.g. Child report)

To develop a thorough understanding of the integrated socio-ecological system (SES), especially in the regional context, for maintenance of a resilient SES and to balance human activities and development inside and around the KNP with the need to conserve ecosystem integrity and wilderness qualities by agreeing on a desired[1] set of future conditions, and by developing an adequate suite of principles and tools.

[1]These are (a) necessarily environmentally fluctuating and (b) realistic but aspirational

People Objectives

To provide human benefits and build a strong constituency, preserving as far as possible the wilderness qualities and cultural resources associated with the KNP.

Enabling Objectives

To provide cross-cutting support services which enable KNP to achieve the line function biodiversity and people objectives, and balance these effectively.

NB : must be cross-linked with and is subject to growth depending on further demands from the other three objectives.

Biodiversity and Ecosystem Objective

To understand and manage the KNP as part of the lowveld savanna and its river catchment areas in such a manner as to conserve and restore its varied natural structure, function and composition over time and space, and its wilderness qualities, through an approach integrating the different scales and types of objectives.

Atmospheric Effects

To understand the major effects of climate (esp. rainfall) in influencing biodiversity, and therefore if, when and how to take management decisions (including the no-action decision) with this clearer context.

Water in the Landscape

To develop an integrated understanding of non-terrestrial ecosystem diversity and dynamics (including sub-surface water) and it's links with terrestrial systems, and to maintain the intrinsic biodiversity as an integral component of the landscape and maintain or where necessary restore or simulate natural structure, function, composition and processes.

Terrestrial Ecosystem

To develop an integrated understanding of ecosystem diversity and dynamics, and where necessary intervene with appropriate strategies, in order to conserve and restore terrestrial biodiversity and natural processes.

Alien Impact

To anticipate, prevent entry and where possible control invasive alien species, in an effort to minimise the impact on, and maintain the integrity of indigenous biodiversity.

Threatened Biota

To prevent extinction within the Kruger Park of any species on the IUCN's global critically endangered or endangered lists, and to work with other conservation initiatives to secure and strengthen the future of such species over their historic distribution ranges. To put in place appropriate monitoring and conservation efforts of other threatened species or lower taxonomic division, including considering recommendations of experts of invertebrate taxa for which no formal red-listing has been done, according to a realistic framework. Except in crucial instances for the survival of globally critically endangered species, management for system integrity and biodiversity must take precedence over species management.

[32] SANParks 2008

Box 3b. Objectives of Kruger National Park continued[33]

Integrating Objectives

(= sustainable utilisation if defined broadly and holistically, e.g. Child report)

To develop a thorough understanding of the integrated socio-ecological system (SES), especially in the regional context, for maintenance of a resilient SES and to balance human activities and development inside and around the KNP with the need to conserve ecosystem integrity and wilderness qualities by agreeing on a desired[1] set of future conditions, and by developing an adequate suite of principles and tools. [1]These are (a) necessarily environmentally fluctuating and (b) realistic but aspirational

Strategic Adaptive Management Objective

To reach or stay within the desired conditions agreed upon, KNP will adopt a strategic adaptive management approach. The strategic component will keep the longer view in focus, while the adaptive components will strive to ensure continual feedback at various levels in a spirit of continuing learning, fine-tuning and adjustment.

Balanced Development and Biodiversity Planning Objective

Appreciation and Inculcation of VSTEEP Framework Objective

To understand the reciprocal effects between those major realities and forces over which we have little, or at this stage only indirect, control, and biodiversity outcomes, and to influence, or adapt to, these where possible.

Environmentally Responsible Practices Objective (green living ethic and compliance)

To promote environmental best practice within and around the KNP.

Alignment of Business Operations and Plans Objective

To align the KNP's business plans and operations (including staff KPAs) with key biodiversity and people objectives with the major emphasis on maintaining the balance between these.

People Objectives

To provide human benefits and build a strong constituency, preserving as far as possible the wilderness qualities and cultural resources associated with the Kruger National Park.

Tourism Objective

To develop, manage and enhance a range of sustainable tourism products in synergy with the KNP conservation ethic. This will be done by satisfying evolving market needs, through predictable service excellence, high quality standards and infrastructure. Sound business principles will be used to generate revenue from the tourism initiative to support the SANParks conservation mandate.

Wilderness Resource Objective

To protect, maintain and where possible restore wilderness within the KNP through defined management of wilderness zones aimed at preserving the intrinsic values and benefits this scarce resource offers current and future generations.

Direct Human Benefits Objective

To provide benefits, particularly in the sense of 'benefits beyond boundaries', to meet or exceed reasonable expectations and foster partnerships, in a spirit of equity redress.

Constituency Building Objective

To build an effective constituency at all levels in SA and abroad, which fosters and enhances sustainable public support for SANParks' objectives and actions, and for the conservation cause in general.

Cultural Heritage Objective

To preserve, and wherever possible utilise, for human enrichment cultural resources* associated with KNP while complying with and effectively using relevant national, provincial and local legislation and procedures. *see Galla figure overleaf xref: tourism, education, community relations

Rehabilitation[34] forms an integral part of Kruger's conservation strategy to minimize man-induced impacts that detract from or threaten the biodiversity and cultural heritage resources of the park. Although localized to a certain extent, past management interventions and developments had negative impacts on ecological processes, "sense

[33] SANParks 2008

[34] Extracted from SANParks 2008.

of place" and wilderness qualities within the park and these must be mitigated or rehabilitated to an acceptable level. These include the closure, removal and rehabilitation of certain artificial water sources such as dams, reservoirs and drinking troughs, the closure and rehabilitation of disused management roads, the removal and rehabilitation of redundant structures (if not protected under SAHRA) and the rehabilitation of all man-induced erosion and other disturbed sites such as disused gravel pits. The rehabilitation plan aims to:

- identify redundant structures and impacted sites within the park which require removal and/or rehabilitation in order to restore wilderness qualities and 'sense of place' and also to improve ecosystem functioning;
- prioritise rehabilitation goals with highest priority given to wilderness zones and areas bordering on those zones;
- determine the rehabilitation needs for the next five years with associated timeframes and projected funding requirements;
- identify associated research and monitoring needs;
- highlight potential risks or threats.

The most immediate need is the removal and rehabilitation of redundant manmade structures. Priority attention must be given to the removal of these structures from the wilderness areas of the park if they are not protected by SAHRA. Kruger management must therefore commit to a structured and integrated rehabilitation approach if the legal designation of these areas is to be achieved.

Firebreak and management roads to be closed and rehabilitated have been identified and those within wilderness areas prioritised. Current erosion problems in Kruger are mainly associated with incorrect alignment of firebreaks and management roads through sensitive soils and seep lines. Another source of man-induced erosion occurs around artificial water sources such as dams and windmills where excessive trampling and the unnatural channeling of water results in ongoing erosion problems. Approval for the systematic closure and removal of certain dams and windmills were granted by the SANParks Board following proposals stemming from the 1997 Kruger Management Plan revision. Numerous windmills were subsequently closed and a number of dams were breached and rehabilitated. Unfortunately most of the closed windmills and associated structures were never removed or the sites properly rehabilitated. A number of earthen and concrete dams remain operational and need to be removed and the sites rehabilitated as soon as possible. The Working for Wetlands programme achieved good results though in the removal of some dams and helped restore hydrological flows along the Levuvhu floodplain and is a good example of an approach to follow in future.

Fire management must satisfy the Park's ecosystem objectives, which stress heterogeneity over space and time. The current intended lightning-driven system meant to achieve this, but proved to be dominated instead by fires caused by illegal immigrants. This led to revision that focuses on various fire zones (Map 8) and specific targets and actions for each (Table 3).

Water provisioning aims to restore the natural availability and variation in availability across Kruger. The requires several boreholes to be closed and earthen dams to be removed and rehabilitated (Map 9) which will span a period of 15 years.

Map 8. Fire management zones in Kruger National Park[35].

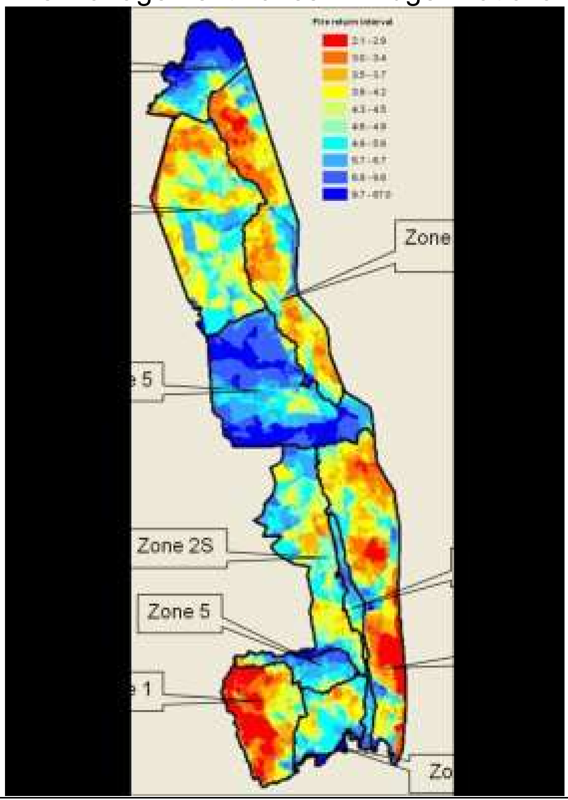
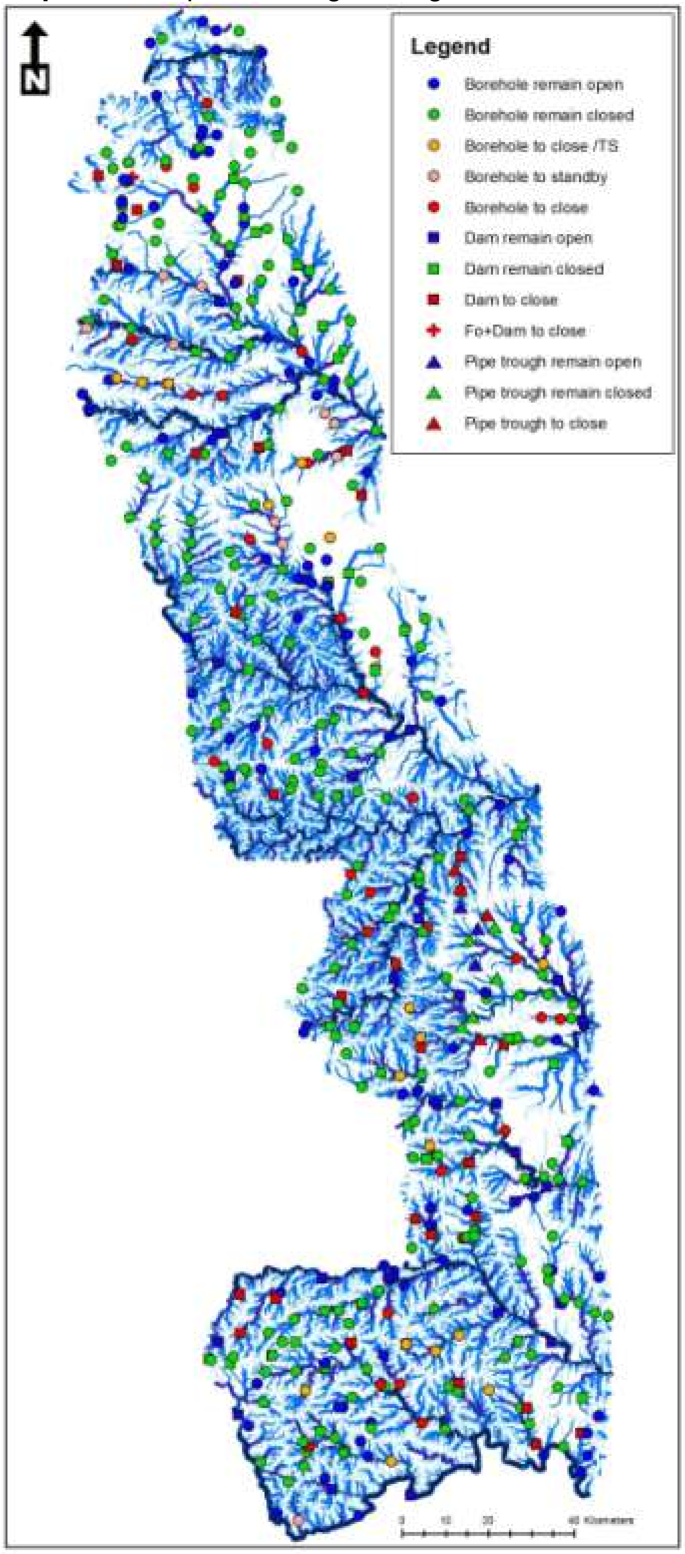


Table 3. Fire management zones and approaches for Kruger National Park[36].

Zone	Description	Objective	Management approach
1	High rainfall granitic sourveld area in south-west of KNP	Encourage tall tree open sourveld woodland with improved grazing quality	Frequent management fires, with planned-and-controlled high intensity fires from time to time at preselected locations
2S	Southern and central granitic KNP (non-mopane granites)	Reduce woody encroachment in open grassy areas (e.g. mid and footslopes), allowing landscape heterogeneity to create tall tree refugia and tall tree recruitment zones	Management fires at discretion of managers (e.g. can put in cooler early season patch burns on crests to create fire "safe" zones in anticipation of larger and higher intensity fires on grassy mid-and footslopes later in season)
2N	Northern granitic KNP (mopane granites)	Reduce woody encroachment in open grassy areas (eg. mid and foot slopes). Tailored for low-rainfall mopane veld	Management fire at rangers discretion. Early season patch fire on crests to create safe zones. Larger high intensity fires on foot & mid slopes Tailored for low-rainfall mopane veld
3S	Southern and central basaltic KNP	High quality grazing (sweetveld); open savanna. Increase herbivory and reduce fire frequency & intensity	Reduce fire frequency and intensity. Act. 1- Eastern boundary firebreak Act. 2 – Reduce the late season management fires Act. 3- Increase early season fire
3N	Northern basaltic KNP	High quality grazing (sweetveld); open savanna. Increase herbivory and reduce fire frequency & intensity Tailored for low-rainfall mopane veld	Reduce fire frequency and intensity. Act. 1- Eastern boundary firebreak Act. 2 – Reduce the late season management fires Act. 3- Increase early season fires
4	Southern ecca shale landscape between granites and basalts	Area to act as natural fire barrier between granitic and basaltic zones (fire barrier between zones 2S and 3S)	No management fires to be started in this zone Whatever fires (management or otherwise) coming into this zone can be condoned
5	Olifants/Letaba, Levuvhu/Limpopo, Sabi and Crocodile River Valley	Fire naturally not a regular process in this zone	No management fires to be started in this zone Whatever fires (management or otherwise) coming into this zone can be condoned

[35] Provided by Navashni Govender, SANParks, Skukuza, South Africa.
[36] Provided by Navashni Govender, SANParks, Skukuza, South Africa.

Map 9. Water provisioning in Kruger National Park[37].



[37] Provided by Sandra MacFadyen, SANParks, Skukuza, South Africa.

Population management of other species[38] follow a flux paradigm that seeks heterogeneity across space and time that favors biodiversity and ecosystem resilience. As such, not all landscapes have the same densities as is anticipated by traditional carrying capacity approaches. Carrying capacity approaches is embedded in productionists views aimed at maximizing population growth based on the amount of herbage produced, proportion of that consumed and the efficiency of conversion to animal abundance or biomass. The application to conservation required apportioning herbage produced to different species based on a subjectively chosen benchmark of what large mammalian herbivore community composition may be. Virtually all criteria reflect opinion and is not based on robust data. In addition, the apportioning of grazing components to a species is subjective and arbitrarily adjusted depending on apparent overestimation of grazing capacity. Grazing capacity is furthermore subjectively converted to a stocking unit with an intuitive proportional make-up of a herbivore community.

Carrying capacity approaches to conservation also ignores ecological complexity as several factors are additional drivers determining ecosystem integrity so that a generalized succession sequence, the basis of rangeland management, is not true. Species do not respond consistently to grazing, and often several alternative states may be possible at a specific locality. Proponents of the use of carrying capacity in a conservation environment have introduced a concept of “rain use efficiency” to adapt stocking rates to local conditions usually defined as the local specific mean annual rainfall. Stocking rates derived from carrying capacity models thus predict stability at an abundance derived from regional grazing and browsing capacities adapted to local mean annual rainfall. It essentially forces dynamics across inappropriate scales that may have consequences for the maintenance of biological diversity and thus contrast the achievement of key mandates assigned to conservation agencies.

Much of the desire to make use of the carrying capacity approach to conservation stems from restrictions on the landscape imposed by history. For instance, traditional landscape interventions interferes with vital rates and fall into three categories: 1) those that affect dispersal such as fences and water provision; 2) those that affect survival such as culling and removals and water provision; and 3) those that affect fecundity such as contraception and culling that reduced densities. Conservationists can address such effects of historical legacies by restoring spatial and temporal limitations and/or mimicking the effects of spatial and temporal limitations when restoration is constrained for several reasons. This reflects a paradigm of the flux of nature which upholds that heterogeneity enhances diversity which enhance resilience. Mimicking ecological effects when landscape intervention imposition cannot be restored thus need to reflect heterogeneity to fully support conservationists key mandates. Large mammal management is thus embedded in the flux paradigm and as such in Kruger allow populations to evolve and develop as near natural as possible.

2.5 Elephant management in Kruger

Expectations around the outcomes of elephant management approaches in Kruger have changed over time, particularly in recent years. The section below provides a brief overview of the history of elephant management and how elephants, other biological values and people responded to various management approaches.

[38] Extracted from Ferreira & Hofmeyr 2011.

2.5.1 The history of elephant management[39]

Elephant management was preservationist from the onset of the Park up to the 1960s. In the late 1960s intensive management of elephant numbers followed under the premises that 1) intra-specific competition between elephants precludes population growth, 2) elephants compete with other species, 3) the western fence created an artificial system within which managers could not allow elephant numbers to increase, and 4) disturbance through culling would reduce elephant excursions along the Crocodile River.

The premises were embedded in rangeland ecology and management[40] with defined stocking rates based on those at which elephants disperse automatically, and decisions on removal numbers based on predicted vegetation damage at waterholes and dams[41]. Decisions were often constrained by contrasting ecological and tourism demands. The command-and-control policy persisted for 30 years in the face of scientific development, strong animal rights movements and changes in societal expectations. In 1994 SANParks placed a moratorium on elephant culling[42]. Translocations were ongoing which developed during the late 1980s and early 1990s[43].

In the 1990s SANParks adopted an adaptive management approach and redefined the Kruger National Park management objectives through an extensive consultation process[44]. The new approach set Thresholds of Potential Concern[45] as triggers for decision-making and shifted management from using numbers to environmental indicators. However, the primary trigger in the revised elephant management approach of 1997 still focused on numbers, allowing variation in elephant densities in six different zones across Kruger to learn about ecosystem responses[46]. The 1997 policy proposed to control fluctuations in certain areas through both culling and translocation, but encountered opposition in the form of ecological thinking, animal rights and societal values in spite of a broad consultative process in 2004 through the Elephant Indaba and the Luiperdskloof scientific meeting in 2005.

Political and public pressure prompted the Minister of Environment and Tourism Affairs to convene a Science Round Table who advised that there is no need for the immediate and large scale reduction of elephant numbers in Kruger. The advice affected all landowners with elephants in South Africa which the Scientific Round Table acknowledged by suggesting that in some instances elephant density, distribution and population structure may need to be managed to achieve biodiversity and other objectives[47]. An external peer-reviewed scientific assessment of elephant management[48] followed and was published in early 2009. At the same time the Minister embarked on an extensive consultation process and produced the Elephant Management Norms and Standards[49] in 2008. These explicitly recognized the management of elephant impact, conflict and effects on stakeholders rather than elephants, but needing to do so differently at different places and at different times.

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[39] Caruthers *et al.* 2009
[40] Westoby *et al.* 1989
[41] van Wyk & Fairall 1969
[42] Carruthers *et al.* 2009
[43] Grobler *et al.* 2009
[44] Rogers 2003, Venter *et al.* 2008
[45] Biggs & Rogers 2003
[46] Whyte *et al.* 1999
[47] Owen-Smith *et al.* 2006
[48] Scholes & Mennell 2009
[49] DEAT 2008

SANParks embraced the evolution of ecological thinking in the revised Kruger National Park Management Plan[50] and removed the precautionary principle as the basis for management and integrated all terrestrial concerns, including elephants, into a single objectives hierarchy. This facilitates the development of a process-based approach to elephant management focusing on dealing with causes and mechanisms of elephant effects, rather than purely on symptoms and reactive means of minimizing impacts, conflicts and stakeholder interactions. This is in line with recent development in ecological thinking[51].

Elephant management decisions originated from different sources. Decisions up to the early 1990s were internally park-based and had little input from the SANParks Board or the public. In the mid 1990s the Board had a major role with assistance from external scientists and animal welfare groups. From the late 1990s to early 2000s, the Board rarely influenced decisions which were driven by an internal joint management and scientist team with some input from external scientists and neighbouring communities. In recent years external scientists played a significant role in influencing decisions made by SANParks. This management plan accommodates the historical legacies and structures of decision-making with regards to managing elephant impacts in Kruger.

2.5.2 Historical trends

Kruger was void of elephants in 1900 due to extensive hunting, most of which supported the ivory trade in the 1700s and 1800s[52]. The first elephant was noticed in 1905 close to the Olifants and Letaba Rivers' confluence[53]. The re-colonization and spread of elephants resulted in most of present day Kruger occupied by elephants by 1958 (Box 4). Elephant numbers increased over several eras of management actions (Box 5). During 2008 for instance, helicopter counts estimated 12 930 elephants in Kruger[54].

Kruger was for a large part since its origin closed from surrounding areas through fences. Fences erected from 1973 to 1977 isolated Kruger from adjoining areas until the removal of some fences in the 1990s[55]. A few experiments evaluated birth control for elephants[56], but this was not conducted at a large scale.

The first concerns of elephant impact were in 1959 when stands of aloes disappeared in the Doispane area. In the late 1960s it was suggested that elephant utlilization was low to moderate and accentuated during the dry season[57]. Subjectively assigned elephant damage to marula and knobthorn trees became apparent in the late 1970s[58]. By 1974, the number of mature trees declined to 6.4% of densities in 1944 in the Satara region[59]. Elephants apparently use marula and knobthorn trees selectively based on subjectively assigned criteria of elephant damage[60].

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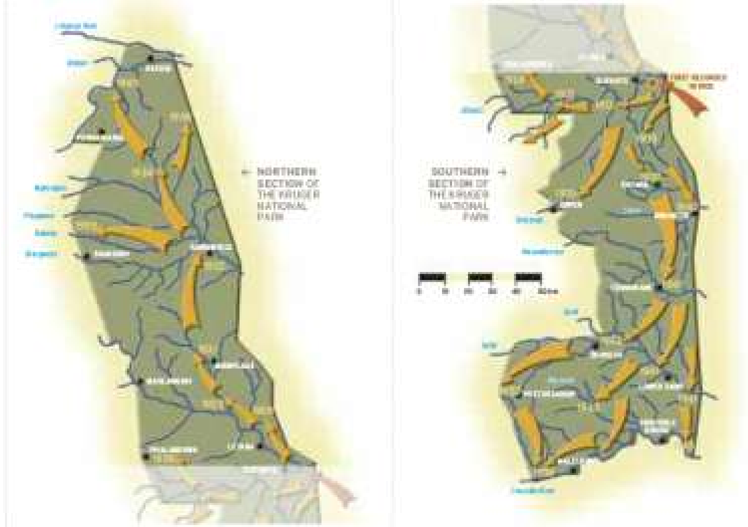
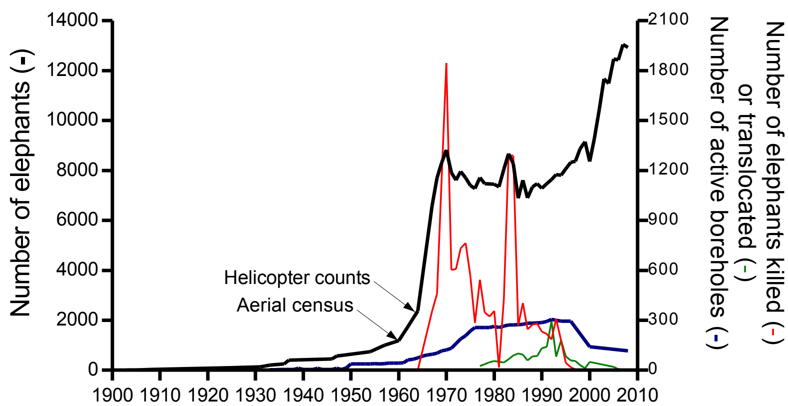
[50] SANParks 2008
[51] Bulte *et al.* 2004, van Aarde *et al.* 2006, van Aarde & Jackson 2007
[52] Hall-Martin 1992
[53] Whyte 2001
[54] Data provided by Cathy Greaver, Regional Ecologist, SANParks, Skukuza, South Africa
[55] Grant *et al.* 2009
[56] Whyte *et al.* 1998, Fayer-Hosken *et al.* 2000, Pimm & van Aarde 2001
[57] van Wyk & Fairall 1969
[58] Coetzee *et al.* 1979, Engelbrecht 1979
[59] Viljoen 1988
[60] Shannon *et al.* 2008

Box 4. Elephant colonization patterns in Kruger between 1903 and 1958[61]



The first elephants in Kruger were recorded in 1905 near the Olifants River Gorge. Ranger records allowed researchers to track the colonization. Elephants colonized Kruger and were present in the north by 1945 and in the south by 1958.

Box 5. Historic trends in elephant numbers in Kruger[62]



Elephant numbers increased slowly during the early part of the 20th century (black line). During the culling period numbers remained relatively stable. After culling, elephant numbers increased, but the rate of increase within Kruger has reduced in recent years. The first boreholes were opened in 1933 with a peak of 306 boreholes in 1993. Intense borehole closure started in 1998 and by 2008 there were 114 active boreholes left in the Park (blue line). Culling started in 1967 and continued to 1994 (red line). The first elephant translocations were in 1977 (green line). The first aerial survey was in 1960. Prior to that numbers were based on guesses. Helicopter counts started in 1964.

Aerial photos showed that woody cover increased by 12% on granite soils, but declined by 64% on basalts, primarily because of a 38% decline in trees larger than 5m in height[63]. These observations suggest that patterns of vegetation change were not consistent through landscapes. Generally it appears that increased mortality of large trees, assumed to be a result of elephant interactions, and declining recruitment

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[61] Adapted from Whyte 2001
[62] Data extracted from Whyte 2001 and the SANParks database – Database Manager Judith Kruger, SANParks, Skukuza, South Africa
[63] Eckhardt *et al.* 2000

assumed to be caused by fire may be the drivers of such change. The suggestion is in line with results elsewhere on the interactions between fire and elephants as drivers of change in savanna systems[64].

Incidences of damage caused by elephants in areas abutting Kruger in South Africa varied between the northern and southern regions of the Park. Records are vague prior to 2000. A total of six humans lost their lives from 2000 to 2005 (5 people that lived in villages abutting Kruger and 1 field ranger while on patrol)[65]. In the same period the Limpopo Department of Environmental Affairs killed 75 elephants associated with fence breakages and damage to property in the areas abutting Kruger National Park north of the Olifants River[66]. Mpumalanga Province Tourism and Parks Agency also killed and unknown number of elephants south of the Olifants River in recent years.

Recent records of damage-causing animals are well noted for the Limpopo Province in the areas abutting Kruger north of the Olifants River. Since 2005, elephants comprised 29% of the damage-causing animals noted. However, absolute incidences as well as the relative contribution of elephants to damage-causing animals declined (Table 1). Only 8% of the incidences in 2008 were associated with elephants. Incidences of lion are increasing and it is speculated that this may be associated with water closures over time. The drivers of such lion interaction is the focus of an ongoing study in the north-western part of Kruger.

Table 1. Summary of the recent instances of damage causing animals in the areas abutting Kruger north of the Olifants River in South Africa[67].

	Lion	Elephant	Hippo	Crocodile	Snake	Leopard	Hyena	Rhino	Buffalo
2005	10	55	16	6	9	2	2	2	11
2006	10	26	11	4	10	0	0	1	27
2007	18	10	3	3	0	1	3	0	8
2008	34	8	18	8	2	0	0	0	29
Total	**72**	**99**	**48**	**21**	**21**	**3**	**5**	**3**	**75**

Although there are no formal records of tourist sightings of elephants, in recent times, elephant sightings by tourists are a common daily occurrence. There is some perception that elephants are now more aggressive and that tourists experience elephant charges more often than before. Other perceptions are that breeding herds are currently more docile with tourists viewing breeding herds at close range that are quite calm. Previously breeding herds were usually skittish of vehicles. No data is available to evaluate these perceptions and the drivers of such patterns, if present, may be complex.

2.5.3 The response to elephant management

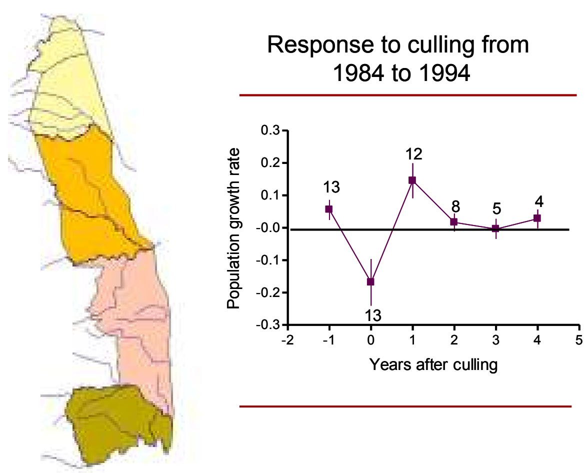
The long history of elephant management in Kruger has provided some lessons and gives guidelines to how future management actions may affect elephants and impacts they have on other conservation values. Summarized below are the responses by elephants; how ecological impact was affected by management actions; the effects of actions on minimizing damage-causing incidences, disease outbreaks and human conflict; and how management actions influenced tourism experiences. Information on responses by elephants are most extensive and reflect numerical (*i.e.* changes in

[64] Sankaran *et al.* 2005, Sankaran *et al.* 2008
[65] Data provided by Freek Venter, SANParks, Skukuza, South Africa
[66] Data provided by Sam Mashele, Department of Environmental Affairs, Limpopo Province, South Africa
[67] Data provided by Sam Mashele, Department of Environmental Affairs, Limpopo Province, South Africa

abundance), demographic (*i.e.* changes in vital rates such as birth and death rates) and spatial responses (*i.e.* changes in distribution). These helped SANParks to learn from historical management actions and developed management objectives and actions for the Kruger Elephant Management Plan spanning 2011 to 2020.

Numerical responses by elephants

The recording of elephant population data as well as records obtained from culled individuals[68] allows evaluation of elephant population responses to management. SANParks defined four regions in Kruger and removed elephants from these on a rotational basis[69]. A specific region had elephants culled (or translocated) once every four years. Elephant population growth rates responded to these interventions on a local scale (Box 6). In the year before culling, elephant populations in regions were growing at 6.5%, but decreasing sharply in the year of culling, followed by excessively high population growth the year following culling[70]. The net result was that at a local scale no changes in elephant numbers took place and over the next three years populations in a region remained relatively stable. If elephant impact is associated with elephant numbers as assumed by several studies[71] then constant impact across the Park was maintained through the continuous removal of elephants. These responses to culling are in line with observations made on removal of elephants in Uganda[72], Zimbabwe[73] and Zambia[74]. It also parallels the observations noted for other species[75].



Box 6. Regional elephant population growth rates relevant to the year of removal (culling and/or removal through translocation) in Kruger[76]. Population growth is the exponential growth rate. The numbers represent sample sizes.

[68] SANParks database – Database Manager Judith Kruger, SANParks, Skukuza, South Africa
[69] Whyte 2001
[70] van Aarde *et al.* 1999
[71] Cumming *et al.* 1997
[72] Laws *et al.* 1975
[73] Cumming & Jones 2005
[74] Hanks 1979
[75] Coltman 2008
[76] Extracted and adapted from van Aarde *et al.* 1999

The numerical responses to water provisioning, fence construction and fire policies are not so clear to evaluate. Four management eras characterize available data from 1967 to 2004 (Table 2).The annual counts allowed observed population growth rates to be calculated for each era. The number of elephants removed each year allowed corrected growth rates to be estimated, while birth and death rates (extracted from specimens and through a rapid population assessment[77] in 2004) allowed predicted population growth rates to be calculated from demographic rates. Predicted growth is not affected by dispersal so that the difference between corrected and observed growth reflects net migration rates (Table 3).

Table 2. Management eras and features from 1967 to 2004[78].

Era	Density	% Killed	% Moved	Fencing	Boreholes	Fire	Rainfall
Onset of culling (1967-1974) (*n*=8)	0.41±0.03 (0.35 to 0.46)	10.2±5.1% (5.4 to 20.9)	-	Open	96-207	Prescribed	534±11 (510 to 605)
Ongoing culling (1975-1984) (*n*=10)	0.41±0.03 (0.38 to 0.46)	7.1±5.0% (0.2 to 15.6)	0.4±0.4% (0.0 to 1.1)	Partial	236-272	Prescribed	516±12 (358 to 591)
End of culling (1985-1994) (*n*=10)	0.39±0.02 (0.36 to 0.41)	3.5±0.9% (2.3 to 5.3)	1.7±0.9% (0.9 to 3.9)	Closed	272-306	Prescribed-Mimic natural	398±13 (144 to 478)
Post culling (1995-2004) (*n*=10)	0.50±0.07 (0.42 to 0.61)	0.1±0.2% (0.0 to 0.6)	0.4±0.4% (0.0 to 1.0)	Partial	141-294	Mimic natural	538±10 (430 to 597)

In the years of culling (killing and some translocation) observed growth rate remained close to zero. During the eras when Kruger was not completely fenced (Onset of Culling and Ongoing Culling Eras) corrected growth (*i.e.* the effect of culling eliminated) exceeded predicted growth suggesting that net movement of elephants was into Kruger. The last two eras had similar corrected and predicted growths when Kruger was predominantly fenced. Fences thus influenced elephant population growth rates through the limitations on elephant movements (see also Table 5 later).

[77] Ferreira & van Aarde 2008

[78] Data extracted from SANParks' databases – Database Manager, Judith Kruger, SANParks, Skukuza, South Africa

Table 3. Observed, corrected and predicted population growth for elephants in Kruger during four different management eras. Values in brackets are the 95% confidence intervals[79].

Era	Observed Growth	Corrected Growth	Predicted Growth
Onset of culling (1967-1974) (*n*=8)	0.65% (0.59 to 0.70)	11.65% (8.01 to 15.29)	0.48% (-1.55 to 2.47)
Ongoing culling (1975-1984) (*n*=10)	1.51% (-2.54 to 5.55)	10.06% (6.19 to 13.92)	2.66% (1.23 to 4.08)
End of culling (1985-1994) (*n*=10)	1.23% (-2.16 to 4.62)	6.46% (6.03 to 6.89)	5.79% (4.24 to 7.32)
Post culling (1995-2004) (*n*=10)	4.04% (-0.39 to 8.47)	4.37% (4.08 to 4.65)	3.91% (-0.31 to 8.10)

Recent fence removals may restore movement patterns previously constrained by fences. The first fence removal was in 1994 between Kruger and some of the private nature reserves to the west of Kruger[80]. Population growth rates on 8 adjacent private properties to the west of Kruger range from -1% to 42% per annum since 1996[81]. Five of eight properties exceed 6%, the theoretical maximum growth that elephant populations can grow annually from births and deaths[82]. The difference reflects movements, a large part of which may come from Kruger.

In addition to allowing movements when fences were removed, managers also provided elephants with opportunities to make choices with regards to landscape features. The properties west of Kruger have much higher densities of boreholes and dams that provide additional water[83]. Movement from Kruger to private properties west of Kruger was most likely accentuated by abundant water availability on these properties when Kruger managers started closing boreholes.

Demographic responses by elephants

The four eras of management through the period of culling and removing provide further insight into how elephant populations responded demographically. Age at first calving, calving intervals and survival differed between eras for elephants living in Kruger (Table 4).

[79] Unpublished results obtained from Sam Ferreira, SANParks, Skukuza, South Africa and Rudi van Aarde, University of Pretoria, Pretoria, South Africa
[80] Whyte 2001
[81] Data extracted from Whyte 2001 and the SANParks database – Database Manager Judith Kruger, SANParks, Skukuza, South Africa
[82] Calef 1988
[83] Mike Peel, Agricultural Research Council, Nelspruit, South Africa

Table 4. Demographic measures (age at first calving, calving interval and survival) measured during four different management eras. The values in brackets are the 95% confidence intervals[84].

	Age at first calving	Calving interval	Survival
Onset of Culling Era	12.4±0.3	4.8±1.1	0.943
(1967-1974)	(11.7-13.0)	(3.7-5.9)	(0.915-0.972)
Ongoing Culling Era	13.0±0.2	4.2±0.8	0.960
(1975-1984)	(12.7-13.3)	(3.6-5.0)	(0.939-0.981)
End of Culling Era	13.1±0.2	3.5±1.0	0.988
(1985-1994)	(12.8-13.5)	(2.5-4.5)	(0.965-0.995)
Post Culling Era	14.1±0.3	3.9±0.3	0.984
(1995-2004)	(13.2-15.0)	(3.6-4.3)	(0.941-0.995)

Comparison of eras highlights demographic responses (Table 5). These suggest that water provision raised birth rates and improved survival while higher densities reduced birth rates. This is in line with several observations recorded in other studies[85]. By limiting densities through culling Kruger managers most likely enhanced birth rates, and by providing additional water death rates were lowered.

Table 5. A summary of the demographic responses noted to the key management changes (∆) between pairs of eras. The values in brackets represent the effect size of the differences between two eras[86].

		Demographic Responses			Movement Responses
Era	Effect	∆ Birth Rate	∆ Death Rate	Effect	Movement
Onset of Culling	Water Added	0.03	-0.017	Open	$\lambda_c > \lambda_d$ – Immigration
Ongoing Culling		(0.94)	(1.15)	Open	$\lambda_c > \lambda_d$ – Immigration
Ongoing Culling	Drought	0.05	-0.028	Open	$\lambda_c > \lambda_d$ – Immigration
End of Culling	Water added	(0.82)	(2.33)	Closed	$\lambda_c \approx \lambda_d$ – No movement
End Culling	Density increased	-0.04	0.004	Closed	$\lambda_c \approx \lambda_d$ – No movement
Post Culling		(0.50)	(0.18)	Closed	$\lambda_c \approx \lambda_d$ – No movement

Spatial responses by elephants

The spatial responses of elephants to management are hard to define[87] primarily because only distribution data during the dry season were consistently recorded in

[84] Unpublished results obtained from Sam Ferreira, SANParks, Skukuza, South Africa and Rudi van Aarde, University of Pretoria, Pretoria, South Africa
[85] Wittemyer *et al.* 2007a, Wittemyer *et al.* 2007b, Chamaille-Jammes *et al.* 2007, Trimble *et al.* 2009
[86] Unpublished results obtained from Sam Ferreira, SANParks, Skukuza, South Africa and Rudi van Aarde, University of Pretoria, Pretoria, South Africa
[87] Smit *et al.* 2007a, Smit *et al.* 2007b

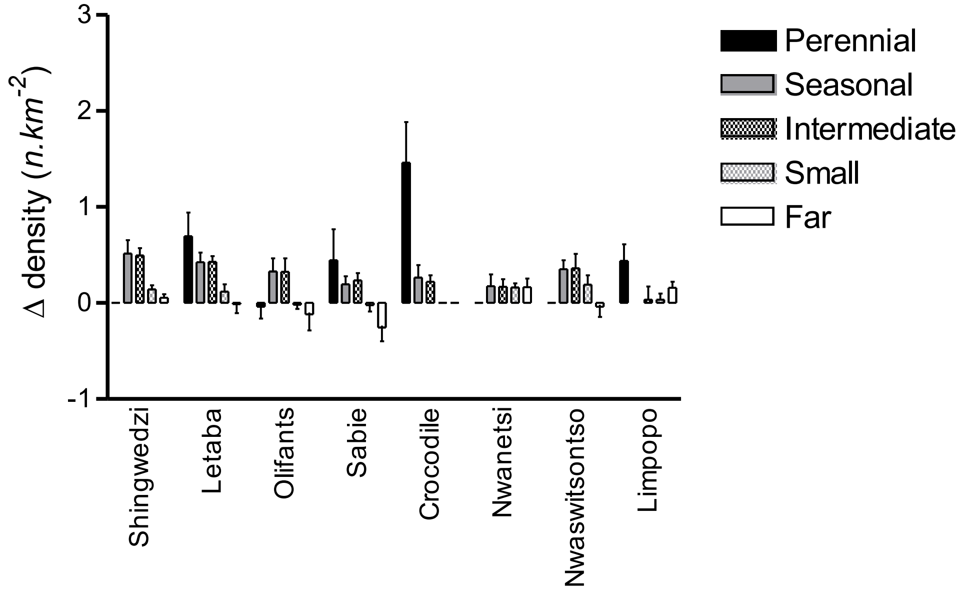
recent years. This data show that the distribution of elephants becomes less clumped as elephant numbers increase[88]. Reduction of elephant numbers may thus have maintained clump distributions.

The historic distribution data does not allow evaluation of how variable distribution was at a specific locality. If there was no variability, elephants were consistently at the same place from year to year when managers kept elephant numbers low. Variability in density at different scales shows significant declines at the 1 km^2, 5 km^2 and 25 km^2 scale with increase in elephant numbers, but not so at the 100 km^2 and 400 km^2 scale between 1998 and 2004. This means that elephants respond to landscape features differently at different scales. Part of these spatial patterns noted from the distribution recorded in the dry season relate to food availability, but vegetation productivity, a measure of food availability explained on average only 14% of the dry season distribution of elephants between 1998 and 2004[89]. The unexplained variation may be associated with other factors such a water distribution or selection for riparian areas for reasons other than food resources such as seeking shade.

Patterns in elephant densities along different rivers provide some insight into spatial responses by elephants to management[90]. Rivers in Kruger can be perennial, large seasonal, intermediate seasonal and small streams. Several places are relatively far from rivers. Change in densities within 2 km of these types of rivers from an era of intensive management (*i.e.* culling and water provision prior to 1994) to an era of reduced management (*i.e.* no culling and reduced water provision after 1998) varied between the eight major catchments in Kruger (see Box 7). Densities increased dramatically along the Crocodile River, but declined along the Olifants River. More importantly, variance in densities from year to year increased when management intensity reduced (Table 6). This suggests that spatial responses to management may alter spatial and temporal variation in the intensity with which elephants use landscapes in Kruger.

[88] Young *et al.* 2009a
[89] Young *et al.* 2009a
[90] Unpublished results obtained from Izak Smit, SANParks, Skukuza, South Africa and Sam Ferreira, SANParks, Skukuza, South Africa

Box 7. Spatial responses of elephants to management[91]



Change in elephant density came from subtracting bootstrapped densities recorded in 2 km buffer zones around five river classes during the era of wide-scale water provision and culling (1985-1994) from densities in the era of reduced water provision without culling (1999-2007). The error bars represent standard errors of the mean densities for each river class within the 8 river catchments mentioned above. This reflects on the certainty of density changes. For instance, error bars suggest that the changes noted along the Sabie River are not-significant. The data suggest that spatial responses by elephants to management actions restoring limitations are likely to be variable and desirable.

Comparison of Kruger with other places in Africa provides further insight to spatial responses of elephants[92]. Seasonal home ranges for individual elephants extracted from radio collared animals during the intensive management eras overlapped significantly more than anywhere else once the effect of rainfall and density has been accounted for (see Box 8). Intensive management may thus have increased the intensity with which an individual elephant uses a specific landscape. Such changes in the intensity of use may drive how elephants affect other conservation values.

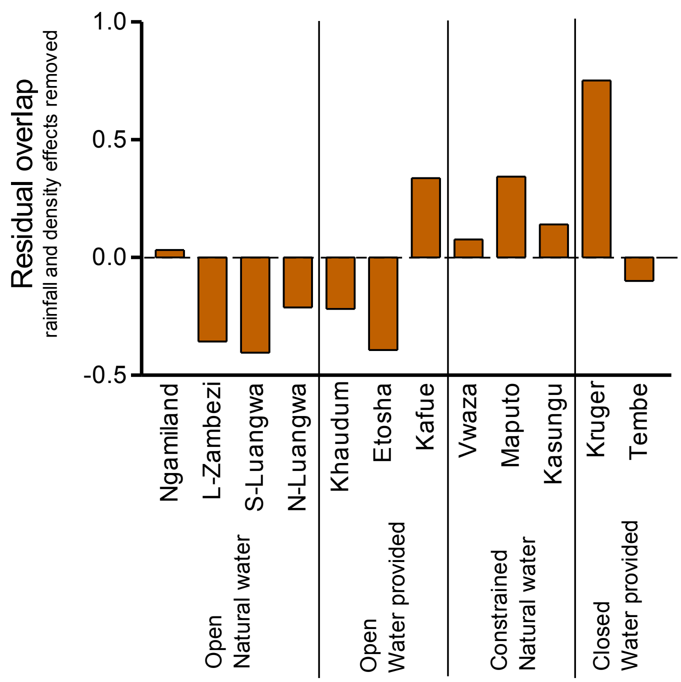
[91] Unpublished results obtained from Izak Smit, SANParks, Skukuza, South Africa and Sam Ferreira, SANParks, Skukuza, South Africa

[92] Unpublished results obtained from Sam Ferreira, SANParks, Skukuza, South Africa and Rudi van Aarde, University of Pretoria, Pretoria, South Africa

Table 6. Change in the residual variance in density recorded from one era of management to the next in different catchments for the various classes of rivers. Residual densities came from the predicted densities given population growth rates in each era within a catchment and river class. F_{max} tests evaluated whether residual variances in density for a specific river class in each catchment decreased, remained the same or increased. The overall management effect was a trend of increased temporal variability when management was reduced[93].

	Decrease	Non-significant		Increase
		Decrease	Increase	
Catchment	0	1	7	0
Large Perennial Rivers	0	1	3	1
Large Seasonal Rivers	0	1	6	1
Intermediate Seasonal Rivers	0	0	7	1
Small Streams	0	4	2	1
Far from Rivers	0	1	5	0

Box 8. Management effect on seasonal home range overlap[94]



Residual seasonal overlaps came from calculation of seasonal core home ranges and overlaps in these. Relating overlaps to rainfall and density at a particular locality allowed the comparison between different places with different management histories. Intensely managed areas tend to have higher than expected seasonal home range overlaps with Kruger being exceptionally high.

[93] Unpublished results obtained from Izak Smit, SANParks, Skukuza, South Africa and Sam Ferreira, SANParks, Skukuza, South Africa
[94] Unpublished results obtained from Sam Ferreira, SANParks, Skukuza, South Africa and Rudi van Aarde, University of Pretoria, Pretoria, South Africa

Impacts of elephants

Little data exist to evaluate how elephant impact has responded to management actions. Historically, the assumption that elephant impact is directly related to the number of elephants[95] dominated decision-making philosophies. However, this assumption was challenged by the observation that limiting the elephant population did not prevent a decline in the structural diversity of the woody vegetation of Kruger[96]. In addition, evaluations that focused on relating vegetation change to local dry season elephant density showed that vegetation diversity increased with high elephant density in certain regions of Kruger[97]. The conclusion is however constrained by limited data as elephant density data are only available for the dry season and may not reflect at all how intensely elephants use a landscape given the likely mechanism of elephant impacts. In addition, the collection of this data took place in 2008 after Kruger managers had substantially reduced water provision through boreholes. The induction of variance in densities both spatially and temporally which may reflect on variance in spatial use noted before may better explain this result.

Damage-causing elephants

The effect of management on incidence of damage caused by elephants within and around Kruger is hard to define. However, limited data[98] suggest that incidences of damage caused by elephants may not be clearly related to how many elephants there are. Since 2005 incidences decreased and were negatively associated with elephant population size north of the Olifants River (see Box 9). This was also the time after Kruger managers had closed large numbers of boreholes in the region. It is uncertain how water closure altered elephant spatial use and hence the chance of interacting with humans on Kruger's borders or if this pressure will increase during the next drought or dry cycle. Mozambican authorities have expressed concern around the increasing interactions between elephants and local communities previously not exposed directly to elephant impacts and conflict. Even so, these limited results suggest that damage-causing incidences may respond to management actions that alter spatial use of elephants rather than actions merely reducing elephant numbers.

Diseases

Elephants affect disease dynamics primarily through fence breakages which allow key hosts such as buffalo to come into contact with livestock[99]. Elephants may be enabling increased human-wildlife-stock-disease interactions through fence breakages. This can have implications for national agricultural practices, with international ramifications, and the concerns from TFCA partner states should not be underestimated.

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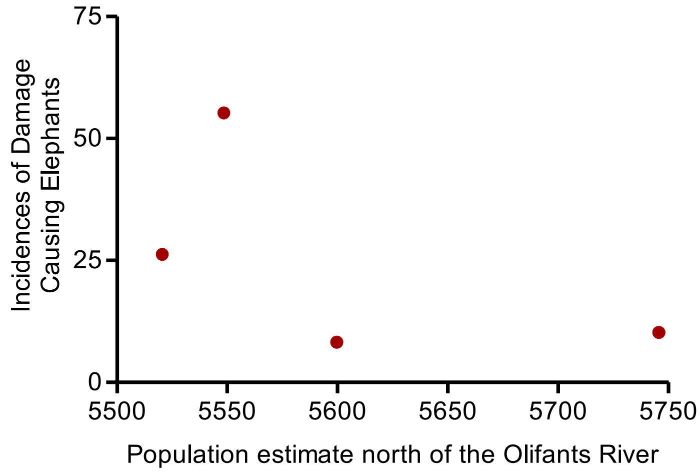
[95] Cumming *et al* 1997, Whyte *et al.* 1999, Cumming & Jones 2005,
[96] Trollope *et al.* 1998
[97] Unpublished data, Rina Grant, SANParks, Skukuza, South Africa
[98] Data provided by Sam Mashele, Department of Environmental Affairs, Limpopo Province, South Africa and SANParks database – Database Manager Judith Kruger, SANParks, Skukuza, South Africa
[99] Grant *et al.* 2009

Box 9. Association of incidences of damage causing elephants and elephant numbers as recorded for north-western Kruger[100]



Tourism and stakeholders

The consequences of elephant management for tourism and stakeholders are unknown and not measured in Kruger. However, anecdotal evidence suggests increased aggressive interactions of elephants with KNP tourists as the elephant population has increased since the suspension of culling. In addition, major concerns have been raised by stakeholders from the Sabi Sands and Associated Private Nature Reserves on Kruger's open western boundary that elephants are increasingly impacting on the aesthetics of these reserves through changing vegetation structure, particularly affecting large trees. This formed part of the discussions informing stakeholders.

2.5.4 Implications of the effects of past elephant responses to management

The above sections, outlining current understanding and knowledge, have implications for how SANParks can manage elephant impacts in future. Elephants in Kruger live longer, breed faster and have smaller home ranges than elephants elsewhere in Africa. Elephants re-colonized Kruger after colonial hunting caused their local extinction. By the mid 1960s, conservationists became concerned by the fast increasing number of elephants. Since then the elephant population has experienced various direct and indirect management actions.

Nearly three decades of annual culling and removal of live animals (1967-1994) artificially stabilised elephant numbers and densities. Elephant management took place in concert with other management actions and culling overlapped with the provision of water at various intensities since 1933. The culling era also included active control of the severity of fires, while fences erected from 1973 to 1977 isolated Kruger from adjoining

[100] Data provided by Sam Mashele, Department of Environmental Affairs, Limpopo Province, South Africa and SANParks database – Database Manager Judith Kruger, SANParks, Skukuza, South Africa

areas until the removal of some fences in 1994. A few experiments evaluated birth control as a potential management method, while models predicted levels of contraception needed to stop population growth.

The available data suggest that water provisioning increased elephant survival, fences decreased elephant movement and culling lowered elephant densities that induced higher birth rates. In addition, data from collared individuals also suggest that overlap of seasonal home ranges is disproportionately high given the rainfall and density at which elephants live in Kruger compared to other places in Africa. This suggests higher intensities of landscape use which may lead to undesirable elephant impacts on other values.

Nevertheless, even though the effect of the various management actions on elephant population dynamics is relatively well understood, the consequences for elephant spatial dynamics and impacts are relatively poorly known. Following the removal of fences between Kruger, private land and Mozambique, recent data from collared individuals[101] suggest that elephants move freely across the landscapes that span the private land, Kruger, Zimbabwe and Mozambique.

Retrospective analyses of elephant temporal and spatial responses derived from annual census and distribution data suggest that when culling stopped and water provisioning was reduced, temporal and spatial variability in densities increased in different catchments and along different types of rivers. However, elephant population growth rates declined when densities were high in areas within 2 km from seasonally variable rivers, which was not the case for the perennial rivers[102]. These patterns suggest that elephants respond to the restoration of spatial limitations, but that lags in those responses may lead to concerns about local elephant impacts on other biodiversity and heritage values, the riparian systems being a case in point.

Kruger's elephants are now part of a regional population. They are no longer spatially restricted to Kruger in their land use. Much of their current patterns of landscape use seems to be associated with where water is and some demographic limitations have been removed by past management actions. The historical consequence is that within Kruger National Park and its surrounds, elephants have used landscapes intensely and may do so more intensely at selected places due to lags in the responses of spatial and temporal dynamics to the restoration of earlier landscape limitations. This may require targeted short- to medium-term reactive management responses such as excluding elephants from selected areas close to some rivers using fences or disturbances such as vocal-induced elephant avoidance. Localized reduction in densities through removal by translocation or culling may also be a reactive management option.

The scale of interactions of elephants with humans is largely unknown and speculative. For instance, patterns generated by the overkill of elephants by humans[103] can also be explained by indirect influences that humans have on how elephants use landscapes[104]. It is likely that historical human presence reduced elephant presence in some landscapes or along rivers which may have lead to markedly reduced elephant impacts at local scales. In the present day context, interactions focus on potential human-elephant conflict and damage-causing elephants within rural and commercial farming communities around the park, and tourist experiences on private land as well as

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[101] Monthly Reports provided by Michelle Henley and Steve Henley, SAVE, Timbavati, South Africa

[102] Unpublished results obtained from Izak Smit, SANParks, Skukuza, South Africa and Sam Ferreira, SANParks, Skukuza, South Africa

[103] Surovell *et al.* 2005

[104] Harris *et al.* 2008

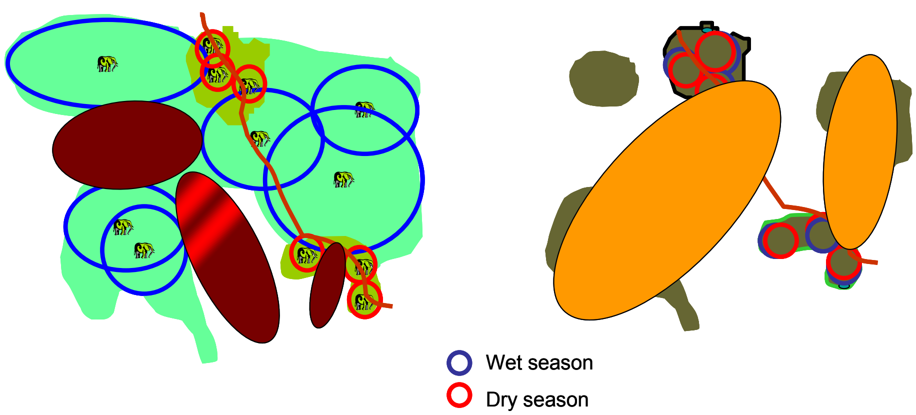
within Kruger. Boreholes and dams that provide water are historical key focal points for tourists of which a large game-viewing expectation remains.

The above discussion strongly indicates that spatial variability is most desirable. Kruger's large mammal management in general follows this approach as highlighted earlier. Elephants in Kruger *per se* epitomizes challenges and in the modern day paradigm of flux of conservation management, elephant densities are preferred to reflect a range of local densities, as an index of how intensely they use landscapes and potential may impact values. Such densities may vary from extremely low (<0.01 elephant.km^{-2}) to very high temporary and spatially (>3 elephants.km^{-2}), and will be achieved through the restoration of spatial limitations on population dynamics.

2.5.5 Mechanisms of effects

The various management approaches and concomitant responses provide some guidance on the anticipated mechanisms that lead to elephant effects on ecological and social aspects. The underlying causes consistently suggest that elephant spatial use, driven by the distribution of critical resources, defines the intensity with which elephants use a landscape or specific localities. This in turn most likely determines the effect that elephants have on ecological values, the damage they cause to human livelihoods, and how tourists and stakeholders experience elephants. When these mechanisms are interfered with effects are accentuated (see Box 10).

Box 10. Mechanisms of elephant ecological and human effects[105]



In unconstrained systems (depicted on the left) elephant responses to critical distribution of resources (green shaded areas) spatially separate their presence and use of areas between seasons and is spatially separate most of the time from humans (brown areas). The addition of water, placing of fences and fragmentation of habitat constrain systems (schematic on the right). This increases the intensity of use when seasonal home ranges are on top of each other and humans and elephants interact when competing for critical resources. Tourist experiences are enhanced by strategically placed waterholes (light blue circles) that may influence other effects. Managing elephant effects thus should focus on restoring or mimicking the spatial and temporal factors that affect elephant spatial use.

[105] Diagram extracted and modified from a diagram provided by Tim Jackson, African Geography, Pretoria, South Africa and Rudi van Aarde, University of Pretoria, Pretoria, South Africa

2.6 Kruger National Park Elephant Management Objectives

The above sections suggest that the effects of elephants on the ecological and social systems are accentuated by three aspects, namely

- the reduction of historical spatial and temporal limitations,
- the presence of constraining features that maintain reduced spatial and temporal limitations (*i.e.* additional water, dams and fences), and
- the outcome and lag effects of past management approaches and actions both for biodiversity and tourism.

Following the strategic directions of SANParks, elephant management should thus address these aspects by restoring, or mimicking, the limitations imposed by humans and natural landscape features on elephant landscape use and population demography. However, elephant life-histories result in spatial and temporal lag responses. In addition, legislative and budget constraints may also reduce immediate temporal and spatial restoration options. During such time concerns about local impacts may necessitate reactive actions such as elephant exclusion and local elephant removal. The elephant management objectives for Kruger attempt to accommodate these eventualities (see Box 11) and dove-tail with and support the park management plan objectives which are aimed at defining the desired state of Kruger (Box 12).

Box 11. Elephant Management Objectives for Kruger National Park

Objective 1

To manage elephant ecological impact, damage-causing elephants and their interactions with humans through inducing spatial and temporal variation in elephant use of landscapes by restoring the spatial limitations of the landscape. This will be pursued through:

- Minimizing the distribution of additional water points and dams
- Mimicking the effect of natural water distribution
- Expanding the effective conservation area through contracts and agreements
- Removing restrictions such as fences where appropriate

Objective 2

To ensure that the consequences of historic management actions, and any associated lag effects thereof, are minimized by proposing short- to medium-term actions, evaluating risks to other objectives, and implementing actions that do not compromise SANParks' strategic objectives and primary mandate of biodiversity conservation

Objective 3

To align SANParks' Elephant Management Plan with co-management and contractual agreements by revisiting existing and establishing new agreements with stakeholders and affected parties where appropriate

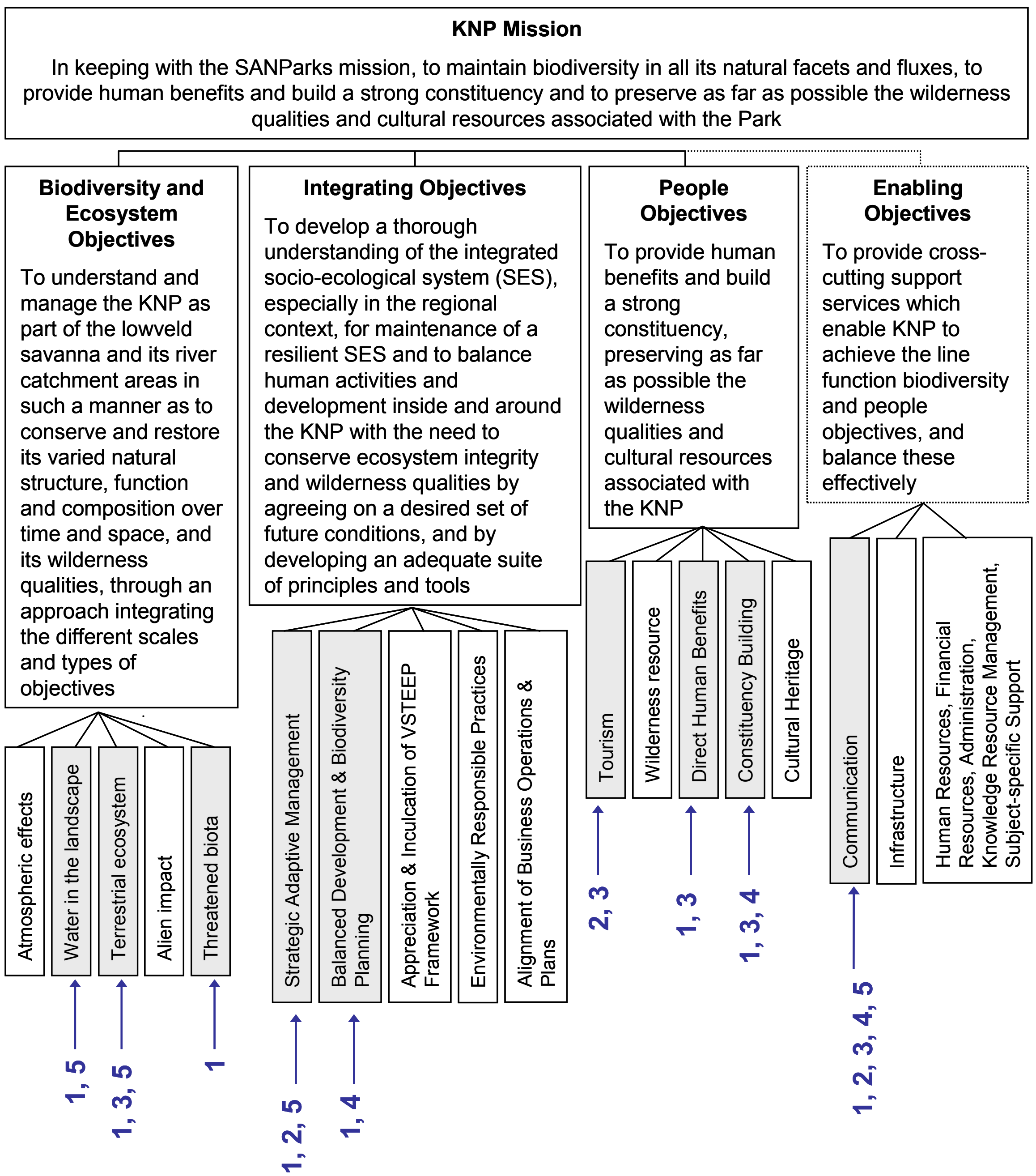
Objective 4

To align SANParks' and Trans Frontier Conservation Area Elephant Management Policies

Objective 5

To evaluate, inform and revise elephant management through collaborative monitoring efforts and research agreements

Box 12. Alignment of Kruger Elephant Management Objectives with the overall objectives hierarchy in support of the desired state of Kruger National Park



Numbers refer to the Kruger Elephant Management Objective number as in Box 11.

3. Operational planning

Several options relating to management interventions are available to SANParks and to identify and prioritize, two key aspects were included in the planning process.

3.1 Stakeholder participation

SANParks interpret the Norms and Standards for Elephant Management as an outcome of extensive public participation. As such consultation with regards to the Kruger Elephant Management Plan focused on immediately affected stakeholders, mostly neighbours abutting Kruger. Seminars to interested and affected parties including representatives of the Associated Private Nature Reserves, Sabie Sands Game Reserve, Limpopo National Park in Mozambique. Makuleke Community Trust, Limpopo Department of Environmental Affairs and Tourism and the Mpumalanga Province Tourism and Parks Agency. Approximately 70 presentations at various meetings, conferences and forums were directed at informing SANParks stakeholders, including the key stakeholders listed above. This aided in a general acceptance of the strategic focus of SANParks approach to manage elephant effects rather than elephants.

3.2 Science and management participation

A key challenge is identifying issues and concerns that are likely to impact on the achievement of the identified elephant management objectives. This is a key aspect contributing to the adaptive planning process and helps setting management actions, which emerge at the operational end of the objectives hierarchy of SANParks management plans[106].

A biodiversity mechanisms approach provides a tool for overcoming disjunction between higher and lower level planning by unpacking concerns according to how they link with objectives, the mechanisms that cause this concern and the factors that modulate these mechanisms. It can take the form of a mechanistic framework or a linear unpacking in terms of the key driver that influences one of the three broad strategic objectives of SANParks, *i.e.* maintaining ecological integrity, providing a tourist experience, or enhancing stakeholder relationships within the context of local communities, logistics and financial viability. The mechanism by which such a driver operates is then explored. The above discussion thus far illustrated a variety of effects associated with elephants as a key driver, but the mechanism always converges on how elephants use space, which in turn are modified by managed features such as water provisioning and fences.

Unpacking a concern in this way provides four critical benefits apart from a common understanding. Firstly, it provides clear guidance in terms of what to manage in order to address the park's objectives. Secondly, it minimizes the unpredictability and subjectivivity inherent in setting Thresholds of potential concerns[107]. Thirdly, unpacking concerns into mechanisms helps identify what to measure. Lastly, unpacking of concerns inadvertently imposes a first level of management prioritization because often the unpacking exercise identifies a concern as only a perceived one.

Defining the linkages of management actions to objectives is thus a key step in helping to decide what action to implement, what the anticipated consequences would

[106] Gaylard & Ferreira 2011.
[107] Biggs *et al.* 2011.

be and how to measure those. In addition, it is relatively easy to define mechanisms-based TPCs allowing management response long before biological integrity degrades. The unpacking of a concern clearly illustrates how measuring SANParks objectives in such a strategic adaptive management framework forces conservationists to monitor across the range of individual species to ecosystems. This helps to understand whether the proposed mechanism of a concern has been adequately addressed through a management action.

A first level of prioritization of possible conservation actions may result from the mechanistic approach to address a concern after unpacking the mechanisms leading to features that raised the concern. Invariably multiple actions may be available to address the same concern. Each possible management option has associated risks and benefits for SANParks, as well as logistical, capacity and cost requirements. In addition to these considerations, SANParks has three pillars of strategic objectives that also require consideration in all management decisions. Its biodiversity mandate provides the key objective, but tourism objectives provide revenue paying for conservation actions, while stakeholder objectives capture the complexity of the socio-economic-ecological matrix within which parks are embedded. Formal risk assessments should thus capture this full range of divergent objectives.

Risk assessment is a well established technique in several fields including conservation. In conservation, however, it is often confused with priority setting approaches or population viability analyses, a common tool evaluating extinction risks. The actual use of such planning tools to help make consensus decisions when multiple management options are available is limited.

SANParks make use of a process for conservation risk assessment that defines benefits (positive result or outcome using a specific option) and risks (negative result or outcome using a specific option) for each of the three pillars: biodiversity, tourism, stakeholders. A risk and/or benefit has an impact (*i.e.* effect on what conservationists seek to achieve) as well as likelihood value (*i.e.* chance that the impact will happen if a specific action was applied). Expert knowledge and science-management interactions at Science Management Forums or specially called workshops assign these values through consensus. Weighted averages allow decision makers to compare all the risks with the benefits of one option with those of another option. A similar approach is taken to evaluate cost and logistical constraints[108].

This approach provides three benefits – it helps define the most appropriate action SANParks can take given its various legislative, policy, financial, stakeholder, capacity and logistical constraints. Secondly, it defines what needs to be measured and provides insight into how the ecosystems function even in a constraining decision-making environment. Essentially it empowers SANParks to fulfill the adaptive management philosophy it has embraced. And lastly, it provides a robust way to maintain a reputation as a responsible custodian of biodiversity in South Africa by illustrating how a specific decision was reached transparently following trade-offs with other options. Various management options, particularly those pertaining to achieving objective 2 were considered within this framework.

4. Management Actions

The elephant management objectives for Kruger National Park are not mutually exclusive and several objectives can be addressed by the same management action.

[108] Ferreira *et al.* 2011.

Actions are grouped into those addressing each of the five elephant management objectives and are associated with managing elephant impact, conflict and stakeholder relationships, as well as the lag effects associated with response times. Although actions provide for inclusion of the full suite of options provided by the relevant Norms and Standards, they focus on actions affecting spatial use *i.e.* range manipulation through management of water supply, enclosures or excluding elephants, corridors of movement between different areas, and expansion of elephant range by acquisition of land. These are primarily captured in actions directed at achieving Elephant Management Objective 1. Removal through translocation or culling is provided as options for actions directed at achieving Elephant Management Objective 2. Links to the Kruger National Park Management Plan and specific lower level plans are made explicit. SANParks also provide clear indication how each action will be evaluated (AR – annual reports; SR – science reports).

4.1 Achieving Objective 1

"To manage elephant ecological impact, damage causing elephants and their interactions with humans through inducing spatial and temporal variation in elephant use of landscapes by restoring the spatial limitations of the landscape"

Elephant impact management will be directed by factors directly affecting elephant spatial use. Human-elephant conflict, however, is a complex issue as three main land uses abut Kruger National Park. The magnitude and dynamics of human-elephant conflict are unknown and is likely to have very different effects and management response requirements depending on land use. Several diseases, endemic and exotic, threaten humans and their livelihoods. Elephants potentially accentuate the spread of disease through the way they use landscapes and particularly damage fences when they encounter these. In Kruger's case the spread of foot-and-mouth disease and bovine tuberculosis into commercial and rural stock land uses is of highest concern.

Elephant impact, elephant conflict management and disease effects will be directed by a formal monitoring programme that evaluates Thresholds of Potential Concern following the general framework illustrated in Box 2. The monitoring will provide feedback in the form of Annual Reports and Science Reports (see Section 4) as well as Interim Management Plan Evaluations and Audits (see Section 5).

Managing mechanisms of elephant ecological impact

The review of management and responses of elephants to management evoke an understanding that elephant responses to spatial distribution of resources define how intensely they use landscapes and how their numbers are limited. Spatial use defines intensity of use and is the key aspect that influences the effects elephants have on biodiversity. Actions are thus directed at maintaining and restoring biodiversity in varied landscapes across Kruger National Park by restoring or mimicking the mechanisms that determine elephant spatial use.

Managing mechanisms of damage-causing elephant interactions

It is likely that within neighbouring communities, conflicts could arise as a result of management actions directed at restoring landscape limitations on elephant populations.

Damages caused by elephants are one of the key aspects for elephant management in Kruger. In addition, observations in Kruger and likely mechanisms suggest that incidences of damage caused by elephants are associated with spatial use of elephants which in turn are associated with the distribution of critical resources. SANParks will thus direct actions at minimizing the effects of damage-causing elephants by restoring or mimicking the mechanisms underpinning spatial use of elephants (*e.g.* restoring natural variability across time and space of water availability and quality).

Managing mechanisms of disease effects

Disease associates with elephants primarily through indirect effects when elephants break veterinary fences. The rates at which elephants may encounter fences are primarily driven by where the critical resources are. Hence the provision of water, fences constructed for other purposes and presence of humans may have consequences for the incidences of elephant damages to fences and thus risks of disease outbreaks. SANParks will implement actions directed at minimizing the risk of disease outbreaks by targeting mechanisms determining elephant spatial use.

Management actions to restore or mimic mechanisms that mitigate ecological impacts of elephants (EI), damage-causing effects (DC), disease effects (D). Evaluation is through Annual (AR) or Science (SR) Reports.

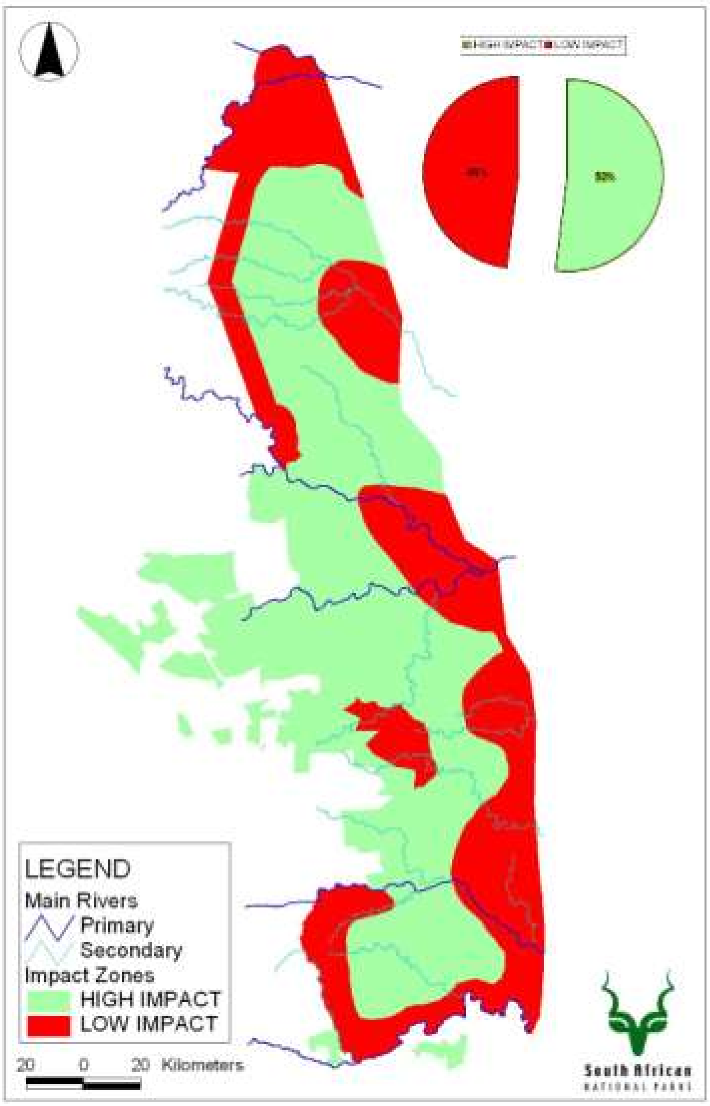
No.	Action	Target mechanism	Operational Target	Evaluation	Kruger Park Management Plan Reference
1.1	Identify zones of biological importance and areas of ecological, economic and social risk	EI, DC, D	2012	AR	Conservation Development Framework and Zonation Programme
1.2	Define zones of impact tolerance based on action 1.1 (see Box 13)	EI	2012	AR	Conservation Development Framework and Zonation Programme
1.3	Where appropriate, acquire additional zones of biological importance through contracts and agreements	EI	Ongoing	AR	Land Issues and Effective Park Expansion Programme
1.4	Remove fences between existing and acquired zones	EI, DC, D	Ongoing	AR	Land Issues and Effective Park Expansion Programme Biodiversity Management Programme Roads, Fence and Dam Management Programme
1.5	Close boreholes that provide access to additional water in naturally drier areas	EI, DC, D	2014	AR	Biodiversity Management Programme Restoration Programme Sustainable Tourism Programme
1.6	Remove earth dams that provide inappropriately placed additional water	EI, DC, D	2016	AR	Biodiversity Management Programme Restoration Programme Sustainable Tourism Programme Roads, Fence and Dam Management Programme
1.7	Provide water that mimics natural distribution in temporal and spatial variability of water availability and quality	EI, DC, D	2016	AR	Biodiversity Management Programme Sustainable Toursim Progarmme

No.	Action	Target mechanism	Operational Target	Evaluation	Kruger Park Management Plan Reference
1.8	Measure the spatial response of elephants by placing collars on selected individuals	EI, DC, D	Ongoing	SR	Research Programme
1.9	Measure the spatial response of elephants by evaluating annual distribution	EI, DC, D	Ongoing	SR	Research Programme
1.10	Model landscape use from elephant spatial data	EI, DC, D	Ongoing	SR	Research Programme
1.11	Measure the demographic response by determining age- and sex structures	EI	Bi-annual	SR	Research Programme
1.12	Measure the demographic response by determining the fecundity schedule	EI	Bi-annual	SR	Research Programme
1.13	Model population change from demographic data	EI	Bi-annual	SR	Research Programme
1.14	Count elephants using an optimized design	EI	Bi-annual	SR	Biodiversity Management Programme
1.15	Measure other biodiversity values	EI	Ongoing	SR	Biodiversity Management Programme
1.16	Relate elephant spatial use underpinned by landscape features to measures of change in biodiversity	EI	Bi-annual	SR	Research Programme
1.17	Identify zones of potential human-elephant conflict and damages caused by elephants	DC	2012	AR	Conservation Development Framework and Zonation Programme
1.18	Define zones of elephant-human interactions, damages caused by elephants and impact (Box 13)	DC	2012	AR	Conservation Development Framework and Zonation Programme
1.19	Engage with local communities and neighbours around human-elephant conflict and damages caused by elephants and how to minimize that	DC	Ongoing	AR	Stakeholder Relationship Management Programme Environmental Education and Interpretation Programme Communications Strategy
1.20	Measure the conflict profile of humans in an around Kruger National Park	DC	Bi-annual	SR	Academic Contractual agreements
1.21	Relate elephant spatial use underpinned by landscape features to measures of human-elephant conflict	DC	Bi-annual	SR	Academic Contractual agreements
1.22	Identify the type and distribution of diseases	D	2012	SR	
1.23	Identify the modes of transmissions and how elephants may affect these	D	2012	SR	
1.24	Identify zones of potential disease hot spots	D	2012	AR	
1.25	Define zones of elephant-mediated disease impact (Box 13)	D	2012	AR	Conservation Development Framework and Zonation Programme Management of Damage Causing Animals Programme
1.26	Measure the disease profile of humans, wildlife and stock in and around Kruger National Park	D	Bi-annual	SR	Academic Contractual agreements
1.27	Relate elephant spatial use underpinned by landscape features to measures of disease profiles and disease outbreaks	D	Bi-annual	SR	Academic Contractual agreements

* Note: implementation of certain of these actions is dependent on appropriate available funding outside of current operational budgets.

Note that several actions as part of other Lower Level Plans are already active. As part of naturalizing water distribution, the number of active boreholes available to elephants have been reduced and some earthen dams have been demolished. This is ongoing over the extend of the present elephant management plan. As part of the Park Expansion Programme several initiatives have been completed and/or are ongoing including fence removal between private nature reserves and Kruger as well as Limpopo National Park and Kruger. This forms part of the Greater Limpopo Transfrontier Park initiatives. These initiative purposefully address the key mechanisms that may lead to local undesirable elephant effects on several conservation values.

Box 13. Impact zones informing elephant management in Kruger



The Kruger impact zoning approach drafted during 2008. This considered several aspects including various biodiversity values, national targets, incidences of and risks from damage-causing animals, tourism expectations, landscape linkages and transfrontier opportunities. Impact refers to overall impact tolerance of the areas and not just that ascribed to elephants.

4.2 Achieving Objective 2

"To ensure that the consequences of historic management actions, and any associated lag effects thereof, are minimized by proposing short- to medium-term actions, evaluating risks to other objectives, and implementing actions that do not compromise SANParks' strategic objectives and primary mandate of biodiversity conservation"

Managing outcomes of historic management and lag effects on ecological impacts

The elephant population in Kruger experienced several years of management that reduced or removed spatial and temporal limitations. Elephants will take time to respond both spatially and demographically to management actions directed at restoring mechanisms that mitigate ecological effects. Short- to medium-term actions such as localized elephant exclusion or removal through fences, translocation or culling are expected to be required in response to potential lag effects of elephant populations created through historical management actions. Triggers will be informed by the relationship between how elephants use landscapes and changes observed as a result of that once the effects of fire and climate have been accounted for.

Managing outcomes of lag-effects in addressing damage-causing incidences

Reduction of densities, fences and water provision altered elephant spatial dynamics and demographics. Long life-history characteristics of elephants mean that populations may take some time to respond to management actions directed at restoring or mimicking the mechanisms that mitigate human-elephant interactions that lead to damages. In addition, restoration of mechanisms mitigating ecological effects may carry cascades of short-term responses of elephants moving across landscapes that increase their chance of coming into contact with humans. Management actions directed at these lag effects or responses induced through actions directed at other objectives may require short- to medium-term reactive actions (local exclusion or reducing densities) to ensure short- to medium-term achievement of Park objectives.

Managing outcomes of lag effects in addressing disease concerns related to elephants

Lags in spatial and demographic responses to management may also affect diseases through the same mechanisms as before. The largest threat is that restoration of mechanisms mitigating other effects may carry cascade effects when elephants move across landscapes that increase their chance of coming into contact with fences. Management actions directed at these lag effects or responses induced through actions directed at other objectives may require short- to medium-term reactive actions to ensure short- to medium-term achievement of Park objectives and disease management.

Managing outcomes of lag effects in addressing eco-tourism expectations and objectives

Tourism is one of the key features of SANParks and forms an integral part of the Kruger National Park Management Plan. Historically, management actions were often directed at enhancing tourist experiences, which in some instances may have lead to undesirable local effects on biodiversity. SANParks provide tourist opportunities formally, but also engage commercial and local community business opportunities to provide tourist experiences and extract benefits from tourist activities. Certain short- to medium-term actions around elephant management (and other synergistic management responses *e.g.* changing water provisioning policies and approaches) will be required to mitigate the anticipated lag effects of elephant impact and population responses to management actions under Elephant Management Objective 1.

Scientific robustness of managing lag-effects

Managing lag effects provides opportunities to learn from management actions using the adaptive management framework adopted by SANParks. Management actions include the design of appropriate adaptive management experiments that allow evaluation of desired outcomes or reactive management actions including fencing, removal, translocation, contraception and culling. In the short- to medium-term actions will focus on locally excluding elephants and/or locally reducing elephant densities.

Management actions to accommodate lag-effects of elephant responses on ecological impact (EI), damage-causing (DC), disease (D), tourism (T) aspects. Evaluation is through Annual (AR) or Science (SR) Reports.

No.	Action	Target mechanism	Operational Target	Evaluation	Kruger Management Plan Reference
2.1	Use existing data on elephant spatial use to develop models of elephant ecological effects accounting for climate and rainfall influences	EI	2014	SR	Research Programme
2.2	Identify localities of ecological change associated with elephant lag-effects	EI	2014	SR	
2.3	Propose short- to medium-term reactive fencing, removal, translocation, contraception, culling, including scenarios, opportunities for learning and risk analyses	EI, DC, D, T	As needed	AR	Land Issues and Effective Park Expansion Programme Biodiversity Management Programme Sustainable Tourism Programme Stakeholder Relationship Management Programme
2.4	Design robust adaptive management experiment to evaluate the outcome of short- to medium-term reactive actions	EI, DC, D, T	As needed	SR	
2.5	Implement adaptive management experiment for short- to medium-term reactive fencing, removal, translocation and contraception actions	EI, DC, D, T	As needed	SR	
2.6	Develop Ministerial Plan for reactive short- to medium-term culling	EI, DC, D, T	As needed	AR	
2.7	Design robust adaptive management experiment to evaluate the outcome of reactive short- to medium-term culling	EI, DC, D, T	As needed	SR	
2.8	Implement Ministerial Plan for reactive short- to medium-term culling, including adaptive management experiment	EI, DC, D, T	As needed	AR	

No.	Action	Target mechanism	Operational Target	Evaluation	Kruger Management Plan Reference
2.9	Implement the Damage-Causing Animals Policy to damage causing incidences associated with elephants	DC	Ongoing	AR	
2.10	Use existing data on elephant spatial use to develop models of elephant damaging effects to humans	DC	2014	SR	
2.11	Identify hotspots of damages associated with elephant lag-effects	DC	2014	SR	
2.12	Inform the State Veterinary Department and implement the Department's Policy on disease incidences associated with elephants where necessary	D	Ongoing	AR	
2.13	Use existing data on elephant spatial use to develop models of elephant disease effects	D	2014	SR	
2.14	Identify hotspots of diseases associated with elephant lag-effects	D	2014	SR	

4.2.1 Operational options and adaptive elephant management

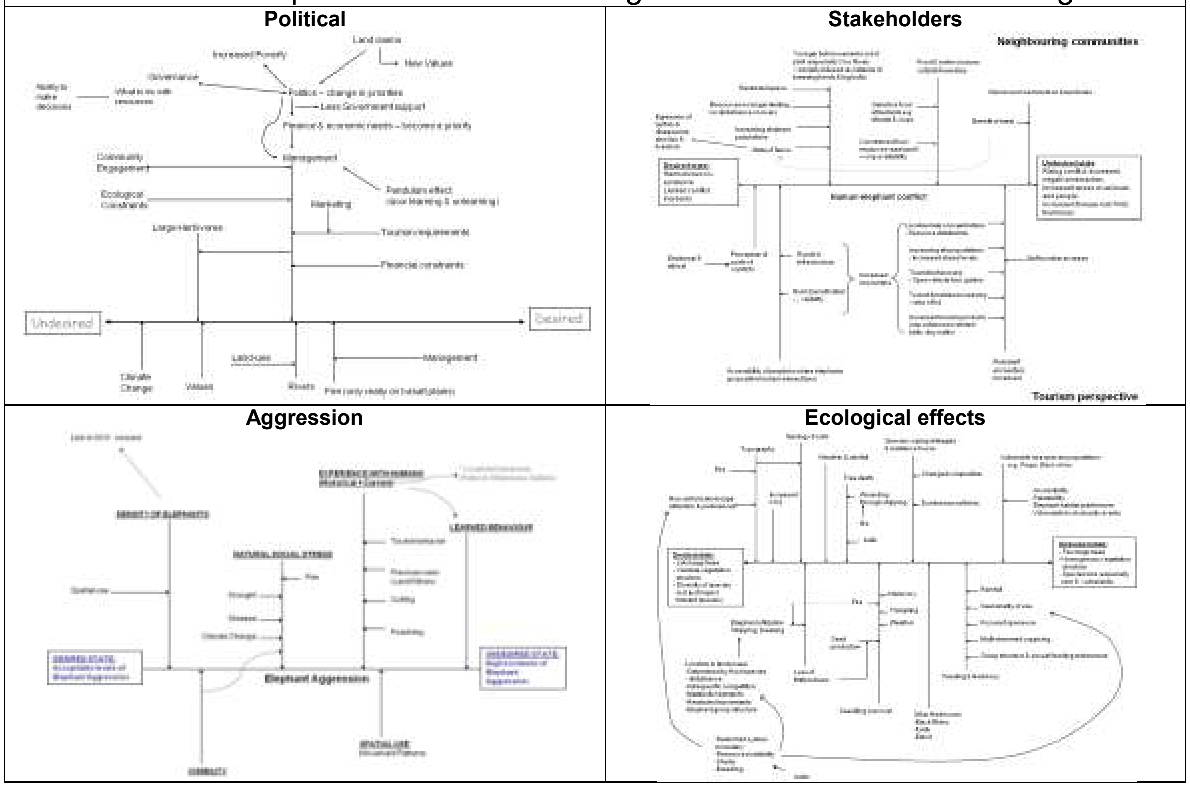
Four regional workshops in Kruger identified concerns following the process highlighted above. Concerns varied between regions and were generalized to nine concerns across the four regions (Table 3). These nine could be grouped based on likely common drivers as follows: Political concerns, stakeholder views, elephant behavior and a large grouping associated with key spatial drivers (human-elephant conflict, damage to infrastructure, vegetation structure – loss of large trees, vegetation species composition, terrestrialization of water courses and decrease of specific species). For these four groups of concerns we consolidated mechanisms diagrams developed at the regional workshops (see Box 14 for examples).

Table 3. Concerns at a regional level across Kruger National Park.

Concern	Nxanatseni North	Nxanatseni South	Marula North	Marula South
Political influences		Restrictions of N&S leading to paralysis feeling		Restrictions of N&S leading to paralysis feeling
Stakeholder views		Mental models differ from SANParks and expectation of use of elephants as a resource		SANParks reputational risk as a known responsible environmental manager
Elephant behavior	Change in elephant aggression		Change in elephant aggression	Change in elephant aggression
Human-elephant conflict	Shangoni, Punda Maria and Limpopo National Park			
Damage to infrastructure	Punda Maria Section			
Vegetation structure – loss of large trees	Pafuri floodplains and basalt plains	Perenial rivers and basalt plains	Ecca shales, basalt plains and large seasonal rivers	Biyamiti, Basalt plains and Gabbros
Vegetation species composition	Pafuri floodplains and basalt plains	Perenial rivers and basalt plains	Ecca shales, basalt plains and large seasonal rivers	Biyamiti, Basalt plains and Gabbros
Terrestrialization of water courses			N'waswitsontso River	
Decrease of specific species		*Commiphora*, *Sterculia* and *Aloe* at Olifants-Letaba confluence	*Acacia tortilis* on Timbavati	*Aloe marlothi* and *Pterocarpus angoliensis*

Unpacking the mechanisms underpinning how concerns arise more or less converged onto spatial mechanisms for all types of elephant effects (Box 14).

Box 14. Examples of mechanisms diagrams for the concerns for Kruger



Rangers, managers and scientists at the regional workshops proposed various management options to address the local concerns (Table 4). These all can be categorized within the broader strategic directions for elephant management, even though they differ from region to region. Note that some concerns translate to strategic actions directed at the direct cause (relate to actions to achieve elephant management objective 1) while a large part of actions focus on managing the lag effects, the primary aim of achieving elephant management objective 2.

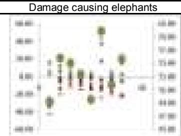
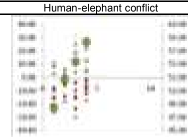
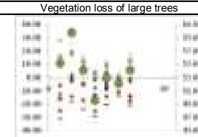
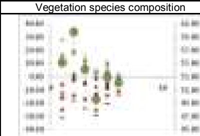
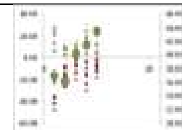
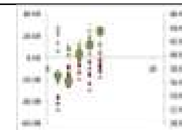
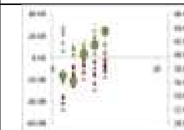
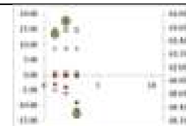
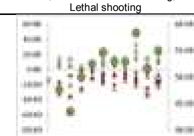
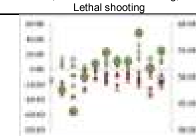
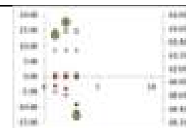
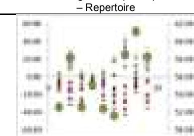
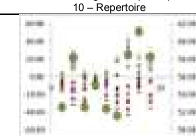
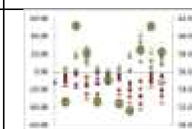
Using the mechanisms diagrams developed for concerns allowed us to conduct risk assessments and evaluate different options against each other (Box 15). This serves to illustrate the due consideration of any option to manage the lag effects that Objective 2 seeks to address.

Table 4. Management options considered for various concerns associated with elephants in Kruger National Park. NN – Nxanatseni North, NS – Nxanatseni South, MN – Marula North, MS – Marula South. See box 15 for detail summary of what actions entail.

Strategic objective	Political influences		Contrasting stakeholder views		Damage causing elephants		Human-elephant conflict		Change in elephant behavior		Vegetation loss of large trees		Vegetation species composition		Terrestrailization of streams		Decrease of specific species	
	Option	Region	Option	Region	Option	Region	Option	Region	Option	Region	Option	Region	Option	Region	Option	Region	Option	Region
Resource distribution																		
Water					Provide water	NN	Provide water	NN										
											Close unnatural water	NS	Close unnatural water	NS			Close unnatural water	NS
											Supplement natural water	NS	Supplement natural water	NS			Supplement natural water	NS
											Drain natural pans	MN	Drain natural pans	MN	Drain natural pans	MN	Drain natural pans	MN
Resource accessibility																		
Fences					Electrified fence	NN												
					Pepper fence	NN												
					Gabioned fence	NN												
					Noise fence	NN												
					Permeable fence	NN												
											Bee deterrence	MS	Bee deterrence	MS			Bee deterrence	MS
											Fenced enclosures	NN, MS	Fenced enclosures	NN, MS			Fenced enclosures	MS
											Rocks around tree	NN	Rocks around trees	NN			Rocks around trees	MN,MS
Scale of resources																		
Fences											Remove fences	NS	Remove fences	NS			Remove fences	NS
Simulate spatial variation																		
Interference											River tented camps	NN	River tented camps	NN				
											Reintroduce humans	MN	Reintroduce humans	MN	Reintroduce humans	MN		
Guarding					Game guards	NN												
							Bantam flights	NN										
Non-lethal											Noise	NN, MN, MS	Noise	NN, MN, MS	Noise	MN	Noise	MN, MS
											Pepper fire	NN	Pepper fire	NN				
											Dung fire	NN, MN, MS	Dung fire	NN, MN, MS	Dung fire	MN	Dung fire	MN, MS
											Peppers	MN	Peppers	MN	Peppers	MN	Peppers	MN
											Acoustic	MN	Acoustic	MN	Acoustic	MN	Acoustic	MN
											Hormonal	MN	Hormonal	MN	Hormonal	MN	Hormonal	MN
											Disruptive moving	MS	Disruptive moving	MS			Disruptive moving	MS
											Shock collars	MS	Shock collars	MS			Shock collars	MS
							Disturbance shooting	NN			Disturbance shooting	NS, MS	Disturbance shooting	NS, MS			Disturbance shooting	NS, MS
Lethal							Lethal shooting	NN			Lethal shooting	NS, MN, MS	Lethal shooting	NS, MN, MS	Lethal shooting	MN	Lethal shooting	NS, MN, MS
											Helicopter shooting	MS	Helicopter shooting	MS			Helicopter shooting	MS
											Elephant pitfalls	MN	Elephant pitfalls	MN	Elephant pitfalls	MN		
Reduce numbers																		
Culling					Culll culprits	NN												
											Cull bulls	NN						
Stakeholder engagements																		
	DEA Plan	MS, NS	Communication Plan	MS, NS					Ranger Training	MS, NN								
									Guide Training	MS, NN								
									Tourist Guidelines	MS, NN								

Box 15. Risk assessments of various management options for the concerns in the four different regions within Kruger National Park.

Small circles represent biodiversity objective, triangles represent tourism objectives, squares represent stakeholder objectives, diamond represent logistics and short line represent costs. These are presented as additive. Above the line in green represent benefits, while below the line in red represent risks. The large green circles is an achievability index with the highest value on the secondary y-axis reflecting the option with the least amount of risk relative to the most amount of benefits. Below we provide also clarification of what each management action comprises.

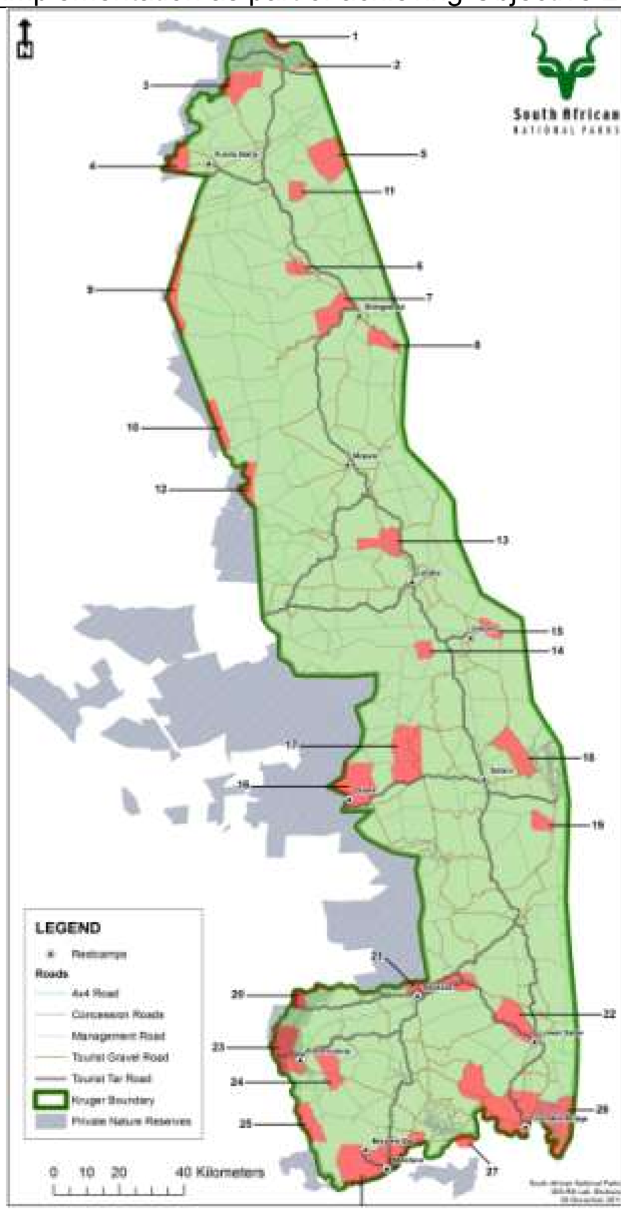
	Political influences	Contrasting stakeholder values	Damage causing elephants	Human-elephant conflict	Change in elephant behavior	Vegetation loss of large trees	Vegetation species composition	Terrestrialization of streams	Decrease of specific species
Nxanatseni North	-	-						-	-
	-	-	1 – Open Coetzer Windmill, 2 – Electrified fence, 3 – Pepper fence, 4 – Gabioned fence, 5 – Noise Fence, 6 – Premeable elephant bull fence, 7 – Game guards, 8 – Cull culprits	1 – Provide water, 2 – Bantam flights, 3 – Disturbance shooting, 4 – Lethal shooting	1 – Ranger training, 2 – Guide training, 3 –Tourist guidelines	1 – Fenced enclosures, 2 – Rocks around trees, 3 – River tented camps, 4 – Noise, 5 – Pepper fire, 6 – Dung fire, 7 – Cull bulls	1 – Fenced enclosures, 2 – Rocks around trees, 3 – River tented camps, 4 – Noise, 5 – Pepper fire, 6 – Dung fire	-	-
Nxanatseni South	Only DEA Engagement Option	Only Elephant communication plan Option	-	-	-			-	
	-	-	-	-	-	1 – Close unnatural water, 2 – supplement natural water, 3 – Remove fences, 4 – Disturbance shooting, 5 – Lethal shooting	1 – Close unnatural water, 2 – supplement natural water, 3 – Remove fences, 4 – Disturbance shooting, 5 – Lethal shooting	-	
Marula North	-	-	-	-					
	-	-	-	-	1 – Ranger training, 2 – Guide training, 3 –Tourist guidelines	1 – Drain natural pans, 2 – Re-introduce humans, 3 – Noise, 4 – Dung fires, 5 – Peppers, 6 – Acoustic, 7 – Hormonal, 8 – Lethal shooting, 9 – Elephant pitfalls, 10 – Repertoire	1 – Drain natural pans, 2 – Re-introduce humans, 3 – Noise, 4 – Dung fires, 5 – Peppers, 6 – Acoustic, 7 – Hormonal, 8 – Lethal shooting, 9 – Elephant pitfalls, 10 – Repertoire	1 – Drain natural pans, 2 – Re-introduce humans, 3 – Noise, 4 – Dung fires, 5 – Peppers, 6 – Acoustic, 7 – Hormonal, 8 – Lethal shooting, 9 – Elephant pitfalls, 10 – Repertoire	1 – Drain natural pans, 2 – Rocks around trees, 3 – Noise, 4 – Dung fire, 5 – Peppers, 6 – Acoustic, 7 – Hormonal, 8 – Lethal shooting
Marula South	Only DEA Engagement Option	Only Elephant communication plan Option	-	-				-	
	-	-	-	-	1 – Ranger training, 2 – Guide training, 3 –Tourist guidelines	1 – Bee deterrence, 2 – Fenced enclosures, 3 – Noise, 4 – Dung fires, 5 – Disruptive moving, 6 – Shock collars, 7 – Disturbance shooting, 8 – Lethal shooting, 9 – Helicopter shooting	1 – Bee deterrence, 2 – Fenced enclosures, 3 – Noise, 4 – Dung fires, 5 – Disruptive moving, 6 – Shock collars, 7 – Disturbance shooting, 8 – Lethal shooting, 9 – Helicopter shooting	-	1 – Bee deterrence, 2 – Rocks around trees, 3 – Fenced enclosures, 4 – Noise, 5 – Dung fires, 6 – Disruptive moving, 7 – Shock collars, 8 – Disturbance shooting, 9 – Lethal shooting, 10 – Helicopter shooting

Management Action Summary

DEA Engagement Meetings advocating political challenges and short comings of Norms and Standards	**Elephant communication plan** Broad-scale communication to several stakeholders	**Open Coetzer Windmill** Re-opening of the closed Coetzer Windmill	**Electrified Fence** Establishing a fence electrified by several means	**Pepper Fence** Placing material that hold chilly pepper paste for several days against fences	**Gabion Fence** Construction of fence with gabions protruding to deter elephants	**Noise fence** Noise making devices such as crackers or steel bangers attached to fences	**Permeable elephant bull fence** Fence is low enough that allow elephant bulls in particular to climb over without breaking the fence	**Game Guards** Regular deployment of game guards that patrol affected areas and disturb elephants with warning shots
Cull culprits Identification of regular transgressors and killing these through shooting	**Provide water** Create or re-open water holes in vicinity of conflict to attract elephants away from people	**Bantam flights** Do regular Bantam flights, identify potential transgressors and chase these away from target area	**Disturbance shooting** Regular visit the area of concern and shoot rifles irrespective of elephants present or not	**Lethal shooting** Regular visit the area and shoot young bulls and/or family groups. Distress calls must be allowed to be uttered.	**Ranger training** Focal training on elephant behavior and how to behave in their presence to field rangers	**Guide training** Focal training on elephant behavior and how to behave in their presence to field guides	**Tourist guidelines** Updated brochures on elephant behavior and how to behave in their presence to tourists	**Fenced enclosures** Areas fenced to keep elephants out. This can take several forms, but typically involve two electrified strands.
Rocks around trees Placing of sharp rocks facing upwards around focal trees	**River tented camps** Establishments of a series of tented camps along rivers which has variable usage	**Noise** Regular visiting areas and setting of large noise making devices such as crackers	**Pepper fire** Burning of chilly peppers in areas of concern	**Dung fire** Burning of dung in areas of concern	**Cull bulls** Killing young bulls non-selectively in the area of concern	**Close unnatural water** Closure of water pumps that provide water in troughs as well as breaching and restoring earthen dams	**Supplement natural water** Drilling of boreholes at pans that dry up seasonally and establishing permanent water in those pans	**Remove fences** Removal of existing boundary fences particularly with Limpopo National Park in Mozambique
Drain natural pans Pump water from pans that hold water throughout the season within the areas of concern	**Reintroduce humans** Allow humans to use resources and temporary settle in areas of concern	**Peppers** Place chilly pepper holding devices at strategic localities within area of concern	**Acoustic** Use devices to play back elephant distress calls	**Hormonal** Place devices that release hormonal signals of musth bulls in areas of particularly high bull presence	**Elephant pitfalls** Establish traditional elephant pitfalls in areas of concern. Distress calls must be allowed to be uttered.	**Bee deterrence** Establish beehives with disturbance triggers in area of local concern	**Disruptive moving** Capture specifically breeding groups and move to other areas in an attempt to reduce local elephant density temporarily	**Shock collars** Fitting of collars that deliver a deterring effect (shock or sound) when an elephant enter an area of concern. Bulls and matriarchs can be targeted.
Helicopter shooting Intensive killing of elephants in an area of local concerns in an attempt to reduce local abundance temporarily	**Repertoire** Involves a combination of pepper, noise, musth dung and light electric fences							

Consolidated concerns and mechanisms allowed the definition of spatially explicit management actions directed at altering the intensity of use of elephants at local areas (Map 8) where elephant effects may contrast SANParks objectives. These will be constructed as an adaptive management experiment as part of implementing actions to achieve Objective 2. The experiment will seek measures on the spatial and population consequences for elephants, the consequences of intensity of use by elephants of these areas and the consequences on the outcomes of the concerns raised.

Map 8. Adaptive elephant management experiment across Kruger National Park for implementation as part of achieving Objective 2.



	Concerns	Preferred Options
Nxanatseni North	**Biological** 1 – Limpopo riparian forests and Pan woodlands 2 – Confluence fever tree forests 3 – Levhuvhu riparian forests 4 – Punda Maria Boabab woodlands 5 – Sandveld 6 – Mpongolo Riparian surrounds 7 – Shingwedzi confluence riparian surrounds 8 – Lower Shingwedzi Riparian surrounds **Social** 4 – Human conflict 9 – Fence Breakages 10 – Fence breakages **Opportunity** 11 – Roan camp	**Biological** • Pepper fence • Rocks around trees • Fenced enclosures • River tented camps • Cull bulls • Pepper fires **Social** • Permeable fence • Electrified fence • Shooting culprits
Nxanatseni South	12 – Klein Letaba confluence riparian surrounds 13 – Letaba-Tsendze confluence riparian surrounds 14 – Olifants riparian surrounds 15 – Olifants-Letaba confluence riparian surrounds	• Lethal shooting • Disturbance shooting • Fence removal • Close unnatural water
Marula North	16 –Acacia luderitzi woodlands 17 – Timbavati Acacia tortilis woodlands 18 – Mavumje riparian surrounds 19 – Sweni riparian surrounds	• Lethal shooting • Repertoire • Peppers • Acoustic • Hormonal • Rocks around trees
Marula South	20 – Upper Sabie riparian surrounds 21 – Mid Sabie riparian surrounds 22 – Lower Sabie riparian surroundsand Acacia nigrescens woodlands 23 –Pterocarpus angoniensis woodlands 24 – Acacia nigrescens woodlands 25 – Olea africana woodlands 26 – Kandiswe biodiversity hotspot 27 – Majejane Crocdile riparian surrounds 28 – Crocdile riparian surrounds, Acacia nigrascens woodlands, Sclerocarya birrea woodlands	• Lethal shooting • Disturbance shooting • Helicopter shooting • Fenced enclosures • Rocks around trees

Operational options and responses to various elephant effects follow standard operating procedures. Three key aspects influence these: 1) Policy associated with the control of damage causing animals, 2) Veterinary procedures, and 3) Policy associated with the handling of ivory.

4.2.2 Damage animal control procedures

Elephants causing damage falls into two categories – those leaving the park and posing potential threat to human life or causing damage to property including crops, and those posing threats to staff and tourists when entering rest camps or staff villages. Elephants inside the Park may also pose threats to people taking part in tourist activities such as game drives and nature walks.

4.2.2.1 Damage causing elephants inside Kruger

Elephants entering staff villages and rest camps will be chased out using several means and is the responsibility of the local section ranger. Incidences should be reported to the relevant section ranger who will then decide on the most appropriate means.

Repeat offenders, defined as an identifiable elephant that regularly enter rest camps and staff villages during the day and pose a threat to human life will be shot following approval by the Head of Department: Conservation Management. An elephant that has posed a threat to human life (*e.g.* turning over a vehicle) or caused death of a human will also be shot if the culprit can be tracked down. In this case, approval from the Head of Department: Conservation Management is required.

Elephants can be shot in self-defense when human life is endangered in the daily operations of field staff of SANParks.

In all cases, incidences are reported through the formal reporting structures of SANParks.

4.2.2.2 Damage causing elephants outside Kruger

Elephants leaving Kruger National Park at the Mozambican and Zimbabwean side of Kruger enter areas that are mostly conservation friendly land uses. Those leaving Kruger in South Africa, particularly into areas owned by local traditional communities, falls under the jurisdiction of the Local Provincial Authority.

Operational procedure. In the South African cases an agreement between SANParks, Mpumalanga and Limpopo guides responses. The complaint will be investigated by the provincial authority involved with wildlife management. Two designated officers will be dispatched to the scene. These officers will evaluate the scene based on the following criteria:

- Other possible stake holders (landowners, relevant management authorities of protected areas, relevant provincial departments or agencies)
- Number of elephants involved
- Injury or loss of life of people and livestock and damage to crops or property
- Potential danger to human lives, livestock or crops
- Human population, infrastructure and cultivated land status of the area
- Time of day
- The landscape and topography of the area

- The distance to the protected area from which the elephant came
- The general weather conditions
- Specific individual involved, *e.g.* an exceptionally large tusker

All the above factors will determine the final decision in terms of the action to be taken.

In the event of the relevant Provincial Issuing Authority not being able, for whatever reason, to respond to a specific complaint, SANParks at its discretion will act to resolve the issue after informing the relevant Provincial Issuing Authority. To this end a standing permit will be issued to selected officials, usually the relevant Section Ranger, of SANParks with the required skill and experience.

In dealing with the situation, the above-mentioned officials must consider the following options, in the sequence listed below:

a) Chase offending animals back to the protected area where they allegedly escaped from and repair of the fence to prevent animals from escaping;
b) Capture and translocation if feasible;
c) If the above two options are not feasible, killing or destrying will be the last resort.

Whatever the decision taken on the ground, it must be sanctioned by the Head of Department: Conservation Management. As soon as practical, the official involved in the action must submit a report containing relevant information to the applicable parties, *i.e.* Kruger National Park, Limpopo or Mpumalanga of the outcome of the operation.

Before animals are chased back into the Park, the persons responsible for the management of these areas must be notified of the intention to do so, as well as the date, time and place where this will take place. If required, due to the very real threat of foot and mouth disease and bovine TB and the high probability of an outbreak and the subsequent serious consequences thereof, the Kruger National Park will make one of its helicopters available to deal with the case. In the event of one of the Kruger National Park helicopters not being available, one of three local helicopter charters may be contracted to assist with cost against the Kruger National Park's account.

Jurisdiction over escaped wounded elephants. In the event of a damage causing elephant being wounded and it moves out of the area of jurisdiction of either the Management or Issuing Authority, the authority responsible for the initial action will remain the owner of the animal. Disposal of the carcass will be at the discretion of the relevant authority responsible for the action.

Compensation. In terms of the National Environmental Management: Biodiversity Act, 2004 (Act No 10 of 2004) Draft National Norms and Standards for the management of Damage-Causing Animals in South Africa, paragraph 19 state that each conservation agency may develop a compensation strategy for the payment of compensation to a person who has experienced damage caused by a damage causing-animal. Such a strategy could consider, but not limited to, the following criteria to determine under which circumstances compensation could be paid:

(a) financial cost to implement to compensation strategy;
(b) type of compensation (monetary, meat, skins);
(c) possible reduction in the occurrence of damage as a result of compensation;
(d) negligence
(e) proposed management methods already implemented;
(f) consultation with the relevant effected parties;
(g) the written agreement between the MEC of a province and the management authority of a national park, as required in terms of Regulation 3 of the TOPS Regulations; and

(i) insurance of the person who experienced the damage.

In SANParks case, compensation is primarily through making available elephant carcasses to the owner of the land on which an individual was culled.

Disposal of carcasses. The tusks will be removed. If the elephant was culled within the boundaries of a provincial or privately owned protected area, the tusks will remain the property of the Provincial Issuing Authority. If the elephant was culled outside of a protected area, the tusks will remain the property of the relevant province in which the elephant was culled.

The meat will remain the property of the owner of the land on which the elephant was culled. If the elephant was culled in a tribal area, the meat will be utilized by the local community.

4.2.3 Veterinary considerations and procedures

SANParks follow the standard operating procedures which establish guidelines for the capture using chemical capture agents, transport or maintenance in holding facilities of one or several elephant to meet an objective of SANParks. The process begins with the preparations and planning of the actions to be taken by the Veterinary and Operations staff of Veterinary Wildlife Services and ends when the task has been completed successfully and the results recorded.

These procedures affect and guide several personnel and people including Veterinary Wildlife Services, SANParks staff involved in the capture, transport or holding of animals, researchers conducting research in Kruger, private veterinarians involved in the capture, transport or holding of animals on behalf of SANParks, private game capture companies or individuals involved in the capture, transport or holding of animals on behalf of SANParks, and visitors to SANParks that are attending or happen to be present at a capture location.

4.2.3.1 Relevant policies and procedures

Several policies are relevant as follows:

- SABS 10331: 2000 South African Standard, Code of Practice, Translocation of certain species of wild herbivores, The South African Bureau of Standards
- SABS 1884 – 1: 2004 South African National Standard Holding pens for temporary housing of animals Part 1: Holding pens for wild herbivores at auctions and in quarantine facilities. Standards South Africa (a division of SABS)
- SABS 1884 – 1: 2004 South African National Standard Holding pens for temporary housing of animals Part 2: Vehicles for transportation of wild herbivores by road to holding pens and other facilities. Standards South Africa (a division of SABS) (Currently being developed)
- Elephant Management Norms and Standards as published by DEAW

These guide the operations policy of Veterinary Wildlife Services aimed at:

- That the safety of people involved in the capture, transport or holding of animals is not compromised at any time.
- That operations are planned and the techniques selected to ensure the safety and welfare of the animals.
- That the animal survives the immobilization procedure with the minimum effect on its natural behaviour or other activities.
- That the minimum amount of restraint consistent with accomplishing the task is used.
- That no capture, transport, holding or manipulation of any animals for the purposes of researches (other than where these standard operating procedures are used) is undertaken without the support of SANParks Animal Use and Care Committee.

The administration of immobilizing drugs including, but not restricted to, opioids and cyclohexylamines, and the performing of veterinary procedures are the responsibility of the responsible veterinarian for each operation.

4.2.3.2 Responsibilities

The *general manager* of VWS is responsible for ensuring compliance to this procedure as well as the detailed planning of this procedure with the assistance of other members of VWS or specialists in the handling and care of the animals to be captured and translocated that he/she deems fit to include in the team chosen to undertake the task.

The *assigned leader* of the team that undertakes the planned procedure will ensure 1) that the procedure is completed as planned and that the objectives are met; 2) that changes are made to the procedure to meet the needs of the situation that may develop when the planned actions are set in motion; and 3) that such changes are communicated clearly to all the members of capture team to enable them to complete their supportive roles in completing the procedure.

Only the *veterinarian* can administer chemical agents including immobilizing drugs, and perform veterinary procedures. They are responsible for the health and welfare of animals. *Veterinary technologists* assist veterinarians in collection and processing of biological samples as well as record keeping, while *veterinary assistants* provide operational support to the veterinarian and veterinary technologist.

An *operations manager* oversees compliance to the operational aspects of this procedure in the capture, holding and relocation operations according to SANParks strategy and policy. The *operations coordinator* implement and coordinate operations including vehicles, equipment, facilities and staff, while the *capture supervisor* implement capture and transport operations. The team also comprise a *specialist driver/capture assistant* which provide operational and driving support to the capture supervisor and operations coordinator with driving the heavy duty trucks and operating the cranes, as well as general operational support as required by the operations coordinator. *Capture assistants* provide operational support to operations coordinator and capture supervisor

SANParks make use of a *boma supervisor* that oversees operation of holding facilities, including aspects of animal husbandry and welfare to which *boma assistants* provide operational support to the boma supervisor

4.2.3.3 Preparation and planning

The preparation for the capture will be undertaken by members of the capture team (SOP 1. General principles; 1.1 Chemical capture)

4.2.3.4 Drug administration

Choice of drugs and dosages to be used. Drug combinations vary per age of individual elephants (Table 5). All doses are administered intramuscularly. A30-80 on its own gives quick knockdown time, but has a shorter effect and more unpredictable wake-up responses and is therefore given as a mixture with M99.

Table 5. Drugs used in SANParks for the immobilization and transport of elephants.

	Immobilizing drug mixture				Tranquillization		
					Administer following antidote	Tranquillizers administered as required during transportation	
	Etorphine (mg)	Etorphine/A30-80 combination	Azaperone (mg)	Top-up dart dose	Azaperone (mg)	Azaperone (mg)	Haloperidol (mg)
Adult bull	15-20	1/3 A30-80 and 2/3 M99 equivalent to M99 dose aforementioned	60	5-8mg M99 or A30-80 and 40mg Azaperone	60-80	80-120	20-30
Adult cow	9-12	1/3 A30-80 and 2/3 M99 equivalent to M99 dose aforementioned	60	5-8mg M99 or A30-80 + 40mg Azaperone	60	80-120	20-30
Sub-adult	6-9	1/3 A30-80 and 2/3 M99 equivalent to M99 dose aforementioned	60	4-6mg M99or A30-80 + 40mg azaperone	40-60	40-60	10
Juvenile	4-6	1/3 A30-80 and 2/3 M99 equivalent to M99 dose aforementioned	40	2-4 M99 or A30-80 + 20mg Azaperone mg	≤40	≤40	-
Calf	1-3	1/3 A30-80 and 2/3 M99 equivalent to M99 dose aforementioned	20	1mg M99 or A30-80	-	-	-

The dose of the drugs administered is adjusted to the circumstances in which a capture will take place. Pregnant animals may need higher doses, animals in poor condition less. The dosages in the above table are therefore guidelines.

Top-up drug administration when immobilized. Frequently during elephant captures, extended immobilization times are needed whilst elephants are loaded into the transport vehicles. The safest and most effective method is a constant infusion drip with up to 60mg azaperone and 2mg M99 infused over an hour. If a drip is not available then 0.4mg M99 (diluted solution of M99) can be administered IV every 15 minutes or to effect from 45 minutes after the initial dart was administered. A bolus of 20mg azaperone is added to the IV administration every 30 minutes. Should such frequent administration not be possible then a bolus of 1-2mg M99 is administered IV to effect – note that a lot of M99 will be used and the elephant's physiological parameters will be less constant than when using the above method. Azaperone at doses of 20mg IV can also be administered to help regulate high blood pressure and with every second M99 bolus.

Administering antidotes (IV or IM). Diprenorphine at 3 to 5 times the etorphine dose in mg. Naltrexone at 15 to 25 times the etorphine dose in mg is frequently given in combination with diprenorphine, but is considered just as effective on its own when field releases are done. When reversing elephants for transport a lower dose of naltrexone is used (5x etorphine dose) and the full diprenorphine dose to ensure a more tranquilized effect when moved to the transport crate. The same doses of diprenorphine and naltrexone are used to reverse the effects of thiafentanil.

Alternative immobilizing opioids. Thiafentanyl has been used successfully in the immobilization of elephants. Thiafentanil in combination with etorphine at a ratio of 1:3 can be used to reduce induction times in all age groups of elephants when compared to the use of etorphine only. It works very effectively as a top-up dart. Used as the primary induction agent is avoided due to shorter duration of action and unpredictable wake-up signs. Fentanyl is not recommended in adult elephants, although it has been used in combination with azaperone in juvenile animals.

Tranquillizers. Azaperone is frequently added to the drug cocktail to reduce hypertension. Only relatively small doses should be included in the dart as the immobilized animal may have difficulty standing on recovery. IV azaperone can be administered as described before. Further doses of azaperone may be given to animals in the crates following the antidote being administered. Azaperone plus haloperidol is routinely given to adult males and females prior to long distance transportation. Further doses of azaperone may be given to effect as required during the transportation of elephants. Calves that are still suckling from their mothers will probably not require any further tranquillization. Haloperidol is effective in the tranquillization of individual elephants especially those that are less responsive to azaperone, and has a more prolonged effect, up to 10 hours.

Additional drugs. Adding 1250 to 5000 IU of hyaluronidase to the immobilizing drug mixture will assist drug absorption and thereby reduce the time from darting to recumbency. Dopram can be given in 5-10ml boluses IV to stimulate depressed elephants that may have received too large a dose. Butorphanol is the new drug of choice to administer in 5mg increments to elephants that receive too high a dose of the opioid or are not responding well to the immobilization procedure – beware of awakening elephants, they are sensitive to the antagonistic effects of the drug. If oxygen is available then it can also be given to depressed elephants to improve the physiological parameters of the immobilized elephant.

Drug delivery. Elephants will be darted from a helicopter whenever possible. Be aware that darting on foot or from a vehicle is potentially more dangerous, especially if working with family groups, as it affords less control over darted animals during the induction phase. For elephant capture and translocation it is essential that all members of a family group are selected. This can be difficult in a clan formation. Avoid darting young adult males as a component of a family group as they frequently split from the group once darted. They are also aggressive to the other members of the family once in the crate. Adult bull elephant are darted individually due to the transport limitations of only 2 adult bulls at a time.

Dart the animals in the large muscle groups of the hindquarters, back or shoulders. Avoid areas in the region of the ears. Due to the thickness of the skin a dart must be placed at right angles to the body surface to ensure a deep intramuscular injection. Dart the matriarch and other dominant females first when capturing family groups. Other members of the group are only darted once these first animals are significantly affected and almost stationary. If younger members are darted too early there is an increased chance that the group will fragment during the induction phase. Dart the members of a family group in order from the oldest to youngest animals (largest to smallest); this reduces the chances of larger animals collapsing on smaller individuals.

Induction times vary from 5 to 15 minutes. Large bulls may take a longer time to become recumbent. The signs of induction in a darted animal include a slowing of pace, dropping of the head, relaxation of the penis and flaccidity of the trunk. If elephants are darted for collaring then the chosen animal needs to be kept with the group until it becomes immobilized so that any calves that are with the cow can be pushed away with the helicopter. If this is not done calves will remain at their sleeping mother and may then have to be immobilized as well to allow handling of the adult animal. Collaring operations can be done with a helicopter crew only, but requires experienced personnel to do this.

4.2.3.5 Handling of the immobilized animal

A family group that is being captured should only be approached once all animals are immobilized. The exception, are small calves (≤ 12 months), which are administered the immobilizing drugs by hand. Beware of the youngsters running away. A helicopter or runner must follow them until they become affected when they can be loaded onto a pick-up and brought back to the main group.

Immobilization may be maintained over a prolonged period using and infusion or the administration of multiple small doses of etorphine. Dose for sub-adults; 2mg etorphine / hour, constant rate infusion (e.g. saline drip infusion) or 0.4mg every 15min. for a sub-adult and adults. Lower doses are required for juveniles. Titrate dose to effect in all animals.

Elephants are obligate nasal breathers and it is essential that the trunk does not become obstructed or blocked, this is ensured by inserting a twig into the external opening of the trunk and maintaining the trunk in a straight position. Due to the shape of the thoracic cavity and the large bulk of the digestive tract elephants can only remain in sternal recumbency for relatively short period before they must be rolled onto their side. It can be extremely difficult to roll an animal into lateral recumbency, especially an adult bull, which is lying with its hind legs in the “splits” position. Take cognizance of the safety of personnel on the ground and if possible administer the full antidote dose in these cases. An immobilized animal with its head lying downhill will experience respiratory distress. In the laterally recumbent animal the top ear is folded over the eye to protect it from damage due to sunlight, dust and trauma.

Elephants usually maintain effective cardiovascular and respiratory function when immobilized. Pulse rate is monitor by palpating an artery on the back of the ear, 40 to 50 beats per min. is considered normal. Respiration should be deep and at least 6 to 8 breaths per min. in adults and faster in younger animals. Arterial blood should be “cherry” red in color. Body temperature should not exceed 41°C and an animal should be vigorously cooled with water should its body temperature start approaching these levels.

Two to five year old animals appear to be the age group most sensitive to the side effects of etorphine and are most likely to receive higher dose than required and should be monitored closely. The same applies to old and very young animals. All animals need to be marked with an identifiable number and cows and calves need to be pointed out to operations staff so that they can be loaded together. Drugs administered and samples taken need to be correlated with the elephant number for processing and accurate record keeping.

Radio collaring for research and management purposes is a frequent reason for elephant immobilization in SANParks and should be conducted by Veterinary Wildlife Services who have extensive experience in doing this work. Collars should be fitted so that they are not too loose or too tight, which is often difficult to judge when the collar is fitted to an elephant lying on its side. A long piece of cable or rod must be part of collaring equipment to pass under the elephant to pull the collar through. Elephants that cannot be placed in lateral recumbency must be collared in sternal position as quickly as possible and then given the full antidote as quickly as possible. If there is any doubt on the well-being of the elephant full reversal must be given even if the collaring procedure was not completed to ensure the well-being of the elephant.

4.2.3.6 Loading of elephants

The most difficult component of capturing and transporting elephant is lifting them off the ground onto a trailer or low bed for transportation to recovery truck. The latest method that has improved efficiency of loading is lifting elephant with straps around all four feet and a crane onto the back of a truck. A large rubber mat is placed on the truck loading bin onto which the elephants are loaded. The elephants are then strapped to the truck with straps without impeding their breathing ability. Large bulls need to have their tusks strapped to support their heavy heads when lifted off the ground upside down. It is possible to load a number of elephants onto a large truck, which can then be transported to the recovery crate together.

Larger elephants can be lifted by their feet and placed on a mat on the ground if a crane not strong enough to lift them off the ground is used. The elephant is strapped onto the mat and winched onto a tilting trailer hooked onto a 4x4 tractor. This method is also employed to recover elephant from difficult terrain where big trucks cannot get to. Elephants transported on the back of the truck on the mat must be placed so that trunks and abdomens are not obstructed by other elephant. A veterinarian and helpers need to be present at all times during transport to administer top-up drugs or partial antagonists where needed. The mat with elephant is then carefully and well-coordinated pulled off the truck into the recovery truck by the transport vehicle. Operations staff need to be fully in control of the operation as this is particular dangerous for onlookers.

Once in the recovery truck anti-dotes are given under the supervision of a veterinarian and operations staff as close together as possible to ensure elephants wake up together. It is critical to ensure that young calves are woken up with their mothers so the veterinarian darting needs to coordinate with operations staff that mothers and staff are identified early in the operation and are loaded together. A prodder must be at hand to stimulate sluggish elephant to stand up when others have already stood up. The prodder is also sometimes needed to move elephants across from the recovery crate into the transport crate. The prodder should only be used when absolutely necessary.

Only approved and inspected elephant loading and transport crates will be used if equipment other than SANParks designed and built equipment is used.

4.2.3.7 Transportation

The translocation of adult elephants requires specialized and purpose built crates. They need to be strong enough and large enough to contain the animals and yet still be within size and weight limits to travel on public roads.

The capture and loading of elephant family groups and adult bulls (≥ 2.5 m shoulder height) should only be done if necessary recovery equipment and highly skilled and experienced capture personnel are available.

Adult bulls (≥ 2.5 m shoulder height) are transported in individual crates and family groups are placed in mass crates and transported as a unit. It is essential that mothers and their calves are correctly identified and placed together. The crates for adult bulls should be of sufficient height and just wide enough to allow the animal to stand comfortably. The animal should not be able to turn around or lie down in the crate. Transport crates must allow for adequate drainage and ventilation during the journey as elephants produce large quantities of faeces and urine. Animals of similar size, especially sub-adults, should be grouped together in crates as larger animals, especially young adult males, tend to bully smaller individuals.

Elephants are very effectively tranquillized with relatively low doses of azaperone. A single dose of azaperone is usually effective for two hours and, therefore, animals should be monitored every two hours. Very young calves (small enough to fit under their mother's stomach) seldom need tranquillization. Haloperidol is used as an effective tranquillizer in those animals that become refractory to the effects of azaperone. It is also used to tranquillizers individuals for longer periods of time, up to 10 hours.

Elephants will seldom drink or eat when being transported, even over long distances. However, in extremely hot weather or on prolonged journeys animals must be cooled with water and offered water to drink.

Any animal that dies should be removed from the transport/wake-up crate where possible as it will influence the behavior of the other animals in the crate during transportation. They will not move away from the carcass.

The administration of tranquillizers should be done 30 minutes prior to off-loading. Tranquillize the matriarch and other adults and sub-adults with azaperone and if necessary haloperidol. Trilafon and acuphase can successfully be used at low doses to ensure tranquilization for longer periods (days) but no tranquilization will prevent elephants that are determined to break out of a boma or fences. Known fence breakers should therefore not be selected for translocation.

4.2.3.8 Maintenance in holding facilities

At the point of destination, elephants should be off-loaded into a secure boma, one hectare in size and surrounded by a multi-stranded electric fence, which has been strengthened by cables. House elephants in these facilities for a maximum of 12 hours to allow them to settle down, re-establish family bonds and become exposed and conditioned to electric fences. Animals that are kept for longer periods tend to break out of the boma as they are bored and hungry. Elephants are highly social animals and should preferably not be housed separately.

It is essential that they have access to grazing, browse and fresh water; the water should be provided in abundance, as they will use this for spraying themselves and cooling off as well**.** Provide shade in the form of large trees. The enclosure should be well designed and managed to contain the animals and to minimize exposure to stressful factors from the surroundings. Large trees should be removed from the inside of the boma close to the fence as elephants can push them over and created an electrical short and facilitate breakouts. Habitual fence breakers are almost impossible to contain in any fenced area if the elephant is determined to break out, even under heavy tranquilization. It is therefore stressed again to avoid translocating known fence breakers.

4.2.4 Handling of ivory procedures

Elephant tusks and ivory pieces found and collected during patrols and management activities taking place throughout the Kruger National Park need to be handed in at the Game Processing Plant office/vault for proper recordkeeping. It is imperative to manage this ivory properly by law in terms of marking the ivory with CITES numbers and reporting annually to the Department of Environmental Affairs. Management also refers to the legal sale of ivory to South African citizens.

SANParks ivory handling procedure makes provision for the safeguarding of ivory from the time of the animal's death or discovery thereof until the sale of the products. Ivory which are being exhibited (*e.g.* Letaba Elephant Hall), is the responsibility of the person in charge of the stock in the building where these items are being exhibited.

4.2.4.1 Sale of Ivory

Standard operating procedure. Any interested party wishing to purchase ivory from SANParks is required to send their written application or an "offer to purchase", along with all the relevant contact and purchase details, to the Managing Executive, Kruger National Park for perusal and submission to the Manager, Game Processing Plant, Skukuza for further handling. Once a written application or "offer to purchase" has been received by the Manager, Game Processing Plant from the Managing Executive, the Manager Game Processing Plant must ensure that all the interested party's personal details (ID number, full names and address) as well as the specifications of the ivory (*e.g.* 5kg complete tusk, or a piece less than 1kg) have been recorded. As soon as the personal details are obtained, these should be sent to the Head Corporate Investigation Services for verification. Should any inconsistencies be found or queries needing further attention the request will be placed on hold pending the outcome of the verification process. During this phase of the request no agreement will be discussed, entered into or financial value of the ivory discussed with the interested party.

After the verification process has been completed and a recommendation to continue with the process has been received from Corporate Investigation Services, the Game Processing Plant Manager will complete an official "Request for authorization form". This form will include the interested party's personal details along with his financial offer and ivory specifications. The "Request for authorization" form should then be forwarded to the Head of Department Conservation Services, Kruger National Park for perusal and recommendation. The authorization request should then be sent to the Managing Executive, Kruger National Park for perusal and recommendation prior to the document being forwarded on to the Chief Executive of SANParks for final approval of sale.

Invoicing and Payment. After final approval has been granted by the Chief Executive, SANParks, an official SANParks tax invoice, with all relevant details, will be handed over or sent to the purchaser for payment. All moneys derived from ivory sale must be paid into the specific SANParks Special Project account. A SANParks tax invoice will be completed with all the relevant details relating to the purchaser and the ivory being purchased. Confirmation of payment will take place twice. Once through the proof of payment deposit slip made by the interested party and the second confirmation will be from Head Office once the funds show in the Special Projects account.

Permits. As soon a confirmation of payment has been received from the purchaser, an application for the necessary Permits can proceed. If the purchaser's residential address is anywhere other than in the Mpumalanga Province, Export Permits out of the Province and or transport permits for the respective province/s through which the buyer needs to travel should be requested from the respective offices or Mpumalanga Tourism and Parks Board by the purchaser. The relevant Veterinary Permit will be obtained for any animal product leaving the park boundaries. This permit is obtained from the State Veterinary Services Department within the Kruger National Park. Note that international visitors may not purchase ivory in which case CITES rules apply.

A "Controlled Item" permit must also be obtained from the Kruger National Park Protection Services department before the ivory can be removed from the Kruger National Park. An official "Ownership Letter" must be obtained from the Kruger National Park Managing Executive's office. This letter will confirm the purchasers details and the CITES requirements for the ivory. A form will be drawn up for the "confirmation of receipt" of ivory.

Collection of ivory. The purchaser must make prior arrangements for the collection of ivory. The collection of ivory will be carried out at the Game Processing Plant warehouse in Skukuza. During this collection process, the purchaser will supply his vehicle registration number in the entry control book at the warehouse. The purchaser will receive the original invoice, ownership letter and permits. The new owner will then sign the confirmation of receipt of ivory form, for SANParks record purposes.

Should the owner send a representative to collect the ivory on his/her behalf, that person must have a permission letter from the owner stating the collectors name and ID number (all procedures will apply to the collector of the ivory).

In the case whereby ivory must be sent to the purchaser via the South African Postal service, the parcel will include the “proof of receipt” of ivory along with all the relevant documentation as describe. The Proof of Receipt form must be signed by the owner and faxed or posted to the office of the Game Processing Plant manager for filing.

Administration. The office of the Game Processing Plant manager will keep copies of all the documentation as well as hard copies of any email correspondence and a copy of the purchaser’s identity document. Each new owner or interested party’s details will be recorded and kept on file. The Manager: Game Processing Plant will ensure that an entry is made in the appropriate Ivory Register relating to the sale of the ivory and cross referencing to the appropriate invoice number and client record.

Security. Upon exiting the park, the security personnel must carry out a verification process of the ivory. The permits must be verified with the actual CITES numbers on the tusks or pieces of ivory. Those numbers must be recorded in the “Incident report” book. Security staff must phone the Game Processing Plant manager to confirm the ivory leaving the park. The purchaser must not be allowed to leave the park unless the process as describe has been confirmed.

4.2.4.2 Monitoring and Evaluation

Recordkeeping is done by means of transfer documentation and copies kept by both parties involved in sales agreements. Electronic data records are kept by the Manager: Game Processing Plant. Photographic records of Ivory intake are kept by the Manager: Game Processing Plant. CITES numbers are punched into Ivory pieces (where possible). The Ivory vault is fitted with Close Circuit Television cameras and an alarm system which is monitored by Protection Services, Chubb Security and Corporate Investigation Services. Evaluation of the potential buyers is done by Corporate Investigation Services. Invoice and payments are monitored by the Manager: Game Processing Plant.

4.2.4.3 Roles and Responsibilities

The *Manager: Game Processing Plant* is responsible for checking, receiving and transfer documentation by relevant section rangers when ivory is received. This include weighing, measuring, marking and cleaning of ivory before storage. The manager ensures safekeeping of the Ivory stockpile, record keeping of ivory in the form of stockpile registers, and perform correspondence with the potential buyer, including invoices, payments, collection, permits and all administration of the process. The manager is also responsible for submitting motivations for sale authorizations and associated recordkeeping of all necessary documents including correspondence with account manager regarding payments.

The *Head of Corporate Investigation Services* is verification and approval of potential buyer. *The Head of Department: Conservation Management* monitor and evaluate performance of the Manager: Game Processing Plant and scrutinize and recommend motivations for sale. The *Managing Executive: Kruger National Park* also scrutinize and recommend motivations for sale, while the *Chief Executive: SANParks* provide approval of motivational documents.

Protection Services is responsible for verification of permits including number of pieces as well as the CITES numbers. After confirming with the Manager: Game Processing Plant of the sale, they can issue a removal permit.

4.2.4.4. Budgetary and Operational Implications

The Game Processing Plant's operational budget will cover all the other expenses regarding the intake and safekeeping of ivory. The Game Processing Plant budget will also be responsible for the building of transportation crates for the ivory sold.

4.3 Achieving Objective 3

"To align SANParks' Elephant Management Plan with co-management and contractual agreements by revisiting existing and establishing new agreements with stakeholders and affected parties where appropriate"

Kruger National Park is embedded in a complex landscape of three primary land uses – traditional local rural communities with persistence farming, ecotourism and commercial farming. As a result several stakeholders influence and/or are influenced by elephants and how SANParks manage elephant impacts.

Local community concerns

A number of local rural communities, Mozambican, Zimbabwean and South African, live around Kruger National Park. These communities are directly influenced by how SANParks manage elephants and their affects on other values, particularly human-elephant interactions and damage caused by elephants to livelihoods.

Private land owners

Several private landowners abut the Kruger National Park in South Africa, Mozambique and Zimbabwe. These affect SANParks' management of elephants and their impacts, while private land owners may themselves be affected by elephants and their impacts as well as how SANParks manage elephants and their effects on other values such as tourism experiences or commercial farm production.

Eco-tourism operations (both SANParks and other operators)

SANParks will conduct actions that will contribute to SANParks' tourist experiences and thereby enhance a user-stakeholder relationship. Kruger has an extensive and well developed infrastructure for tourists that include a variety of experiences. The existing infrastructure and financial demand on tourism revenue creates expectations that may contrast biodiversity outcomes. SANParks accommodate these expectations.

Several concessionaires already make use of Kruger National Park, both as private game lodges within Kruger and as game drive operators from outside Kruger. In addition, SANParks wish to provide specific opportunities for local communities to develop tourism opportunities. However, these need to be conducted in a way that does not affect the primary mandate of SANParks *i.e.* the protection of biodiversity.

Management actions to address elephant - stakeholder requirements, specifically local community concerns (LCC), private landowner concerns (PL), SANParks' concessionaires and other tourism operators (C&O). Evaluation is through Annual (AR) or Science (SR) Reports.

No.	Action	Target mechanism	Operational Target	Evaluation	Kruger Management Plan Reference
3.1	Establish elephant management discussion groups as part of Park Management Forums	LCC, PL	2012	AR	Stakeholder Relationship Management Programme Communications Strategy
3.2	Inform local communities, private landowners and concessionaires about the Kruger Elephant Management Plan	LCC, PL, C	2012	AR	Stakeholder Relationship Management Programme Environmental Education and Interpretation Programme Communications Strategy
3.3	Inform local communities about human-elephant conflict, damage-causing elephants and how to minimize threats	LCC	2012	AR	Stakeholder Relationship Management Programme Environmental Education and Interpretation Programme Communications Strategy
3.4	Provide regular feedback through the elephant management discussion groups on progress of SANPark's implementation of the Kruger Elephant Management Plan	LCC, PL, C	Annual	AR	Stakeholder Relationship Management Programme Communications Strategy
3.5	Evaluate the perception of local communities and private landowners with regards to how SANParks manage elephants and their effects on other values	LCC, PL	Bi-annual	SR	Stakeholder Relationship Management Programme
3.6	Relate local community and private landownders perception to SANParks actions	LCC, PL	Bi-annual	SR	
3.7	Re-view existing contractual agreements with communities and private landowners, where appropriate	LCC, PL	2012	AR	Stakeholder Relationship Management Programme
3.8	Ensure that existing co-management agreements are aligned with the Kruger Elephant Management Plan	LCC, PL	2012	AR	Stakeholder Relationship Management Programme
3.9	Participate in the establishment of further appropriate co-management agreements with other local communities and private landowners in alignment with the Kruger Elephant Management Plan	LCC, PL	As needed	AR	Stakeholder Relationship Management Programme
3.10	Implement co-management and contractual agreements	LCC, PL	Bi-annual	AR	
3.11	Ensure that tourists have an opportunity to view wildlife	T	2012	AR	Sustainable Tourism Programme
3.12	Evaluate the experience of tourists visiting Kruger National Park	T	Bi-annual	SR	Sustainable Tourism Programme

No.	Action	Target mechanism	Operational Target	Evaluation	Kruger Management Plan Reference
3.13	Relate tourist experience to SANParks elephant management actions	T	Bi-annual	SR	
3.14	Establish concessionaire and other tourism operator elephant management discussion forums	C&O	As needed	AR	Stakeholder Relationship Management Programme Sustainable Tourism Programme Communications Strategy
3.15	Provide opportunities for local communities to develop elephant-based tourism opportunities	C&O	Bi-annual	SR	Tourism Programme
3.16	Review existing contractual agreements with concessionaires and local communities	C&O	2012	AR	Sustainable Tourism Programme
3.17	Ensure that existing contractual local community and concessionaire agreements are aligned with the Kruger Elephant Management Plan	C&O	2012	AR	Sustainable Tourism Programme
3.18	Establish contractual agreements with other concessionaires and local communities	C&O	As needed	AR	Sustainable Tourism Programme
3.19	Ensure that other contractual local community and concessionaire agreements are aligned with the Kruger Elephant Management Plan	C&O	As needed	AR	Sustainable Tourism Programme
3.20	Implement tourism contractual agreements	C&O	Bi-annual	AR	Sustainable Tourism Programme
3.21	Evaluate the experience of concessionaire- and community-based tourists visiting Kruger	C&O	Bi-annual	SR	
3.22	Relate concessionaire- and community-based tourist experience to SANParks' elephant management actions	C&O	Bi-annual	SR	

4.3.1 Anti-poaching procedures

Although incidences of elephant poaching is low in Kruger, SANParks have an established structure in place based on activities to curb rhino poaching. The strategic directives focus on pro-activeness (lobbying political support, intelligence gathering and increased area coverage both in time and space); improved reactive responses (rapid response capacity in ranger corps and hot pursuit concessions); and coordination (Rangers, Conservation Management and Corporate Investigation Services).

4.3.1.1 Political Lobbying

It is considered critically important to lobby political support. The support of the ministers dealing with environmental issues should be lobbied to increase anti-crime operations in the area of the TFCA. The Department of Home Affairs should also support the cross-border activities needed to bring syndicated criminals to book which target rhino in the TFCA.

4.3.1.2 Concessions for cross-border operations

The lack of cross-border concessions for Rangers was identified as a critical shortcoming in current operations. Concessions to operate across the border will be on condition that all other protocol is observed before crossing the border, *e.g.* informing Home Affairs, Border Police, obtaining permission from the Acting Managing Executive and the Chief Executive Officer. Section Rangers must at all times work in close co-operation with Corporate Investigation Services for all cross-border operations.

4.3.1.3 Team/support structure – weekly meetings

A Tactical Task Team formed for rhinos provide the same structure that can be used for elephants if poaching incidences increase. This team provides support to operational teams and evaluate tactics. The Team typically meet on a weekly basis to get feedback of the progress, successes and areas of concern where additional support is needed. Debriefing meetings are held with all involved after each anti-poaching operation to evaluate the success/shortcomings/progress.

4.3.2 Threats and security procedures

Matters relating to the security of elephants are dealt with in section 4.3.1 as part of anti-poaching operations. Threats and safety associated with elephants are primarily covered under section 4.2.2 on controlling damage causing elephants.

SANParks, however, seek to be pro-active and provide guidelines at gates to visitors as well as staff villages to staff in how to behave specifically in a vehicle to elephants.

4.4 Achieving Objective 4

"To align SANParks' and Trans Frontier Conservation Area Elephant Management Policies"

Kruger National Park forms an integral part of the Greater Limpopo Transfrontier Conservation Area. The Greater-Limpopo is in early stages of development and trilateral agreements between South Africa, Mozambique and Zimbabwe have recognized that elephant management is a key aspect. SANParks will address these requirements.

Management actions to accommodate Transfrontier Conservation Area needs

No.	Action	Operational Target	Evaluation	Kruger Management Plan Reference
4.1	Review the available information on elephants, their impacts and conflicts with humans in the Greater-Limpopo TFCA region	2012	SR	Transfrontier Conservation Area Programme
4.2	Facilitate through the Greater-Limpopo Joint Management Board the establishment of a panel to develop an Elephant Conservation and Management Policy for the Greater-Limpopo TFCA	2012	AR	Transfrontier Conservation Area Programme
4.3	Participate in and prepare an Elephant Conservation and Management Policy for the Greater-Limpopo TFCA	2013	AR	Transfrontier Conservation Area Programme
4.4	Ensure that the Kruger Elephant Management Plan and the Elephant Conservation Management Policy for the Greater-Limpopo TFCA are aligned	2013	AR	Transfrontier Conservation Area Programme Biodiversity Management Programme
4.5	Implement the Greater-Limpopo Elephant Conservation and Management Policy	Bi-annual	AR	Transfrontier Conservation Area Programme

4.5 Achieving Objective 5

"To evaluate, inform and revise elephant management through collaborative monitoring efforts and research agreements"

Several management actions are directed at measuring responses to an action. This is embedded in the Strategic Adaptive Management Approach adopted by SANParks. In addition, several of these actions require information that is not readily available and need specific research questions to be answered.

Management actions to monitor and inform the progress of SANParks with elephant management

No.	Action	Operational Target	Evaluation	Kruger Management Plan Reference
5.1	Develop an integrated annual monitoring programme which addresses elephant demography, impact, conflict and consequences for stakeholders	2012	SR	Biodiversity Management Programme
5.2	Implement the integrated monitoring programme	Annual	SR	Biodiversity Management Programme Research Programme
5.3	Provide monitoring report	Annual	SR	
5.4	Develop an integrated research programme which addresses elephant demography, impact, conflict and consequences for stakeholders	2012	SR	Research Programme
5.5	Implement the research programme	Annual	SR	Research Programme
5.6	Provide research report	Annual	SR	Research Programme
5.7	Provide summarized recommendations	Annual	SR	Biodiversity Management Programme Research Programme

4.5.1 Monitoring approaches and guidelines[109]

SANParks' Framework for Biodiversity Monitoring guides the structure and development of the Biodiversity Monitoring System (BMS) for SANParks. The BMS provides strategic direction for investment in this core component of biodiversity conservation and management. Several approaches available for categorizing the multitude of monitoring requirements were considered in the development of the BMS, and 10 Biodiversity Monitoring Programmes (BMPs) were selected that provide broad coverage of higher-level biodiversity objectives for parks. A set of principles was adopted to guide the development of BMPs, and data management, resource and capacity needs will be considered in the process.

Monitoring of elephant management actions are diverse given the mechanisms-based approach used. This plan thus makes use of the Biodiversity Mechanisms Directives Monitoring Programme (BMDMP) to provide guidance that makes use of a mechanistic approach to define the causal basis of the underlying drivers and modulators giving rise to a management concern. It then goes on to develop predictions from the defined mechanisms and use risk assessment approaches to define the most appropriate action for SANParks. The BMDMP monitors the implementation of these actions, as well as the consequences thereof, evaluates predictions and provides learning about the mechanism through which an aspect, element or feature influence SANParks in achieving its mandate. This allows direct feedback to conservation managers with new insights about the causal basis of how a particular ecosystem component influences objectives, allowing refinement of conservation actions if required.

Within this context the information needs of SANParks with regards to elephant management in Kruger National Parks requires evaluation of elephant population temporal (annual helicopter-based total counts[110] and demographic profiling[111]) and spatial dynamics (distribution and focal collared elephants). These focus on the response of elephants.

At the same time SANParks will measure vegetation responses using appropriate vegetation techniques (note that specific techniques is case specific) directed at measuring vegetation structure as well as composition. SANParks, however, will also make use of social surveys to evaluate tourism experiences as well as stakeholder perceptions.

A major aspect imposed by the mechanisms-based approach is that SANParks will explicitly link measures to the various conservation management actions. This takes the form of an adaptive management experiment with changes in measures associated with effects of management actions the key purpose of collecting information. Results will then serve to inform SANParks of the success of management actions in achieving objectives.

[109] Extracted from SANParks 2011
[110] Whyte *et al.* 2003
[111] Ferreira & van Aarde 2008

5. Reporting

SANParks will make use of two kinds of reporting. Annual reports will be used to evaluate active conservation management actions against the time frame highlighted for each action. This type of reporting will form part of the formal performance review system of SANParks and will be measured against the Key Performance Areas of the Managing Executive; Kruger National Park.

Science Reports will be used for information and generate actions and will be measured against the Key Performance Area of the Managing Executive: Conservation Services. These reports will require internal peer-review and at intervals, associated with Section 5, external reviews.

Actions to report on the progress with implementation of SANParks' elephant management plan

No.	Action	Operational Target	Evaluation
1	Establish Key Performance Criteria in Managing Executive's (KNP and Conservation Services respectively) Balanced Score Cards	2012	AR
2	Establish standard Annual Report formats	2012	AR
3	Establish standard Science Report formats	2012	AR
4	Evaluate reporting and performance	Annual	AR

6. Management Plan review and variance

The Norms and Standards Regulations released by the Minister require an Elephant Management Plan for each Park to be prepared by an elephant ecologist. The Large Mammal Ecologist for SANParks is responsible for this function. However, SANParks will establish an Elephant Management Advisory Committee comprising of an elephant population expert, elephant behaviour expert, biodiversity impact expert, human interaction expert, ethics expert and SANParks liaison. Membership will be on a short-term basis with half of the members replaced every 5 years. Maximum membership is 10 years.

The SANParks Elephant Management Advisory Committee will have the primary role of providing an interim evaluation of the achievement of Elephant Management Objectives at 2 year intervals. Every 5 years the Advisory Committee will provide an extensive review of how SANParks perform in achieving Elephant Management Objectives. After 10 years, the Advisory Committee will facilitate an external review directed at revising the Elephant Management Plan for Kruger National Park if needed.

Actions to evaluate and vary the Elephant Management Plan

No.	Action	Operational Target	Evaluation
1	Establish the Terms of Reference for an Elephant Management Advisory Committee	2012	AR
2	Establish an Elephant Management Advisory Committee	2012	AR
3	Ensure interim review of the Management Plan by the Advisory Committee	Bi-annual	AR
4	Ensure an extensive review of the Management Plan by the Advisory Committee	2016	AR
5	Ensure an extensive external review of the Management Plan by the Advisory Committee	2021	AR
6	Revise the Elephant Management Plan according to recommendations	2021	AR
7	Implement the revised Elephant Management Plan	2022	AR

7. Budget (Estimated for the lifetime of the plan – 2011 to 2020)

Implementation

Strategic Action	Operational Action	Objective	Operational	Capital	Personnel	Total
			Budget (ZAR)			
Management	Managing impact, damage and human interactions	To implement management actions of Objective 1	8,169,000[112]	-	-	8,169,000
	Managing historic and lag effects	To implement management actions of Objective 2	17,634,000[113]	-	-	17,634,000
	Managing stakeholder and affected parties	To implement management actions of Objective 3	3,134,000[114]	-	-	3,134,000
	Managing transfrontier policies	To implement management actions of Objective 4	817,000	-	-	817,000
Communication	Science Management Forum	To ensure robust science underpins management and implement part of management actions of Objective 5	327,000	-	-	327,000
	Elephant Advisory Committee	To ensure external evaluation and implement part of management actions of Objective 5	817,000	-	-	817,000
Sub-total			**30,898,000**	**-**	**-**	**30,898,000**

Monitoring

Strategic Action	Operational Action	Objective	Operational	Capital	Personnel	Total
			Budget (ZAR)			
Elephant demography	Evaluating, informing and revising management	To establish predictive models and test the outcomes of various management scenarios by defining demography and how landscapes and elephant density influence these.	332,000	149,000	265,000	746,000
Elephant spatial use	Evaluating, informing and revising management	To establish the intensity with which elephants use landscapes by defining spatial use, the factors influencing spatial use and how density alters these factors.	776,000	654,000	310,000	1,740,000
Biodiversity consequences	Evaluating, informing and revising management	To evaluate how the change in composition structure and function in the ecosystem associated with elephant intensity of use.	1,634,000	327,000	1,307,000	3,268,000
Sub-total			**2,742,000**	**1,130,000**	**1,882,000**	**5,754,000**

Research

Strategic Action	Operational Action	Objective	Operational	Capital	Personnel	Total
			Budget (ZAR)			
Elephant dynamics	Landscape effects on elephant demography	To evaluate how landscapes with different water availability and geographical features affect elephant demography.	100,000		150,000	250,000
Biological Impact	Elephant and fire as drivers of change in Kruger	To evaluate the relative importance of fire and elephants in explaining variation in biodiversity.	30,000		150,000	180,000
	Elephant impacts along rivers in Kruger	To evaluate the short to medium terms consequences of changes in elephant intensity of use close to rivers.	100,000	28,000	150,000	278,000
	Mechanisms of bull spatial use in Kruger and associated impacts	To evaluate the potential differential role that bulls may play in affecting other biological values.	164,000	200,000		364,000
	Mechanisms of local impacts by elephants in Kruger	To evaluate local scale impacts of elephants.	100,000	28,000	150,000	278,000
	Restoration constraints of elephant impacts	To evaluate the relative importance of elephants as agent of change and other herbivores of controllers of change.	150,000	300,000	150,000	600,000
Stakeholder impacts	Human-elephant interactions in the conflict, economic and demographic profile of Kruger neighbours	To describe the human-elephant interaction profile in traditional, private and commercial communities abutting Kruger National Park.	200,000		150,000	350,000
Sub-total			**844,000**	**556,000**	**900,000**	**2,300,000**

Total			**34,484,000**	**1,686,000**	**2,782,000**	**38,952,000**

[112] Estimated costs for the removal of fences, earthen dams and management of water supply
[113] Estimated costs for the exclusion of elephants, removal through translocations and upgrade of facilities to process specimens from localized reactive culling
[114] Estimated operational costs for community beneficiary programmes and stakeholder forums

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