Desert Lion Conservation

Research Report – 2010

The impact of male-biased mortality on the population structure of desert-adapted lions in Namibia

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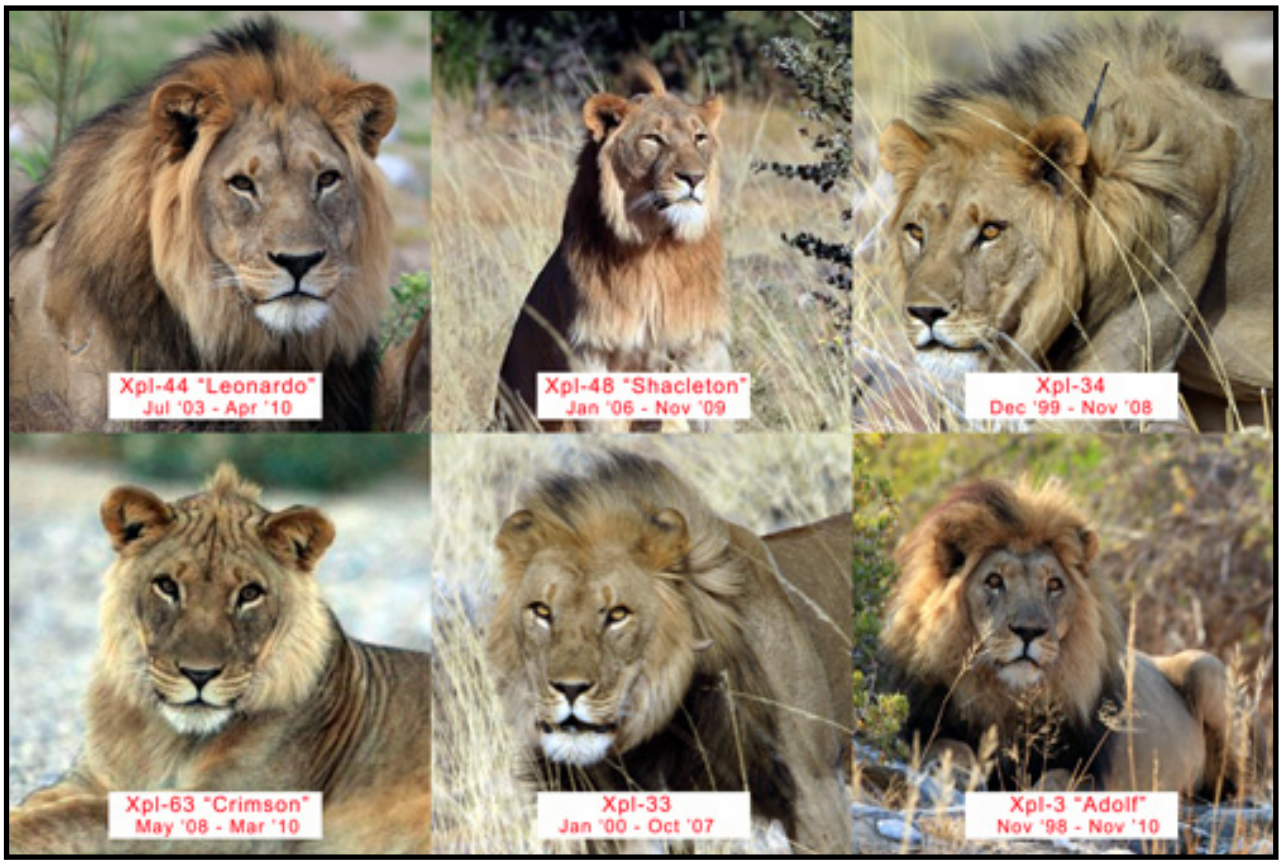


Introduction

The lion is one of the more vulnerable large mammal species in Namibia. Their distribution is mainly confined to large protected areas. Throughout their range, and along the borders of the protected areas, conflict between lions and the Namibian people is a regular and significant problem. These incidents of Human Lion Conflict (HLC) result in significant financial and conservation losses.

The Kunene Region, in northwest Namibia, supports a unique population of desert-adapted lions that occur mostly outside protected areas, where local communities share their land with free-ranging lions. Despite frequent incidents of Human Lion Conflict, it is one of the only places in Africa where the lion population is on the increase. Namibia has received international recognition (e.g. *CITES*) for successful conservation efforts, such as the communal conservancy program, that led to significant increases in wildlife numbers, especially in the arid areas. With the growing wildlife populations the conflict between lions and the local people has intensified as lions are killing livestock more regularity.

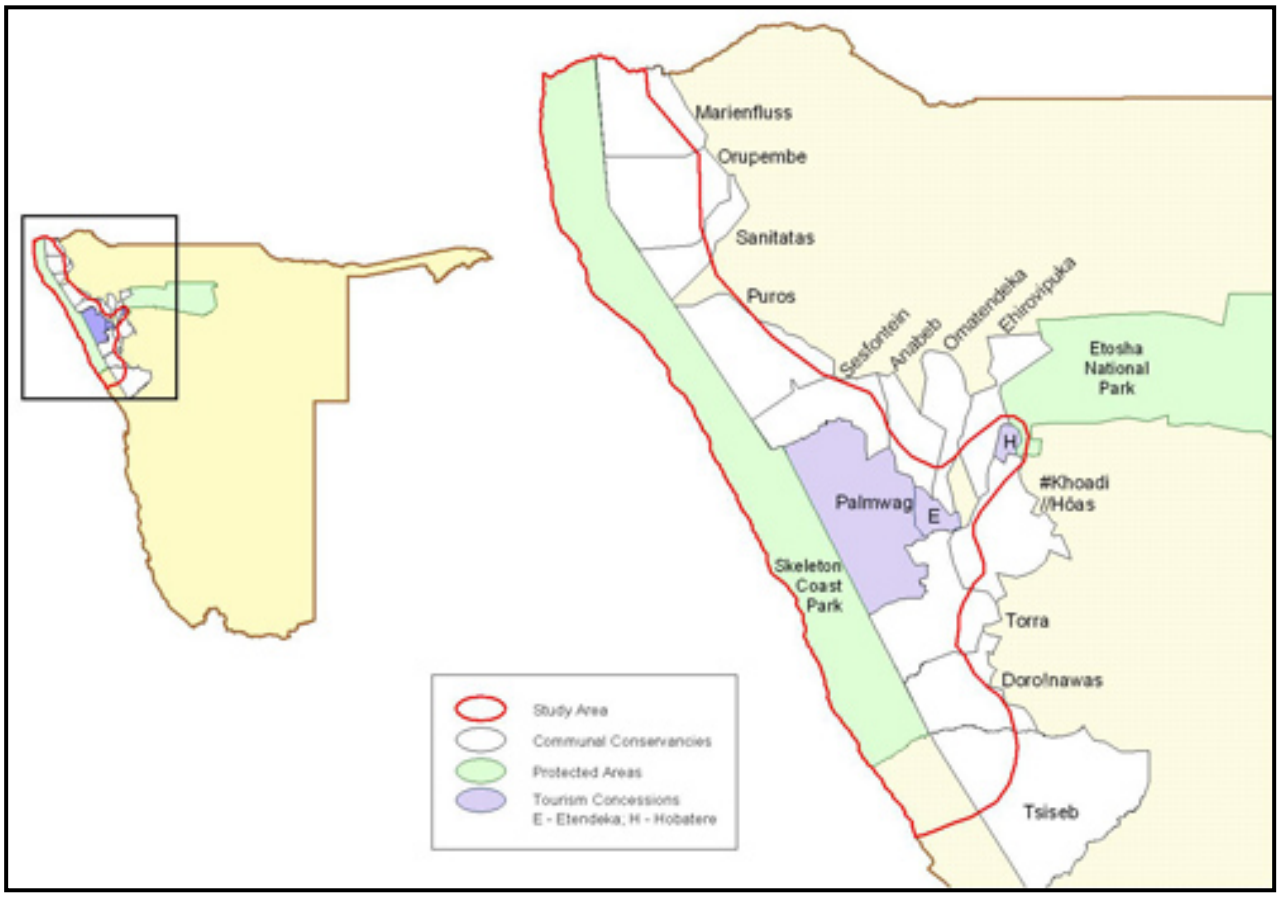
The “Desert” lion is a prominent feature in Namibia and is highly valued, both aesthetically and financially, by the growing tourism industry. Tourism and hunting currently generates substantial benefits and income to local communities in the Kunene, and play an important role in the protection and conservation of wildlife and the natural environment. The simultaneous growth of wildlife populations, tourism, and community-based conservation in the Kunene is testimony to this. Under the current climate where local people benefit from wildlife, through tourism and trophy hunting, and where communal conservancies enter into agreements with tour/safari operators, the tourism industry’s potential impact on wildlife conservation is increasing. It is suggested that the income generated from lions through tourism and trophy hunting in the Kunene during the past decade amounts to a staggering figure, and that the income and benefits that filtered through to the local communities, out-way the losses incurred when lions killed livestock.

Notwithstanding, people still pose the biggest threat to lions. The tourism industry and related entities (including communal conservancies) enjoy the lion’s share of the benefits, whilst the local people that live close to lions (i.e. individual farmers) suffer all the losses. Because local farmers do not share equally in the benefits from tourism and hunting, they continue to shoot or poison lions to protect their livestock. Furthermore, the selective and unsustainable shooting and trophy hunting of male lions is detrimental to the social structure and the long-term viability of the Desert lion population. There is an urgent need to address the unsustainable off-take of adult and sub-adult male lions. In this report data are presented on the population dynamics of the Desert lion for the period 1998 to 2010. Emphases are placed on changes in the age/sex structure, the causes of lion mortality in relation to age and sex, and the impact of male-biased mortality on the lion population.

Study Area

The Desert Lion Project covers the entire distribution of desert-adapted lions in the northwest of Namibia. Roughly 51,500 km^2 of arid habitat that falls in the Etendeka Plateau landscape of the northern Namib Desert, with an annual rainfall of 0 - 100 mm (Mendelsohn et al. 2002). The area is dissected by a series of ephemeral drainage lines that provide food, water and shelter to most of the large mammal species that live here. The area includes the Palmwag, Etendeka & Hobatere Concessions, the Skeleton Coast Park, and bordering Communal Conservancies (Figure 1). It is inside these conservancies that lions overlap with human settlements and livestock farming.

Figure 1. The distribution of lions and the study area of the Desert Lion Project, in relation to the protected areas, concessions and conservancies in the Kunene Region, Namibia.



Methods

Studying a large carnivore species that live at low density in a mountainous arid habitat, and collecting reliable data on numbers and population ecology, is a difficult task. It requires a long-term effort of consistent and intensive monitoring of individual animals in the population. Between 1998 and 2010 the Desert Lion Project have combined age-old techniques, such as tracking and the interpretation of the spoor of lions (Stander 1997), common wildlife management techniques (Teer 1982), radio-telemetry (Amlaner & Macdonald 1980), and modern GPS/satellite technology to study the lion population.

The study area is covered systematically by tracking spoor, setting out bait and using sound playbacks to locate and capture individual lions. All lions, including small cubs, are photographed, using high-quality equipment, and individually identified using vibrissae spot patterns (Pennycuick & Rudnai 1970). Adult and sub-adult lions are captured and individually marked with a hot brand, and several lions in each group are marked with a VHF radio collar. At least one adult lion in each major group and some key individuals are fitted with a GPS or satellite radio collar. A light aircraft is occasionally used to systematically locate radio-collared animals. Aerial and satellite locations are followed-up by ground observations to record group composition in relation to individuals and age/sex structure, and the ratio of marked to unmarked individuals. ID files are constructed for each individual and their life history and movements are updated regularly. The majority of lions are entered in the ID database as small cubs (when they are first photographed). These long-term individual records, aided by the use of radio-telemetry and GPS/satellite technology, provide reliable base-line data. The population dynamics of lions are evaluated by monitoring key parameters, such as birth rates, age-specific survivorship, fecundity, population rate of increase, and age/sex specific mortality.

Results

Lion density and population size

Between 1998 and 2010 consistent records were kept of the life history of 135 individual lions. During this period, radio collars were fitted to 74 lions and GPS/satellite collars to 19 different lions to aid the monitoring process. Regular monitoring of the marked lions, supplemented by spoor counts and observations by tour operators, NGOs and other parties, contribute to a population estimate of 112 to 139 lions over the age of one year (Table 1).

Table 1. Desert lion population estimate and associated information for May 2010.

Study area	51,500 km^2
Area inhabited by lions during 2008-2010	38,950 km^2
Current number of marked / known lions	86
Current number of radio-collared lions	38
Current number of GPS/satellite-collared lions	10
Current number of distinct groups/prides	10
Lion density (lion $100km^{-2}$)	0.28 – 0.35
Lion population estimate	**112 – 139**

Population growth

In 1999/2000, when the Desert lions were restricted in their distribution to the central Palmwag Concession area, a core group of 13 lions were marked with radio collars. The life history of these individual lions has subsequently been documented, and forms the bases of assessing population growth and expansion. During the early part of the study (2000 & 2001) the population increased at a phenomenal rate 22% and 23% per year respectively. The rate of increase dropped to below 10% p.a. in 2004, but increased again to above 10 % by 2008. The high initial increase and stabilising of the population growth is best expressed by a logarithmic rate of increase (Figure 2), and the annual growth rates, by the Log exponential rate of annual growth (Figure 3).

Figure 2. Exponential annual rate of increase of the Desert lion population between 1999 and 2009.

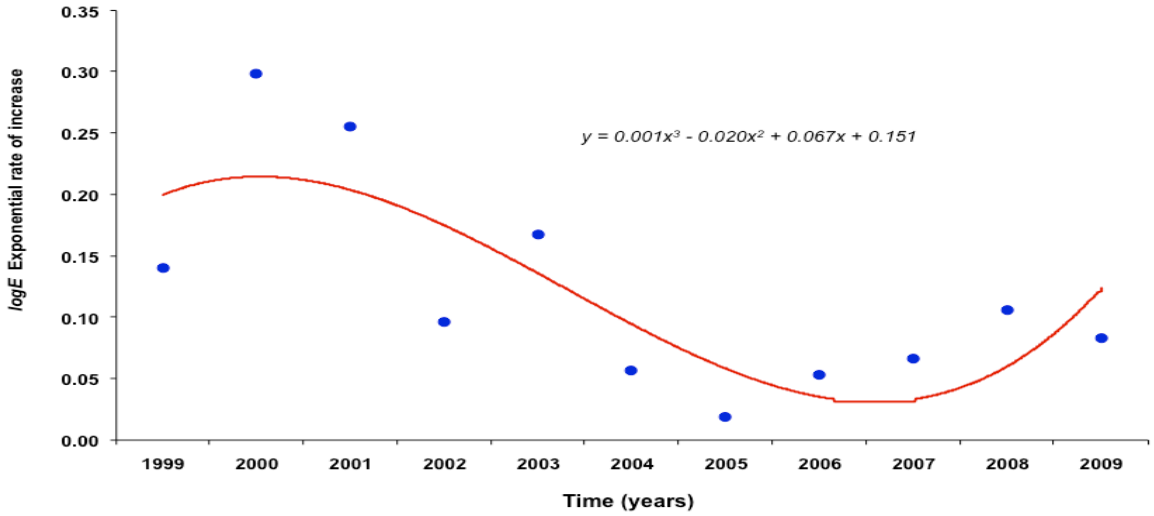
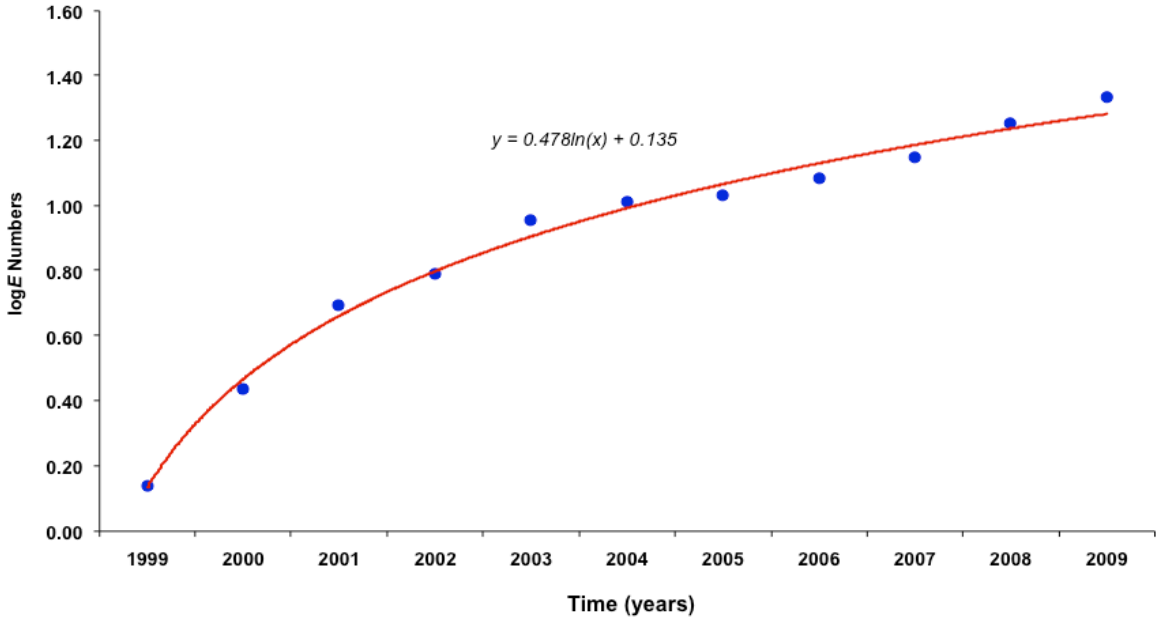


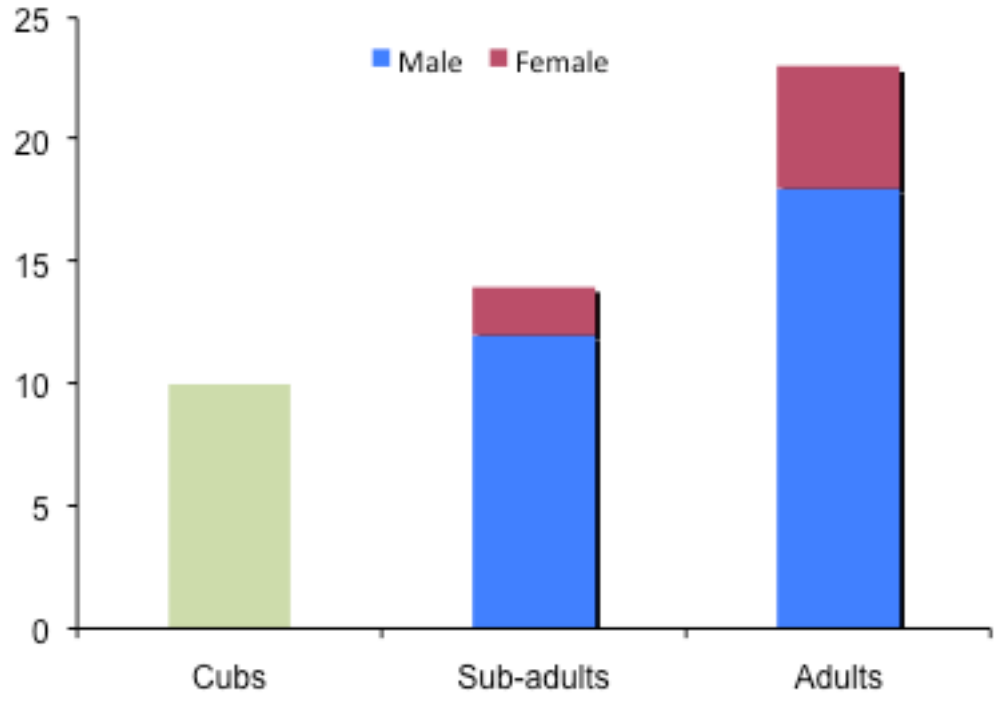
Figure 3. Growth rate of the *Desert lion population between 1999 and 2009.*



Mortality

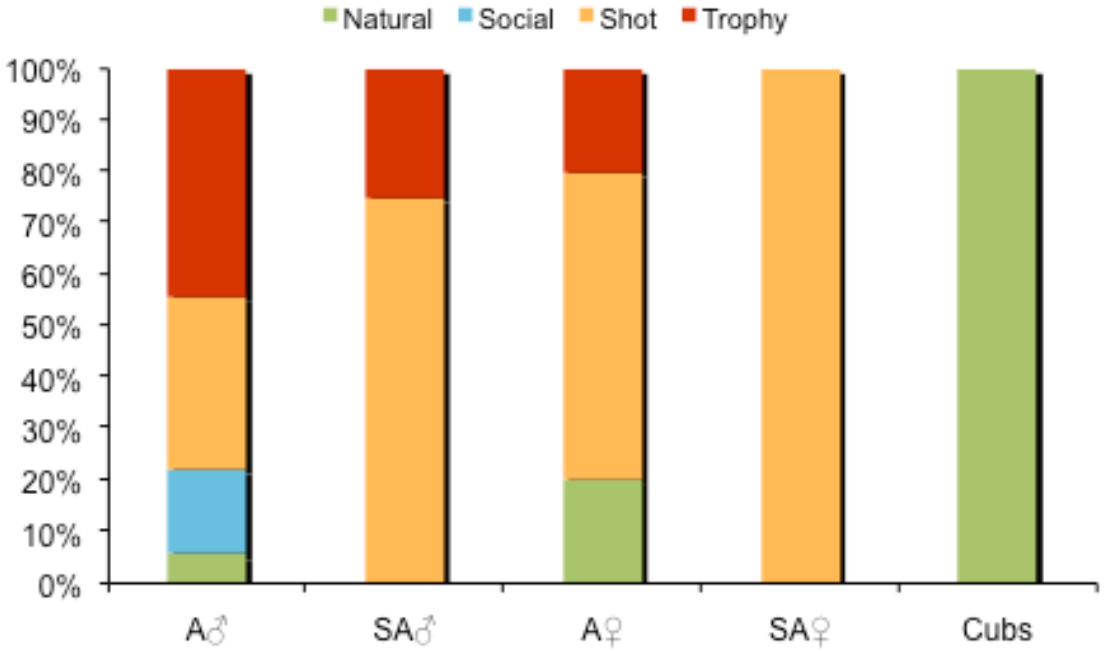
Between 2000 and 2010 details surrounding the death of 47 individually known radio-collared lions were recorded. Most of the lions that died were adults (n = 23) or sub-adults (n = 14) and consisted primarily of males (77%; Figure 4)

Figure 4. The age and sex structure of 47 lions that died between 2000 and 2010.



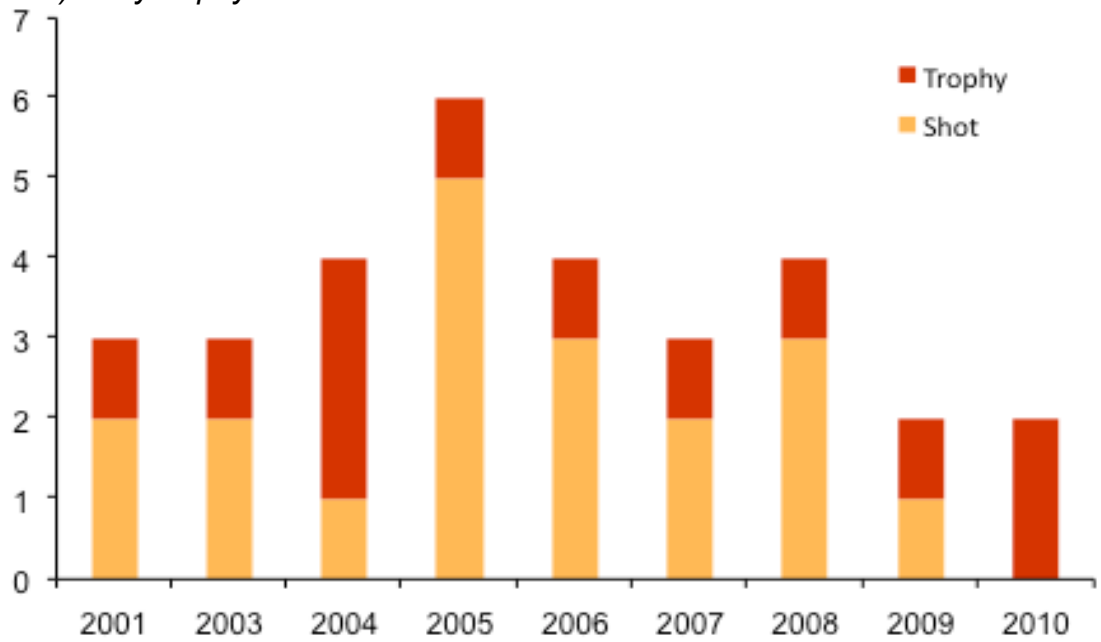
The causes of mortality were divided into three categories: human induced (shot or poisoned by people as a result of HLC and trophy hunting), social conflict (inter-specific competition between lions) and natural causes (e.g. starvation or injuries sustained from hunting). Most of the lions (n = 32) were killed by people. Of these the majority (n = 20) were shot or poisoned by local people during incidents of HLC, and the remainder (n = 12) were shot for trophy hunting. Lion cubs (< 2 yrs) died of natural causes, whilst sub-adult lions were mostly shot (or poisoned) by local people, although three sub-adult males were shot for trophy hunting (Figure 5). Amongst the adults, shooting and poisoning by local people accounted for most of the female mortalities, whilst > 50% of adult males were shot by trophy hunters (Figure 5).

Figure 5. Causes of mortality, presented for five age/sex categories of the Desert lion population, between 2000 and 2010.



Shooting/poisoning by local people and trophy hunting of adult and sub-adult lions (n = 32) occurred frequently and was a major cause of mortality between 2004 and 2008 (Figure 6). Alarmingly, the vast majority of these lions were males (n = 26).

Figure 6. The number of lions (adults and sub-adults) killed per year by local people (shot) or by trophy hunters.



Mortality amongst male lions

During the course of the study (11 years) a sample of 31 male lions were marked with radio collars or GPS/satellite collars to assess longevity and causes of mortality. In al 31 cases the lions were known since birth and they were immobilised and radio-collared between the ages of 1.5 – 2 years. Today there are eight lions (26%) still alive in the population. Only two of these males reached adulthood (current ages: 10.4 & 10.5 years). The remaining six males that are still alive, were marked recently and the average age is 2.6 years (Table 2).

Two males dispersed to Etosha National Park at the age of 4 years (at least one is still alive; now 9.8 years old) and two adult males were killed by other male lions during social conflicts and pride take-overs.

The rest of the male lions (n = 19; 61%) were killed (legally) by people. Eight lions were shot or poisoned by local farmers (because the lions attacked their livestock), and 11 lions were trophy hunted. Male lions that were trophy hunted were significantly older (mean = 5.8 yrs, median = 6.1, S.D. = 1.9) than those killed by local people (mean = 5.2 yrs, median = 3.8, S.D. = 2.7; Mann-Whitney $W = 65.0$, $P < 0.05$).

Of the 11 males shot for trophy hunting, five were taken on annual trophy hunting quota permits, issued by the Ministry of Environment & Tourism, in accordance to CITES requirements. The remaining six were taken on “problem animal” permits, also issued by the Ministry of Environment & Tourism. “Problem animal” permits are issued during incidents of Human Lion Conflict in an effort to a) solve the problem of lions killing the livestock of local farmers, and b) to generate income for the local communities from the trophy hunting fees. In all six cases, however, it is arguable whether the adult males that were shot, were in fact the lions responsible for the killing of livestock.

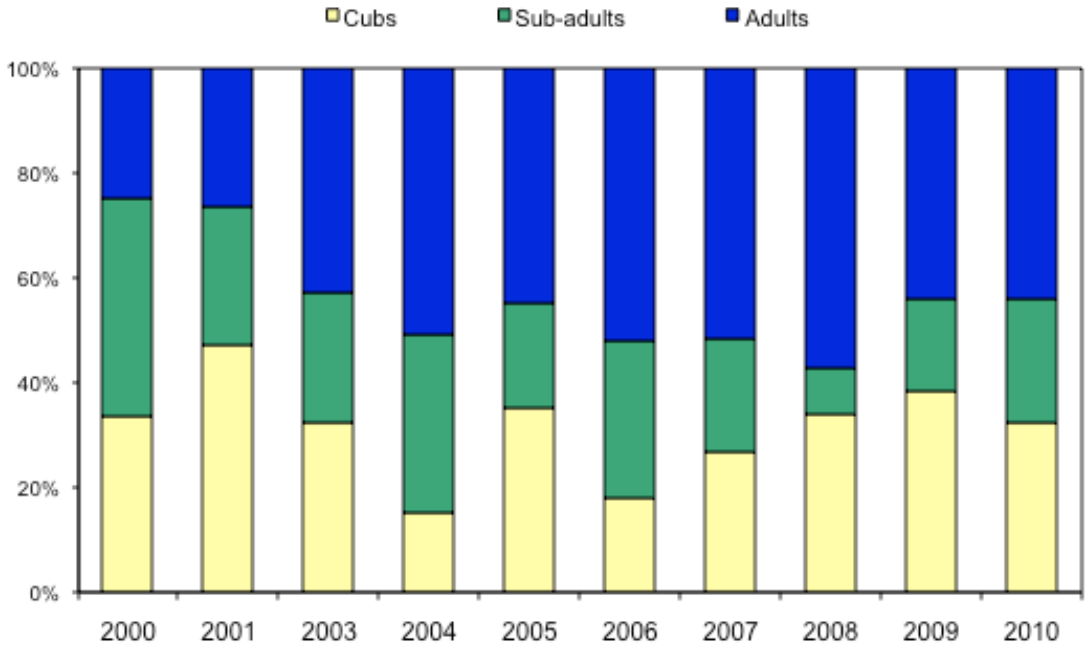
Table 2. The life history and mortality of 31 male lions marked with radio telemetry at a young age, between 1999 and 2010.

Current status	Number	Notes
Alive	8	2 lions (10 yrs), 6 lions (mean 2.6 yrs)
Dispersed	2	To ENP, 1 alive, age 9.8 yrs
Killed by lions	2	Social conflict
Killed by local people	8	Killing livestock, mean age 5.2 yrs
Trophy hunted	11	Mean age 5.8 yrs
Total	31	

Age structure

The age structure of the lion population was monitored between 2000 and 2010. There are slight discrepancies and changes in the age structure of the population over the 11-year period (Figure 7). These differences can be explained by high fecundity and population growth between 2000 and 2003 (hence the preponderance of cubs and sub-adults) and high levels of mortality amongst sub-adult and adult lions (2004-2008). However, the composition of age classes is expected to vary over time and the annual data between 2000 and 2010 reflect this fluctuation.

Figure 7. Changes in the distribution of age classes (cubs < 2 yrs, sub-adults 2 – 4 yrs, adults > 4 yrs) for the Desert lion population, between 2000 and 2010.



Sex ratios

Long-term data on the sex ratios in three age classes of the Desert lion population demonstrate a marked decline in the number of adult and sub-adult males since 2005 (Figure 8a & b). This reduction of adult males is of serious concern and puts into question the long-term viability of the Desert lion population. There are currently only five adult males in the population, compared to 27 adult lionesses (1♀ : 0.18 ♂), and six of the major prides (including the Agab, Floodplain, Hoanib, Hoaruseb & Obab prides) are without a resident pride-male.

When the data for sub-adults and adults are combined (Figure 9), the ratio of males to females show a significantl decline between 2000 and 2010. This decline is due, almost entirely, to the killing of sub-adult and adult male lions by people (see Figures 4, 5 & 6, and Table 2). Between 2000 and 2010 local people killed 15 male lions (9 sub-adults & 6 adults) in protection of their livestock, and 11 male lions (3 sub-adults & 8 adults) were selectively shot for trophy hunting.

Although there are slight annual fluctuations in the sex ratio of lion cubs, the differences balance out over time and the ratio remains even (1♀ : 0.96 ♂, n = 149, Figure 8c).

Figure 9. The decline of males in the sex ratio (1♀ : x ♂) of sub-adult and adult lions in the Desert lion population, between 2000 and 2010.

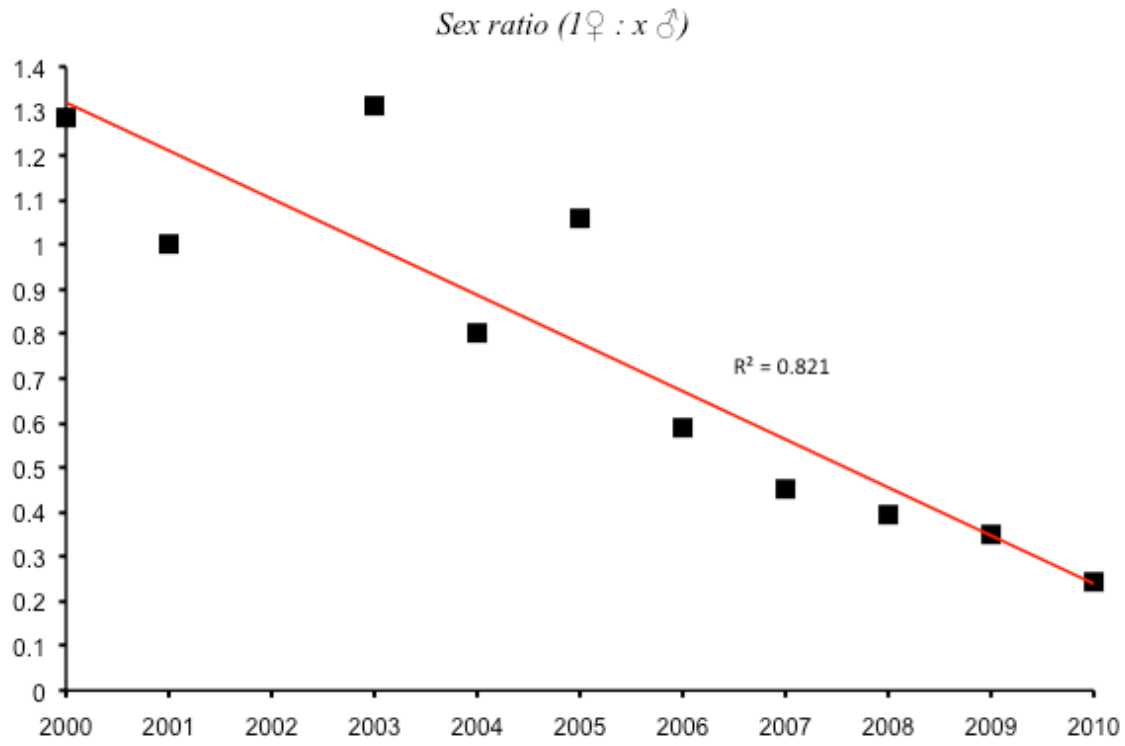


Figure 8. Changes in the sex ratio (■ females: ■ males) of Desert lions for the three major age categories (a. Adults > 4 yrs; b. Sub-adults 2 - 4 yrs; c. Cubs < 2yrs), between 2000 and 2010.

Age-specific survivorship & mortality

Life tables of individual lions (for both sexes combined) were used to calculate mortality rates and survivorship at different ages (Caughley & Sinclair 1994). Mortality rate (Figure 10) is a measure of the probability of a lion dying at any specific age. The probability of survivorship (Figure 11) is highest at birth (P = 1) and then drops progressively over time, depending on the risks they encounter, so that the older a lion becomes the lower its probability of survivorship. In the Desert lion population the risk of dying is highest between three and six years of age (Figure 10), and as a result, the probability of survivorship is reduced sharply to < 40% (Figure 11). These mortalities are primarily due to Human Lion Conflict and trophy hunting. The results indicate that if lions survive this critical age-period (which account for 65% of the human induced mortalities), survivorship increases and mortality rates drop to P ≤ 0.1. The probability of survivorship then declines steadily towards the limit of longevity. Low sample sizes towards the end of the age-scale may introduce bias.

Figure 10. Probability of age-specific mortality rates in the Desert lion population, between 2000 and 2010 (n = 502 lion-years).

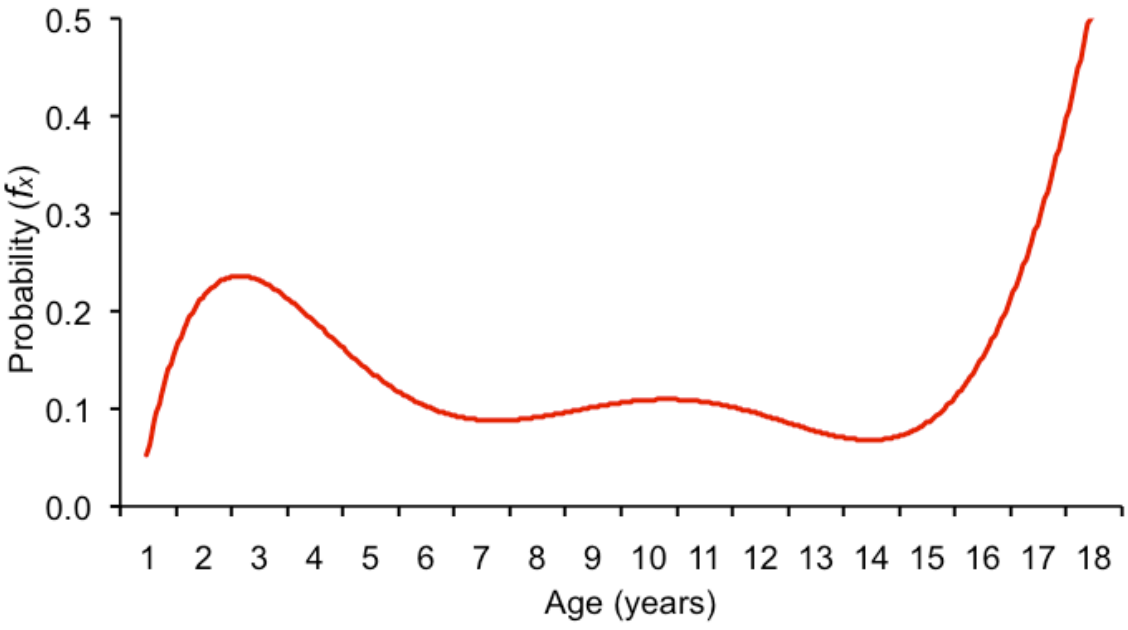
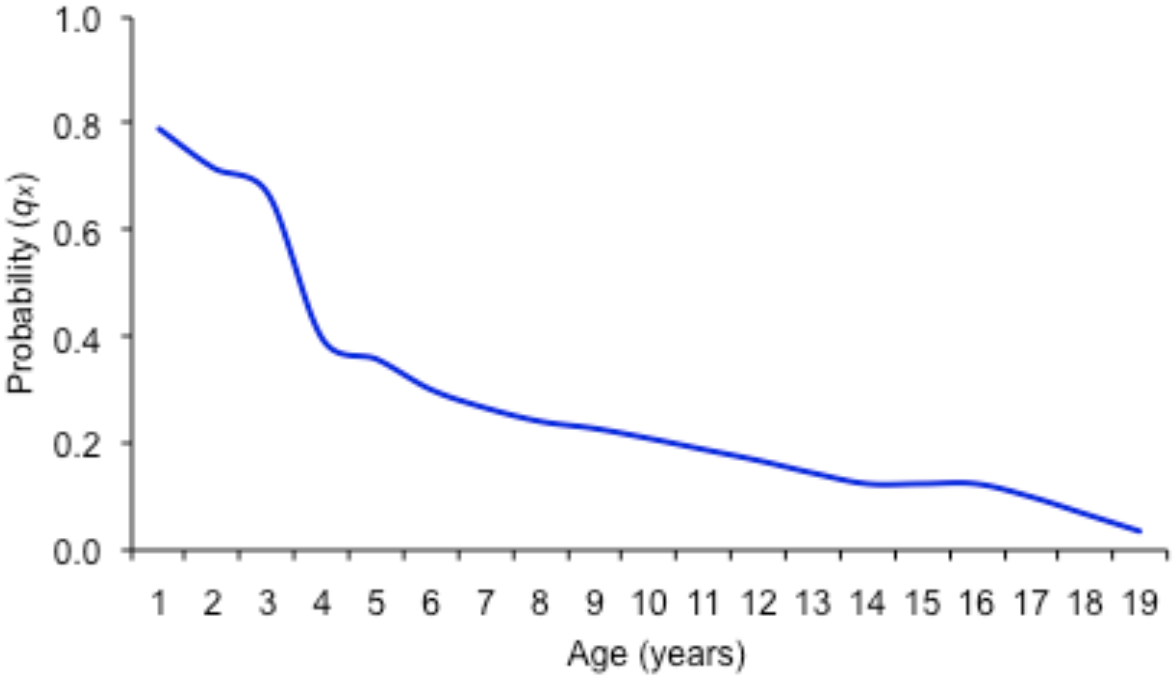
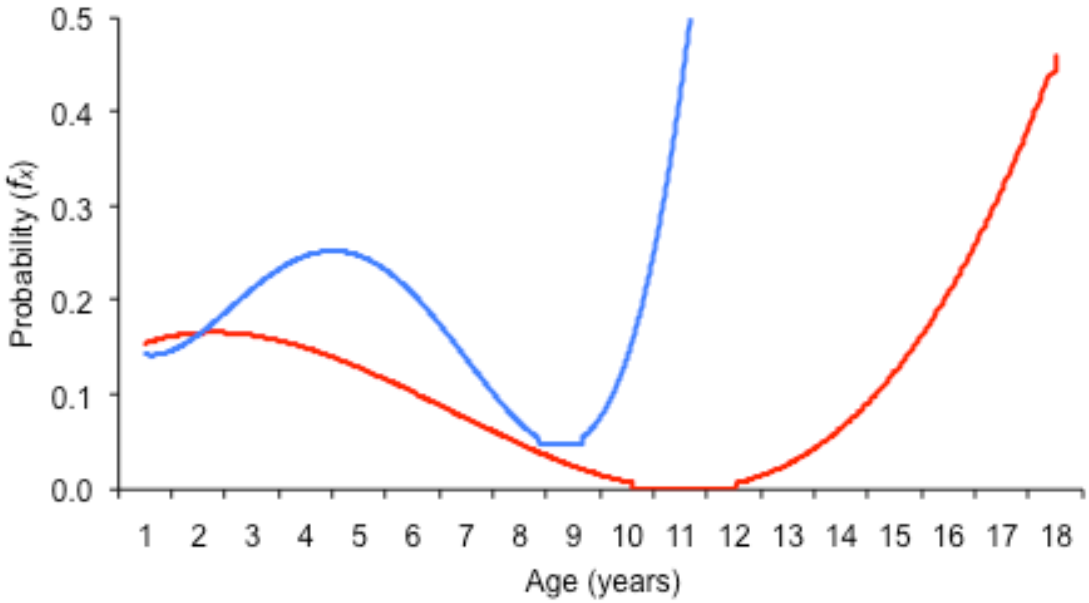


Figure 11. Probability of age-specific survivorship in the Desert lion population, between 2000 and 2010 (n = 502 lion-years).



As a result of the significant bias towards males in mortalities resulting from conflicts with people and trophy hunting, the age-specific mortality rates are calculated separately for males and females. The result reveals a marked difference in age-specific mortality rates between the two sexes (Figure 12). After the early mortality risks associated with all lions cubs < 1 year, the probability of lionesses dying decreases and it is only at the age of 14 years (when they are past their prime) that mortality rates increase again as they near the end of their lives at 18 to 20 years. For male lions, by contrast, mortality rates increase sharply due to the human-induced mortalities and are high (P = 0.25 – 0.43) between the ages of 3 and 6 years. Thereafter mortality rates drop to levels similar to those for lionesses, but at the age of 11 years the mortality rate shoots up to P = 0.5 and the probability of mortality for male lions over the age of 12 years is P = 1.

Figure 12. Probability of age-specific mortality rates for females (red line) and males (blue line) in the Desert lion population, between 2000 and 2010 (females: n = 277 lion-years; males: n = 225 lion-years).



Conclusion

The conservation successes achieved by Namibia, especially in the Kunene, have received international recognition. The progressive community-based conservation initiatives, the development of communal conservancies, the involvement of the private sector and the tourism industry, the direct benefits received by local communities from wildlife, and ultimately, the significant increase in wildlife populations, is testimony to this achievement.

Wildlife management and conservation, especially in a large arid ecosystem such as the Kunene, is complex. Long-term conservation success is an ongoing process that relies on sound base-line data for the key natural resources (such as population estimates), good monitoring systems to ensure sustainable use of the resources (both consumptive and non-consumptive), and an ability to continuously adapt and improve management structures.

A key element to the conservation success achieved in the Kunene is because local people benefit from wildlife. These benefits are derived from tourism that includes consumptive use, such as trophy hunting. In recognition of the value of hunting to the people and the long-term conservation of wildlife in the Kunene, this report presents data indicating that the selective shooting / trophy hunting of male lions is not sustainable.

The major cause of mortality in the lion population between 1999 and 2010 was the killing (by local people during HLC) and trophy hunting of adult and sub-adult lions. Male lions were particularly vulnerable and contribute to >80% of the recorded mortalities. The regularity, especially since 2004, at which male lions were shot or hunted, and the selection of adult males for trophy hunting, have resulted in a significant reduction of males in the population. It also contributed to vastly different age-specific mortality rates between males and females, that serves to illustrated the negative impact on the population. Increasingly skewed sex ratios, favouring females, have reached critical levels (2010 - 1♀ : 0.18 ♂). Six of the nine major prides are currently without a pride male.

The long-term viability of the Desert lion population has been compromised by the excessive killing of adult and sub-adult males. There is an urgent need to adapt the management and utilisation strategies relating to lions, if the long-term conservation of the species in the Kunene were to be secured.

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