Panthera pardus – Leopard

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Regional Red List status (2016)	**Vulnerable C1*†‡**
National Red List status (2004)	Least Concern
Reasons for change	Genuine change: Continuing decline
Global Red List status (2016)	Vulnerable A2cd
TOPS listing (NEMBA) (2007)	Vulnerable
CITES listing (1975)	Appendix I
Endemic	No

*Watch-list Data †Watch-list Threat ‡Conservation Dependent

> The long-term viability of the Leopard population within the assessment region may be at risk due to unsustainable trophy hunting and retaliatory killings. Although there is a low risk of extinction over the next 25 years, there is a very high probability of population decline (Swanepoel et al. 2014).

Taxonomy

Panthera pardus (Linnaeus 1758)

ANIMALIA - CHORDATA - MAMMALIA - CARNIVORA - FELIDAE - *Panthera* - *pardus*

Synonyms: *Felis pardus* (Linnaeus 1758)

Common names: Leopard (English), Luiperd (Afrikaans), Ingwe (Ndebele, Swati, Tshivenda, Xhosa, Xitsonga, Zulu), Nkwe (Sesotho, Setswana), Isngwe, Mdaba (Shona)

Taxonomic status: Species

Taxonomic notes: According to genetic analyses, nine subspecies are recognized, with all continental African Leopards attributable to the nominate form, *P. p. pardus* (Miththapala et al. 1996; Uphyrkina et al. 2001).

Assessment Rationale

Although this is a widespread species within the assessment region, it is secretive and faces severe threats, especially outside protected areas. The most systematic population estimate ranges from 2,813–11,632 Leopards, which equates to 1,688–6,979 mature individuals (60% mature population structure). All subpopulations number fewer than 1,000 mature individuals except the bushveld subpopulation (Kruger National Park, Limpopo, Mpumalanga and North West Province), which is likely to number between 1,113–4,454 mature individuals. However, as these estimates are derived from habitat suitability models and could under- or over-estimate actual abundances, caution should be used when applying the numbers (for example, in setting hunting quotas). Two independent simulation models project an ongoing population decline, largely due to unsustainable rates of persecution (direct and indirect) and a poorly managed trophy hunting industry, over the next 25 years. This is corroborated by empirical research that shows Leopard proportional survival in non-protected areas is only 57 ± 14% compared to 86 ± 5% inside protected areas. Additionally, Leopards within the assessment region are facing an emerging threat of being hunted for cultural regalia (for example, an estimated 17,240–18,760 illegal Leopard skins are believed to be used for ceremonial church activities). Similarly, the rise of intensive wildlife breeding for high-value game species may also be increasing the extent and intensity of persecution.

Province-wide population ecology studies at four independent localities (two in KwaZulu-Natal Province and two in Limpopo Province) show severe declines over short time periods: Leopard density has declined far in excess of 10% over the past 4–7 years (Welgevonden: 33% decline in 6 years; Lajuma: 22% decline in 7 years; Hluhluwe-iMfolozi: 40% decline in 4 years; uMkhuze: 13% decline in 5 years; G. Balme unpubl. data), which suggests that the data are not local aberrations or fluctuations but indicate systemic or widespread population decline.

Thus we list Leopards as Vulnerable C1 due to small population size and an estimated continuing decline of at least 10% over three generations (18–27 years). Severe declines are corroborated both by model simulations and empirical data from disparate geographical locations within protected areas and private land. Given the lower survival rate of Leopards outside protected areas, declines are suspected to be similar or more severe in such areas. Although the rate of decline between this assessment and the previous assessment is difficult to measure due to the variance in population estimates, we construe the net continuing population decline, the emerging threat of being hunted for cultural regalia, and the possible increase in persecution with wildlife ranch expansion as a genuine change in listing. Monitoring frameworks, which enable provinces to track regional Leopard subpopulation trends should be established so as to more accurately estimate population reduction over three generations, as this species may justify a more threatened listing under the A criterion. Key interventions include the adoption of sound harvest management regulations, the use of livestock guarding dogs to reduce conflicts, and the use of faux Leopard skins as a cultural regalia substitute.
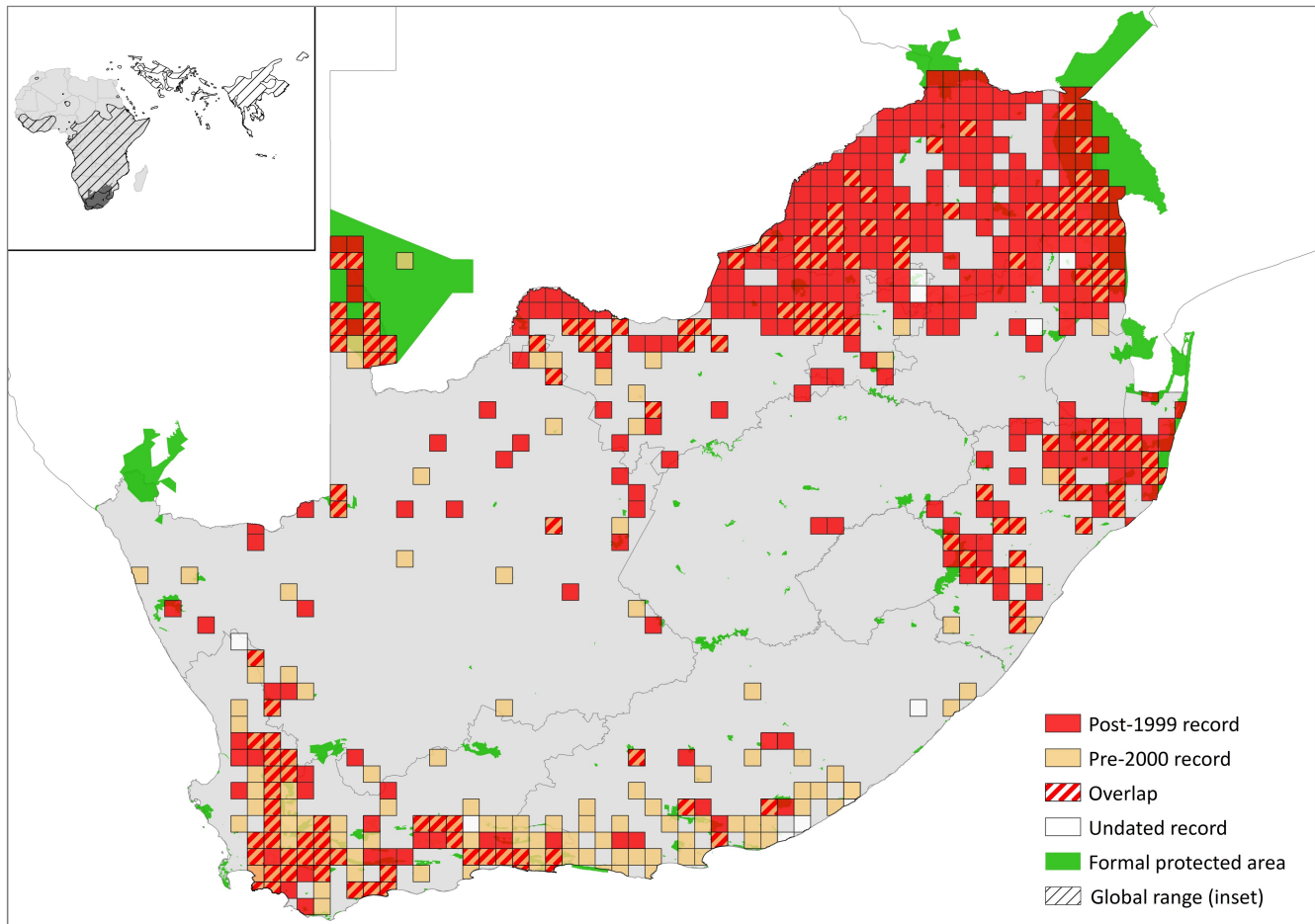
Figure 1. Distribution records for Leopard (*Panthera pardus*) within the assessment region

Legend:
- Post-1999 record
- Pre-2000 record
- Overlap
- Undated record
- Formal protected area
- Global range (inset)

Table 1. Countries of occurrence within southern Africa

Country	Presence	Origin
Botswana	Extant	Native
Lesotho	Absent	-
Mozambique	Extant	Native
Namibia	Extant	Native
South Africa	Extant	Native
Swaziland	Extant	Native
Zimbabwe	Extant	Native

Regional population effects: Although no quantitative assessment has been done regarding the extent of suitable Leopard habitat across the southern African region, dispersal occurs between neighbouring countries (Fattebert et al. 2013). This has to some extent been facilitated by the establishment of Transfrontier Parks. However, continued human population growth and livestock/game farming along South African and neighbouring country borders (even within some Transfrontier Parks), means the associated Leopard-landowner conflict might limit the rescue effect of South Africa's neighbouring countries (Purchase & Mateke 2008). Furthermore, Leopard subpopulations along South African borders also face similar threats like illegal harvesting, persecution, poorly managed trophy hunting and incidental snaring (Purchase & Mateke 2008; Jorge et al. 2013). As such, although the rescue effect is possible, it is unlikely to be a significant factor in reducing extinction risk within the assessment region.

Distribution

Leopards remain widely, but patchily, distributed (Stein et al. 2016), having been lost from at least 37% of their historical range in sub-Saharan Africa (Ray et al. 2005), and 28–51% of their historical range in Southern Africa (Jacobson et al. 2016). The most marked range loss has been in the Sahel belt, as well as in Nigeria, Malawi and, importantly, South Africa (Stein et al. 2016), where Leopards have become extinct in 67% of the country (Jacobson et al. 2016). The species has become locally extinct in areas of high human density or extensive habitat transformation (Hunter et al. 2013). Within the assessment region, they range extensively across all provinces (except the Free State Province and the greater Karoo basin in the Northern and Western Cape provinces), including Swaziland but not Lesotho (Figure 1); and they occur in all biomes of South Africa, with a marginal occurrence in the Nama Karoo and Succulent Karoo biomes. While Leopards were present in both Free State Province and Lesotho historically (Lynch 1983, 1994), they are very rare or absent entirely from these areas today. However, there has been a recent record (2014) from Clocolan, Free State Province by the Department of Economic Development, Environment, Conservation and Tourism, that occasionally attends to Leopards as damage-causing animals (N. Collins pers. comm. 2016). Additionally, Swanepoel et al. (2014) estimated that 8–26 individuals may occur in the Free State Province based on habitat suitability.

Available habitat is becoming increasingly rare: recent habitat suitability models classed only around 20% of South Africa as suitable habitat (Swanepoel et al. 2013), although both the extent of occurrence and area of

occupancy inferred to have remained stable or even increased from 2000 to 2010 in North West Province (Thorn et al. 2011; Power 2014). All areas identified as suitable habitat need to be surveyed for confirmed Leopard presence. For example, potential Leopard habitat in the Western Cape, excluding isolated areas where they have been sighted, is approximately 40,000 km^2 (Martins 2010), composed of 10,000 km^2 conserved areas, state land and mountain catchment areas (prime habitat), with the remaining 30,000 km^2 comprising crop and livestock farming and small towns, which may support resident Leopards or transitory individuals. Further research and field surveys investigating spatial patterns of Leopard subpopulations outside of protected areas is needed (Balme et al. 2014). They are able to disperse large distances. For example, an individual from Maputaland, KwaZulu-Natal Province, traversed three countries covering 353 km (Fattebert et al. 2013).

Suitable Leopard habitat in South Africa has been further fragmented into four core areas, based on MaxEnt models using true positive data (Swanepoel et al. 2013), namely 1) the west coast and southeast coast of the Western and Eastern Cape Provinces; 2) the interior of KwaZulu-Natal Province; 3) the Kruger National Park and the interior of Limpopo, Mpumalanga and North West Provinces; and 4) the northern region, containing the Kgalagadi Transfrontier Park (KTP) and adjacent areas of the Northern Cape and North West Provinces. There may be a fifth subpopulation pending further investigation: we are still unsure of the Northern Cape population documented in Namaqualand and up to the Richtersveld, which may be connected to the Western Cape subpopulation, but phenotypically they are more similar to Leopards elsewhere in the country (McManus et al. 2015a).

Population

The Leopard is an adaptable, widespread species that nonetheless may have many threatened subpopulations. Leopard population size and trends are notoriously difficult to estimate, due to their secretive nature and the high financial costs involved in population monitoring. As such, density and population estimates can have low precision which makes interpretation difficult. As Table 2 shows, the most systematic estimate (based on habitat availability and suitability, as well as a range of density estimates for each province) ranges from 2,813–11,632 Leopards, with a median (best scenario) estimate of 4,476 (Swanepoel et al. 2014). If we assume that 60% of the population is mature, (30% males, 30% females, 15% sub-adult males and females and 10% juveniles; Swanepoel et al. 2014), there are 1,688–6,979 mature individuals within the assessment region. This estimate is similar to the 4,250 estimated by Daly et al. (2005), but much lower than the 10,000 estimated by Martin and De Meulenaer (1988). The latter has been criticised as being an overestimate (Norton 1990). Such large variance makes quantitative interpretation difficult and thus these data can only be used as a rough guideline of the South African Leopard population. Caution should therefore be applied when using these data quantitatively (for example, to set hunting quotas). The estimated generation length ranges from six years (IUCN unpubl. data) to nine years (Pacifici et al. 2013), yielding the three generation window as 18–27 years. Leopards become sexually mature at 2.5–3 years old (Nowell & Jackson 1996; Skinner & Chimimba 2005). First-year mortality was estimated to be 41–50% (Martin &

De Meulenaer 1988; Bailey 1993) and cub survival was estimated to be only 37% (Balme et al. 2013).

Two independent models indicate a continuing decline in the population: Daly et al. (2005) projected a continuing population decline of 16% between 2005 and 2025 under a trophy hunting quota of 150 animals per year. This is congruent with stochastic population results from Swanepoel et al. (2014), where all provincial populations showed consistent declines under a range of realistic scenarios of harvest and damage-causing animal control over the next 25 years, although overall extinction risk is low (< 10% probability). Furthermore, current province-wide population ecology studies in KwaZulu-Natal and Limpopo Provinces show subpopulation declines in several protected areas (Welgevonden: 33% decline in 6 years; Lajuma: 22% decline in 7 years; Hluhluwe-iMfolozi: 40% decline in 4 years; uMkhuze: 13% decline in 5 years; G. Balme et al. unpubl. data). Additional survey data reveal negative subpopulation trends (from 2–4 repeated surveys) for 10 out of 13 sampled protected areas across the country (G. Balme unpubl. data). Thus, declines projected from model outputs are corroborated by empirical data from localities in different regions, which 1) suggests a generalised widespread decline (rather than local short-term fluctuations or aberrations); and 2) a rate of decline that exceeds the 10% threshold over three generations and may indicate a greater national population reduction. Further monitoring is required to estimate or project past and future population reduction.

We suspect overall population declines may be greater, as estimated declines are from within protected areas and Leopard survival is lower outside of protected areas, and hence may be subject to more severe declines. For example on private land in the western Soutpansberg Mountains, Limpopo Province, preliminary analyses suggest that the Leopard density has declined from 10.7 individuals / 100 km^2 in 2008 (Chase Grey et al. 2013) to approximately 4 Leopards / 100 km^2 in 2015 (S. Williams unpubl. data). Research shows Leopard survival in non-protected areas is 57 ± 14% while in protected areas is 86 ± 5% (Swanepoel et al. 2015b). Survival is especially low for females (Balme et al. 2013; Swanepoel et al. 2014). Similarly, densities can be low in highly suitable areas, whether protected or not. For example, in the Phinda–Mkuze complex (KwaZulu-Natal Province)

Table 2. Population estimates for the Leopard (*Panthera pardus*) in South Africa (from Swanepoel et al. 2014)

Province	Population size (minimum)	Population size (maximum)	Mature population size (range)
Limpopo	1,682	7,168	1,009–4,301
Mpumalanga	338	1,851	203–1,111
North West	174	255	104–153
Gauteng	25	31	15–19
Northern Cape	68	262	41–157
Free State	8	26	5–16
KwaZulu-Natal	247	1,120	148–672
Western Cape	200	619	120–371
Eastern Cape	71	299	43–179
South Africa (total)	**2,813**	**11,631**	**1,688–6,979**

Leopard density declined from the core of the reserve (11 ± 1 individuals / 100 km²) to the border (7 ± 1 individuals / 100 km²), being the lowest in non-protected areas adjoining the reserve (3 ± 0.9 individuals / 100 km²), and was not related to prey abundance or interspecific competition (Balme et al. 2010b). In North West Province, there is an estimated annual persecution rate of 0.4 individuals killed / 100 km² (Thorn et al. 2012), while the western Kalahari region may have experienced a significant decline in Leopard numbers as inferred from the number of damage-causing animal control records (Power 2014).

Recent multiscale genetic analysis suggested southern African Leopards comprise a single population of distinct geographically isolated groups (Ropiquet et al. 2015). This supports previous analyses (Miththapala et al. 1996; Uphyrkina et al. 2001), and confirms evidence for geographically isolated groups (for example, Western and Eastern Cape are geographically isolated from Limpopo; Tensen et al. 2011). However, genetic work from Leopard subpopulations within Eastern and Western Cape provinces detected significant population clustering, with low emigration and immigration between subpopulations (McManus et al. 2015a, Swanepoel et al 2013). Evidence is thus amassing that suggests local population isolation can be attained within relatively few generations highlighting the importance of management actions that aims to increase habitat connectivity and reduce human–carnivore conflict (McManus et al. 2015a).

Current population trend: Declining, estimated and projected from model simulations based on harvesting and persecution data; as well as inferred decline in area of occupancy.

Continuing decline in mature individuals: Yes, from damage-causing animal control, trophy harvesting, snaring and poisoning.

**Number of mature individuals in population**: 1,688–6,979 (Swanepoel et al. 2014).

Number of mature individuals in largest subpopulation: 1,316–5,565, based on abundance estimates for Limpopo, Mpumalanga and North West provinces (Swanepoel et al. 2014).

Number of subpopulations: 4–6 depending on how many subpopulations are present in the Western and Eastern Cape provinces (McManus et al. 2015a).

Severely fragmented: Moderate, based on current habitat suitability models and genetic population models (Swanepoel et al. 2013; McManus et al. 2015a).

Habitats and Ecology

The Leopard has a wide habitat tolerance, including woodland, grassland savannah and mountain habitats but also occur widely in coastal scrub, shrubland and semi-desert (Hunter et al. 2013; Stein et al. 2016). Densely wooded and rocky areas are preferred as choice habitat types. Leopards also have highly varied diets, including more than 90 species in sub-Saharan Africa, ranging from arthropods to large antelope up to the size of adult male Eland (*Tragelaphus oryx)* (Hunter et al. 2013). Their main prey is in the weight range of 10–40 kg, where the preferred mass of prey is 25 kg, and, since they are solitary predators, they would generally capture prey similar to their own weight (Hayward et al. 2006). In South Africa, medium-sized ungulates such as Impala
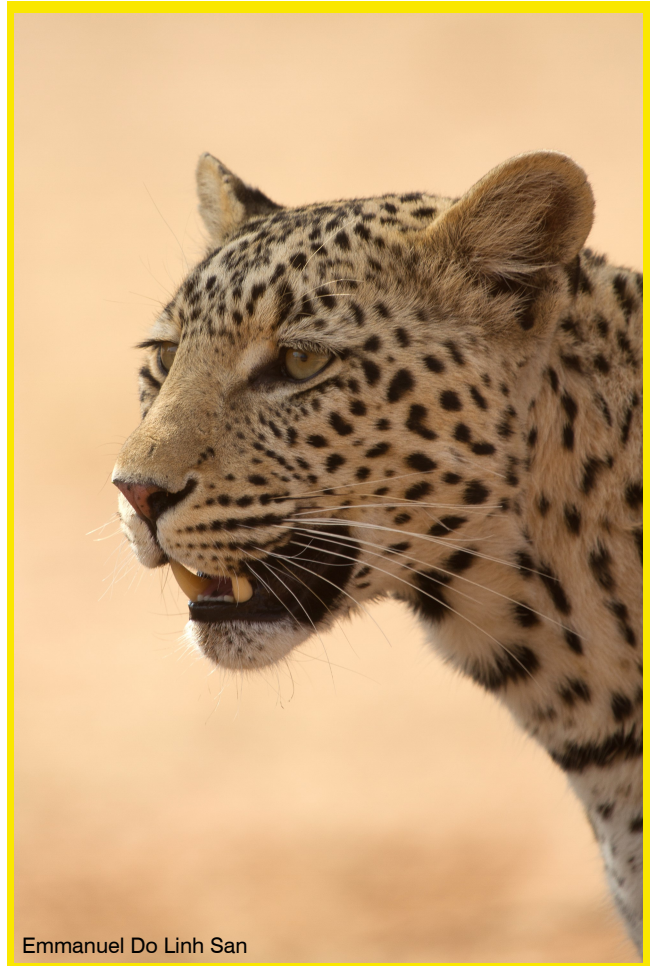
Emmanuel Do Linh San

(*Aepyceros melampus*), Grey Duiker (*Sylvicapra grimmia*), and Bushbuck (*Tragelaphus scriptus*), are all preferred species (Hayward et al. 2006; Balme et al. 2007; Pitman et al. 2013), which is the case in most game reserves and ranchland country in the savannah biome where such species do occur, and thus brings Leopards into conflict with humans (for example, Power 2014). Elsewhere in the country, particularly in the montane and rocky areas of the Western Cape and Northern Cape provinces, small prey such as Rock Hyraxes (*Procavia capensis*) and Klipspringer antelope (*Oreotragus oreotragus*) are extensively utilised (Norton et al. 1986; Stuart & Stuart 1993; Bothma & Le Riche 1994; Martins et al. 2011). This is similar to other rocky areas elsewhere, such as the Rhodes Matopo National Park in Zimbabwe as determined by faecal analysis (Grobler & Wilson 1972).

Leopard densities vary with habitat, prey availability, and threat severity, from fewer than one individual / 100 km² to over 30 individuals / 100 km², with highest densities obtained in protected East and southern African mesic woodland savannas (Hunter et al. 2013). Within the assessment region, the lowest densities are in the Kalahari and Western Cape mountains (Martins 2010). For example, Western Cape densities range from 0.25–2.3 individuals / 100 km² (Martins 2010). Density estimates for South Africa are summarised in Swanepoel et al. (2014) with additional densities in Swanepoel et al. (2015b). It is not a migrant species but its genetic viability dependends on sufficient gene flow between populations (and thus dispersal) over relatively large areas. Male Leopards in the Waterberg region in Limpopo have range sizes of about 290 km² (Swanepoel 2008). The home ranges of male and female Leopards in the Kgalagadi

average 2,182 km² and 488 km² respectively (Bothma 1998). In the Soutpansberg Mountains, male Leopards occupied a home range of approximately 100 km² while females occupied approximately 20 km² (S. Williams unpubl. data).

Ecosystem and cultural services: As one of the last remaining widespread large carnivores in South Africa, Leopards may play an important role in regulating terrestrial ecosystems (Ripple et al. 2014). In the Western Cape, they are the apex predator, impacting on mesopredator behaviour and possibly densities, such as with Caracal (*Caracal caracal*). Such regulation will depend on Leopard densities (Soulé et al. 2003), suggesting that such ecosystem services might be restricted to certain areas in South Africa. Leopards also prey upon Black-backed Jackal (*Canis mesomelas*) (Bothma & Le Riche 1994), which is a well-known problem predator species (Stuart 1981), so they conceivably can control these species to an extent. Camera trapping evidence from comparable ecological areas of the North West showed a fivefold increase in jackal abundance when Leopards were absent, which is evidence for mesopredator release in the absence of apex predators (Power 2014; Minnie et al. 2016), and thus support for holistic ecosystem management. Similarly, Leopards prey upon Chacma Baboons (*Papio ursinus*) (Pienaar 1969; Stuart & Stuart 1993), where they form an important prey source in the Waterberg bushveld and Soutpansberg (Stuart & Stuart 1993; Swanepoel 2008; Jooste et al. 2013; Pitman et al. 2013), and thus may help to control baboon numbers.

Leopards further play an important role in the trophy hunting and ecotourism industries, where people pay significant sums of money to shoot or view and photograph this iconic species (Balme et al. 2012). As such, they are an important flagship species for certain conservation actions and areas in South Africa. Leopards also play an important cultural role in South Africa; for example, Leopard skins are worn by members of the Shembe Church as a sign of worship and by high-ranking Zulus as a status symbol (Hunter et al. 2013).

Use and Trade

Leopards are hunted (legally and illegally) as a trophy animal within the assessment region. When properly managed, trophy hunting should have little effect on

population persistence (Swanepoel et al. 2014); however, research from KwaZulu-Natal (Balme et al. 2009, 2010b), Limpopo (Pitman et al. 2015) and Tanzania (Packer et al. 2011) suggest that poorly managed trophy hunting might lead to Leopard population declines . In South Africa, population models, which only include off-take from trophy hunting, suggest that current trophy harvest levels have little impact on population persistence (Swanepoel 2013; Swanepoel et al. 2014). However, when other forms of human-induced mortality (for example, legal and illegal retaliatory killing due to human-Leopard conflict) are included, trophy hunting quotas become unsustainable (Swanepoel 2013; Swanepoel et al. 2014). The detrimental impacts of trophy hunting may be reduced by improving current management practices, most notably by banning the hunting of female Leopards and ensuring the equitable distribution of hunting effort across Leopard range (Balme et al. 2010a). Suspicions are that captive-bred-animals are laundered into the trophy hunting industry and this should also be investigated. Additionally, there is a suspected industry in catching Leopards from the wild and providing them for the trophy hunting industry. Authorities are constantly confiscating such animals and attempting to repatriate them elsewhere without any knowledge of their origin (R.J. Power unpubl. data).

The likely impacts of the illegal skin trade also need to be factored into assessments of harvest sustainability. Surveys suggest as many as 17,240–18,760 illegal Leopard skins are used by members of the Shembe Church for religious regalia and may be replaced every 3–5 years due to wear (G. Balme unpubl. data). Although interviews with traders suggest many skins originate outside South Africa (G. Balme unpubl. data), the trade is likely to affect Leopard population viability throughout the assessment region. While wildlife ranching and game farming might be increasing in suitable habitat for Leopards (Power 2014), such industries are normally in conflict with predators (Thorn et al. 2012), especially as the recent shift to breeding high-value species and colour variants has increased hostility towards carnivores (Thorn et al. 2013). This is reflected by the rapid increase in the number of damage-causing animal (DCA) permit applications received from game farms in areas such as the Waterberg (Lindsey et al. 2011). An increase in ranching rare/expensive game, especially intensive breeding for trophies and colour variants, may thus impact negatively on the Leopard population through increased persecution, exclusion with predator-proof fences and

Table 3. Use and trade summary for the Leopard (*Panthera pardus*)

Category	Applicable?	Rationale	Proportion of total harvest	Trend
Subsistence use	No	-	-	-
Commercial use	Yes	Leopards are traded locally for traditional medicine and ceremonies. Trophy hunting.	All	Increasing
Harvest from wild population	Yes	Most animals hunted will be free roaming (but see below). This includes harvest of wild Leopards for keeping in captivity.	Majority	Increasing: CITES quota increased and there are increasing numbers of DCA permits issued.
Harvest from ranched population	No	-	-	-
Harvest from captive population	Unknown	There is anecdotal evidence that Leopards are bred in captivity for trophy hunting.	Minority	Unknown

Table 4. Possible net effects of wildlife ranching on the Leopard (*Panthera pardus*) and subsequent management recommendations

Net effect	Unknown
Data quality	Suspected
Rationale	Wildlife ranchers are protective over valuable game stocks and are suspected to persecute leopards.
Management recommendation	Leopard conflict management among game farmers is more difficult, but can include fencing off valuable game, stocking only native species adapted to the area and sustaining natural prey to buffer Leopard predation.

limitation of gene flow. Such conflict results in two outcomes; 1) increased persecution or legal removal (DCA permits) and 2) possible exclusion through improved fencing to keep predators out. While Leopards appear to be unhindered by standard game farm fences (Fattebert et al. 2013), the quality of predator-proof fencing has improved to such an extent that it may hinder their movement between properties (du Plessis & Smit 1999).

Threats

Within the assessment region, the major threats to Leopards are intense persecution, both directly through hunting (trophy or DCA control) or indirectly through snaring, and demand for their skins for cultural regalia (Hunter et al. 2013). Compared to other African countries, South Africa is highly developed and thus Leopard subpopulations have become fragmented (Swanepoel et al. 2013), and there has been a long history of persecution owing to real or perceived livestock depredations (Stuart 1981; Norton 1986; Lindsey et al. 2005; St John et al. 2011). These threats are more pronounced outside protected areas (Swanepoel et al. 2015a,b), where mortality on non-protected land is due to legal and illegal damage hunting/control, whereas snaring and poisoning are significant causes of mortality inside protected areas. For example, in the Soutpansberg Mountains, Limpopo Province, the most common cause of death of eight Leopards that were fitted with GPS collars between 2012 and 2015 was snaring, followed by illegal activity to protect livestock predation, such as shooting and poisoning (S. Williams unpubl. data). North West authorities, however, do mitigate this by removing snares from collared Leopards by airborne immobilisation, treatment and re-release. Stationary Leopards are thus immediately investigated with the suspicion that they are ensnared (R.J. Power pers. obs. 2015).

Ongoing habitat loss and fragmentation also threatens the recovery of this species (see below).

1. **Direct persecution**: Sustainability of trophy harvest is reduced due to high incidences of direct persecution in South Africa (Swanepoel et al. 2014). This, on its own, reduces Leopard population size and disrupts social organisation (Balme et al. 2013). Swanepoel et al. (2014) estimated that 35% of all Leopards killed in retaliatory actions are reproductive females. Such removals of females leads to reduced survival of Leopards in non-protected areas and thus affects long term population viability (Swanepoel et al. 2015b). Compounding this problem is an obvious lack of clear national conservation objectives resulting in large disparity in the number of DCA permits issued in different provinces, which ranges from 17 in one year to only two between 2007 and 2013 in the same province (Q. Martins and R.J. Power pers. obs. 2015). The reduction in permits was partly attributed to a local conservation NGO monitoring the permit issuing

process. Direct poaching of Leopards is also suspected to be increasing due to the demand for skins (see below), which may be far more severe a threat than problem-animal control and unsustainable trophy hunting combined.

2. **Cultural regalia**: There appears to be a strong demand for Leopard skins for cultural regalia. Preliminary capture-recapture analyses suggest that members of the Nazareth Baptist Church (also known as the Shembe) may be in possession of 17,240–18,760 illegal Leopard skins with a subsequent high rate of removal from the wild (G. Balme unpubl. data). This represents an emerging threat to this species within the assessment region.

3. **Trophy hunting**: Unsustainable and poorly-managed trophy hunting can cause subpopulation decline (Balme et al. 2009, 2010b; Packer et al. 2011; Swanepoel 2013; Swanepoel et al. 2014). Poorly managed trophy quotas are characterized by the hunting of females, clumped harvests (excessive hunting around protected areas, and multiple tags in the same area) and hunting of inappropriate age classes (for example, excessive hunting of prime adults males) (Packer et al. 2009, 2011; Balme et al. 2012). Excessive and clumped harvest of male Leopards < 7 years old can destabilise Leopard social organisation, leading to reduced cub survival and increased female mortality (Balme et al. 2012). Similarly, hunting females can reduce overall reproductive output causing population declines (Dalerum et al. 2008). While hunting of females is detrimental, South African law still allows for female harvest (32–50% of hunted Leopards are females; Swanepoel et al. 2014). Even in countries with only male harvest, like Tanzania, females comprised 29% of 77 trophies shot between 1995 and 1998 (Spong et al. 2000). The use of national population estimates to set trophy hunting quotas is perilous. For example, the over-estimate of 10,000 Leopards in South Africa (Martin & De Meulenaer 1988; Norton 1990) was used by conservation authorities to set hunting quotas from 2005 onwards (Daly et al. 2005).

4. **Indirect persecution**: While snares laid out for bushmeat hunting threaten Leopards, especially inside protected areas, a rapidly increasing threat is the poisoning of carcasses, either as a means of predator control or incidentally. The rise of intensive wildlife breeding for high-value game species may also be increasing the extent of both direct and indirect persecution (Thorn et al. 2012, 2013).

5. **Radio-collars**: Another significant and localised threat is the injudicious use of radio-collars for research and recreational purposes. Sub-adults exhibit rapid growth and have a high neck-head circumference ratio (G. Balme unpubl. data). Collars can asphyxiate Leopards if they cannot be loosened. Poor capture

techniques also pose a threat to Leopards. Despite this, radio-collars are widely deployed on Leopards in South Africa, often with little oversight. Eighty percent of Leopard projects in South Africa, reviewed in a recent study, used radio-telemetry (N = 39; G. Balme unpubl. data.), and most of these projects failed to deploy breakaway devices on collars. Similarly, many (63%) did not contribute to the scientific literature, even though some were active for over 12 years (Balme et al. 2014). It appears the motivation for much Leopard research in South Africa, particularly hands-on research such as radio-collaring, is to enable commercial volunteer programmes, where laypeople (typically foreign graduate students) pay to experience research (Balme et al. 2014). North West Province have instituted the policy of controlling all Leopard collaring under their bannership and research, and insist upon recaptures and collar removal via conditioning animals upon recapture.

6. **Road collisions**: Although the effect of this threat on the population is unknown, Leopards are amongst the species killed on roads, even within protected areas (Photo 1).

Current habitat trend: Continuing decline. Although total habitat may be increasing with the advent of wildlife ranching, many ranchers persecute Leopards as damage-causing animals to protect valuable game species. Such suitable habitats thus become ecological traps (Balme et al. 2010b), whereby Leopard populations can actually decline, even though the habitat is suitable. Similarly, continuing urban and rural settlement expansion (average rates between 2000 and 2013 corresponding to 9.9 ± 12% and 10.3 ± 3.5% respectively; GeoTerraImage 2015), will increasingly bring Leopards into conflict with humans. Thus, the net effect of habitat recovery is debatable. Although this species survives well in inaccessible areas, such as rocky outcrops and mountainous regions (which can act as refugia for some subpopulations), the suitability of such areas in the assessment region is declining. For example, the Waterberg (which has always been a Leopard stronghold due to inaccessibility and ruggedness) has seen a massive growth in game farming. This growth has also led to the Waterberg having the highest number of DCA and trophy hunting permits issued (Lindsey et al. 2011). In the mountainous region of the Northern Cape, conflict with small livestock farmers is the biggest threat to Leopards (Q. Martins pers comm. 2016).

Conservation

Although Leopards occur in numerous protected areas across their range, the majority of the population occurs outside of protected areas, necessitating a need for improved conflict mitigation measures, trophy hunting management, non-lethal mitigation actions, centralised monitoring of trophy harvest and quality, issuing of DCA permits as well as providing education programmes to ensure Leopards do not become locally threatened. Currently, the best conservation effect on Leopard conservation in South Africa can be made along two general fronts, namely policy development and conflict mitigation. These can be distilled into four pillars of conservation action: 1) livestock and game conflict mitigation, 2) applying sustainable trophy hunting regulations, 3) reducing the illegal trade in skins and 4) protected area expansion to create a more resilient population overall.

Photo 1. Example of a Leopard (*Panthera pardus*) killed in 2014 on a road within the Greater Mapungubwe Transfrontier Conservation Area (W. Collinson)

Firstly, it is important to revise current Leopard management policies implemented by local conservation authorities and councils. These include adoption of stringent control methods in Leopard trophy hunting, which include age based harvest (for example, harvest of old males; Balme et al. 2010a, 2012), enforcement of male only harvest (Balme et al. 2010a; Swanepoel et al. 2014) and non-spatial clumped harvest (Balme et al. 2010a). Furthermore, issuing permits to destroy damage-causing Leopards needs to be revised by including better conflict mitigation actions (for example, guard dogs and predator-proof fencing; McManus et al. 2015b), and implementing/monitoring mitigation actions, especially preventing the destruction of female Leopards (Swanepoel et al. 2014). Secondly, such policies being implemented by the different provincial governments must be continuously monitored. These two management actions should be nationally implemented. A national monitoring framework should be established to analyse trends in Leopard off-take (via the different mortality sources) and to detect changes in Leopard occupancy and local densities. However, regional populations have additional threats which should be addressed at a local scale. Thus, conservationists should focus on the following interventions:

- Livestock conflict mitigation through use of guarding dogs and improved livestock husbandry (Marker et al. 2005). While various pilot projects have been established in Limpopo, North West, Northern and Western Cape provinces, little research has been done about their overall effectiveness within the assessment region, especially for Leopards. Preliminary findings suggest that livestock guarding dogs can decrease depredation by 69% (McManus et al. 2015b).

- Applying and enforcing more sustainable trophy hunting and damage-causing animal regulations (Balme et al. 2012), which are described above.

- Reducing the illegal trade in skins by providing faux furs for use at cultural ceremonies. Since the project began in 2013, 5,160 Leopard skins have been donated by the conservation NGO *Panthera* to members of the Shembe Church. Results are preliminary, but the ratio of fake to authentic skins observed at Shembe gatherings has increased from 1:8 to 1:4 (G. Balme et al. unpubl. data). However, the overall impact of the intervention on the regional

Table 5. Threats to the Leopard (*Panthera pardus*) ranked in order of severity with corresponding evidence (based on IUCN threat categories, with regional context)

Rank	Threat description	Evidence in the scientific literature	Data quality	Scale of study	Current trend
1	*5.1.3 Persecution/Control*: illegal lethal control of putative damage-causing Leopards.	Lindsey et al. 2005	Attitudinal	Regional	Increasing – increase in the breeding of rare/expensive game leading to increased hostility towards large carnivores.
		Balme et al. 2009	Empirical	Local	
		St John et al. 2011	Attitudinal	Regional	
		Thorn et al. 2012	Attitudinal	Regional	
		Thorn et al. 2013	Attitudinal	Regional	
		Swanepoel et al. 2014	Simulation	National	
		Swanepoel et al. 2015b	Empirical	National	
2	*5.1.1 Hunting & Collecting Terrestrial Animals*: illegal trade in Leopard skins for cultural/religious regalia.	G. Balme unpubl. data	Empirical – capture-recapture analyses suggest 17,240–18,760 illegal Leopard skins among members of the Shembe Church.	National	Increasing – the Shembe Church has grown from 250,000 to over one million members since 2001.
3	*5.1.1 Hunting & Collecting Terrestrial Animals*: unsustainable legal trophy hunting.	Balme et al. 2009	Empirical	Local	Decreasing – national and provincial authorities are reforming trophy hunting policies.
		Balme et al. 2010a	Empirical	Local	
		Swanepoel et al. 2014	Simulation	National	
		Swanepoel et al. 2015b	Empirical	National	
		Pitman et al. 2015	Empirical	Empirical	
4	*5.1.3 Persecution/Control*: legal lethal control (and translocation) of putative damage-causing Leopards.	Balme et al. 2009	Empirical	Local	Increasing – increase in the number of damage-causing animal permits awarded in Limpopo since 2008.
		Swanepoel et al. 2014	Simulation	National	
		Swanepoel et al. 2015b	Empirical	National	
		Pitman et al. 2015	Empirical	Regional	
5	*5.1.2 Hunting & Collecting Terrestrial Animals*: incidental snaring.	Swanepoel et al. 2015b	Empirical	National	Increasing – snaring rates increasing in many protected areas: 13 % of mortality of females outside protected areas.
6	*5.1.2 Hunting & Collecting Terrestrial Animals*: incidental snaring. Current stress *1.2 Ecosystem Degradation*: loss of Leopard prey base.	S. Williams unpubl. data	Anecdotal	-	Increasing – snaring rates increasing in many protected areas; partly offset by increase in natural prey due to game ranching.
7	*6.3 Work & Other Activities*: injudicious radio-collaring of Leopards.	G. Balme unpubl. data	Empirical	National	Increasing – number of Leopard projects using telemetry increasing due to growth of commercial volunteer industry.
8	*4.1 Roads & Railroads*: mortalities from road collisions.	Swanepoel et al. 2015b	Empirical	National	Unknown
9	*1.1 Housing & Urban Areas*: human settlement expansion causing habitat loss. Current stress *1.3 Indirect Ecosystem Effects*: habitat fragmentation.	Swanepoel et al. 2013	Empirical	National	Unknown – increased development/human population growth potentially offset by spread of game ranching (though many of these areas are unsuitable for Leopards due to hostile landowners).
		McManus et al. 2015a	Indirect	Regional	

Leopard population remains unknown. More generally, this also includes interventions aimed at reducing demand for anatomical parts for both ceremonial and medicinal uses.

- Protected area expansion will also benefit this species by increasing Leopard densities in core areas and creating a more resilient population as individuals are free to roam across greater areas. The most important population is undoubtedly the Kruger National Park, and its adjacent private game reserves. The establishment of larger and better-connected protected areas, especially transfrontier conservation areas, will enhance metapopulation persistence, as had been modelled for Leopard in the Maputaland–Pondoland–Albany biodiversity hotspot (Di Minin et al. 2013). However, due to high levels of persecution and "edge effects", even if new protected areas are created, success will largely depend on the attitudes and densities of local people (Thorn et al. 2012; Balme et al. 2010b).

- Reintroduction is not recommended as a conservation tool at this stage. While there have been improvements in reintroduction success (Hayward et al. 2007), general consensus seems that translocation is of limited use in Leopard conservation (Athreya et al. 2011; Weilenmann et al. 2011). Furthermore, recent research on dispersal

patterns in Leopards has demonstrated that competition for mates was the main driver for dispersal and thus dispersal increased with local subpopulation density (Fattebert et al. 2015). Therefore, interventions that increase local abundance of Leopards will also restore dispersal patterns disrupted by unsustainable harvesting and thus improve connectivity between subpopulations (Fattebert et al. 2015). Interventions that reduce the unsustainable harvesting and persecution of Leopards may also thus galvanise natural recolonisation and population dynamics.

Recommendations for land managers and practitioners:

- Monitoring frameworks should be established to track provincial population trends, facilitating effective adaptive management. This could be a combination of both intensive (annual camera trap surveys in strategic sites) and extensive (change in harvest composition, hunting success and Leopard occupancy determined by trophy photographs, hunt return forms and province-wide questionnaire surveys gauging presence/absence of Leopards).

- Adoption of sustainable science-based hunting regulations at a national level. For example, recommend a ban on the hunting of female

Table 6. Conservation interventions for the Leopard (*Panthera pardus*) ranked in order of effectiveness with corresponding evidence (based on IUCN action categories, with regional context)

Rank	Intervention description	Evidence in the scientific literature	Data quality	Scale of evidence	Demonstrated impact	Current conservation projects
1	*5.2 Policies & Regulations* and *3.1.1 Harvest Management*: adoption of sustainable trophy hunting policies.	Balme et al. 2009 / Balme et al. 2010a	Empirical / Empirical	Local / Local	Population density increased by 60% after 4 years.	Provincial monitoring frameworks, *Panthera* / North West Leopard Project
2	*5.2 Policies & Regulations* and *3.1.1 Harvest Management*: adoption of sustainable legal DCA policies.	Balme et al. 2009	Empirical	Local	Population density increased by 60% after 4 years.	North West Leopard Project / Provincial monitoring frameworks, *Panthera*
3	*2.1 Site/Area Management*: site-specific conflict mitigation measures, including the use of livestock guarding dogs.	Rust et al. 2013 / McManus et al. 2015b	Indirect / Indirect	Local / Local	Livestock depredation rates reduced.	*Landmark Leopard and Predator Foundation*, Primate and Predator Project
4	*6.2 Substitution*: install faux Leopard furs to replace authentic skins at cultural/religious gatherings.	G. Balme unpubl. data	Indirect	Regional	Ratio of fake to authentic skins observed at gatherings decreased from 1:8 to 1:4 in 2 years after provision of 5,000 faux furs.	Furs for Life, *Panthera*
5	*5.4 Compliance & Enforcement*: increased site security/law enforcement in protected areas to combat snaring.	-	Anecdotal	-	-	North West Provincial Government Operations
6	*4.3 Awareness & Communications*: educating landowners of the efficacy and efficiency of holistic management.	-	Anecdotal	-	-	Cape Leopard Trust, Primate and Predator Project

Leopards (Daly et al. 2005; Balme et al. 2010a), for hunting effort to be equitably distributed across Leopard range (Balme et al. 2010a), and that hunting be limited to male Leopards > 7 years old (Packer et al. 2009; Balme et al. 2012). Professional Hunters should be scrutinised for experience and efficacy in terms of identification of the right animal to be hunted. It should be a highly specialised hunt, with proper assessments done beforehand.

- Similarly, sustainable DCA protocols for putative problem Leopards should be adopted at a national level, where there is improved record keeping of trophy hunting and DCA permits. Integrated conservation plans are necessary. For example, in response to a fragmented (Swanepoel et al. 2013), and declining Leopard population (Power 2014), North West conservation authorities have embarked upon operations, combining law enforcement and problem animal control, to restore the species population status by reintroducing injured or problem individual Leopards. Call centres should be established to assist landowners with conflict management.

- Public awareness and education programmes should be used to encourage livestock and wildlife owners to adopt non-lethal conflict mitigation approaches to reduce the risk of depredation (Ogada et al. 2003; Rust et al. 2013; McManus et al. 2015b), or to encourage product substitution among the Shembe (and other traditional users of Leopard skins).

- Increased enforcement of the illegal persecution or use of Leopard skins for cultural and religious purposes should be promoted.

Research priorities: Leopard research in South Africa is biased toward protected areas, and thus quantitative assessment of Leopard viability in the assessment region is hampered by a number of key areas of data deficiency (Swanepoel 2013; Balme et al. 2014). These include:

- The effect of land type on Leopard population status and trends: there are limited data on population sizes and trends in non-protected areas.

- The scale and scope of the illegal trade in Leopard skins for cultural/religious regalia: there are limited data on illegal harvest and persecution.

- Further research and monitoring is needed on the effects of persecution and illegal harvest on population persistence, as well as the efficacy of education and awareness programmes in mitigating this threat. Greater effort will be needed to collate the number of DCA and trophy hunting permits issued.

- Research on actual versus perceived impacts on game ranches via Leopard predation (Funston et al. 2013). Conversely, investigating the impact of commercial game ranching on Leopard population persistence.

- The effectiveness of non-lethal mitigation approaches to reduce human–Leopard conflict.

- Further clarification on genetic structure of the population and likely connectivity between subpopulations.

- Relationships between Leopard landscape use and risk of road mortality.

The following research projects are currently ongoing:

- *Panthera*: 1) Provincial Monitoring Frameworks – partnering with provincial and national conservation authorities to establish monitoring networks to track Leopard population trends at meaningful management scales; 2) Furs for Life – combatting the illegal trade in Leopard skins for cultural regalia through education, policy and the provision of faux Leopard furs.

- *Landmark Leopard and Predator Foundation*: ecology of Leopards, remedial action for injured leopards, and conflict management with livestock owners.

- *Primate and Predator Project*: conducting research into the status of Leopards outside of protected areas and in the Soutpansberg Mountains, Limpopo Province.

- *North West Leopard Project*: investigating the ecology of Leopards in the province through camera trapping and GPS collars, with a view to enable province-wide management (for example, setting quotas, conflict management and translocation appraisal).

- *Cape Leopard Trust*: continuing work on Leopards in the greater Western Cape, and to venture into Northern Cape. Farmer education and ecological research.

- *Mpumalanga Tourism and Parks Board*: Ingwe Leopard Project: Greater Lydenburg area; Kruger National western boundary carnivore monitoring, including the neighbouring rural areas; spatial ecology, habitat utilisation, population demographics and conservation of Leopards in the Loskop Dam Nature Reserve.

Encouraged citizen actions:

- Report sightings on virtual museum platforms (for example, iSpot and MammalMAP), especially outside protected areas.

- Lobby to insist on proper trophy hunting procedures and permits.

- Conduct camera trapping surveys and submit data to local conservation authority.

- Conduct snare removal on private land.

- Pressure government authorities to pursue criminal cases involving this species.

Data Sources and Quality

Table 7. Information and interpretation qualifiers for the Leopard (*Panthera pardus*) assessment

Data sources	Field study (literature, unpublished)
Data quality (max)	Estimated
Data quality (min)	Inferred
Uncertainty resolution	Confidence intervals
Risk tolerance	Evidentiary

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Details of the methods used to make this assessment can be found in *Mammal Red List 2016: Introduction and Methodology*.

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