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IMPORTANT

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REPUBLIC OF SOUTH AFRICA

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GENERAL NOTICES • ALGEMENE KENNISGEWINGS

DEPARTMENT OF ENVIRONMENTAL AFFAIRS

NOTICE 1190 OF 2015

NATIONAL ENVIRONMENTAL MANAGEMENT: BIODIVERSITY ACT, 2004
(ACT NO. 10 OF 2004)

BIODIVERSITY MANAGEMENT PLAN FOR THE AFRICAN LION (*PANTHERA LEO*)

I, Bomo Edith Edna Molewa, Minister of Environmental Affairs, hereby publish the Biodiversity Management Plan for the African Lion (*Panthera Leo*) in South Africa for implementation in terms of section 43(1)*(b)(i)* read with section 43(3) of the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004), set out in the Schedule hereto.

BOMO EDITH EDNA MOLEWA
MINISTER OF ENVIRONMENTAL AFFAIRS

SCHEDULE


BIODIVERSITY MANAGEMENT PLAN FOR THE LION (Panthera leo) IN SOUTH AFRICA
environmental affairs
Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA
BIODIVERSITY MANAGEMENT PLAN
CSIR
our future through science
PANTHERA
LEADERS IN WILD CAT CONSERVATION

2015-2019

Jointly developed by Dr Paul Funston (Panthera), the CSIR and DEA

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EXECUTIVE SUMMARY

The wild African lion (*Panthera leo*) is the largest African cat and the only feline that is social living in prides that average twelve individuals, but may reach more than thirty. Across their African range lions have declined alarmingly over the last several decades especially in west, but also east Africa. In southern Africa lions are largely stable and have increased with the inclusion of large conservancies in Zimbabwe and over 45 smaller reserves in South Africa. Available data indicates that between 32 000 and 35 000 free-ranging lions live in 67 lion areas (Riggio et al. 2013)

Lions were extirpated from most of their range in South Africa by the 1900s, with historic populations remaining in only Kruger National and Kgalagadi Transfrontier Parks. Today just over 2 300 wild lions are well protected in these and other large national parks and game reserves, with all populations either stable or increasing. Over the last three decades lions have also been re-introduced into over 45 smaller reserves with a total population of what are termed the 'managed wild' lions of about 800 individuals. The management of these lions is challenging, with high growth rates necessitating appropriate population regulation, and the potential for inbreeding due to isolation and small population size in the respective reserves.

The reasons for the decline in lions in Africa are many, and include habitat loss and conversion, indiscriminate killing to protect life and livestock, prey base depletion, bush meat trade, and excessive sport hunting. Because all lions in South Africa are within largely adequately fenced reserves with sufficient management budgets, most of these threats are not imminent to lions here, although lion numbers continentally have decreased by about 30% over the last three decades. Threats to the wild lions currently are generally low. Risks of genetic impoverishment of managed wild lions are low and easily mitigated through robust management interventions, while the lion bone trade may shift from its current base in captive lions to the poaching of wild lions for body parts.

The lion is listed as Vulnerable on the IUCN Global Red List. It is also listed as Vulnerable on the South African list of Threatened and Protected Species (ToPS) in terms of Section 56 (1) of the National Environmental Management Biodiversity Act, 2004 (Act No 10 of 2004). Furthermore it is protected under Appendix II of the Convention on the International Trade in Endangered Species of Wild Fauna and Flora (CITES).

Lions can only exist in areas with sufficient wild prey, and seldom co-exist closely with people. Lions readily adapt to varied habitats and generally have greater hunting success in areas with long grass or dense cover and on moonless nights. Lions select landscape features that aid hunting and kill most of their prey within two kilometres of water. Density and survival rates of lions are positively correlated with prey biomass. Most lions reside in territories with some lions being nomadic. Coalitions of males try to keep other male lions out of their territories, while lionesses try to exclude other prides, which does result in some mortality from inter-pride conflict. An average pride consists of twelve lions, including four to five adult lionesses, two pride males, and

dependent cubs and sub-adults. Lionesses tend to breed synchronously and female relationships do not rely on dominance hierarchies.

Lions favour medium to large-sized prey species with an average body mass of 190–550 kg, and tend to prey on the most common of these species in each area. Rainfall and habitat conditions strongly affect the susceptibility of various prey species to lion predation: lions switch both within and between seasons, thus not selecting for the same prey species or sex all the time. Lions tend to regulate prey populations in large parks, but sometimes negatively affect them in small, fenced reserves.

In South Africa lions are exposed to six major viral diseases, with only canine distemper virus being known to have any major influence on them. Most lion populations appear to be exposed to feline immunodeficiency virus. Lions in Kruger National and Hluhluwe-iMfolozi Parks are infected with bovine tuberculosis. Although there may not be consensus yet on its effect, no major consequences have been detected. On-going studies to determine how this exotic disease affects lions are under way.

Lions are sensitive to excessive harvests because the removal of pride males through hunting often results in infanticide by other males and mortality of dispersing sub-adults forced out of the pride when too young. The trophy hunting of lions is contentious due to uncertainty concerning its conservation impacts and due to the dichotomy of stakeholder views. The captive lion hunting industry has grown rapidly in South Africa while the number of wild lions hunted in other African countries has declined. No negative effects of trophy hunting on wild lion populations in South Africa have been identified. There is intense controversy over the merits and ethics of the captive breeding and subsequent release for hunting of captive bred lions, although it remains legal to do so.

There are substantial economic advantages to many South African societies that accrue from the conservation and use of lions. At times communities bordering protected areas incur stock losses due to lion predation. Fortunately, largely due to adequate fencing, this is not as serious an issue as in other parts of Africa, and park authorities have funds and capacity to deal with this issue.

There are several role player groups well placed to influence the future of lions in South Africa. This Biodiversity Management Plan (BMP) was developed in close consultation with an encompassing group of stakeholders. The first workshop in June 2013 identified the vision, objectives and actions, and the second in March 2014 assigned responsibilities to implementing agencies and refined the monitoring plan. This is the first national BMP compiled for lions in South Africa.

When the objectives for lion conservation in South Africa were developed, important and clear distinctions between the objectives for wild, managed wild and captive lion populations were made. These respective populations are defined as follows:

1. **Wild lions** completely fulfil their role in biodiversity processes and are largely unmanaged, and exist only in formally proclaimed national parks and game reserves. Conservationists do not actively manipulate vital rates and lion demographics.
2. **Managed wild lions** include all lions that have been re-introduced into smaller fenced reserves (<1000km^2), and are managed to limit population growth and maintain genetic diversity. Managers

actively manipulate some vital rates and demographics.

3. **Captive lions** are bred exclusively to generate money. Managers actively manipulate all vital rates and demographics.

A specific set of actions was defined for each objective. Lead agents or groups were then assigned to each action, to ensure that the lines of responsibility for action are clear. It was proposed that SANParks, supported by Ezemvelo KZN Wildlife and the Lion Management Forum (LiMF), (a group of interested parties which get together to discuss the status of lion in South Africa and collaborate in developing better management strategies for the important fenced populations), should be the lead agents for wild and managed wild lions. Furthermore it was proposed that DEA establish a forum or working group to guide the implementation of the lion BMP. DEA will develop Terms of Reference for the forum, perform the administrative duties and make appointments.

The vision for the South African lion population is that:

Through the existence of stable, viable and ecologically functional populations of wild and managed wild lions, along with well-managed captive populations that have minimal negative conservation impacts, lions will provide key opportunities for biodiversity conservation, economic development, social benefits and improved management capacity.

Objective 1

Improve the conservation status of lions within a broader conservation context.

***Sub-objectives*:**

1.1. Maintain the current degree of protection of wild and managed wild lions;

1.2. Reassess the conservation status of lions in South Africa;

1.3. Enhance the conservation status of managed wild lions; and

1.4. Assess the management of the captive lion population.

Objective 2

Develop and implement effective communication tools that are informed by scientific research. (Communication, Education, and Public Awareness)

Sub-objectives:

2.1. *Maximise the educational and research opportunities derived from lions*

Objective 3

Ensure legislative alignment both provincially and nationally and improve capacity to implement legislation effectively.

Objective 4

Establish a lion forum or working group to assist in the implementation of the BMP

Objective 5

Ensure the alignment of this BMP with lion conservation plans in neighbouring countries and link with international working groups.

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Figures and Tables

LIST OF ACRONYMS

AGM	Annual General Meeting
BMP	Biodiversity Management Plan
BMP-S	Biodiversity Management Plan for Species
bTB	Bovine tuberculosis
CBD	Convention on Biological Diversity
CDV	Canine Distemper Virus
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CSIR	Council for Scientific and Industrial Research
DAFF	Department of Agriculture, Forestry and Fisheries
DEA	Department of Environmental Affairs
DRC	Democratic Republic of the Congo
ECNC	Eastern Cape Nature Conservation
FIV	Feline Immunodeficiency Virus
GNC	Gauteng Nature Conservation
HiP	Hluhluwe-iMfolozi Park
IUCN	International Union for the Conservation of Nature
KZN	KwaZulu-Natal
LiMF	Lion Management Forum
LPTB	Limpopo Parks and Tourism Board
MTPA	Mpumalanga Tourism Parks Agency
NCNC	Northern Cape Nature Conservation
NDF	Non-detriment finding
NEMBA	National Environmental Management Biodiversity Act, 10 of 2004
NWPTB	North-West Parks and Tourism Board
SADC	Southern African Development Community
SANBI	South African National Biodiversity Institute
SANParks	South African National Parks
SSC	Species Survival Commission
ToPs	Threatened or Protected Species

1 INTRODUCTION

The African lion (*Panthera leo*) is the largest African member of the genus *Panthera*, weighing up to about 230 kg, and is followed in size by the leopard (*Panthera pardus)*. The African lion is confined to the African continent, with Indian lions belonging to a different subspecies (*Panthera leo persica*). The lion is a highly charismatic member of the megafauna of Africa and is the only cat species that is conspicuously social (Schaller 1972). African lions were largely eradicated from vast areas of Africa for agricultural development in the last century, and have started to show alarming declines in the last few decades (Bauer *et al*. 2008; Packer *et al*. 2013). The current extent of free-ranging lion populations is 3.4 million km2 or about 25% of the savannah (Riggio *et al*. 2013). Although the estimates are not absolute, it is unlikely that more than 32 000 to 35 000 wild lions exist (Riggio *et al*. 2013), with about 3 000 (about 10% of the continental population) occurring in South Africa. Additionally about 6 000 lions exist in captivity in South Africa, bred largely for hunting and other tourism activities (Taljaard 2009; Lindsey *et al*. 2012a; PHASA 2013). The African lion plays a key role in the ecological functioning of the African ecosystems, but also provides key challenges when they come into conflict with other land uses like stock farming. African lion is a flagship species for tourism in South Africa.

1.1 Why the lion (*Panthera leo*) requires a Biodiversity Management Plan

The African Lion is one of the flagship species of Africa for research, tourism and trophy hunting. The presence of lion in an area contributes as an indicator of its natural integrity. The lion is also a primary attractor for tourism and one of Africa's "Big Five" trophy animals. Regional surveys have indicated a suspected decline of 30 to 50% of the African Lion population, with current estimates ranging from 23000 to 39000 across Africa. South Africa was a party to the development of the Conservation Strategy for the Lion in Eastern and Southern Africa, published in 2006, which recognised *inter alia* that the problems facing lions would require international, national and local resources to solve, and called for individual lion range States to develop national lion action plans. The Scientific Authority established through the NEMBA and in line with the suggestions received from the Regional Conservation Strategy for the African Lion in Eastern and Southern Africa recommended the development of a BMP for the African Lion.

The African Lion is listed as ''vulnerable'' in terms of section 56(1) of NEMBA and the IUCN Red List of threatened species (Bauer *et al*. 2008). The Act also makes provision for the development of Biodiversity Management Plans for Species and Ecosystems in need of protection. Additionally, the African Lion is protected under Appendix II of the Convention on the International Trade of Endangered Species (CITES). The greatest threats to lion include trophy/sport hunting, indiscriminate killing (primarily as a result of retaliatory or pre-emptive killing to protect life and livestock) and prey base depletion. In addition to these, habitat loss and conversion has led to a number of populations becoming small and isolated leading to inbreeding. Diseases such as Bovine Tuberculosis (BTB) are also a major threat affecting lion populations. All these factors have led to the decline in lion populations in remote parts of South Africa.

In South Africa, lions were extirpated from much of their historical range by the 1900s (Nowell & Jackson 1996). Historic populations survived in Kruger National and Kgalagadi Transfrontier Parks, while conservationists re-introduced lions into the Hluhluwe-iMfolozi Park in the 1950s (Anderson 1980). Lions re-colonized Mapungubwe National Park in about 2000 by moving in from Botswana. Lions in these parks are wild and free ranging with no vital rates and demographics actively managed. Since the early 1990s, lions have been reintroduced into 45 small, fenced areas (<1000 km^2) in South Africa, including private reserves, conservancies, protected areas, national and provincial parks (Funston 2008; Slotow & Hunter 2009). Although lions in these small areas are wild and free-ranging, some vital rates and demographics are actively managed. Apart from the 3000 wild lions in the above-mentioned parks, there are about 6000 captive lions in South Africa, which are used for breeding, hunting, petting tourism and walking with lions (Taljaard 2009; Lindsey et al. 2012a) and are also increasingly used as a source of lion products (particularly skeletal products and skins) for international commercial trade.

1.2 Alignment of the Biodiversity Management Plan with regional strategies

There are several different role player groups who are well placed to have a significant influence on the future of wild lions in South Africa. All contributed to the Regional Strategy for Lions in East and Southern Africa in 2005 (IUCN SSC Cat Specialist Group 2006), and participated in the lion BMP stakeholders workshops held in July 2013 and March 2014. The regional strategy produced detailed recommendations for the conservation of lions across range states. The regional strategy mandated the development of national strategies, aligned with national strategies of neighbouring countries. In order to be effective, the South African Lion BMP required an iterative process with input from representative stakeholder groups. NEMBA specifies that all BMPs need to be revised every five years. Thus this plan will be the first in a series of five-year iterations where the success of the preceding five years will be measured, and adaptations made to ensure that the plan for the following five years is appropriate for the circumstances at the time.

1.3 Motivation for assigning priority to the development of this Biodiversity Management Plan

Lions are listed as Vulnerable according to the South African List of ToPS in terms of section 56(1) of NEMBA. This BMP is also responding to the Regional Strategy for Lions in East and Southern Africa in 2005 (IUCN SSC Cat Specialist Group 2006) which South Africa contributed to during the development phase. The Regional Strategy encouraged the development of national strategies aligned with national strategies of neighbouring countries. This BMP for African lion will be regarded as the national strategy for African lions in South Africa.

1.4 Anticipated Outcomes

The outcomes of the planning process were as follows:

- Development of a database of role players and stakeholders;
- An agreed structure for monitoring implementation;

- Clarity and acceptance of roles and responsibilities amongst the role players;
- Acceptance of and support for the plan amongst stakeholders;
- A plan that comprehensively and concisely covers all aspects related to the conservation of lions and provides realistic targets for the five year life of this iteration;
- Clear goals and time frames for their achievement; and
- Key performance indicators that could be used to assess progress towards defined goals.

1.5 Parties currently responsible for management of the lion

Several government and non-government role player groups are well placed to have a significant influence on the future of wild lions in South Africa. These include:

- Department of Environmental Affairs (DEA)
- South African National Parks (SANParks)
- Ezemvelo KZN Wildlife
- North-West Parks and Tourism Board (NWPTB)
- Mpumalanga Tourism Parks Agency (MTPA)
- Limpopo Tourism Agency (LTA)
- Northern Cape Department of Environment and Nature Conservation (NCDENC)
- Gauteng Department of Agriculture & Rural Development (GDARD)
- Western Cape Nature Conservation (Cape Nature)
- Private Sector
- Lion Management Forum (LiMF)

1.6 Summary of the Planning Methodology

The development of the BMP for the African lion was broken down into five phases, including:

1. Planning, Background Information and Literature review;
2. 1st Participatory Stakeholder Workshop, which took place in June 2013;
3. Development of the Action and Monitoring plans;
4. 2nd Participatory Stakeholder Workshop, which took place in March 2014; and
5. Final Review and Acceptance by DEA by end of September 2014.

1. Planning, Background Information and Literature Review

During the planning phase, the consultants (CSIR and Panthera) met with DEA on 14 March 2013 to plan the process towards drafting the BMP for the African lion in South Africa. At this meeting it was decided that the process would commence in April 2013. As well, it was agreed that the consultants would conduct a review with the available information and literature pertaining to aspects of the lion in South Africa as outlined by the terms of reference stipulated in the contract between DEA and CSIR. After internal review within the consultants/DEA team it was agreed that the background document was to be distributed to as wide a group of stakeholders as possible for inputs before the workshop.

2. 1st Participatory Stakeholder Workshop

A public participatory stakeholder workshop was held at SANBI in Pretoria on 18/19 June 2013. The workshop was convened by DEA who invited as many stakeholders as could be identified (see Appendix 1). DEA presented the welcome and opened the workshop. This was followed by another presentation by the DEA giving an introduction to, and overview of the BMP process. The next presentation was by the consultant who went through the background information and literature review that he had compiled with assistance from CSIR.

The facilitator helped to coordinate the development of a vision, specific objectives and the initial development of a set of actions to achieve the stated objectives. This process took the full day of the 18th. A smaller group comprising DEA and the consultant met for a morning session on the 19th of June 2013 to review the progress made during the stakeholder workshop to ensure that all the information had been captured to start a process towards developing an action and monitoring plan, and to plan the next stage of the process.

3. Development of the Action and Monitoring Plans

Following the stakeholder workshop the consultants synthesised the input from the participants to define a vision, objectives and actions needed to meet the stated objectives. The input was thus primarily from the workshop participants. The consultant then developed a monitoring plan to accompany the stated actions. This was submitted to DEA for review. A project management meeting was held in 20 November 2013 where DEA and other reviewers presented feedback on the draft action and monitoring plans, and outlined the required revisions and schedule. The revised plan was submitted to DEA for review in February 2014.

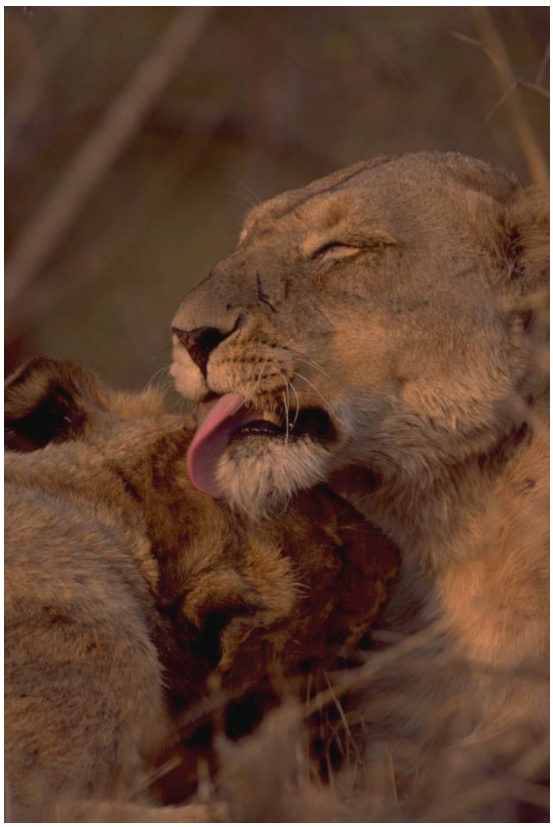
4. 2nd Participatory Stakeholders Workshop

A second stakeholder workshop was held on 18 March 2014 at SANBI in Pretoria (see Appendix 2). The aim of the workshop was to review the action and monitoring plan and to ascertain if the respective parties were willing to take responsibility for the various actions that were ascribed to them. A further objective of the workshop was to get additional stakeholder input into the action and monitoring plan. This finalised the stakeholder participation and set the BMP up for final review.

5. Final Review and Acceptance by DEA

After the final recommendations were made at the 2nd Participatory Stakeholders Workshop, the final revised BMP was submitted to DEA on 26 June 2014. The BMP was the taken through government governance structures for approval for implementation

2 CONSERVATION STATUS AND LEGISLATIVE CONTEXT



2.1 Status of the lion in terms of the various conservation instruments and legislation

The African lion is listed as Vulnerable on the IUCN Red List (Bauer *et al*. 2008) and is protected under Appendix II of the CITES. Lions are listed as Vulnerable according to the South African List of ToPS in terms of section 56(1) of the NEMBA.

In July 2013 the Scientific Authority of South Africa as established in terms of Section 60 (1) of the NEMBA in 2013 conducted a Non-Detriment Finding (NDF) assessment for the African lion (Figure 1) in terms of the CITES. An NDF assessment determines whether or not trade of a species is likely to have a detrimental impact on populations of the species.

The finding of the assessment was that there are currently no major threats imposed by legal local and international trade on the wild lion populations in South Africa, although the management of managed wild lions needs to be improved. Minor threats include over-utilisation, disease, poaching and conflict with communities around protected areas.

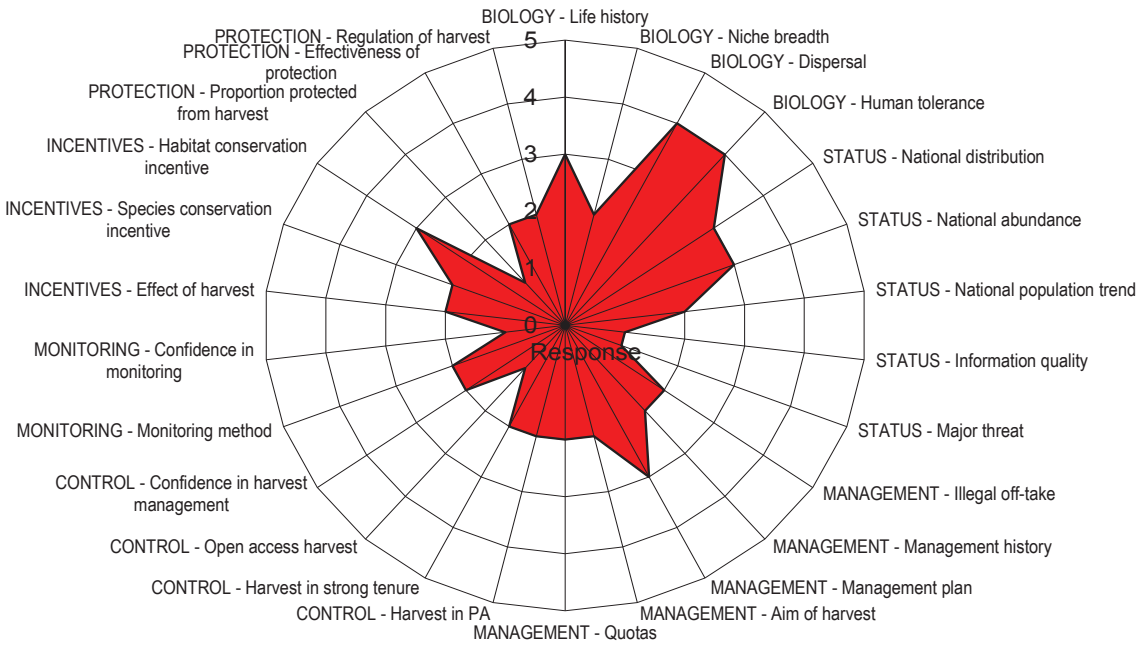


Figure 1. Radar chart summarizing the South African non-detriment finding (NDF) assessment for the African lion (*Panthera leo*) in accordance with the CITES NDF checklist. Higher scores are indicative of higher risk. The relatively limited shading indicates only a moderate risk to the species ascribed to trade (reproduced with permission from SANBI 2013).

Although there are no specific official figures on the illegal trade in lions and lion products in South Africa besides what are reported in the media or by annual reports on seizures and prosecutions. Most reports refer to illegal translocations of animals. Trade in South Africa is contrasted within a network of dealers that operate both legally and illegally. The illegal trade in lions and their body parts usually involves restricted activities for which offenders are not in possession of a permit to breed, keep, hunt, catch, sell, convey or export a live animal or parts thereof. Since the African lion is listed on Appendix II of CITES, any international trade requires a CITES export permit and there have been various reports of illegal lion trade over the years which seems to have increased since 2008 (TRAFFIC, 2013). In conclusion the NDF assessment demonstrated that legal local and international trade in lions poses a moderate, but non-detrimental risk to the species in South Africa (Figure 1).

The species is well managed and the Scientific Authority does not have any current concerns relating to the export of lion in accordance with Article IV of the CITES as the South African lion population is included in Appendix II of CITES. In terms of Article IV of the CITES, an export permit shall only be granted for an Appendix II species when a Scientific Authority of the State of export has advised that such export will not be detrimental to the survival of that species. The assessment only considered wild and managed populations of the African lion and did not consider captive populations.

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

The Act gives effect to the CBD and Section 24 in the Bill of Rights of the Constitution of the Republic of South Africa, 1996. In terms of Section 24 (b) *everyone has the right to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that-*

(i) Prevent pollution and ecological degradation;

(ii) Promote conservation; and

(iii) Secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.

Chapter 3 of the Act provides for the planning and monitoring of biodiversity. Section 43 (1)(b) and (c) of the Act provide for any person, organization or organ of state, desiring to contribute to biodiversity management, to submit to the Minister for approval a draft management plan for an indigenous or migratory species warranting special conservation attention.

Section 44 of the Act empowers the Minister to enter into an agreement with any person, organization or organ of state for the implementation of a Biodiversity Management Plan for Species.

2.1.2 Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

The International Union for the Conservation of Nature (IUCN) classifies the African lion as Vulnerable, which means it is considered to be facing a high risk of extinction in the wild (Bauer *et al*. 2008). This classification is based on a suspected reduction in population of approximately 30% over the past two decades (Bauer *et al*. 2008). The CITES lists the African lion on Appendix II. International trade in species listed on Appendix II must be strictly regulated in order to avoid utilisation incompatible with their survival. Trade in specimens of Appendix II species is accomplished by the issuance of permits from the exporting country, and the presentation of those export permits to the importing country. The exporting country must ensure that a number of conditions are met before issuing an export permit. Furthermore, a Scientific Authority of the exporting country must monitor both the export permits granted and the actual exports of such specimens.

The Parties to CITES have agreed to conduct a periodic review for lion, based on the current biological and trade information, to ensure that it is appropriately listed in the Appendices to CITES. The periodic review process will be concluded before the next Conference of Parties, scheduled to take place in 2016.

There has been increasing pressure to list lions in Appendix I of CITES. In 2004, Kenya (where sport hunting has been illegal since 1977) submitted a proposal that lions be listed on CITES Appendix I at the 13th Conference of the Parties (Nowell 2004). Then in 2011 a consortium of US-based non-governmental organizations petitioned the United States government to list lions as endangered under its Endangered Species Act. Concurrent efforts are underway to encourage the European Union to ban lion trophy imports.

2.1.3 Convention on Biological Diversity(CBD)

The CBD addresses conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising from the use of biological and genetic resources. The CBD also provides guidelines to manage biodiversity, but does not provide specific protection for the African lion or any individual species. The only international agreement that offers specific and significant protection to the African lion is CITES.

2.1.4 Southern African Development Community (SADC) Protocol on Wildlife Conservation and Law Enforcement

Eleven African lion range states signed the Treaty of the SADC: Angola, Botswana, Democratic Republic of Congo (DRC), Malawi, Mozambique, Namibia, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe (SADC 2008). Among SADC's objectives is to "achieve sustainable utilisation of natural resources and effective protection of the environment". Article 22 of the SADC Treaty calls for the establishment of Protocols to achieve the Treaty's objectives. The Protocol on Wildlife Conservation and Law Enforcement of the Southern African Development Community (SADC 1999) elaborates on Article 5 (g) of the Treaty. Its objectives are to: a) promote the sustainable use of wildlife; b) harmonise legal instruments governing wildlife use and conservation; c) enforce wildlife laws within, between and among States/Parties; d) facilitate the exchange of information concerning wildlife management, utilisation and the enforcement of wildlife laws; e) assist in the building of national and regional capacity for wildlife management, conservation and enforcement of wildlife laws; f) promote the conservation of shared wildlife resources through the establishment of transfrontier conservation areas; and g) facilitate community-based natural resources management practices for management of wildlife resources (Article 4).

With regard to wildlife management and conservation programmes, Parties are required to establish management programmes for the conservation and sustainable use of wildlife. These programmes should be integrated into national development plans and assess and control activities that may significantly affect the conservation and sustainable use of wildlife so as to avoid or minimise negative impacts. Parties are also required to take measures to ensure the conservation and sustainable use of wildlife including: a) the protection of wildlife and wildlife habitats to ensure the maintenance of viable wildlife populations; b) prevention of over-exploitation and extinction of species; c) restrictions on the taking of wildlife, including but not limited to restrictions on the number, sex, size or age of specimens taken and the locality and season during which they may be taken; and d) restrictions on trade in wildlife and its products, both nationally and internationally, as required by relevant international agreements.

Article 12 of the Protocol concerning sanctions states:

1. *Sanctions may be imposed against any State Party which: a) persistently fails, without good reason, to fulfil obligations assumed under this Protocol; or b) implements policies that undermine the objectives and principles of this Protocol.*
2. *The Council [SADC Council of Ministers] shall determine whether any sanction should be imposed against a State Party and shall make the recommendation to the Summit if it decides that a*

sanction is called for. The Summit shall decide, on a case-by-case basis, the appropriate sanction to be imposed.

2.2 Cultural conservation value of the species

Lions have been an iconic species for humans for thousands of years, appearing in cultures across Europe, Asia, and Africa. They are used in coats of arms, heroic names of former kings, frescos, names of football teams, tales, proverbs, sayings, advertising and many other arenas. Despite incidents of attacks on humans, lions have enjoyed a positive depiction in culture as strong and noble. A common portrayal is their representation as "king of the jungle" or "king of beasts". Hence, lions have been a popular symbol of royalty and stateliness, as well as a symbol of bravery. Lions featured in several fables of the 6th century BC Greek storyteller Aesop.

2.3 Indigenous knowledge value of the species

Commonly called iBhubesi and iNgwenyama in local Nguni languages, the lion body parts and derivatives are used in African traditional medicine preparations and have routinely been recorded in South African muthi market surveys since the 1980s. A 1987 survey conducted by Cunningham & Zondi (1991) recorded lions as the seventh most popular animal species used by 52% of traditional healers. Healers routinely use pairs of bones usually phalanges as instruments of divination though citations of their use in this manner are uncommon. Lion fat, skin, and bones are usually included as an ingredient in medicines to treat kings and chiefs in the absence of parts of preferred spotted predators such as cheetahs, leopards and genets. The physical strength, agility in attacking prey and the predatory behaviour of lions is cited as a reason for their use and can be conferred to community leaders and thus provide them with the necessary power to rule their people. The traditional leaders also wear traditional attire decorated with these skins to signify and/or manifest that power.

The lion is a powerful and omnipresent symbol, and its disappearance would represent a great loss for the traditional culture of Africa. The lion is also a source of personal and economic advantages and benefits. It is a principal element of tourist attraction and one of the "Big Five", the five great species of trophy hunting in Africa. Tourism is today one of the most significant industries in the world, and a flourishing tourist industry is necessary for the economies of developing countries as it constitutes one of the principal generators of foreign currency for some of these countries.

3 SPECIES DETAILS

3.1 Taxonomy

The lion (*Panthera leo*) was first described by Linnaeus 1758, who gave it the name *Felis leo*, in his 18th-century work *Systema Naturae*. The derivation of the name *Panthera* is from the Greek πάν*pan-* ("all") and *thēr* ("beast of prey"). The Greek, *pánthēr*, referred to all spotted Felidae generically. *Leo* is derived from the Latin *leo* and the ancient Greek (*leon*).

Order: Carnivora
Family: Felidae
Genus: *Panthera*
Species: *leo* (Linneaus 1758)

The original taxon name *Panthera leo* (Linnaeus 1758) was based on the Barbary lion (from North Africa). The IUCN currently recognises two sub-species of lion; African lion (*P. leo*) and Asiatic lion (*P. leo persica*). This may be slightly out of date following recent evidence. Barnett *et al*. (2006) suggest that the modern lion can be divided into Northern African-Asian, southern African and middle African. More recently Bertola *et al*. (2011) found a closer link between west and central African lions and Asiatic lions than with southern and eastern African lions. There is mounting evidence, accumulated over several years and in several laboratories, for a major evolutionary subdivision within African lions. In a number of separate studies, analyses of mitochondrial DNA have shown that Indian lions and lions from north, west, and central Africa all shared a common ancestor after their split from lions in eastern and southern Africa (Barnett *et al.* 2006a, 2006b, 2009; Bertola *et al*. 2011; Dubach *et al*. 2013). Analyses of nuclear microsatellites revealed similar results (Antunes *et al*. 2008; Dubach *et al*. 2103). Genetic diversity and morphological variation is also higher in eastern and southern Africa than in the rest of the lion's range (Dubach *et al*. 2013).

Regardless of the sub-speciation of the northern, western, central and Asiatic lions, all evidence seems to suggest that southern and eastern African lions are genetically the same sub-species (Antunes *et al*. 2008; Barnett *et al.* 2006). Antunes *et al*. (2008) described four geographically and genetically separate populations within Southern Africa: Namibia (including Etosha National Park), Botswana I (including the Okavango Delta), Botswana II (including Kgalagadi Transfrontier Park) and Kruger National Park. The bulk of South Africa's wild lions are found in two of these areas: Kruger and Kgalagadi. The rest of the wild and managed wild lions are in Mapungubwe, Hluhluwe-iMfolozi and approximately 45 small reserves.

3.1.1 Origins and geographic genetic structure of lions in South Africa

Managed wild lion populations in South Africa have their genetic origins in Etosha National Park (Etosha), Kruger National Park (Kruger) and the Kgalagadi Transfrontier Park (Kgalagadi). Lions from Etosha were introduced into Pilanesberg National Park and Madikwe Game Reserve in the early 1990s and their offspring were used in other reintroductions around South Africa (Slotow & Hunter 2009). Mixing of Kruger, Kgalagadi and Etosha origin lions have been extensive amongst the managed wild

populations (Slotow & Hunter 2009). To the best of our knowledge, none of the lions from Mapungubwe has been mixed with the rest of South Africa's lions. In fact, they appear to be more closely related to the lions of the Bubye Conservancy in Zimbabwe than to any lions in small reserves in South Africa (Miller *et al*. in review).

Genetic inbreeding is a concern for small populations of lion in South Africa. Miller *et al*. (in review) conducted genetic analysis from 17 small reserves and two control populations. Twenty-two microsatellite markers were used to assess the genetic origin and diversity of these populations. As there was little consideration of genetic management when the introductions were planned, there has been a lot of mixing between these populations and as a result minimal signs of inbreeding.

Even so, founder populations, because of their small size, suffer considerable risk of inbreeding (Vartan 2001; Björklund 2003; Hayward *et al*. 2009a). These risks materialized in at least two reserves home to wild managed lions that noted indicators of inbreeding amongst individuals (Trinkel *et al*. 2008, 2010). Although other populations of wild managed lions show limited signs of inbreeding, the movement between reserves has resulted in lions on geographically isolated reserves being, in some cases, quite closely related to each other genetically (Miller *et al.* in review).

In addition, the genes of lions from Etosha National Park would not historically have been as prevalent in South Africa as they are now. Within the South African sample, individual lions originating from Etosha had reduced genetic diversity amongst them (Miller *et al*. in review). The reality is that little geographical structure and/or genetic purity exists in the approximate 1000 managed wild lions in South Africa. The implementation of approaches that mimic social dynamics (Ferreira & Hofmeyr 2014) such as assisted coalition take-overs (*e.g.* Tambling *et al.* 2014) should result in maintenance and/or improvement of genetic diversity across reserves comprising managed wild lions. This could be particularly useful if conservationists consider all reserves comprising managed wild lions as a meta-population or a single population although reserves are geographically separated (Ferreira & Hofmeyr 2014). Thus, genetic testing can assist in evaluating the genetic status of managed wild lions in South Africa as an outcome of management interventions and help assess local inbreeding risks in future.

One particularly challenging small population of lions is the one that originates from the Greater Mapungubwe Transfrontier Conservation Area, which has not mixed with the rest of the managed wild populations in South Africa. These lions showed a reduced genetic diversity. Much of this reduction may result from relative isolation from other sources of lions.

3.2 Population Status

Following the Settler Period, only two lion populations survived within the historical distribution of lions in South Africa. The estimated number of wild and managed wild lion populations in South Africa is about 3155 individuals, which are connected to a further approximately 450 lions in transboundary populations. Altogether about 1900 lions (67%) are protected within South Africa's National Parks. The largest areas with lions in the country are the Kruger National Park (straddling the provinces of Limpopo and Mpumalanga) and the Kalahari Gemsbok National Park in the Northern Cape (part of

Kgalagadi Transfrontier Park). The Kruger National Park had about 1700 lions (range of 1617 – 1751) in 2005/2006 (Ferreira & Funston 2010) with about 300 lions in the private nature reserves bordering the park. About 130 (range of 90 – 160) lions are present in the Kgalagadi Transfrontier Park, with a further approximately 350 lions on the Botswana side of the park (Funston 2011). At time of writing there were 14 lions in the Addo Elephant National Park (2011) (Eastern Cape), eight in the Karoo National Park (2011) (Western Cape) and 13 in the Marakele National Park (2011) (Limpopo). Lions were reintroduced in Hluhluwe-iMfolozi Park in the 1958 with more recent introductions from 1999-2001 to improve the genetic variation (Trinkel *et al.* 2008). The Hluhluwe-iMfolozi Park is estimated to have about 200 lions (Grange *et al*. 2012). Lions also re-colonized the Mapungubwe National Park around 2000, coming in from the Tuli Block in Botswana, but fewer than 10 lions exist there.

The lion populations of Kruger National, Kgalagadi Transfrontier, Mapungubwe and Hluhluwe-iMfolozi Parks' were all recognised by the IUCN in its 2006 report on Southern and Eastern African lions, with the Kruger and Kgalagadi listed as viable populations, and the Mapungubwe (as part of the Greater Mapungubwe Transfrontier Conservation Area) and Hluhluwe-iMfolozi Park populations listed as potentially viable populations (IUCN SSC Cat Specialist Group 2006).

Reintroduction of lions into small reserves (including national parks, provincial protected areas, conservancies and private reserves of <1000 km^2 in area) started in the early 1990s and there are currently about 800 lions in 45 small reserves (Slotow & Hunter 2009; Miller *et al*. 2013). Except for the national parks, South Africa's wildlife is managed at a provincial level. These managed wild lions range freely within their new habitat, hunting and breeding at will, but managers typically control their numbers and enhance genetic diversity (Miller & Funston 2014). The Lion Management Forum (LiMF) was formed to focus on the best management practices for these various lion populations (including the Hluhluwe-iMfolozi and Mapungubwe National Park populations) with the longer-term goal of increasing their conservation value through scientifically based management approaches and thus, if successful, hopefully being recognised collectively as a viable population (Miller *et al*. 2013). None of the managed wild populations in the smaller fenced reserves was listed by the IUCN as viable or potentially viable population. The various populations could potentially be listed as a metapopulation in the future.

In addition to wild and managed wild lions, there are many captive bred lions in most provinces. According to a study initiated in 2008 by the Department of Environmental Affairs and conducted by the University of Free State, an estimated 3596 lions were kept in 174 breeding facilities in South Africa during 2008 (Taljaard 2009). It is estimated that there are currently about 6000 lions in at least 200 breeding/captive facilities in South Africa.

3.3 Distribution, habitat requirements, biology and ecology

3.3.1 Distribution

Lions are largely found in the savanna biome of Africa, which includes areas that receive between 300 and 1500 mm of rain annually. Savannas encompass a wide variety of habitats including grasslands, wetlands, dry woodlands and mosaics of all of these (Riggio *et al*. 2013). Lions no longer occur in the Sahara Desert parts of North Africa, but they do exist in the Namib Desert in Namibia (Bauer & van der

Merwe 2004). Lions once lived across Eurasia, but now only a remnant population of a different subspecies (*Panthera leo persica*) survives in India. Until recently lions were present in certain forest-savanna mosaics in Gabon and the Republic of Congo (Henschel *et al*. 2010). Historically lions would have occurred throughout South Africa, with the possible exception of the KZN/Lesotho Drakensberg Mountains. Once extirpated from the tropical thicket biome of the Eastern Cape in South Africa, lions have recently been successfully re-introduced into these areas (Hayward *et al*. 2007c).

3.3.2 Habitat requirements

Lions can only exist in areas with sufficient wild prey, and seldom co-exist closely with people (Frank 1998; Woodroffe & Frank 2005). Within their home ranges lions require habitats or locations that are suitable for hunting, resting, and breeding. Lions readily adapt to hunting in varied habitats, generally having greater success when hunting in areas with longer grass or cover (Funston *et al*. 2001). Although landscape features may vary from area to area, lions tend to select areas where prey is easier to catch, rather than areas where prey densities are highest (Hopcroft *et al*. 2005). For example erosion embankments and proximity to water are important features for lions when hunting, especially for opportunistic daytime hunts.

In semi-desert and semi-arid woodland environments without significant river systems lions select areas located within two kilometres of a waterhole (Valeix *et al*. 2010), and in all areas lion kills tend to be located closer than expected to watercourses or waterholes (De Boer *et al*. 2010). Proximity to river confluences was significantly correlated with reproductive success in lions (Mosser & Packer 2009). Furthermore the density and survival rates of lions correlate positively with prey biomass (Ferreira & Funston 2010a). Generally, therefore, key habitat features that determine the distribution of prey influence the spatial ecology and movement patterns of lions, thus defining their habitat requirements.

3.3.3 Biology

Lions are the only social felids (Schaller 1972). Generally lions are resident, living in prides in territories that are demarcated and defended, but in most populations there are a small percentage of nomadic lions that do not settle in a territory (Schaller 1972). Prides comprise an average of 12 lions (range 2-35), including 4-5 adult lionesses (range 1-21), 2 pride males (range 1-9) and associated cubs and sub-adults (Schaller 1972; Smuts *et al*. 1978b; van Orsdol *et al*. 1985; Stander 1991; Funston 2011). Although the pride is a stable social unit, lions live in a fission–fusion society, and often individuals from the pride are found in subgroups (Schaller 1972), especially in arid areas (Funston 2011). All females in a pride are related, as are most males in coalitions, but typically unrelated lions mate with each other (Packer *et al*. 1991a, b). Male lions largely try to keep other male lions out of their territories, while lionesses try to exclude other prides (Mosser & Packer 2009). This can result in a fairly high degree of mortality, especially in large, multi-pride systems where neighbours are often killed in territorial skirmishes (Mosser & Packer 2009).

Lions are matrilineal, although about a third of young lionesses disperse from their own prides (Hanby & Bygott 1987; Pusey & Packer 1987). A female who becomes a nomad has much greater difficulty joining a new pride, as the females in a pride are related, and they reject most attempts by an

unrelated female to join their family group (Van der Waal *et al*. 2009). Male cubs are excluded from their maternal pride when they reach maturity, and typically leave their natal pride by the age of 4 years, most of which then form a coalition with other males (Pusey & Packer 1987; Packer & Pusey 1993). Although lions in the migratory Serengeti system are highly nomadic, they are far more resident in wooded savannas such as Kruger National Park and Selous Game Reserve (Spong & Creel 2001, Funston *et al*. 2003).

Male coalitions challenge one another for pride residency. Incoming males kill or evict dependent offspring sired by the previous coalition, so as to accelerate the mothers' return to sexual receptivity (Packer *et al*. 2001). As lionesses typically breed synchronously, a crèche of cubs is formed that is looked after and nursed by the lionesses. In lion prides female relationships are highly symmetrical (i.e. there is no dominance hierarchy), and female lions are "free agents" who only contribute to communal care when they have cubs of their own (Packer *et al*. 2001). Litter size ranges from one to six cubs, with 98% of litters containing one to four cubs (Packer & Pusey 1987). In the wild, lionesses seldom live to more than 14-16 years and most males only live to 12-14 years (Packer *et al*. 1988).

In most large protected areas, lion populations tend to be stable (Packer *et al*. 2005; Ferreira & Funston 2010a), but when introduced into a new reserve with naïve prey, lion populations increase very rapidly (Kilian & Bothma 2003; Lehmann *et al*. 2008a; Miller & Funston 2014) and quickly expand to use the whole area (Druce *et al*. 2004b). In these reserves some form of contraceptive approach (*e.g.* Orford & Perrin 1988) is needed to halt population growth, although most reserves currently favour translocation or culling (Kettles & Slotow 2009; Miller *et al*. 2013).

3.3.4 Ecology

Lions eat a wide variety of mammals as food, tending to favour medium to large sized ungulates with an average body mass of 190–550 kg (Mills & Biggs 1993; Hayward & Kerley 2005; Owen-Smith & Mills 2008a). Lions are also known to scavenge whenever possible (Schaller 1972; Funston *et al*. 1998). Lions respond to behavioural and physiological changes in prey in terms of what species, sex and age of prey they select (Owen-Smith 2008). Typically in a particular area about five ungulate species make up the bulk of the lions' prey, with the relative abundance of suitable prey being a good indicator of what lions are likely to favour in a specific area (Radloff & du Toit 2004; Owen-Smith 2008). This same pattern occurs on the smaller fenced reserves (Power 2003; Druce *et al*. 2004a; Lehmann *et al*. 2008b). Although lions hunt cooperatively (Stander 1992a, b; Scheel 1993) there is no clear evidence that this benefits lions in terms of the amount of food they eat (Packer *et al*. 1988), and thus hunting success is not a driver of sociality in lions (Packer *et al*. 1990).

Lion home range size varies markedly between populations, ranging from as small as 20 km^2 in the Ngorongoro Crater (Elliot & Cowan 1978), to 400 km^2 in Etosha (Stander 1991), and up to 4500 km^2 in the Kgalagadi (Funston 2011). Loveridge *et al*. (2009) found that for females, home range size increased as pride biomass increased, which is strongly suggestive of expansionism (Macdonald 1983). Pride ranges respond to changes in food abundance on an annual timescale rather than on a seasonal timescale (Loveridge *et al*. 2009). Thus female home range size is mainly driven by the size of the pride, but also by prey abundance. Lions hunt most successfully in areas of thick cover and long grass

(Funston *et al*. 2001; Trinkel *et al*. 2007), and especially when there is no moon (Stander & Albon 1993; Funston *et al*. 2001). Additionally when lions are within two kilometres of a waterhole they move at slower speeds, cover shorter distances per night, and follow a more tortuous path than when they are further from a waterhole (Valeix *et al*. 2010).

3.4 Description and map of geographic area for which the plan is proposed

The lion BMP is intended for the whole country of South Africa, the locations of the respective reserves that currently have wild or managed wild lions are depicted in Figure 2.

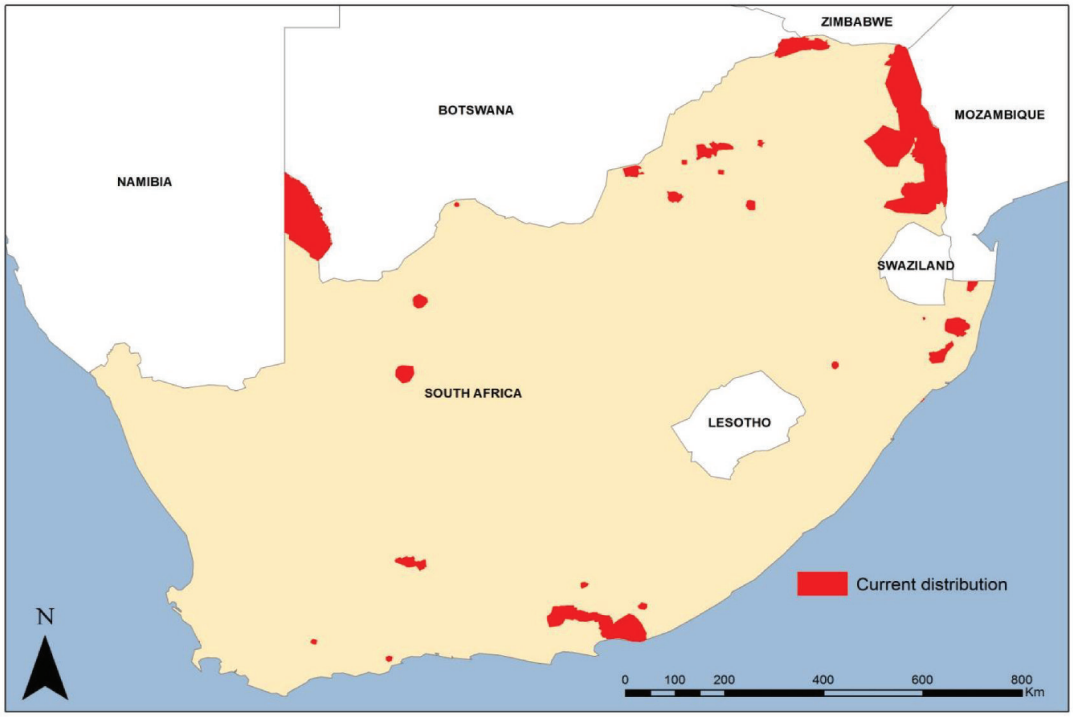


Figure 2. The distribution of lions in South Africa in 2014 including both wild and managed wild lion populations. Contiguous polygons do not imply full connectivity as there are fences separating some of these populations.

3.5 Captive lion populations and their status

Of the South African lion population, approximately 68% is in captivity and 32% are free-roaming in reserves. There were estimated to be around 5800 captive-bred lions in 2013, and almost doubled the number in 2005 (TRAFFIC, 2013). The Free State province is the epicentre of the captive lion breeding industry and has about 3000 lions in 70 breeding and two hunting facilities. The North West province had almost 2200 captive lions in 64 hunting reserves. The number of lions in the North West and Free State provinces fluctuates because of the large number of lion translocations mainly from breeding facilities to the hunting reserves (TRAFFIC, 2013).

The number of facilities however has dropped to 149 in 2013 from the highs of 167-200 between 2008 and 2012. This decrease in the number of breeding facilities has been in the Free State where levels reached 98-107 in 2008-2009 but were 70 in 2013. This is due to the strengthening of regulations within the province that have made it difficult for some breeders to comply with legislation and they have thus closed down the facilities or moved them to the North West province.

Most lions in captivity originate from captive-bred stock that has 'serviced' the trophy hunting industry and since 2008, the lion bone trade, as:

(1) a source of male lions for trophy hunters, the skeletons of which are sold to East–Southeast Asia; and,
(2) the females for breeding stock and purportedly the bone trade once they have ceased to be bred.

In terms of South Africa's ToPS regulations, wild lions should not be introduced into captivity – but illegal incidences of adult lions and cubs being brought into South Africa from the Kgalagadi have been confirmed (CITES Scientific Authority, 2013; Macleod, 2012a; W. Willson, pers. comm., May 2013). Captive lion stocks have occasionally been introduced into fenced reserves and erroneously called "wild". Even more erroneous, until corrected in early 2012, was the practice by some provincial permit Issuing Authorities of reporting captive bred lions hunted for trophies as "wild sourced" on the CITES export permits. This practice led to incorrect reporting of the CITES trade records (CITES Scientific Authority, 2013) and was related to the regulation that lions must be free-roaming for a specified period before they can be shot. However, "free-roaming" does not equate to "wild", and lions are not transformed into self-supporting wild animals after 96 hours in a hunting camp (the minimum release period before hunting can occur in the North West Province, for example).

The prevailing view amongst carnivore specialists is that captive-bred lions do not contribute to the conservation of the species, especially for population restoration purposes, since inbreeding is known to occur and thus compromises genetic integrity and provenance (Slotow and Hunter, 2009; Hunter *et al*., 2012; CITES Scientific Authority, 2013; Packer *et al*., 2013). Lion trophy hunting generates more revenue annually than any other hunted mammals. Accordingly, economic outputs from the captive-bred lion industry are assumed to have increased significantly (Lindsey *et al*., 2012a) as exports of products have increased. However, lion breeding is regarded by many as a controversial "conservation" tool that purportedly reduces consumptive impacts on wild lions through the targeting of captive-bred animals in the trophy hunting industry (CITES Scientific Authority, 2013; Lindsey *et al*., 2012a; Macdonald and Willis, 2013). Most hunting (>95%) takes place on private property in the North West, Free State and Eastern Cape provinces using captive bred lions (CITES Scientific Authority, 2013) – areas not normally associated with free-roaming lions.

Another segment of the South African captive lion population are animals kept in *ex situ* facilities (e.g. sanctuaries, zoos, lion parks) where roaming is restricted and there is a high level of human contact. For the most part these facilities are marketed as tourist attractions. Animals at these facilities may have been:

(1) rescued from zoos, hunting industry, or other circumstances;
(2) born in the wild or in captivity;
(3) may or may not be sterilised; and,

(4) may or may not be kept for breeding purposes.

3.6 The ecological role of lions

Lions are by far the most dominant predator in African savannas, and contribute the major share of animals killed across a wide body size range (Owen-Smith & Mills 2008a). Lion predation regulates the numbers of resident prey in most savanna ecosystems (Mills & Shenk 1992), usually in conjunction with changing rainfall conditions, which affects the relative susceptibility of ungulate species to predation (Mills *et al*. 1995; Funston & Mills 2006; Owen-Smith & Mills 2006). These result in a top-down interaction between lions and prey, which is not easily disentangled from other influences on population dynamics (Owen-Smith & Mills 2006).

Shifting prey selection has been identified as a mechanism potentially regulating predator–prey interactions, but it may also lead to different outcomes, especially in more complex systems with multiple prey species available. In Kruger National Park, wildebeest and zebra constituted the most favoured prey species in a period of high rainfall, while selection for buffalo rose in the south of the park after a severe drought increased their vulnerability (Mills *et al*. 1995; Funston & Mills 2006). These are the three principle lion prey species in Kruger. Selection by lions of alternative prey species, including giraffe, kudu, waterbuck, and warthog, was influenced by the changing relative abundance and rainfall mediated vulnerability of the three principal prey species (Owen-Smith & Mills 2008b). Additionally, declines in the abundance of rare antelope species were associated with a sharp increase in selection for these species at a time when all three principal prey species were less available (Owen-Smith & Mills 2008b).

Lions tend to affect prey populations negatively in most small reserves (Power 2003), especially when managers continue to hunt or capture ungulates for live sale (Peel & Montagu 1999; Tambling & du Toit 2005). Model studies have revealed that increased levels of predation by lions on 'captive/fenced' populations of prey, such as wildebeest, in combination with regular harvesting by park managers, can drive the prey population towards extinction. Without careful monitoring and regulation of large predators, ungulate populations can decline more rapidly than managers expect.

In the small fenced reserves in South Africa lions have the same daily pattern of activity as they do in large reserves (Hayward & Hayward 2007), and select the same preferred prey as in large reserves (Lehmann *et al.* 2008b; Louw *et al*. 2012). In these small fenced reserves lions typically encounter preferred prey species far more frequently than expected based on their abundance, and thus hunt these species more frequently than expected (Hayward *et al*. 2011). Additionally the daily food intake rate and home range use of lions in fenced reserves was the same as lions from large parks (Lehmann *et al*. 2008c; Hayward *et al*. 2009b). This all suggests that from an evolutionary viewpoint, the use of fences for conservation has not affected the natural behaviour of lions as they still conform to predictions derived from unfenced reserves. Hayward *et al*. (2009b) concluded that prey abundance is the key factor in determining the use of space use by lions, and is similar in both fenced and unfenced reserves. This is currently an ongoing debate as Hayward *et al*. (2009b) only looked at a small range of lion behaviours. According to Miller & Funston 2014 growth rates are higher on small reserves and

there is anecdotal evidence that pride structure is disrupted. Research is currently ongoing in this regard.

3.7 Diseases

In recent years disease has become an emerging issue for large carnivore conservation, with canine distemper virus and rabies recognised as the major pathogens affecting wild carnivore populations. For lions, some believe that the risk of disease is increasing as populations have become isolated, placing them at a higher risk when confined by fencing (Keet *et al*. 2009). In addition, their increasing proximity to people and domestic animals exposes them to new diseases (IUCN SSC Cat Specialist Group 2006).

3.7.1 Viral Diseases

Viruses known to infect lions include canine distemper virus, feline leukemia virus, feline immunodeficiency virus, feline herpesvirus, feline calicivirus, feline parvovirus, and feline coronavirus (Hofmann-Lehmann *et al*. 1996). More than 40 years of continuous research on lions in Serengeti National Park and Ngorongoro Crater, Tanzania, has advanced what is known about the prevalence of six of the seven viruses (feline leukemia was absent) known to infect lions (Packer *et al*. 1999). Based on this research, two viruses (feline herpesvirus and feline immunodeficiency virus) are believed to be endemic in most lion populations and four (feline calicivirus, parvovirus and coronavirus, and canine distemper virus) occur in episodic disease epidemics (Packer *et al*. 1999).

3.7.1.1 Canine Distemper Virus (CDV)

In 1994 one-third of the lions in Serengeti National Park died from a strain of the CDV disease (Craft *et al*. 2009), and in 2001 a CDV epidemic (coupled with tick-borne diseases) killed nearly 40% of Tanzania's Ngorongoro Crater lion population (Kissui & Packer 2004; Munson *et al*. 2008). Scientists examined serological exposure to CDV in these well-studied populations and found that at least five "silent" CDV epidemics had occurred between 1976 and 2006 with little mortality or clinical signs of the disease (Munson *et al*. 2008).

The fatal 1994 and 2001 epidemics coincided with unusually high levels of *Babesia sp.* infections. According to Munson *et al*. (2008) *Babesia* is a tick-borne hemoparasite that usually infects the African lion at low levels without compromising health. Both outbreaks were preceded by extreme drought conditions that led to die-offs of host animals such as buffalo. When the rains returned, the surviving animals were heavily infected with ticks, which led to the higher *Babesia* levels in the lion populations. Climate extremes thus seem to exacerbate the severity and occurrence of die-offs caused by CDV as well as the occurrence of deadly co-infections (Kissui & Packer 2004; Munson *et al*. 2008). The Serengeti lion population eventually recovered to pre-epidemic levels due to high cub survival (Packer *et al*. 2005). Repeated outbreaks of CDV over a relatively short time span have prevented recovery of the Ngorongoro population to its carrying capacity (Packer *et al*. 2011). This population has been rendered especially vulnerable due to inbreeding and close proximity to human populations (Kissui & Packer 2004).

3.7.1.2 Feline Immunodeficiency Virus (FIV)

FIV is found in the domestic cat, in which it causes an AIDS-like immunodeficiency disease (Troyer *et al*. 2004), which permanently infects the host. Olmsted *et al*. (1992) and Troyer *et al*. (2004) have documented FIV in eight wild felid species, including the African lion (Roelke *et al*. 2009). The African lion is infected with a lion-specific strain of FIV, known as FIVple, of which there are multiple, highly divergent strains. FIVple is thought to be a relatively old virus that has perhaps been infecting lions for thousands of years (Roelke *et al*. 2009).

FIV infection is common in East and South Africa, with infection rates in four sampled lion populations ranging from 70 to 91% (Brown *et al*. 1994). In the Serengeti lion population incidence of FIV is very high and has been consistently maintained over many years and is believed to be endemic (Brown *et al*. 1994; Hofmann-Lehmann *et al*. 1996; Olmsted *et al*. 1992; Packer *et al*. 1999; Troyer *et al*. 2005). Given the high prevalence of FIVple in many lion populations, it is evident that in several different ecosystems most lions with FIVple have survived and thrived. In natural settings, small decreases in fitness can have large effects during times of stress. However, there is no evidence that FIV compromises the survival of wild African lions (IUCN SSG Cat Specialist Group 2004).

3.7.1.3 Feline Herpesvirus

Herpesvirus has caused the death of a captive lion, but although 100% of the Serengeti population is infected, clinical signs of disease have not been detected (Craft 2008). Lions in the Serengeti have also been exposed to periodic outbreaks of feline parvovirus, calicivirus and coronavirus. However, there have been no consistent signs of clinical disease, excess mortality or decreases in lion fecundity due to infections from any of these three viruses (Driciru *et al*. 2006; Hofmann-Lehmann *et al*. 1996; Packer *et al*. 1999; Spencer 1991; Spencer & Morkel 1993).

3.7.2 Bovine Tuberculosis

Bovine tuberculosis (bTB) is caused by *Mycobacterium bovis.* Although it infects a wide variety of African wildlife, it is not indigenous to Africa and was most likely brought to the continent through the importation of cattle from Europe (Michel *et al*. 2006). African wildlife species have not yet developed immunity to bTB, and many species have the potential to act as a reservoir of infection (Renwick *et al*. 2007). bTB is a growing concern associated, in part, with increased numbers of domestic livestock and the increased overlap between livestock and wildlife (Renwick *et al*. 2007).

In the Kruger National and Hluhluwe-iMfolozi Parks, bTB spread to wild animal populations through the intermingling of domestic cattle with buffalo sometime in the late 1950s or early 1960s (Bengis *et al*. 1996; Keet *et al*. 2009). The disease has since spread throughout these parks seemingly by the movements of the buffalo. Buffalo are thus referred to as 'maintenance hosts' as they do not experience the serious physical effects associated with the disease (Caron *et al*. 2003). bTB is contracted by lions through the ingestion of infected prey (Keet *et al*. 2009). Organs such as the lungs and the lymph nodes contain most of the infectious material (Renwick *et al*. 2007). Once infected, lions

may transmit the disease to other lions primarily through inhalation and secondarily through biting and scratching (Keet *et al*. 2009).

In many parts of Kruger National Park, buffalo are the primary prey of lions (Radloff & du Toit 2004; Funston *et al*. 1998; Owen-Smith & Mills 2008a,b) and over 80% of lions in some areas of the Park are infected by bTB (Keet *et al*. 2009). The clinical signs of infection in lions include respiratory problems, emaciation, lameness and blindness (Renwick *et al*. 2007, Keet *et al*. 2009). However, there are no estimates of the proportion of lions that become infected that develop clinical symptoms. Initial estimates suggest that bTB may not be as severe for Kruger's lions (Ferreira & Funston 2010a) as has been suggested (Keet *et al*. 2009).

3.7.3 Other Diseases

Domesticated pets such as cats and dogs have been known to transmit diseases to African lions such as rabies and feline leukemia virus (FLV), but neither disease is known to have inflicted measurable harm to wild lions.

3.8 Threats

Regional surveys have indicated a suspected decline of 30-50% in the African lion population in recent decades. A decade ago estimates ranged from 23,000 to 39,000 wild lions (Chardonnet 2002; Bauer & van der Merwe 2004), with a current estimate of 30,000 (Riggio *et al*. 2013). The greatest threats to lions generally (Bauer *et al*. 2008) include habitat loss and conversion, indiscriminate killing to protect livestock, prey base depletion, direct consequences of the bush meat trade and excessive trophy hunting.

In South Africa, however, threats to wild and managed wild lions are relatively minimal. Risks of genetic impoverishment of managed wild lions are low and easily mitigated through robust management interventions.

According to the TRAFFIC 2013 report, the trade in lion bones currently has a negligible impact on wild lion populations. The trade in bones appears to be a sustainable by-product of the sizeable trophy hunting in SA and lions that are hunted are almost exclusively captive bred. Incidences of illegal activities such as poaching pertaining to wild lions are too sporadic to be of any detriment. Furthermore, the controversial trade in lion bones for the Asian market appears to be supplied by bones obtained as a legal by-product of the trophy hunting industry where the lions are almost exclusively captive-bred (wild lions account for only 0.9 to 1.1% of lions hunted – Lindsey et al 2012). It would also appear that wild lions in South Africa are safe from the body parts trade for as long as captive-bred lions are the source of the derivatives.The impact of the bone trade on wild lion populations outside of SA however has yet to be determined.

3.9 Utilisation

Lions are particularly sensitive to over-harvesting (Whitman *et al*. 2004) because the removal of pride males through hunting often results in infanticide by incoming males that kill the cubs to stimulate the onset of oestrus in females (Packer *et al*. 1988, 1990). Trophy hunting of lions is contentious due to uncertainty concerning its conservation impacts and because of the polarised views of stakeholder groups. The two areas in South Africa where lions are trophy hunted in line with the most recent guidelines (Lindsey *et al.* 2013) is the Associated Private Nature Reserves (Timbavati and Klaserie Game Reserves) (Funston 2004). National guidelines for the trophy hunting of wild and wild managed lions should be developed. The captive-bred lion hunting industry in South Africa has grown rapidly while the number of wild lions that are sport hunted in other African countries has declined (Lindsey *et al*. 2012a, b).

3.9.1 Impact of utilisation based on evidence

There are no systematic studies of the impact of trophy hunting of wild and managed wild lions in South Africa. However, the low numbers of lions hunted (< 10 lions per year) would suggest that trophy hunting does not impact the viability of wild and managed lion populations. It is generally recommended that lion quotas should either be set at about 3% of the total population (Creel & Creel 1997) or that offtakes should not exceed 0.5 lions/1000 km^2 (Packer *et al*. 2011). Neither of these limits is likely to be exceeded for wild and managed wild lions in South Africa. Wild lions are occasionally hunted from the managed wild population in fenced reserves, such as Madikwe Game Reserve, Pilanesberg National Park and Venetia-Limpopo Nature Reserve. Lions from the Kruger National Park are trophy hunted in the Associated Private Nature Reserves in the Klaserie and Timbavati Game Reserves. These hunts are approved by the South African National Parks and are guided by a strict utilisation strategy (Funston 2004). Some additional permits are associated with damage causing lions as well as illegal hunting of lions that occurs along the northern border of Kruger National Park.

Trophy hunting of wild and managed lions in South Africa can be done in such a way as to not affect populations in any significant way. Permits to hunt lions in South Africa are issued through the provinces, and Professional Hunters are obliged to record all completed hunts in a professional hunting register. The hunting register is then used to compile provincial reports on the number of lions hunted annually, which they submit to the Department of Environmental Affairs (DEA). The number of permits issued to hunt lions is usually more than the number of lions actually hunted and recorded on the register; this is because not all the permits that are issued are used. Accordingly, the number of hunting permits issued cannot be used as a proxy for the number of carcasses potentially available to supply the lion bone trade, hence one is reliant on the accuracy of the hunting register to estimate the:

(1) number of lions hunted,
(2) maximum number of trophies that could be exported, and
(3) number of carcasses available for the bone trade via the hunting industry

3.9.2 Use value of the species

In the ten countries in Africa where wild lions are hunted they attract one of the highest mean prices (R296 000 to R608 000) of all trophy species (Lindsey *et al*. 2013). Although not many wild and managed wild lions are hunted in South Africa, across the various lion hunting countries lions generate 5–17% of gross trophy hunting income on national levels and are thus an important species for the trophy hunting industry (Lindsey *et al*. 2012a,b). The total revenue from hunting wild and managed wild lions in South Africa is thus likely to only be about R3 million per year.

There are at least two tiers to the South African end of the lion bone trade chain to consider when determining the value of the bones:

(1) the price paid to landowners for skeletons by the bone agents, and

(2) the price paid to the bone agents/wildlife traders/intermediaries by the Asian importers.

One must be cautious when evaluating the South African side of the supply chain not to use erroneously the same US dollar prices that are reportedly paid for lion parts and products once they enter the supply chain in Asia. The price being paid to South African farmers/landowners by the bone agents in 2013 was ZAR12 000 to ZAR15 000 (USD1260 to USD1560) per set without skulls, and up to ZAR18 000 to ZAR20 000 (USD1890 to USD2100) with skulls (depending on the size of the skeleton). Thereafter, the bone agents charge the importers a fee of about ZAR3000 (USD315) per set. Thus, the prices paid to South African landowners are substantially less than USD10 000 to USD15 000 per complete set that is frequently alleged to be paid. Ascribing such erroneously high values on the South African side of the supply chain would make it seem plausible that poaching wild lions would be a cheaper alternative to sourcing bones from hunted captive animals and thereby incentivize illegal hunting – which is not the case in South Africa.

The value of lion bones generated as a secondary by-product of the trophy hunting industry has allegedly motivated farmers to exhume carcasses that were discarded after past trophy hunts and captive mortalities. And, whereas lionesses formerly had little or no value to breeders from a trophy hunter's perspective, the emergence of the lion bone trade has generated a previously unexploited value for females. A concern raised was the incentive to breed lions solely for the lion bone trade. What stakeholders are firm on is that there is currently no economic incentive to farm lions solely for bones, especially given the costs involved in raising lions and the current prices paid for skeletons. Since a skeleton was worth, at most, ZAR20 000 (USD2100) in 2013 and a trophy hunted male lion of at least six years old generates ZAR160 000 to ZAR170 000 (USD16 800–USD17 900), it makes no business sense for farmers to breed males for the bone industry and forfeit at least ZAR142 000 (USD14 900) in the process. Thus, selling the bones is of secondary benefit to their operation. Lionesses and juveniles are, however, at risk of being culled – but current data on the average mass of an exported skeleton suggests that the practice of exporting bones obtained from females and juveniles is in the minority for the time being.

3.9.3 Monitoring of current use

Between 1999 and 2008 South Africa reported in terms of the CITES Annual report (based on permits issued), the export of the parts of at least 5 186 lions [comprising trophies (3 983), skins (630), live (514) and bodies (59)]. Of these, 2,962 (about 57%) were reported to be from wild lions [adding

trophies (2 413), skins (453), live (57) and bodies (39)]. Unlike any other range State, South Africa reported the export of a large number of wild source lion specimens that did not originate in South Africa. During that same time period, 316 wild sourced lion trophies, 397 wild source skins and 3 wild source bodies were imported to South Africa, but it is impossible to know from the data how many of these stayed in South Africa or were re-exported (Anon 2011).

From 1977 to 2011, South Africa reportedly issued permits to export 7014 lion trophies to 100 countries – but the number of lion trophies imported to these countries amounted to only 5246 – a difference of 1768 trophies. Up to 2003, the annual differences in exports/imports amounted to 20–50 trophies per annum, but from 2004 the differences usually exceeded 130 trophies per annum and went up to a difference of 373 in 2009. The increase in the number of permits issued for lion trophies, especially from 2006, illustrates the growing demand by foreign hunters.

However, it is possible to learn from the data that a minimum of 88 trophies and 12 skins that originated from wild sources in other range states were exported by South Africa during the decade (Anon 2011). In 2009 and 2010, 833 and 682 lion trophies were reported exported from South Africa respectively, more than double the combined export (2009, 471; 2010, 318) from other African countries (Lindsey *et al*. 2012a, b). There has been an associated increase in the prevalence of the export of lion bones from South Africa, according to the CITES Annual Reports. At least 645 bones/sets of bones were reported as exported in 2010, 75% of which went to Asia.

If the above statistics were an accurate reflection of actual exports of specimens of wild lion, then South Africa would have exported about 8.7% of its entire wild population per year. This clearly did not happen, and these statistics must therefore be carefully interpreted. The numbers of truly wild lions hunted over the same period never reached more than ten individuals per year. Therefore, trade data from South Africa must be treated with caution. Although only few wild lions are hunted in South Africa it does not enforce a strict age minimum for trophies, although some reserves do (Funston 2004).

In response to a ministerial enquiry in December 2013 about lion body part trade to Asia, the DEA released the figures summarised in Tables 1 and 2. South Africa officially issued permits for the export of nearly (if not more than) 1 300 dead lions from South Africa to China, Lao PDR and Viet Nam from 2011 to 2012 inclusive.

Table 1. Ministerial Figures for CITES export permits issued in South Africa in 2011 and 2012 for lion body parts

Category	2011	2012
Live	39	183
Skins	81	93
Bones	55 kg	739 kg
Trophies	313	847
Bodies	40	10
Skulls	181	143
Skeletons	512	114

Table 2. Lion export permits issued in 2011 and 2012 to China, Lao PDR or Viet Nam

Category	China 2011	China 2012	Lao PDR 2011	Lao PDR 2012	Viet Nam 2011	Viet Nam 2012
Live	0	24	-	-	12	-
Skins	0	1	-	-	-	-
Bones	-	-	1 kg	1577 kg	0 kg	739 kg
Trophies	34	36	24	1	0	8
Bodies	16	15	0	20	0	32
Skulls	-	-	0	8	-	-
Skeletons	2	2	425	92	-	-

3.9.4 Current quotas and permits issued

Permits for wild and managed wild lion hunts in South Africa are obtained on application from the appropriate provincial conservation authority, as are permits for hunting captive-bred lions. Clearly permits are not limited, given the number of captive lions hunted. Furthermore, many of the captive hunts are being reported as wild or managed wild lion hunts, and the relevant authorities are in the process of addressing the incorrect use of source codes in the issuance of permits.

3.10 Past conservation measures

In the 1900s lions were largely eradicated from most of South Africa both by sport hunters and for agricultural development (Stevenson-Hamilton 1925). During 1903 Col. Stevenson-Hamilton estimated that there were only a few lions in the Sabi Reserve (Stevenson-Hamilton 1925). With the establishment of the Kruger National Park in 1925 lions started to receive greater protection, although the park's warden and rangers still routinely shot them. This practice was continued in some areas of the park until the 1960s in the hope that this would promote the recovery of ungulate populations (Smuts 1978a). By 1925 it was estimated that there were about 250 lions in the Central District of Kruger, and by 1956 the estimate was 424 (Smuts 1976). By the 1970s there were about 700 lions in the same area (Smuts 1976), which has remained fairly stable since then (Ferreira & Funston 2010a).

The possible influence of predators on prey numbers resurfaced as an issue in Kruger in the 1970s (Smuts 1975) when wildebeest and zebra populations declined in the Central District. This precipitated an experimental culling operation where lions were either removed or thinned from two areas (Smuts 1978b). This programme did not have the intended results and lion numbers recovered quickly. Although Kruger National Park lions are no longer managed in terms of population size, several hundred lions have been euthanized in the last 15 years to test for the extent and consequences of bTB (Dewald Keet *pers. comm.*).

Lions have never been managed in the Kgalagadi Transfrontier Park, although there has been persecution of lions along the Kgalagadi's boundaries for decades (Mills *et al*. 1978; Van Vuuren, Herrmann & Funston 2005; Funston 2011). The lions that were established in the Hluhluwe-iMfolozi Park have been managed, mainly to minimise conflict along the boundary (Anderson 1980) and more recently to improve their genetic diversity and thereby reproductive potential (Trinkel 2008). In all the

larger parks in South Africa lions occasionally venture out of the park and kill livestock. In the Kruger and the Hluhluwe-iMfolozi Parks (Anderson 1980) these lions are generally shot by rangers, whereas in Kgalagadi rangers try and translocate them back to the park (Mills *et al*. 1978; Funston 2002). In Namibia, Stander (1990) advocated translocation first and then if the lions became habitual livestock killers, that they then be destroyed.

The reintroduction of lions into about 45 smaller fenced game reserves in South Africa has largely been for eco-tourism purposes, rather than ecological reasons (Slotow & Hunter 2009). Managed wild lions are currently managed separately in each area, with very little planned genetic exchanges, (Hayward *et al.* 2007a, b, c; Hunter *et al*. 2007; Kettles & Slotow 2009), reducing their conservation value on a regional scale (Slotow & Hunter 2009).

This challenge prompted a group of South African reserve managers and biologists to form the Lion Management Forum (LiMF), which aims to guide and enhance lion management and conservation of managed wild lions in fenced reserves. The major issues being addressed by LiMF are growth rates (Miller & Funston 2014), overpopulation and population control, human conflict and compensation, disease, persistence of biodiversity and prey and genetics (Miller *et al*. in review). Any management recommendations must thus take into account both the economic value of lions and their conservation value guided by the objectives of the land-use for a specific area.

3.11 Socio-economic issues

All lion populations in South Africa are fenced. Across Africa, lion populations in fenced reserves are significantly closer to their estimated carrying capacities than unfenced populations (Packer *et al*. 2013). Whereas fenced reserves can maintain lions at 80% of their potential densities on annual management budgets of about R4500/km^2, unfenced populations require budgets in excess of R18000/km^2 to attain half their potential densities (Packer *et al*. 2013). Lions in fenced reserves are primarily limited by density dependence.

Large African predators, especially lions and leopards are financially valuable for ecotourism and trophy hunting operations also utilised for the production of other wildlife species for the same purpose (Lindsey *et al*. 2012b). Predation of ungulates used for trophy hunting can create conflict with landholders and trade-offs thus exist between the value of lions and leopards and their impact on ungulate populations. Funston *et al*. (2013) showed that lions result in substantial financial costs through predation on wild ungulates that may not be offset by profits from hunting them, whereas the returns from trophy hunting of leopards are projected to exceed the costs due to leopard predation. In the absence of additional income derived from photo-tourism, the number of lions may need to be managed to minimise their impact (Funston *et al*. 2013). Lions drive important ecological processes, but there is a need to balance ecological and financial imperatives on wildlife ranches, community wildlife lands and other categories of multiple land use for wildlife production. This will ensure the competitiveness of wildlife-based land uses relative to alternatives (Funston *et al*. 2013).

There are, however, substantial economic advantages to having lions and although not estimated here, a large amount of wealth is generated in South Africa from the presence of lions. These community benefits are important for lion conservation (Lindsey *et al*. 2013).

4 VISION AND OBJECTIVES

4.1 Vision

This is the first national BMP compiled for lions in South Africa. Following on from the background information the plan proposes a Vision, Objectives with their Actions and Indicators supported by a Monitoring Plan.

The vision for the South African lion population is that:

Through the existence of stable, viable and ecologically functional populations of wild and managed wild lions, along with well-managed captive populations that have minimal negative conservation impacts, lions will provide key opportunities for biodiversity conservation, economic development, social benefits and improved management capacity.

4.2 Objectives

1. **To improve the conservation status of lions within a broader conservation context.**

***Sub-objectives*:**

1.1 Maintain the current degree of protection of wild lions;
1.2 Reassess the status of lions in South Africa;
1.3 Enhance the conservation status of managed wild lions; and
1.4 Assess the management of the captive lion population.

2. **Develop and implement effective communication tools that are informed by scientific research (Communication, Education & Public Awareness)**

Sub-objectives:

2.1 Maximise the educational and research opportunities derived from lions

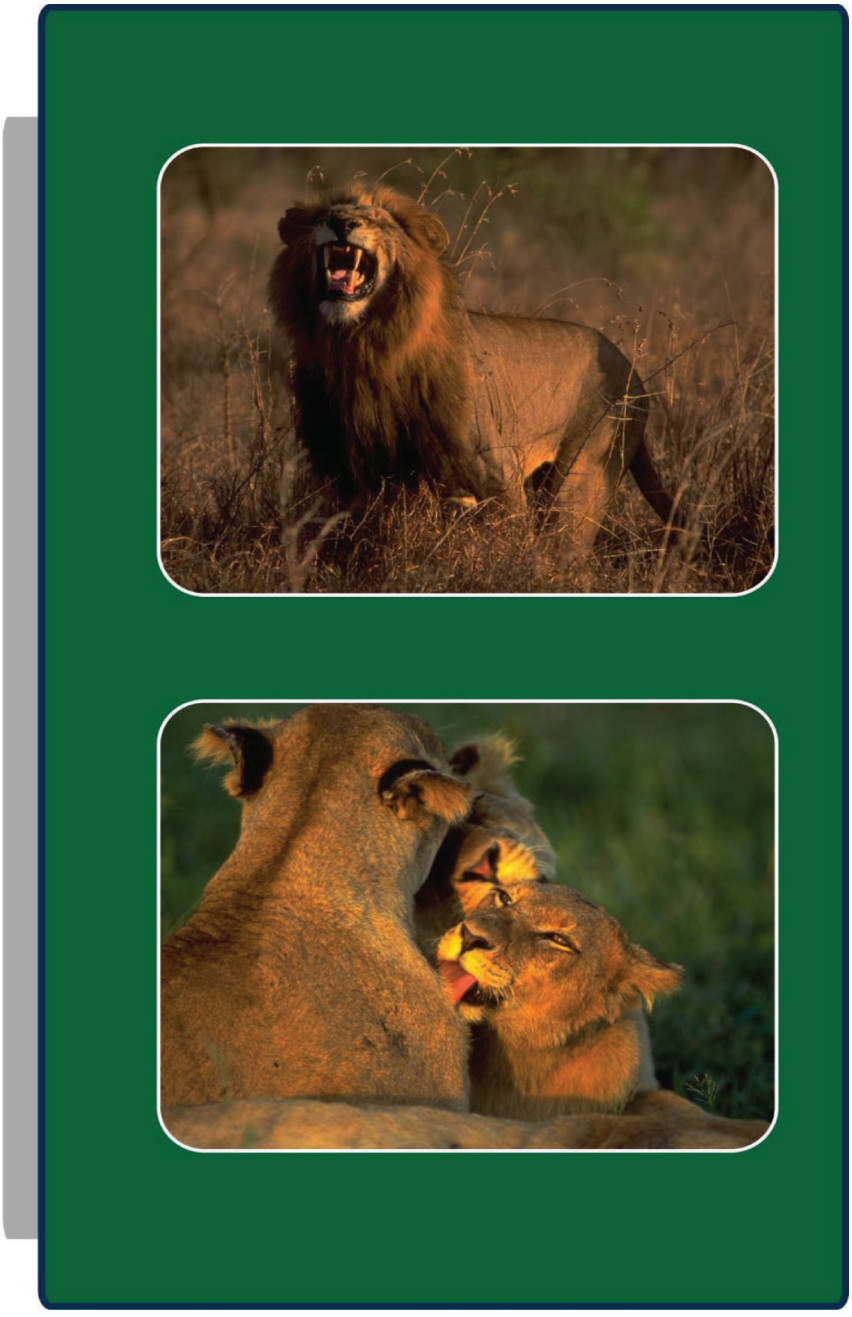
3. **Ensure that existing legal instruments are compatible and complementary at national and provincial levels, and improve the capacity to implement these laws.**

4. **Establish a lion forum or working group to assist in the implementation of the BMP.**

5. **Collaborate the alignment of this BMP with lion conservation plans in neighbouring countries and link with international working groups.**

A specific set of actions were defined for each objective. Lead agents or groups need to be defined for each action. It was proposed that SANParks, in collaboration with LiMF be the lead agents for wild and managed wild lions. Furthermore it was proposed that DEA would appoint at least three lead agents

who would have annual meetings with DEA. DEA will establish a forum or working group, including lead persons from LiMF, SANParks, Ezemvelo KZN Wildlife, North-West Parks and Tourism, and DEA (6-8 people). DEA will develop terms of reference for the forum, and perform the administrative duties and make the appointments.



4.3 Objectives and Actions table

Objective	Sub-objective	Actions	Intended 5-year outcomes	Indicators/due date	Implementing party
1. Improve the conservation status of lions within a broader conservation context	1.1. Maintain the current protection status of wild and managed wild lions	1.1.1. Maintain current level of protection for wild and managed wild lions in all protected areas	Stable wild lion populations in all protected areas No illegal trade in wild lions	Population censuses every three years starting in 2015	SANParks, Provinces, Conservation Agencies, Private Reserves carrying operational costs.
	1.2. Re-asses the conservation status of lions	1.2.1. Reassess the conservation status of wild and managed wild lions	The National IUCN Red Data List reflects the current status of lions in South Africa	The end of 2016	Endangered Wildlife Trust
	1.3. Enhance the conservation status of managed wild lions	1.3.1. Improve and execute a meta-population management plan for managed wild lions	>80% of reserves with managed wild lions integrated into a managed meta-population approach	Start implementing a managed meta-population plan by the end of 2015 >80% reserves included by 2019	DEA, SANParks, Provinces, Conservation Agencies, LiMF, Endangered Wildlife Trust
		1.3.2. Develop norms and standards for the reintroduction of managed wild lions	Published norms and standards for the management of managed wild lions	The end of 2016	DEA, LiMF
		1.3.3. Conduct a census/audit of all populations of managed wild lions and submit to DEA	Clear understanding of population size and trends	The first audit must be compiled by the end of 2015 and annually thereafter	LiMF
	1.4 Assess the management of the captive lion population	1.4.1 Develop national standards for the captive keeping and breeding of lions 1.4.2 Execute an audit of the lion keeping facilities of all current permit holders and cancel the permits of those that are not complying with their permit requirements	The Standards are developed and implemented. Provincial differentiations are superseded by national norms and standards.	By 2019 all permit holders have to comply with minimum standards or be closed down permanently. A detailed report on all conducted research by 2017	DEA, DAFF, Provinces, Academic Institutions& Partners (SAPA, PHASA) but not limited to.

Objective	Sub-objective	Actions	Intended 5-year outcomes	Indicators/due date	Implementing party
		1.4.3 Introduce the mandatory marking of captive-bred lions through micro chipping and/or tattooing 1.4.4 DEA to create and maintain a database of all permitted lion keepers/breeders and of their lion populations' DNA profiles 1.4.5 Conduct a study to determine the contribution of captive bred lions to conservation			
2. Develop and implement effective communication tools that are informed by scientific research (Communication, Education & Public Awareness)	2.2. Maximise the educational and research opportunities derived from lions	2.2.1. Develop a set of material for the education of the public, so that the correct messages can be transferred to the public	The public are better informed about the benefits and realities of lion conservation	Develop educational material by the end of 2017	DEA, DAFF and partners
3. Ensure that existing legal instruments are compatible and complementary at national and provincial levels, and improve the capacity to implement these laws		3.1.1. Ensure alignment on permit decisions between national and provincial legislation	Legislation is effective in supporting lion conservation and use	Redraft national and provincial legislation by the end of 2018	DEA, Provincial conservation authorities
		3.1.2. Address training needs, and implement training course for all aspects of legislation regarding lions	Well-trained managers make better management decisions, leading to sustainable conservation of lions	Develop and implement by the end of 2018	DEA

Objective	Sub-objective	Actions	Intended 5-year outcomes	Indicators/due date	Implementing party
4. Establish a lion forum or working group		4.1. Establish a lion forum or working group to monitor the implementation of the lion BMP and managed meta-population plan Meet on an annual basis	The forum implement and manage the meta-population	Annual report (starting in 2017) based on the minutes of the working group meeting	DEA, SANBI, SANParks, Provinces, Conservation Agencies, LiMF, EWT
5 Collaborate the alignment of this BMP with lion conservation plans in neighbouring countries and link with international working groups		5.1. Complete a review process to check for alignment with other regional strategies	South African Lion BMP closely aligned with neighbouring national and regional lion conservation strategies	Align with other strategies by the end of 2018	DEA
		5.2. Establish and/or maintain affiliations with international work groups	Close ties with IUCN Cat Specialist group and other similar working groups	Establish all necessary ties by the end of 2017	DEA
					TOTAL

5 A MANAGED META-POPULATION PLAN FOR MANAGED WILD LIONS

5.1 Background to the development of a managed meta-population plan for managed wild lions

Lions once roamed across virtually all of South Africa, but were all but extirpated by the early 1900s remaining only in small numbers in what are now Kruger National Park and the Kgalagadi Transfrontier Park. Since then, trends in South Africa contrast that for elsewhere in Africa where African lion numbers are declining. With the formation of Kruger National Park in the 1920s, lion numbers recovered slowly, growing to a stable population of approximately 1700 today (Ferreira & Funston 2010), one of six strongholds for lions in southern Africa (Riggio *et al.* 2012). The Kgalagadi Transfrontier Park has a smaller, yet also stable, population of lions and is also considered a lion stronghold (Riggio *et al.* 2012). Lions re-colonized Hluhluwe-iMfolozi Park (HiP) in the 1950/60s (Maddock *et al.* 1996) and were augmented to counteract inbreeding in the late 1990s early 2000s (Trinkel et al. 2008). The HiP population is stable at approximately 120 lions (Dave Druce *pers. comm.*).

The three focal wild lion populations are complemented by a fragmented population of wild managed lions in South Africa found on small fenced areas or reserves typically less than 1000km^2 in size. This largely results from private property as well as wildlife ownership rights enforced by fencing as required by South African law. Such laws do not exist in the rest of Africa and thus fencing is rare outside of South Africa. Even though varied opinions abound on the pros (Packer *et al.* 2013) and cons (Creel *et al.* 2013) of fencing as an essential component of lion conservation in future, the use of fences are likely to increase as human land-use continues to expand into lion ranges. This predicts continued fragmentation of lion habitats (Riggio *et al.* 2012, Dolrenry *et al.* 2014). The managed wild lions of South Africa thus may provide a key example in how to achieve integrated lion conservation goals in a changing African context. Already managers of lions in fragmented habitats associated with fenced reserves in Namibia and Zimbabwe are facing similar challenges to those experienced by South African managers.

5.2 South Africa's managed wild lion population - a brief history and management lessons

Since the 1990s, public and private game reserves started appearing in South Africa and many of them reintroduced lions, mostly as a tourist draw card. Lions from these early populations were then used for yet more reintroductions and the total number is now about 800 lions on over 45 small, fenced reserves (Miller *et al.* 2013). Many of these reserves only have one or two prides of lions, with the largest (Pilanesberg National Park and Madikwe Game Reserve) having four or five prides. Most managers of these reserves have tended to manage their lion populations in isolation although there was some movement of 'excess' lions. Fragmented isolated management called into question the conservation value of these lions (Hunter *et al.* 2007, Slotow & Hunter 2009).

Fragmented isolated management created several challenges. Researchers noted indicators of inbreeding in two reserves (Trinkel *et al.* 2008, 2010), while several reserves experienced increased lion population growth rates with subsequent high lion densities (Miller & Funston 2014). The combination of high lion densities and restricted size of these reserves disrupt predator-prey relationships – often prey dramatically decline (Tambling & du Toit 2005, Slotow & Hunter 2009). In addition, managers increasingly find it hard to locate new areas for 'excess' lions (Kettles & Slotow 2009). LiMF, formed in 2010, provides a platform for concerned managers to discuss the unique issues surrounding small, fenced lion populations. LiMF members recognise that many of the natural processes characteristic of large naturally functioning lion populations have been disrupted on these small reserves. Limited opportunities for restoration of these processes exist. An alternative is thus to use management interventions to mimic the outcomes of such natural processes (Miller *et al.* 2013; Ferreira & Hofmeyr 2014).

5.3 Maintaining ecological processes with managed wild lions

The restoration and maintenance of predation is one of the key biological processes managers would want to restore in any protected area (Dalerum *et al.* 2008). However, the challenges of maintaining ecological processes that involve lions in small, protected areas or reserves are complicated by expectations and attitudes of stakeholders (Kerley *et al.* 2003). These range from positive, such as a general assumption that the presence of lions enhances a tourism experience (Okello *et al.* 2008), to negative such as towards livestock losses as a result of lions spilling over into areas surrounding small reserves (Inskip & Zimmermann 2009).

Reintroduction of lions should mimic the sequence whereby species predictably colonize degraded or disturbed areas (Wassenaar *et al.* 2005). Such mimicking facilitated by translocations into newly established fenced reserves, however, was never explicit. The most challenging management consequences of the reintroduction of lions into small reserves isolated from each other are both ecological (Hayward & Kerley 2009) and genetic (Trinkel *et al.* 2008, 2010, 2011). Lions breed excessively successfully (Miller & Funston 2014) in these new environments with naïve (Hayward *et al.* 2007) and confined prey (van Dyk & Slotow 2004; Hayward & Kerley 2009), often depleting the prey base in a non-sustainable way in spatially limited environments (Tambling & du Toit 2005, Slotow & Hunter 2009). These then lead to a disruption of dynamic predator–prey relationships that may undermine ecological objectives, affect meso-predators such that in the absence of lions these species may become excessively abundant (Prugh *et al.* 2009), and that when lions are reintroduced persistence of rarer small carnivores may be challenged through meso-predator suppression (Ritchie & Johnson 2009).

In addition to the above ecological challenges, lion reintroductions are often token ecological actions because the primary motive is financial through eco-tourism (Kerley *et al.* 2003, Okello *et al.* 2008). The National Environmental Protected Areas Act (Act No. 57 of 2003) of South Africa provides for such activities as long as the ecological integrity of the protected area is not jeopardized. The disruption of prey-related processes when confined in small areas may be defined as illegal and in contravention of the act. Managers of protected areas are thus particularly accountable for dealing with disrupted predator–prey relations when large carnivores have been introduced into small areas.

Many of the above challenges originate from considering each reserve holding managed wild lions in isolation. This led to approaches based on the principle of establishing some or other 'carrying capacity' of predators based on available prey (Hayward *et al.* 2007). The approach is not inherently aligned to the modern conservation paradigm that acknowledges the flux of nature and importance of spatio-temporal patchiness and habitat heterogeneity (Stalmans *et al.* 2001). Ferreira & Hofmeyr (2014) offer a complimentary conceptual model to the single population carrying capacity approaches adhered to at present (Hayward *et al.* 2007). Their approach hinges on mimicking natural social dynamics that conceptually integrates several isolated reserves into a single population.

5.4 Mimicking natural social dynamics for managed wild lions

5.4.1 Reserve level management

Lion abundance and density correlate with the quantity and spatial distribution of prey biomass (van Orsdol *et al.* 1985, Packer *et al.* 2005). The variable social nature of lions influences this relationship with social factors tending to limit minimum home range sizes and often reduce survival and fecundity (Bertram 1973). For lions, this frequently results in long-term population trends being relatively stable (Packer *et al.* 2005). One consequence of fenced confined areas is an increase in the likelihood that individuals may become more tolerant of each other as is the case when unrelated lions are placed in a small boma (Ferreira & Hofmeyr 2014). In small areas spatial restrictions may thus remove one of the key mechanisms of population regulation of large carnivores, *i.e.* social unfamiliarity.

The disruption of social dynamics, particularly mechanisms inducing group living, may also be a key driver of disrupted predator-prey dynamics associated with lions in small reserves. Living in groups enables females to defend their cubs against roaming males (Packer & Pusey 1983, Packer et al. 1990) and to defend their territories against other lions or groups (Mosser & Packer 2009, Valeix *et al.* 2012). In most small enclosed areas few if any roaming males reside and often only one pride is present. The defense motivation for living in groups may therefore not be present. Foraging efficiency may be a third motivation for living in groups – when prey is scarce, lions do better by foraging alone or in a large group (Caraco & Wolf 1975). Foraging efficiency may thus only be a secondary motivation for living in groups. Disruption of group living mechanisms predict lions roaming more independently in small, enclosed areas compared to large open systems. Several lions on their own, or in smaller fractions, efficiently hunting different prey individuals simultaneously (Caraco & Wolf 1975; Lehmann *et al.* 2008c) disrupt predator-prey dynamics.

The social basis of group living creates considerable social stress, which can impose energetic constraints on females. In open natural systems, this can impose reduced birth rates through 1) postponing age at first birth, 2) lengthening birth intervals and 3) reducing litter sizes. Social stressors also impose reduced fitness, subsequently reducing survival rate. In addition, individuals of several mammal species display reduced survivorship during times of dispersal and territory establishment (Johnson & Gaines, 1990). Small, enclosed reserves prevent natural dispersal of lions. The disruption of social mechanisms resulting from spatial isolation and small sizes of areas where wild managed lions reside predicts increased reproductive outputs and longer life-spans of lions that leads to higher population growth rates already noted in several small reserves (Miller & Funston 2014).

The disruption of reasons for group living in lions is thus a key driver of the small enclosed reserve management challenges – rapid growth in lion numbers and increased predation pressure that degrade predator-prey relationships. For those reintroductions done to generate revenue through game viewing, a third challenge may arise. As depicted by mass media, large males and groups with cubs are an important factor for lion watching tourists. Reduced group living by lions in small, enclosed reserves thus impose on game viewing experiences that managers seek to achieve.

Conceptually, therefore management of lions in small reserves should focus on managing social relations (Ferreira & Hofmeyr 2014), key mechanisms of carnivore population regulation (Bertram 1973) as well as variability in predation risk, vulnerability and fear landscapes, complimenting a population approach with fixed 'carrying capacity' (Hayward *et al.* 2007). Given this context, most small protected areas and private reserves in South Africa are only capable of dealing with one to four prides of lions with management outcomes possibly being improved by focusing on social units rather than managing each individual in isolation (Ferreira and Hofmeyr 2014). This approach focuses on the biological mechanisms that are most likely disrupting predator–prey relationships and reducing genetic integrity.

The social approach allows reserve managers to mimic behaviour and dynamics of lion prides and other subgroups using the following basic biological characteristics for the species. Female lions conceive as early as 32 months, but typically give birth to cubs in normally functioning populations at 40 to 60 months of age (Smuts *et al.* 1978). In small confined populations lions tend to breed at younger ages (Miller & Funston 2014). Litter sizes averages three with a range of one to six (Smuts *et al.* 1978, Miller & Funston 2014). Birth intervals depend on whether cubs are raised to maturity, with lions in Kruger National Park having new litters every 30-36 months (Smuts *et al.* 1978). When litters are lost, intervals range between four and six months (Packer & Pusey 1987). In southern Africa in habitats with resident prey ranging from arid Kalahari to mesic Kruger National Park, cub survival is high, ranging from 60-80% in the first year (Funston 2009, 2011). Cub mortality increases when new males take over a pride (Packer *et al*. 1988). Sub-adults and adults have higher survival rates than cubs (Funston *et al.* 2003, Ferreira & Funston 2010).

Five management options are available to mimic social and population dynamics for females (Ferreira & Hofmeyr 2014). These include: 1) increasing the age at first reproduction using contraception of sub-adult females or 2) establishing longer intervals between births using contraception of adult females (Munson 2006, Bertschinger *et al*. 2008); 3) reducing age specific fecundity through reduced litter sizes using unilateral tube-tying of fallopian tubes (Alhasani *et al.* 1984); 4) mimicking female dispersal by removing as well as introducing sub-adult females; 5) mimicking higher death rates of old females by removing the oldest females in the pride. Unilateral tube tying of fallopian tubes may require experimental evaluation and clinical improvement before implementation.

The goal should be to maintain the variance in the number of adult females comprising a pride reflecting average values in large typically functioning populations (*e.g.* Kgalagadi Transfrontier Park, Kruger National Park). This converges onto four (range 1-20) in most southern African savannas (Smuts 1976, Stander 1991, Funston 2001). Managers may thus use modeling approaches (Quadling & Starfield 2002, Miller, Tambling & Funston *in press*) to define a mixture of the five options to achieve an average pride size of four. Managers will need to also (evaluate the number of breeding females in the context of their desired population size and they may need to reduce the number of breeding females as well. The Growls model (Miller *et al.* in review) can be used to explore the effectiveness of the various planned

interventions. Growls can be customised to most closely mimic a manager's situation and plans.

Male survival rates are typically lower than those of females (Ferreira & Funston 2010), but this discrepancy dissipates when in small confined areas (Slotow & Hunter 2009). Three management options are available for males: 1) mimic male dispersal through removal and introductions of sub-adults; 2) mimic pride take-overs – tenure is on average three years (Funston *et al.* 2003), and 3) mimic higher death rates of old males by removing the oldest males. Managers can again use modeling approaches (Whitman *et al*. 2004, Whitman *et al*. 2007) to achieve at least coalition tenure of three years and allowing each coalition to have only one breeding opportunity. No active switches of coalitions may be required if sub-adult male introduction and the oldest male removals are staggered. A pride take-over may then follow naturally, with subsequent consequences for cub mortality.

5.4.2 Meta-population level management

The social approach (Ferreira and Hofmeyr 2014) at reserve levels require interactions with other reserves as sources for management-assisted colonizing lions and destinations of management-assisted dispersing lions. This together with reproductive control essentially allows coalitions only one opportunity to breed. The external linkages in the network of reserves will maintain evolutionary potential as well as genetic diversity over time. If managers collaboratively mimic social dynamics similar to lions in large areas, genetic integrity will be an outcome, in stark contrast to approaches used until now (see Trinkel *et al.* 2010). Thus the key elements of a 'managed meta-population' of lions in small reserves in South Africa are:

1) Simulating natural social-based population regulation and space use patterns at the level of each reserve, and

2) Switching male coalitions and females between reserves on a sufficiently regular and irregular basis respectively to maintain typical tenure lengths, minimize breeding with relatives, and facilitate natural mortality rates of cubs, which are ethically challenging to simulate in any other ways.

5.5 Risks of mimicking social dynamics of managed wild lions

Several risks may materialize (Ferreira & Hofmeyr 2014), which in some cases are only speculative challenges:

5.5.1 Health risks

Some cases have been reported where contraception imposes individual health threats; including i) when lionesses are chemically prevented from having their first cycle, ii) lionesses that have been on contraception for extended periods when allowed to cycle again may do so irregularly or not at all, and iii) the physical tying of uteri tubes may result in complications and associated infections.

5.5.2 Behavioral changes

Without the demand of large cubs or sub-adults to feed this may reduce an adult lionesses' individual need to hunt in a group resulting in individual hunting and leading to fragmentation of prides (Lehmann 2008). This may also be induced by social familiarization in confined, small areas. This argues strongly for ensuring that new male coalitions are introduced into small reserves about once every three years minimum. Failing that some key objectives of each reserve may be challenged, including providing for tourism experiences, and not increasing overall predation rates. At least two papers have shown how social manipulation of lions can both decrease (Lehmann *et al.* 2008b) and increase (Tambling *et al.* 2013) predation rates.

5.5.3 Space use shifts

It is not yet clear how manipulated lions would respond in terms of space use (*e.g.* Kerley & Shrader 2007), which in turn may disrupt predator–prey interactions across landscapes. These will need to be evaluated as a potential consequence of a socially-based approach to carnivore management (Ferreira & Hofmeyr 2014).

5.6 Applying the 'meta-population' theory to lions on small reserves in South Africa

The situation in South Africa where cheetahs and wild dogs are described as being managed, or in the case of lions are recommended to be managed, as a 'meta-population' with single populations separated by large distances does contradict the theory of meta-population dynamics to some extent. Meta-populations are those with spatio-temporally variable subpopulation dynamics, variable dispersal and availability of empty habitats that are largely connected (Olivier *et al.* 2009). This is not the case with most managed wild lion populations on small reserves in South Africa. Thus in essence the 'managed meta-population' is a unique product of the South African response to manage and conserve large carnivores on isolated small reserves. The approach essentially recognizes a single population with social groups spatially isolated over vast areas. Some of these challenges can be reconciled through identifying regional nodes (see Figure 3). See also Marnewick *et al.* (2007) for cheetahs based on genetic geographical structure.

Lions for the reintroductions into South Africa's small reserves were initially sourced from Etosha National Park as well as Sabi Sand Game Reserve, adjacent to the Kruger National Park. Recently, SANParks relocated some animals from the South African part of Kgalagadi Transfrontier Park (Slotow & Hunter 2009). Managers applied minimal genetic management throughout the history of lion reintroductions (Slotow & Hunter 2009, Trinkle *et al.* 2010). As a result, geographic genetic structure in the managed wild lion meta-population reflect mixed origins with few reserves having lions of only one origin (Miller *et al.* in review). The South African managed wild lions thus represent a novel lion genetic diversity not associated with a single origin. Maintaining the origin of the base genetic stock is thus a low priority.

One of the challenges of the 'managed meta-population' approach is that it is intensive and potentially costly and requires many linkages and management agreements between several conservation areas. The number of linkages depends to a large extent on the size of each population, as measured by the number

of prides in a reserve. It is suggested that most integration is within regional nodes (see Figure 3) with rare external linkages to other nodes based on biome characteristics (Ferreira & Hofmeyr 2014, Miller *et al.* in review).

The mimicking of social dynamics make specific predictions of genetic integrity which can serve as a strong indicator and informant of the success and implementation of the meta-population management plan for wild managed lions in South Africa. Regional clustering into four sub-populations (Figure 3) facilitates collaborative management and legal processes such as provincial permitting. This makes predictions for the genetic structure of sub-populations as well as the meta-population if social dynamics are effectively implemented to mimic that of a large lion population. Levels of genetic diversity indicators of the wild managed lions in South Africa should thus reflect that of levels of indicators for the Kruger National Park and Kgalagadi Transfrontier Park. To facilitate this genetic monitoring and informing management, Miller *et al*. (2014) developed microsatellite loci for relatedness testing.

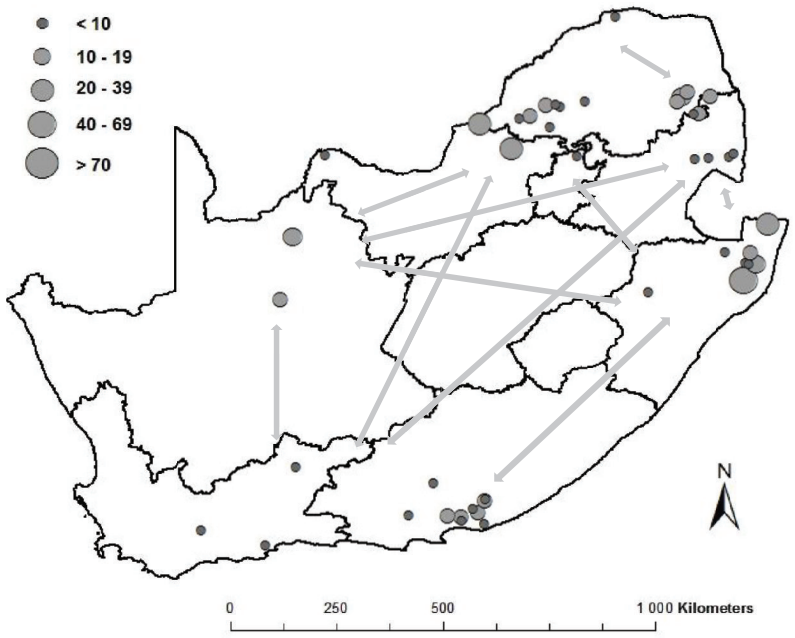


Figure 3. Location of reserves in South Africa with managed lions and proposed management clusters (shaded areas). The size of each dot represents the number of lions on the reserve. A national network of reserves is envisaged where translocations between reserves within the clusters occur on a regular basis (as required by each reserve) with less frequent translocations between clusters (indicated by arrows). This should improve the genetic integrity of this population as a whole (map from Miller *et al.* 2013).

A key advantage of several small lion populations is that it is relatively easy to track individual lions and some of their life-history. This provides opportunities to also use studbook approaches in keeping track of progress with implementation of a meta-population management plan for wild managed lions in South Africa. The combination of integrated social mimicking of lion dynamics in regional nodes together with genetic and studbook monitoring informing and evaluating implementation of the meta-population management plan for wild managed lions in South Africa will allow the creation of the seventh wild lion population in southern Africa albeit of novel genetic make-up. It will also create several opportunities aligning with the overall vision of the BMP for Lion in South Africa.

5.7 Objectives

5.7.1 To maintain the wild managed lions of South Africa as a key population that contributes to several socio-economic-ecological opportunities as part of reserve objectives by inducing social limitations through

5.7.1.1 Mimicking changes in lion survival associated with social stress and prey biomass limitations;

5.7.1.2 Mimicking changes in lion fecundity by increasing the age of first reproduction, decreasing litter sizes and/or increasing interval between births;

5.7.1.3 Mimicking high mortality in young cubs and old individuals.

5.7.2 To maintain lion genetic integrity by inducing social limitations through management-assisted dispersal and changes in dominance hierarchies.

5.8 Actions Tables

Implementation of the meta-population management plan for wild managed lions in South Africa will help address actions directed at achieving Objective 1.3 (*i.e.* Enhance the conservation status of managed wild lions) of the BMP for Lion in South Africa. The establishment of a lion forum or working group (Objective 4 of the BMP for Lion in South Africa) is a key element providing oversight of this integrated approach. Specific actions are as follows:

Objective 5.7.1 - To maintain the wild managed lions of South Africa as a key population that contributes to several socio-economic-ecological opportunities as part of reserve objectives by inducing lion social limitations.

Action	Target	Accountability	Evaluation
Model required changes in life-history variables to achieve dynamic social groups on a reserve	2015	LiMF	Science Report
Develop 5 year action plan as guidance for interventions	2015	LiMF	Action Plan
Inform and update stakeholders	Ongoing	DEA	Meeting Report
Complete reserve risk assessments of proposed management actions	Ongoing	Reserve Management	LiMF Data Submission
Mimic survival changes through lethal and non-lethal removal	Ongoing	Reserve Management	LiMF Data Submission
Mimic required immigration and emigration through removal and introductions at defined intervals	Ongoing	Reserve Management	LiMF Data Submission
Mimic required changes in age at first reproduction and interval between births through selective application of contraceptives	Ongoing	Reserve Management	LiMF Data Submission
Measure the spatial response of carnivores by evaluating annual distribution through cyber tracker data	Annual	Reserve Management	LiMF Data Submission
Collate and model landscape use from wildlife spatial data	Bi-annual	LiMF	Science Report
Measure the demographic response by determining age- and sex structures of carnivore species through ranger observations	Annual	Reserve Management	LiMF Data Submission
Collate and model social group change from demographic data	Bi-annual	LiMF	Science Report
Count wildlife using an optimized design	Annual	Reserve Management	LiMF Data Submission
Relate carnivore spatial use and social dynamics to measures of wildlife dynamics	Bi-annual	LiMF	Science Report
Inform park management on the progress of managing predator-prey relations	Annual	LiMF	Meeting Report
Inform park stakeholders on the progress with managing predator-prey relations	Ongoing	DEA	Meeting Report

Objective 5.7.2 - To maintain lion genetic integrity by inducing social limitations through management-assisted dispersal and changes in dominance hierarchies.

Action	Target	Accountability	Evaluation
Identify and extract life-history characteristics of lions	2015	LiMF	Science Report
Define social dynamics from the literature of lions	2015	LiMF	Science Report
Develop a 5-year action plan as guidance	2015	LiMF	Action Plan
Inform and update stakeholders of the genetic integrity of lions	Ongoing	DEA	Meeting Report
Complete a risk assessment of proposed species management actions	Ongoing	Reserve Management	LiMF Data Submission
Mimic male dispersal from and into the social unit through removal and introductions at age of sexual maturity	Ongoing	Reserve Management	LiMF Data Submission
Mimic dominance changes at intervals reflecting natural dominance hierarchies through switching of dominant males in particular	Ongoing	Reserve Management	LiMF Data Submission
Mimic occasional female dispersal from and into the social unit at intervals reflecting natural dispersal through removal and introductions	Ongoing	Reserve Management	LiMF Data Submission
Model genetic diversity from individual life histories	Every 5 years	LiMF	Science Report
Measure the genetic diversity of the social units	Every 5 years	LiMF	Science Report
Inform park management on the progress of managing predator-prey relations	Annual	LiMF	Meeting Report
Inform park stakeholders on the progress with managing predator-prey relations	Ongoing	DEA	Meeting Report

6. MONITORING AND EVALUATION

6.1 Monitoring Plan

The guiding principle for the monitoring of the actions defined in this BMP is adaptive management: using information or opinions on how systems function to conduct management that makes predictions of how a system should respond if the information or opinions were correct, measure these predictions robustly and adapt management actions accordingly if needed (Rogers 1997, Biggs & Rogers 2003, Tompkins & Adger 2004). The relatively short cycle of five years for which the lion BMP is valid permits changes to be incorporated relatively quickly. Monitoring and evaluation should have a process that allows those findings to enter the lion BMP as they become available. Thus the BMP should be viewed as a living document with the opportunity for changes to be implemented. It is DEAs responsibility to oversee the implementation and monitoring that has been stipulated in this BMP, although DEA can appoint agencies to be responsible for both implementation and monitoring.

6.1.1 Key Targets

The five overarching BMP objectives comprise two objectives that are outcome focused with the remaining objectives focused on providing processes and tools. Reporting on targets defined for the outcome focused objectives (1: To improve the conservation status of lions within a broader conservation context, considering the respective role of wild, managed wild and captive populations; and 2: Encourage the development of opportunities for economic and social benefits from responsibly managed wild, managed wild and captive lion populations) will thus reflect on achievement of the BMP vision.

1. Persistence of wild lion populations

Measure 1: Stability of all existing wild lion populations.

2. Persistence of managed wild lion populations

Measure 2: Stability or increasing meta-population of managed wild lion population.

Measure 3: Comparative level of genetic diversity of the meta-population of managed wild lions with that of wild lion populations.

3. Norms and standards for captive lions

Measure 4: Zero deviations from norms and standards defined in permit conditions.

4. Economic opportunities

Measure 5: Growth in lion-based economic outputs matches national economic growth indicators.

5. Social benefits

Measure 6: Growth in indicators of lion-based benefit sharing match national equitable benefit sharing indicators.

6.1.2 Monitoring Schedule

The key aspects that require monitoring are largely covered by the objectives and actions table (see Section 6.1.2 for summary of monitoring schedule). The schedule need to be met, and to monitor progress towards their fruition, the implementing party for each respective action should submit an annual report to DEA outlining the progress and milestones achieved.

Action	Date of Monitoring Inception	Monitoring Schedule
1.1.1. Maintain current level of protection for wild and managed wild lions in all protected areas	2015	Population surveys every three years
1.2.1. Reassess the conservation status of wild and managed wild lions	2017	Every five years
1.3.1. Improve and execute a meta-population management plan for managed wild lions	2016	Review every five years
1.3.2. Develop norms and standards for the reintroduction of managed wild lions	2016	Review every five years
1.3.3. Conduct a census/audit of all populations of managed wild lions and submit to DEA	2016	Review every year
1.4.1 Develop national standards for the captive keeping and breeding of lions	2016	Review every five years
1.4.2 Execute an audit of the lion keeping facilities of all current permit holders and cancel the permits of those that are not complying with their permit requirements	2016	Review every two years
1.4.3 Introduce the mandatory marking of captive-bred lions through micro chipping and/or tattooing	2016	Review every two years
1.4.4 DEA to create and maintain a database of all permitted lion keepers/breeders and of their lion populations' DNA profiles	2016	Review every two years
1.4.5. Conduct a study to determine the contribution of captive bred lions to conservation	2017	Review every 5 years
2.1.2. Develop and implement guidelines to support the permitting process	2016	Review every ten years
2.2.1. Develop a set of material for the education of the public, so that the correct messages can be transferred to the public	2016	Review every ten years
3.1.1. Ensure alignment on permit decisions between national and provincial legislation	2016	Review every five years
3.1.2. Address training needs, and implement training course for all aspects of legislation regarding lions	2016	Assess annually
4.1. Establish a lion forum to monitor the implementation of the lion BMP and managed meta-population plan Meet on an annual basis	2015	Review every five years
5.1. Complete a review process to check for alignment with other regional strategies	2018	Review every five years
5.2. Establish and/or maintain affiliations with international work groups	2017	Review every five years

6.2 Evaluation Plan

DEA will establish a Lion Forum or working group (Objective 4 of the BMP for Lion in South Africa) that will also have the role of providing an interim evaluation of the achievement of the BMP Objectives at two-year intervals. Every five years the forum or working group will facilitate an external review of how South Africa performs in achieving the BMP Objectives and provide guidance informing the revision of the BMP.

Actions to evaluate and vary the BMP for lion in South Africa

No.	Action	Operational Target	Accountability
1	Establish the Terms of Reference for Lion Forum or Working Group	2016	DEA
2	Appoint members to Lion Forum or Working Group	2016	DEA
3	Ensure interim evaluation of the BMP by Lion Forum or Working Group	Bi-annual	DEA
4	Ensure an extensive external review of the BMP by Lion Forum or Working Group	2018	DEA
5	Revise the BMP according to recommendations	2019	DEA
6	Implement the revised BMP	2019	DEA

7. BIBLIOGRAPHY

Alhasani, S., Vanderven, H., Diedrich, K., Hamerich, U., Lehmann, F. & Krebs, D. (1984). The effect of unilateral as well as bilateral salping-ectomy in rabbit implantation. Zuchthyg Reprod. Dom. Anim. 19: 118.

Anderson, J.L. (1980). The re-establishment and management of a lion *Panthera leo* population in Zululand, South Africa. *Biological Conservation* 19: 107-117.

Anon (2011). Before the secretary of the interior petition to list the African lion (*Panthera leo*) as endangered pursuant to the U.S. endangered species act. IFAW, Humane society International, The Humane Society, Born Free and Defenders of the Wild.

Antunes, A., Troyer, J.L., Roelke, M. E., Pecon-Slattery, J., Packer, C., *et al*. (2008). The evolutionary dynamics of the lion *Panthera leo* revealed by host and viral population genomics. *PLoS Genet.* 4: e1000251.

Barnett, R., Yamaguchi, N., Barnes, I. & COOPER, A. (2006). The origin, current diversity and future conservation of the modern lion (*Panthera leo*). *Proceedings of the Royal Society* 273: 2119–25.

Bauer, H., & Nowell, K. (2004). Endangered classification for West African Lions. *Cat News, 41*, 35- 36.

Bauer, H. & Van Der Merwe, S. (2004). Inventory of free-ranging lions (*Panthera leo*) in Africa. *Oryx* 38: 26-31.

Bauer, H., Nowell, K., & Packer, C. (2008). *Panthera leo*, IUCN 2010. IUCN Red List of Threatened Species. Version 2010.4. http:// www.iucnredlist.org/ apps/redlist/details/15951/0.

Becker, M.S., Watson, F., Droge, E., Leigh, K., Carlson, R. & Carlson, A.A. (2013). Estimating past and future male loss in three Zambian lion populations. *Journal of Wildlife Management* 77:128-142.

Bengis, R.G., Kriek, N.P.J., Keet, D.F., Raath, J.P., de Vos, V. & Huchzermeyer, H.F.K.A. (1996). An outbreak of bovine tuberculosis in a free-living African buffalo (*Syncerus caffer*) population in the Kruger National Park – A preliminary report. *Onderstepoort Journal of Veterinary Research* 63: 15-18.

Bertschinger, H.J., De Barros Vaz Guimaraes, M.A., Trigg T.E. & Human, A. (2008). The use of deslorelin implants for long-term contraception of lionesses and tigers. *Wildlife Research* 35: 525–530.

Bertola, L.D., Hooft, W.F. Van Vrieling, K., Weerd, D.R. Uit de York, D.S., Bauer, H., Prins, H.H.T., Funston, P.J., Haes, H.A. Udo de Leirs, H. *et al.* (2011). Genetic diversity, evolutionary history and implications for conservation of the lion (*Panthera leo*) in west and central Africa. *Journal of Biogeography* 38: 1356–1367.

Biggs, H.C. & Rogers, K.H. (2003). An adaptive system to link science, monitoring, and management in practice. In J.T. Du Toit, K.H. Rogers and H.C. Biggs (eds.), *The Kruger Experience: Ecology and management of savanna heterogeneity*, pp. 59-80, Island Press, Washington.

Björklund, M. (2003). The risk of inbreeding due to habitat loss in the lion (*Panthera leo*). *Conservation Genetics* 4: 515-523.

Brown, E., Yuhki, N., Packer, C. & O'Brien, S. (1994). Lion lentivirus related to feline immunodeficiency virus: epidemiologic and phylogenetic Aspects. *Journal of Virology* 68: 5953-5968.

Caraco, T., & Wolf, L. 1975. Ecological determinants of group sizes of foraging lions. *American Naturalist* 109: 343-352.

Caron, A., Cross, P.C. & du Toit, J.T. (2003). Ecological implications of bovine tuberculosis in African buffalo herds. *Ecological Applications* 13: 1338-1345.

Castley, J.G., Knight, M.H., Mills, M.G.L. & Thouless, C.R. (2002). Estimation of the lion (*Panthera leo*) population in the southwestern Kgalagadi Transfrontier Park using a capture–recapture survey. African Zoology 37: 27–34.

Chardonnet, P. (Ed.). (2002). *Conservation of the African Lion: Contribution to a Status Survey*. France: International Foundation for the Conservation of Wildlife, USA: Conservation Force.

Craft, M.E. (2008). Predicting disease dynamics in African lion populations. (Unpublished doctoral dissertation). University of Minnesota.

Craft, M.E., Volz, E., Packer, C., Meyers, L.A. (2009). Distinguishing epidemic waves from disease spillover in a wildlife population. *Proceedings of the Royal Society Biological Sciences* 276: 1777– 1785.

Creel, S. & Creel, N.M. (1997). Lion density and population structure in the Selous Game Reserve: Evaluation of hunting quotas and offtake. *African Journal of Ecology* 35: 83–93.

Creel, S., Becker, M.S., Durant, S.M., M'Soka, J., Matandiko, S., et al. (2013). Conserving large populations of lions – the argument for fences has holes. Ecol Lett doi: 10.1111/ele.12145

Croes, B.M, Funston, P.J., Rasmussen, G., Buij, R., Saleh, A., Tumenta, P.N. & de Iongh, H.H. (2011). The impact of trophy hunting on lions (*Panthera leo*) and other large carnivores in the Bénoué Complex, northern Cameroon. *Biological Conservation* 144: 3064–3072.

Dalerum, F., Somers, M.J., Kunkel, K.E. & Cameron, E.Z. (2008). The potential for large carnivores to act as biodiversity surrogates in southern Africa. *Biodiversity & Conservation* 17: 2939–2949.

Davidson, Z., Valeix, M., Loveridge, A.J., Madzikanda, H. & Macdonald, D.W. (2011). Socio-spatial behaviour of an African lion population following perturbation by sport hunting. Biological Conservation 144, 114–121.

De Boer, W.F., Vis, M.J.P, De Knegt, H. J., Rowles, C., Kohi, E. M., *et al*. (2010). Spatial distribution of lion kills determined by the water dependency of prey species. *Journal of Mammalogy* 91: 1280–1286.

Dolrenry, S., Stenglein, J., Hazzah, L., Lutz, R.S. & Frank, L. (2014). A Metapopulation approach to African lion (*Panthera leo*) conservation. PLoS ONE 9(2): e88081. doi:10.1371/journal.pone.0088081.

Driciru, M., Siefert, L., Prager, K.C., Dubovi, E., Sande, R., Princee, F., *et al*. (2006). A serosurvey of viral infections in lions (*Panthera leo*), from Queen Elizabeth National Park, Uganda. *Journal of Wildlife Diseases* 42: 667-671.

Druce, D., Genis, H., Braak, J., Greatwood, S., Delsink, A., Kettles, R., Hunter, L. & Slotow, R. (2004a). Prey selection by a reintroduced lion population in the Greater Makalali Conservancy, South Africa. *African Zoology* 39: 273-284.

Druce, D., Genis, H., Braak, J., Greatwood, S., Delsink, A., Kettles, R., Hunter, L. & Slotow, R. (2004b). Population demography and spatial ecology of a reintroduced lion population in the Greater Makalali Conservancy, South Africa. *Koedoe* 47: 103–118.

Dubach, J.M., Briggs, M.B., White, P.A., Ament, B.A. & Patterson, B.D. (2013). Genetic perspectives on ''Lion Conservation Units'' in Eastern and Southern Africa. *Conservation Genetics* DOI 10.1007/s10592-013-0453-3.

Elliot, J.P. & Cowan, I. Mc T. (1978). Territoriality, density and prey of the lion in Ngorongoro Crater, Tanzania. *Canadian Journal of Zoology* 56: 1726-1734.

Ferreira, S.M. & Funston, P.J. (2010a). Estimating lion population variables: Prey and disease effects in Kruger National Park, South Africa. *Wildlife Research* 37: 194-206.

Ferreira, S.M. & Funston, P.J. (2010b). Age assignment to individual African lions. *South African Journal of Wildlife Research* 40: 1-9.

Frank, L. (1998). Living with Lions: Carnivore Conservation and Livestock in Laikipia District, Kenya. US Agency for International Development, Conservation of Biodiverse Resource Areas Project, Bethesda, Maryland. p. 63.

Ferreira, S.M. & Hofmeyr, M. (2014). Managing charismatic carnivores in small areas: large felids in South Africa. South African Journal of Wildlife Research 44(1): 32–42.

Funston, P.J. (2002). Kgalagadi Transfrontier Lion Project – Final Report. Submitted to the Green Trust and the Endangered Wildlife Trust.

Funston, P.J. (2004). Specialist study: Lion utilization plan for the Associated Private Nature Reserves (APNR). Management Consultancy.

Funston, P.J. & Mills, M.G.L. (2006). The influence of lion predation on the population dynamics of common large ungulates in the Kruger National Park. *South African Journal of Wildlife Research* 36: 9-22.

Funston, P.J. (2008). Conservation and management of lions in Southern Africa: Status, threats, utilization and the restoration option. In: B. Croes, H.H. De Iongh, & H. Bauer (Eds.), Management and Conservation of Large Carnivores in West and Central Africa. (pp. 109-131). Institute of Environmental Sciences, Leiden.

Funston, P.J. (2011). Population characteristics of lions (*Panthera leo*) in the Kgalagadi Transfrontier Park. *South African Journal of Wildlife Research* 41: 1-12.

Funston, P.J., Mills, M.G.L., Biggs, H.C. & Richardson, P.R.K. (1998). Hunting by male lions: ecological influences and socioecological implications. *Animal Behavior* 56: 1333–1345.

Funston, P. J., Mills, M. G. L. & Biggs, H. C. (2001). Factors affecting the hunting success of male and female lions in the Kruger National Park. *Journal of Zoology, London* 253: 419–431.

Funston, P.J., Mills, M.G.L., Richardson, P.R.K. & van Jaarsveld, A.S. (2003). Reduced dispersal and opportunistic territory acquisition in male lions *(Panthera leo*). *Journal of Zoology, London* 259: 1-12.

Funston PJ, Frank L, Stephens T, Davidson Z, Loveridge A, *et al*. (2010). Substrate and species constraints on the use of track incidences to estimate African large carnivore abundance. Journal of Zoology 281: 56–65.

Funston, P.J., Groom, R.J. & Lindsey, P.A. (2013). Insights into the management of large carnivores for profitable wildlife-based land uses in African savannas. PLoS ONE 8(3): e59044. doi:10.1371/journal.pone.0059044.

Groom, R., Funston, P.J. & Mandisodza, R. (2014) Lion surveys in protected areas in Zimbabwe yield disturbing results: what is driving population collapse? *Oryx* . doi:10.1017/S0030605312001457.

Hanby, J. & Bygott, J. (1987). Emigration of subadult lions. *Animal Behavior* 35: 161–169.

Hanby, J.P., Bygott, J. & Packer, C. (1995). Ecology, demography, and behavior of lions in two contrasting habitats: Ngorongoro Crater and the Serengeti plains. In: Sinclair, A. R. E. and Arcese, P. (eds), Serengeti II: dynamics, management, and conservation of an ecosystem. Univ. of Chicago Press, pp. 315-331.

Hayward, M.W. & Kerley, G.I.H. (2005). Prey preferences of the lion (*Panthera leo*). *Journal of Zoology, London* 267: 309–322.

Hayward, M.W. & Hayward, G.J. (2007). Activity patterns of reintroduced lion *Panthera leo* and spotted hyaena *Crocuta crocuta* in Addo Elephant National Park, South Africa. *African Journal of Ecology* 45: 135–141.

Hayward, M., O'Brien, J. & Kerley, G. (2007a). Carrying capacity of large African predators: Predictions and tests. *Biological Conservation* 139: 219-229.

Hayward, M.W., Adendorff, J., O'Brien, J., Sholto-Douglas, A., Bissett, C., *et al*. (2007b). Practical considerations for the reintroduction of large, terrestrial, mammalian predators based on reintroductions to South Africa's Eastern Cape province. *Open Conservation Biology Journal* 11:1-11.

Hayward, M.W., Adendorff, J., O'Brien, J., Sholto-Douglas, A., Bissett, C., *et al*. (2007c). The reintroduction of large carnivores to the Eastern Cape, South Africa: an assessment. *Oryx* 41: 205-214.

Hayward, M.W & Kerley, G.I.H (2009). Fencing for conservation: Restriction of evolutionary potential or a riposte to threatening processes? *Biological Conservation.* 142: 1-13.

Hayward, M.W, Hayward, G.J., Druce, D.J. & Kerley, G.I.H. (2009b). Do fences constrain predator movements on an evolutionary scale? Home range, food intake and movement patterns of large predators reintroduced to Addo Elephant National Park, South Africa. *Biodiversity and Conservation* 18: 887–904.

Hayward, M.W., Hayward, G.I, Tambling, C.J. & Kerley, G.I.H. (2011). Do lions *Panthera leo* actively select prey or do prey preferences simply reflect chance responses via evolutionary adaptations to optimal foraging*? PLoS ONE* 6(9): e23607. doi:10.1371/journal.pone.0023607.

Henschel, P., Azani, D., Burton, C., Malanda, G., Saidu, Y., Sam, M. & Hunter, L. (2010). Lion status updates from five range countries in West and Central Africa. *CatNEWS* 52: 34-39.

Henschel, P., Coad, L., Burton, C., Chataigner, B., Dunn, A., *et al*. (2014). The Lion in West Africa Is Critically Endangered. PLoS ONE 9(1): e83500. doi:10.1371/ journal.pone.0083500.

Hoffmann-Lehmann, R., Fehr, D., Grob, M., Elgizoli, M. Packer, C., *et al*. (1996). Prevalence of antibodies to feline parvovirus, calicivirus, herpesvirus, coronavirus, and immunodeficiency virus and of feline leukemia virus antigen and the interrelationship of these viral infections in free-ranging lions in East Africa. *Clinical and Diagnostic Laboratory Immunology* 3: 554–562.

Hopcraft, J. G. C., Sinclair, A. R. E. & Packer, C. (2005). Planning for success: Serengeti lions seek prey accessibility rather than abundance. *Journal of Animal Ecology* 74: 559–566.

Hunter, L.T.B., Pretorius, K., Carlisle, L.C., Rickelton, M., Walker, C., Slotow, R. & Skinner, J. D. (2007). Restoring lions *Panthera leo* to northern KwaZulu-Natal, South Africa: short-term biological and technical success but equivocal long-term conservation. *Oryx* 41: 196-2004.

Inskip, C. & Zimmermann, A. (2009). Human–felid conflict: a review of patterns and priorities worldwide. *Oryx* 43: 18–34.

IUCN SSC Cat Specialist Group (2004). FIV in lions. Retrieved from http://www.catsg.org

IUCN SSC Cat Specialist Group (2006). Regional conservation strategy for the lion *Panthera leo* in Eastern and Southern Africa. Retrieved from http://www.catsg.org.

Johnson, M.L. & Gaines, M.S. (1990). Evolution of dispersal: Theoretical models and empirical tests using birds and mammals. *Annual Review of Ecology and Systematics* 21: 449-480.

Kerley, G.I.H., Geach, B.G.S. & Vial, C. (2003). Jumbos or bust: do tourists' perceptions lead to an under-appreciation of biodiversity? *South African Journal of Wildlife Research* 33: 13–21.

Kerley, G.I.H. & Shrader, A.M. (2007). Elephant contraception: silver bullet or a potentially bitter pill? *South African Journal of Science* 103:181–182.

Keet, D.F., Davies-Mostert, H., Bengis, R.G., Funston, P., Buss, P., *et al*. (Eds.). (2009). *Lion (Panthera leo) Bovine tuberculosis disease risk assessment* (Workshop report). Skukuza, South Africa: Conservation Breeding Specialist Group (CBSG SSC / IUCN), CBSG Southern Africa, Endangered Wildlife Trust.

Kettles, R. & Slotow, R. (2009). Management of free-ranging lions on an enclosed game reserve. *South African Journal of Wildlife Research* 39: 23-33.

Kiffner, C., Meyer, B., Mühlenberg, M. & Waltert, M. (2009). Plenty of prey, few predators: what limits lions *Panthera leo* in Katavi National Park, western Tanzania? *Oryx* 43: 52–59.

Kilian, P.J. & Bothma, J. Du P. (2003). Notes on the social dynamics and behaviour of reintroduced wild lions in the Welgevonden Private Game Reserve. *South African Journal of Wildlife Research* 33: 119-124

Kissui, B.M. & Packer, C. (2004). Top-down population regulation of a top predator: lions in the Ngorongoro Crater. *Proceeding of the Royal Society of London* 271: 1867-1874.

Lehmann, M.B., Funston, P.J., Owen, C.R. & Slotow, R. (2008a). Reproductive behaviour of a single pride of lions on Karongwe Game Reserve, South Africa. African Zoology 43(2): 230–236.

Lehmann, M.B., Funston, P.J., Owen, C.R. & Slotow, R. (2008b). Feeding behaviour of lions (*Panthera leo*) on a small reserve. *South African Journal of Wildlife Research*. 38, 66–78.

Lehmann, M.B., Funston, P.J., Owen, C.R. & Slotow, R. (2008c). Territorial and home range behaviour of a single pride of lions on Karongwe Game Reserve. *PLoS One* e1000251. doi:10.1371/journal.pgen.1000251

Lindsey, P.A., Alexander, R., Balme, G., Midlane, N. & Craig, J. (2012a). Possible relationships between the South African captive-bred lion hunting industry and the hunting and conservation of lions elsewhere in Africa. *South African Journal of Wildlife Research* 42: 11–22.

Lindsey, P.A., Balme, G.A., Booth, V.R. & Midlane, N. (2012b). The significance of African lions for the financial viability of trophy hunting and the maintenance of wild land. *PLoS One* 7(1): e29332.

Lindsey, P.A, Havemann, C.P., Lines, R.M., Price, A.E., Retief, T.A., Rhebergen, T., Van der Waal, T. & Romañach, S.T. (2013). Benefits of wildlife-based land uses on private lands in Namibia and limitations affecting their development. *Oryx* 47: 41–53.

Lindsey, P.A, Balme, G.A., Funston, P.J., Henschel, P., Hunter, L., Madzikanda, H., Midlane, N. & Nyirenda, V. (2103). The Trophy Hunting of African Lions: Scale, Current Management Practices and Factors Undermining Sustainability. PLoS ONE 8(9): e73808.doi:10.1371.

Louw, H., Funston, P.J., Greeff, A. & Kloppers, H.S. (2012). The applicability of lion prey selection models to smaller game reserves in South Africa. *South African Journal of Wildlife Research* 42(2): 1-9.

Loveridge, A.J., Searle, A.W., Murindagomo, F. & Macdonald, D.W. (2007). The impact of sport-hunting on the population dynamics of an African lion population in a protected area. *Biological Conservation* 134: 548-558.

Loveridge, A.J., Valeix, M., Davidson, Z., Murindagomo, F., Fritz, H. & Macdonald, D.W. (2009). Changes in home range size of African lions in relation to pride size and prey biomass in a semi-arid savanna. Ecography, 32.

Macdonald, D.W. (1983). The ecology of carnivore social behaviour. *Nature* 301: 379-384.

Maddock, A., Anderson, A., Carlisle, F., Galli, N., James, A., Vester, A. & Whitfield, W. (1996). Changes in lion numbers in Hluhluwe-Umfolozi Park. *Lammergeyer* 44: 6-18.

Marnewick, K., Beckhelling, A., Cilliers, D., Lane, E., Mills, M.G.L., Herring, K., Caldwell, P., Hall, R. & Meintjes, S. (2007). The status of the cheetah in South Africa. *CAT News* 3: 22–31.

Michel, A.L., Bengis, R.G., Keet, D.F., Hofmeyr, M., de Klerk, L.M., Cross, P.C., *et al*. (2006). Wildlife tuberculosis in South African conservation areas: Implications and challenges. *Veterinary Microbiology* 112: 91–100.

Mills, M.G.L., Wolf, P., Le Riche, E.A.N. & Meyer, I.J. (1978). Some population characteristics of the lion (Panthera leo) in the Kalahari National Park. *Koedoe* 21: 163–171.

Mills, M.G.L. & Shenk, T.M. (1992). Predator-prey relationships: the impact of lion predation on wildebeest and zebra populations. *Journal of Animal Ecology* 61: 693-702.

Mills, M.G.L. & Biggs, H. C. (1993). Prey apportionment and related ecological relationships between large carnivores in Kruger National Park. *Symposium of the Zoological Society of London* 65: 256–268.

Mills, M.G.L., Biggs, H.C. & Whyte, I.J. (1995). The relationship between rainfall lion predation and population trends in African herbivores. *Wildlife Research* 22: 75-88.

Miller, S.M, Bissett, C., Burger, A., Courtney, B. & Dickerson, T., *et al.* (2013). Management of reintroduced lions in small, fenced reserves in South Africa: an assessment and best practice guidelines. *South African Journal of Wildlife Research.* 43(2): 138–154.

Miller, S.M. & Funston, P.J. (2014). Population growth rates of lions (*Panthera leo*) on small fenced reserves in South Africa: a management dilemma. *South African Journal of Wildlife Research* 44: 43-55.

Miller, S.M., Harper, C.K., Bloomer, P., Hofmeyr, J. & Funston, P.J. (2014). Evaluation of Microsatellite Markers for Populations Studies and Forensic Identification of African Lions (*Panthera leo*). *Journal of Heredity* doi:10.1093/jhered/esu054

Miller, S.M., Riggio, J.S., Hayward, M.W., Funston, P.J. & Ferreira, S.M. (2014). National Red List of Mammals 2014: *Panthera leo* – Lion. Endangered Wildlife Trust, South Africa.

Miller, S.M., Tambling, C.J., Funston, P.J. GrowLS: Lion (*Panthera leo*) population growth simulation for small reserve management planning. In press *South African Journal of Wildlife Research* 44: 43-55.

Miller, S.M. Harper, C.K., Bloomer, P., Hofmeyr, J. Funston, P.J. African lions (*Panthera leo*) in small reserves in South Africa: a genetic assessment and management recommendations. In prep.

Mosser, A. & Packer, C. (2009). Group territoriality and the benefits of sociality in the African lion, *Panthera leo. Animal Behaviour* 78: 359–370.

Munson, L. (2006). Contraception in felids. *Theriogen* 66: 126–134.

Munson, L., Terio, K.A., Kock, R., Mlengeya, T., Roelke, M.E., *et al*. (2008). Climate extremes promote fatal co-infections during canine distemper epidemics in African lions. *PLoS ONE 3*(6).

Nowell, K. & Jackson, P. (1996). Status Survey and Conservation Action Plan Wild Cats. IUCN, Gland, Switzerland.

Nowell, K., (2004). The Cat Specialist Group at CITES 2004. *Cat News* 41: 29.

Ogutu, J.O. & Dublin, H.T. (1998). The response of lions and spotted hyenas to sound playbacks as a technique for estimating population size. *African Journal of Ecology* 36: 83–95.

Okello, M.M., Manka, S.G. & D'Amour, D.E. (2008). The relative importance of large mammal species for tourism in Amboseli National Park, Kenya. *Tourism Management* 29: 751–760.

Olivier, P.I., Van Aarde, R.J. & Ferreira, S.M. (2009). Support for a metapopulation structure among mammals. *Mammal Review* 39: 178–192.

Olmsted, R.A., Langley, R., Roelke, M.E., Goeken, R.M., Adger-Johnson, D., *et al*. (1992). Worldwide prevalence of lentivirus infection in wild feline species: Epidemiologic and phylogenetic aspects. *Journal of Virology* 66: 6008-6018.

Orford, H. & Perrin, M. (1988). Contraception, reproduction and demography of free-ranging Etosha lions (*Panthera leo*). *Journal of Zoology, London* 216: 717-733.

Owen-Smith, N. & Mills, M.G.L. (2006). Manifold interactive influences on the population dynamics of a multispecies ungulate assemblage. *Ecological Monographs* 76: 273–292.

Owen-Smith, N. (2008). Changing vulnerability to predation related to season and sex in an African ungulate assemblage. *Oikos* 117: 602-610.

Owen-Smith, N. & Mills, M.G.L. (2008a). Predator-prey size relationships in an African large-mammal food web. *Journal of Animal Ecology* 77: 173-183.

Owen-Smith, N. & Mills, M.G.L. (2008b). Shifting prey selection generates contrasting herbivore dynamics within a large-mammal predator–prey web. *Ecology* 89: 1120–1133.

Packer, C. & Pusey, A. E. (1993). Dispersal, kinship, and inbreeding in African lions. In: N. Thornhill (Ed.), Natural History of Inbreeding and Outbreeding: Theoretical and Empirical Perspectives. (pp. 375-391). University of Chicago Press, Chicago.

Packer, C. & Pusey, A.E. (1987). Intrasexual cooperation and the sex ratio in African lions. *American Naturalist* 130: 636–642.

Packer, C., Herbst, L., Pusey, A. E., Bygott, J. D., Hanby, J. P., Cairns, S. J. & Borgerhoff-Mulder, M. (1988). Reproductive success in lions. In: Reproductive Success (Ed. by T. H. Clutton-Brock), pp. 363–383. Chicago: University of Chicago Press.

Packer, C., Scheel, D. & Pusey, A. E. (1990). Why lions from groups: food is not enough. American Naturalist 136: 1–19.

Packer, C., Pusey, A.E., Rowley, H., Gilbert, D.A., Martenson, J. & O'Brian, S.J. (1991). Case study of a population bottleneck: lions of the Ngorongoro crater. Conservation Biology 5: 219–230.

Packer, C., Gilbert, A., Pusey, A.E. & O'Brien, S. J. (1991). A molecular genetic analysis of kinship and cooperation in African lions. *Nature* 351: 562–565.

Packer, C., Pusey, A.E. & Eberly, L. E. (2001). Egalitarianism in female African lions. *Science* 293: 690–693.

Packer, C., Altizer, S., Appel, M., Brown, E., Martenson, J., O'Brien, S.J., *et al*. (1999). Viruses of the Serengeti: patterns of infection and mortality in African lions. *Journal of Animal Ecology* 68: 1161-1178.

Packer, C., Pusey, A.E., & Eberly, L.E. (2001). Egalitarianism in female African lions. *Science* 293: 690-693.

Packer, C., Hilborn, R., Mosser, A., Kissui, B., Borner, M., Hopcraft, G., Wilmshurst, J., Mduma, S. & Sinclair, A.R.E. (2005). Ecological change, group territoriality, and population dynamics in Serengeti lions. *Science* 307: 390–393.

Packer, C., Kosmala, M., Cooley, H.S., Brink, H., Pintea, L., Garshelis, D., *et al*. (2009). Sport hunting, predator control and conservation of large carnivores. *Plos ONE* 4: e5491.

Packer, C., Brink, H., Kissui, B.M., Maliti, H., Kushnir, H., & Caro, T. (2011). Effects of trophy hunting on lion and leopard populations in Tanzania. *Conservation Biology* 25: 142-153.

Packer, C., S. Canney, A. Loveridge, S.T. Garnett, M. Pfeifer, K.K. Zander, A. Swanson, D. MacNulty, G. Balme, P.J. Funston *et al*. (2013). Conserving Large Carnivores: Dollars and Fence. *Ecology Letters* doi: 10.1111/ele.12091

Peel, M.S.J. & Montagu, G.P. (1999). Modelling predator-prey interactions on a Northern Province game ranch. *South African Journal of Wildlife Research* 29: 31-34.

Pennycuick, C. & Rudnai, J. (1970). A method of identifying individual lions, *Panthera leo*, with an analysis of the reliability of the identification. *Journal of Zoology, London* 160: 497–508.

Power, R.J. (2002). Prey selection of lions Panthera leo in a small enclosed reserve. *Koedoe* 45: 67-75.

Power, R.J. (2003). Evaluating how many lions a small reserve can sustain. *South African Journal of Wildlife Research* 33:3–11.

Prugh, L.R., Stoner, C.J., Epps, C.W., Bean, W.T., Ripple, W.J., Laliberte, A.S. & Brashares, J.S. (2009). The rise of the mesopredator. *BioScience* 59: 779–791.

Pusey, A. E. & Packer, C. (1987). Evolution of sex-biased dispersal in lions. *Behaviour* 101: 275–309.

Quadling, H.S. & Starfield, A.M. (2002). Exploiting object-oriented programming structures in the quest for an individual-based lion population model with an attractive user interface. *S. Afr. J. Sci.* 98: 449–454.

Radloff, F.G.T. & du Toit J.T. (2004). Large predators and their prey in a southern African savanna: a predator's size determines its prey size range. *Journal of Animal Ecology* 73: 410-423.

Renwick, A., White, P. & Bengis, R. (2007). Bovine tuberculosis in southern African wildlife: a multi-species host-pathogen system. *Epidemiology and Infection* 135: 529-40.

Riggio, J., Jacobsen, A., Lichtenveld, L., Funston, P.J., Dollar, L, Bauer, H, De Iongh, H, Groom, R. & Pimm, S. (2013). The size of savannah Africa: a lion's (*Panthera leo*) view. *Biodiversity and Conservation* 22:17–35.

Ritchie, E.G. & Johnson, C.N. (2009). Predator interactions, mesopredator release and biodiversity conservation. *Ecology Letters* 12: 982–998.

Roelke, M., Brown, M.A., Troyer, J.L., Winterbach, H., Winterbach, C., *et al*. (2009). Pathological manifestations of feline immunodeficiency virus (FIV) infection in wild African lions. *Virology* 390(1).

Rogers, K.H. (1997). Operationalizing ecology under a new paradigm: An African perspective. In S.T.A. Pickett, R.S. Ostfeld, M. Shachak and G.E. Likens (eds.), *The ecological basis of conservation: Heterogeneity, ecosystems and biodiversity*, pp. 60-80. Chapman & Hall, New York.

Schaller, G.B. (1972). The Serengeti Lion: A Study of Predator Prey Relations. University of Chicago Press, Chicago.

Scheel, D. (1993). Profitability, encounter rates, and prey choice of African lions. *Behavioral Ecology, 4*(1), 90-97.

Slotow, R. and G. van Dyk. 2004. Ranging of older male elephants introduced to an existing small population without older males: Pilanesberg National Park. Koedoe 47(2): 91–104. Pretoria. ISSN 0075-6458.

Slotow, R. & Hunter, L.T.B. (2009). Reintroduction decisions taken at the incorrect social scale devalue their conservation contribution: the African lion in South Africa. In: M.W. Hayward & M.J. Somers (Eds.), Reintroduction of Top-Order Predators. (pp. 41-73). Wiley-Blackwell, Oxford.

Smuts, G.L. (1975). Why we killed those lions. *African Wildlife* 29: 30–33.

Smuts, G. L. (1976). Population characteristics and recent history of lions in two parts of the Kruger National Park. *Koedoe* 19:153-164.

Smuts, G.L. (1978a). Interrelations between predators, prey, and their environment. *Bioscience* 28: 1-5.

Smuts, G.L. (1978b). Effects of population reduction on the travels and reproduction of lions in Kruger National Park. *Carnivore* 1: 61-72.

Smuts, G.L., Whyte, I.J. & Dearlove, T.W. (1977). A mass capture technique for lions. *East African Wildlife Journal* 15: 81–87.

Smuts, G. L., Whyte, I.J. & Dearlove, T.W. (1978). Advances in the mass capture of lions. *International Union of Game Biologists* 13: 420-431.

Smuts, G.L., Anderson, J.L. & Austin, J.C. (1978). Age determination and growth in the African lions (Panthera leo). *Journal of Zoology, London* 185: 115-146.

Smuts, G.L., Hanks, J. & Whyte, I.J. (1978). Reproduction and social organization of lions from the Kruger National Park. *Carnivore* 1: 17–28.

Smuts, G.L., Robinson, G.A. & Whyte, I.J. (1980). Comparative growth of wild male and female lions (*Panthera leo*). *Journal of Zoology, London* 190: 365-373.

Spencer, J.A. (1991). Survey of antibodies to feline viruses in free-ranging lions. *South African Journal of Wildlife Research* 21(2).

Spencer, J.A. & Morkel, P. (1993). Serological survey of sera from lions in Etosha National Park. *South African Journal of Wildlife Research* 23(2).

Spong, G. & Creel, S. (2001). Deriving dispersal distances from genetic data. *Proceedings of the Royal Society of London* 268: 2571-2574.

Stalmans, M., Balkwill, K., Witkowski, E.T.F. & Rogers, K.H. (2001). A landscape ecological approach to address scaling problems in conserva- tion management and monitoring. *Environmental Management* 28: 389–401.

Stander, P.E. (1990). A suggested management strategy for stock-raiding lions in Namibia. *South African Journal of Wildlife Research* 20: 53–60.

Stander, P. E. (1991). Demography of lions in the Etosha National Park, Namibia. *Madoqua* 18: 1-9.

Stander, P. E. (1992a). Foraging dynamics of lions in a semi-arid environment. *Canadian Journal of Zoology* 70: 8–21.

Stander, P. E. (1992b). Cooperative hunting in lions: the role of the individual. *Behavioral Ecology and Sociobiology* 29: 445–454.

Stander, P. E. & Albon, S. D. (1993). Hunting success of lions in a semi-arid environment. *Symposia of the Zoological Society of London* 65: 127–143.

Stevenson-Hamilton, J. (1903-1945). Annual reports of the Warden of the Kruger National Park, National Parks Board of Trustees, Pretoria.

Taljaard, P.R. (2009). Report on the captive lion breeding industry in South Africa. Unit for Livestock and Wildlife Economics Department of Agricultural Economics, University of the Free State, Bloemfontein.

Tambling, C.J. & Du Toit, J.T. (2005). Modelling wildebeest population dynamics: implications of predation and harvesting in a closed system. *Journal of Applied Ecology* 42: 431-441.

Tambling, C. J., Ferreira, S.M., Adendorff, J. & Kerley, G.I.H. (2013). Lessons from management interventions: consequences for lion–buffalo interactions. *South African Journal of Wildlife Research* 43: 1–11.

Tompkins, E. L. & Adger. W. N. 2004. Does adaptive management of natural resources enhance resilience to climate change? *Ecology and Society* 9, 10. http://www.ecologyandsociety.org/vol9/iss2/art10/

Trinkel, M., van Niekerk, R.W., Fleischmann, P.H., Ferguson, N. & Slotow, R. (2007). The influence of vegetation on lion group sizes in the Hluhluwe-Umfolozi Park, South Africa. *Acta Zoologica*. 53: 15–21.

Trinkel, M., Ferguson, N., Reid, A, Reid, C., Somers, M., *et al*. (2008). Translocating lions into an inbred lion population in the Hluhluwe-iMfolozi Park, South Africa. *Animal Conservation* 11: 138-143.

Trinkel, M., Funston, P., Hofmeyr, M, Hofmeyr, D., Dell, S., Packer, C. & Slotow, R. (2010). Inbreeding and density-dependent population growth in a small, isolated lion population. *Animal Conservation* 13: 374-382.

Trinkel, M., Cooper, D., Packer, C. & Slotow, R. (2011). Inbreeding depression increases susceptibility to bovine tuberculosis in lions: an experimental test using an inbred-outbred contrast through translocation. *Journal of Wildlife Disease.* 47: 494–500.

Troyer, J. L., Pecon-Slattery, J., Roelke, M.E., Black, L., Packer, C. & O'Brien, S.J. (2004). Patterns of feline immunodeficiency virus multiple infection and genome divergence in a free-ranging population of African lions. *Journal of Virology* 78: 3777-3791.

Troyer, J.L., Pecon-Slattery, J., Roelke, M.E., Johnson, W., Van de Woude, S., *et al*. (2005). Seroprevalence and genomic divergence of circulating strains of Feline Immunodeficiency Virus among Felidae and Hyaenidae species. *Journal of Virology* 79: 8282– 8294.

Whitman, K., Starfield, A.M., Quadling, H.S. & Packer, C. (2004). Sustainable trophy hunting of African lions. *Nature* 428: 175-178.

Woodroffe, R. & Frank, L. (2005). Lethal control of African lion (*Panthera leo*): local and regional population impacts. *Animal Conservation* 8: 91-98.

Valeix, M., Loveridge, A.J., Davidson, Z., Madzikanda, H., Fritz, H. & Macdonald, D.W. (2010). How key habitat features influence large terrestrial carnivore movements: waterholes and African lions in a semi-arid savanna of north-western Zimbabwe. *Landscape Ecology* 25:337–351.

Valeix, M., Loveridge, A.J. and MacDonald, A.W. (2012). Influence of prey dispersion on territory and group size of African lions: a test of the resource dispersion hypothesis. *Ecology* 93: 2490-2496.

Van der Waal, K.L., Mosser, A. & Packer, C. (2009). Optimal group size, dispersal decisions and postdispersal relationships in female African lions. *Animal Behaviour* 77: 949–954.

Van Orsdol, K.G., Hanby, J.P. & Bygott, J.D. (1985). Ecological correlates of lion social organization (*Panthera leo*). *Journal of Zoology, London* 206: 97-112.

Van Vuuren, J.H., Herrmann, E. & Funston, P.J. (2005). Lions in the Kgalagadi Transfrontier Park: modelling the effect of human-caused mortality. *International Transactions in Operational Research* 12: 145–171.

Vartan, S. (2001). Overpopulation and inbreeding in small game reserves: the lion *Panthera leo* as a case study. M.Sc. thesis. University of Cape Town, Cape Town.

Wassenaar, T.D., Pimm, S.L., Van Aarde, R.J. & Ferreira, S.M. (2005). Community convergence in disturbed sub-tropical dune forests. *Ecology* 86: 655-666.

Whitman, K., Starfield, A.M., Quadling, H.S. & Packer, C. (2004). Sustainable trophy hunting in African lions. *Nature* 428: 175–178.

Whitman, K., Starfield, A.M., Quadling, H.S. & Packer, C. (2007). Modeling the effects of trophy selection and environmental disturbance on a simulated population of African lions. *Conservation Biology* 21: 591–601.

Yamazaki, K. (1996). Social variation of lions in a male-depopulated area in Zambia. *Journal of Wildlife Management* 60:490–497.

Appendix 1: Stakeholder lists for the 1st lion BMP workshop

DATE: 18 JUNE 2013

VENUE: PRETORIA, SANBI-BIODIVERSITY AUDITORIUM

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Appendix 2: Stakeholder lists for the 2nd lion BMP workshop

DATE: 18 MARCH 2014

VENUE: PRETORIA, SANBI-BIODIVERSITY AUDITORIUM

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Renny Chetty (012) 748-6375 (Renny.Chetty@gpw.gov.za),

Anna-Marie du Toit (012) 748-6292 (Anna-Marie.DuToit@gpw.gov.za) and

Siraj Rizvi (012) 748-6380 (Siraj.Rizvi@gpw.gov.za)

IMPORTANT

Information

from Government Printing Works

Dear Valued Customers,

Government Printing Works has implemented rules for completing and submitting the electronic Adobe Forms when you, the customer, submits your notice request.

Please take note of these guidelines when completing your form.

GPW Business Rules

1. No hand written notices will be accepted for processing, this includes Adobe forms which have been completed by hand.
2. Notices can only be submitted in Adobe electronic form format to the email submission address submit.egazette@gpw.gov.za. This means that any notice submissions not on an Adobe electronic form that are submitted to this mailbox will be **rejected**. National or Provincial gazette notices, where the Z95 or Z95Prov must be an Adobe form but the notice content (body) will be an attachment.
3. Notices brought into GPW by "walk-in" customers on electronic media can only be submitted in Adobe electronic form format. This means that any notice submissions not on an Adobe electronic form that are submitted by the customer on electronic media will be **rejected**. National or Provincial gazette notices, where the Z95 or Z95Prov must be an Adobe form but the notice content (body) will be an attachment.
4. All customers who walk in to GPW that wish to submit a notice that is not on an electronic Adobe form will be routed to the Contact Centre where the customer will be taken through the completion of the form by a GPW representative. Where a customer walks into GPW with a stack of hard copy notices delivered by a messenger on behalf of a newspaper the messenger must be referred back to the sender as the submission does not adhere to the submission rules.
5. All notice submissions that do not comply with point 2 will be charged full price for the notice submission.
6. The current cut-off of all Gazette's remains unchanged for all channels. (Refer to the GPW website for submission deadlines – www.gpwonline.co.za)
7. Incorrectly completed forms and notices submitted in the wrong format will be rejected to the customer to be corrected and resubmitted. Assistance will be available through the Contact Centre should help be required when completing the forms. (012-748 6200 or email info.egazette@gpw.gov.za)
8. All re-submissions by customers will be subject to the above cut-off times.
9. All submissions and re-submissions that miss the cut-off will be rejected to the customer to be submitted with a new publication date.
10. Information on forms will be taken as the primary source of the notice to be published. Any instructions that are on the email body or covering letter that contradicts the notice form content will be ignored.

You are therefore advised that effective from **Monday, 18 May 2015** should you not comply with our new rules of engagement, all notice requests will be rejected by our new system.

Furthermore, the fax number **012- 748 6030** will also be **discontinued** from this date and customers will only be able to submit notice requests through the email address submit.egazette@gpw.gov.za.

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