Cheetah *Acinonyx jubatus*

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Namibian conservation status	Endangered
Global IUCN status	Vulnerable (2015)
Namibian range	439,400 km^2
Global range	3,123,800 km^2
Population estimate	Widely distributed in central and western Namibia, less abundant in north-east Namibia. Very low densities in south-east and unknown status in north-central Namibia, except for its presence in Etosha National Park. The current population is estimated at 1,500 adult and subadult cheetahs
Population trend	Decreasing
Habitat	In Namibia cheetahs are found across a wide range of habitats from the evergreen tree savannas in the Zambezi Region to the open landscapes of the Namib
Threats	▸ Conflict with livestock and game farmers ▸ Inadequately regulated trophy hunting ▸ Decline of natural prey ▸ Illegal trade and keeping free-ranging animals in captivity ▸ Climate change ▸ Habitat loss and fragmentation (from game fences and main roads) ▸ Road mortalities

DISTRIBUTION

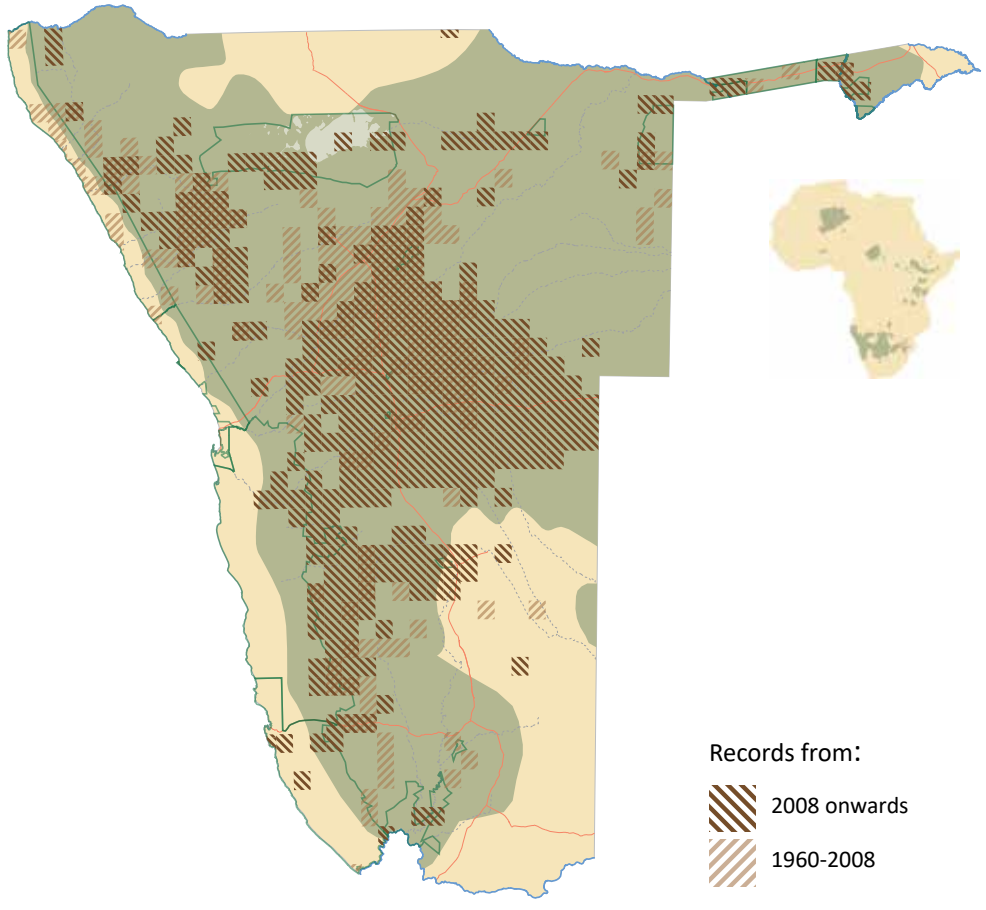
The global cheetah population is divided into 31 populations found in 20 African and Middle Eastern countries (Durant *et al*. 2017, Durant *et al*. 2018, Marker *et al*. 2018a). The largest populations are distributed in fragmented patches through southern and eastern Africa with the strongholds located in Namibia, Botswana, Tanzania and Kenya. Cheetahs also inhabit areas in Algeria, Mali, Niger, Benin, Burkina Faso, Chad, Central African Republic, South Sudan and Ethiopia along the southern margin of the Sahara. A few Asiatic cheetahs (approximately 70) live in Iran (*Acinonyx jubatus venaticus*). In most of the African countries, the status of the species is unknown and little information is available on the population size (Durant *et al*. 2015). The species is currently confined to 9% of its historical range covering 3,123,830 km^2 (Durant *et al*. 2017). The largest remaining viable populations of free-ranging cheetahs are located in southern Africa and are estimated to be approximately 4,000 individuals, of which fewer than 25% occur in protected areas (Durant *et al*. 2017, Weise *et al*. 2017).

Four subspecies of cheetah are formally recognised: *Acinonyx jubatus jubatus*, *A. j. venaticus*, *A. j. hecki* and *A. j.*

Distribution records of cheetah, and present estimated area of distribution in Namibia.

Inset: African distribution of cheetah according to IUCN (RWCP & IUCN/SSC 2015).

The Namibian distribution in the main map is more up to date and does not necessarily agree with the distribution shown in the inset.



soemmeringii. *A. j. hecki* occurs in the north-western African countries, whereas *A. j. soemmeringii* occurs in the north-eastern African countries. The Namibian cheetah is part of the southern African subspecies, *A. j. jubatus*. In the past, it was limited to southern African countries, but was recently expanded on taxonomic grounds to include the cheetahs found in eastern Africa (Kitchener *et al*. 2017).

Historically, cheetahs were distributed widely throughout Namibia (Shortridge 1934, Gaerdes 1973, Joubert & Mostert 1975, Marker-Kraus *et al*. 1996), with population densities presumably varying based on habitat, prey availability and density of competitors. Due to the mostly hostile attitude of small-stock farmers towards predators, cheetahs were extirpated from the southern part of the country, but they are still found widely throughout the central and north-western parts (Marker *et al*. 2018a). Most cheetahs live on privately owned farmland and community land rather than in protected areas (Durant *et al*. 2017). It was previously considered that cheetahs were absent from the desert regions on the western coast of Namibia (IUCN/SSC 2007, Purchase *et al*. 2007, Durant *et al*. 2017, Weise *et al*. 2017, Marker *et al*. 2018a) or that this area is a transient range for cheetahs (RWCP & IUCN/SSC 2015). During 2016 and 2017, intensive research in the arid environments of the Namib Desert and the Skeleton Coast confirmed a resident, reproducing population of desert-adapted cheetahs (Portas *et al*. 2017) and a monitoring programme was started. Despite this, there are still large areas where it is unknown whether cheetahs are transient or resident (Portas *et al*. 2017) and rapid declines might go unnoticed. Little is known about the distribution of cheetahs in the southern part of the country, in the north-western corner and in the communal land in north-eastern Namibia.

POPULATION ESTIMATE AND TREND

Previous population estimates for Namibia were vague and ranged from 2,000 to 8,000 animals (Myers 1975, Joubert & Mostert 1975, Morsbach 1987, Hanssen & Stander 2004, Purchase *et al*. 2007, Ministry of Environment and Tourism 2013b), with the latest estimate being only 1,498 adults and subadults (RWCP & IUCN/SSC 2015).

In the 1970s, the Namibian Department of Nature Conservation (DNC), later the Ministry of Environment and Tourism (MET) and now the Ministry of Environment, Forestry and Tourism (MEFT), conducted a nationwide farmland survey and estimated the cheetah population to be 2,500–3,500 adults and subadults (Nowell 1996). In the mid-1980s, the DNC carried out a radio-telemetry study on cheetahs on freehold farmland east of Windhoek, where

high levels of conflict with farmers were reported, and extrapolated the number of cheetahs for the entire country to be 2,000–3,000 (Morsbach 1987). The survey indicated that the population was declining due to the high level of cheetah removals by farmers. An assessment undertaken in the 1990s combined information provided from a farm survey with research projects in Etosha National Park and Bushmanland and determined a maximum population of 2,905 adult and sub-adult cheetahs (Nowell 1996).

Our current status assessment is based on a series of recent studies, which estimated the distribution and the population of adult and sub-adult cheetahs in Namibia (RWCP & IUCN/SSC 2015, Durant *et al*. 2017, Weise *et al*. 2017). The number of cheetahs was estimated at approximately 2,002 individuals (Weise *et al*. 2017) and 1,500 individuals (RWCP & IUCN/SSC 2015). Also, a variety of methods have been used to estimate the density of cheetahs within the last 10 years, including radio-telemetry and camera trap surveys (Marker *et al*. 2008a, 2008b, Portas *et al*. 2017). The density in central Namibia was estimated to be between 0.36 and 1.9 cheetahs/100 km² (Marker *et al*. 2008a). More recently (2015–2017), several sites across Namibia were surveyed, covering a total of 66,614 km², using a spatial-mark-recapture approach based on movement data of GPS-tracked individuals. This resulted in a set of regional density estimates ranging from 0.1 to 1.1 cheetahs/100 km², with the density in Kaokoland in north-western Namibia being 0.1–0.25 cheetahs/100 km², in the southern Namib Desert 0.2–0.4 cheetahs/100 km², in the Etosha Conservancy 0.6 cheetahs/100 km² and in east-central Namibia 1.1 cheetahs/100 km² (Portas *et al*. 2017).

In summary, central Namibia – largely the Khomas, Omaheke, Otjozondjupa and eastern parts of Erongo and Kunene Regions – have the highest cheetah densities of the country (Marker *et al*. 2008a, Portas *et al*. 2017, Weise *et al*. 2017), with the lowest densities reported in the south and the north-west (RWCP & IUCN/SSC 2015, Portas *et al*. 2017).

ECOLOGY AND BEHAVIOUR

The cheetah is the fastest land mammal, reaching speeds up to 93 km/h in the wild (Wilson *et al*. 2013). However, its lack of stamina requires the cheetah to catch its prey within the first 300 meters (Wilson *et al*. 2013). Cheetahs prefer small to medium-sized ungulates, but can take a wide variety of prey species (Hayward *et al*. 2006b, Wachter *et al*. 2006, Clements *et al*. 2014, Marker *et al*. 2018b). In Namibia, they prey predominantly on scrub hare, spring hare, common duiker, steenbok, warthog, springbok, hartebeest, gemsbok and kudu (Marker-Kraus *et al*. 1996, Marker *et al*. 2003a, Wachter *et al*. 2006). Adult male coalitions are able to take down large prey individuals, and have been observed to successfully hunt an adult kudu bull (J Melzheimer pers. obs. 2012), a juvenile giraffe (F Weise pers. obs. 2010) and a young adult eland bull (L Marker pers. obs. 1997). On Namibian farmlands, based on scat analyses, cheetahs prey primarily on wildlife, and livestock were only found in 4.0–6.4% of scat samples (Marker *et al*. 2003a, Wachter *et al*. 2006). The feeding ecology of cheetahs is influenced by the presence of other carnivore species. In areas where they coexist with lions, spotted hyaenas or leopards, they often lose their kills to these animals (Caro 1994).

Cheetahs have been considered primarily diurnal predators (Caro 1994), however, studies have shown that in areas with low interspecific competition, their activity pattern is shifted to night, early morning, and late afternoon (Marker 2002, Nghikembua *et al*. 2016, Marker *et al*. 2018b), and night activity is additionally favoured by moonlight (Cozzi *et al*. 2012, Broekhuis *et al*. 2014). Other studies hypothesise that this shift is driven by human activity (Belbachir *et al*. 2015).

In southern Africa, cheetahs are found primarily in the savanna biome (Low & Rebelo 1996, Marker *et al*. 2018b). Habitat selection of cheetahs has been linked to visibility, prey availability and large predator avoidance (Hayward *et al*. 2006b, Marker *et al*. 2008a, 2008b, Muntifering *et al*. 2006, Rostro-García *et al*. 2015, Marker *et al*. 2018b). In Namibia, bush encroachment has led to a reduction in preferred habitat (Muntifering *et al*. 2006, Nghikembua *et al*. 2016), but whether this has consequences for cheetah survival remains unknown.

Female cheetahs are either solitary or accompanied by their offspring, whereas males are either solitary or form coalitions of mostly two or three males (Caro 1994, Marker *et al*. 2008b, Wachter *et al*. 2018, Melzheimer *et al*. 2018). Genetic analysis has confirmed that in Namibia males within a coalition are usually related to each other (Marker *et al*. 2008c), similar to Tanzania and Botswana (Caro 1994, Gottelli *et al*. 2007, Dalton *et al*. 2013). Males exhibit two different spatial tactics (Caro 1994, Marker *et al*. 2018b, Wachter *et al*. 2018, Melzheimer *et al*. 2018) with non-territorial males ("floaters") roaming over vast areas and territory holders defending relatively small territories. In Namibia, a long-term study with more than 160 collared cheetah males revealed that the home range sizes of floaters were 1,595 km²±1,131 km², the ones of territory holders 379 km²±161 km² and of females 650±278 km² (Melzheimer *et al*. 2018). The territories are non-contiguous to each other but separated by a matrix of landscape (Melzheimer *et al*. 2020). Territorial males mark in the core areas of the territories at prominent landmarks such as big trees, rocks or termite mounts (Melzheimer *et al*. 2018). As they continuously patrol these marking sites, territorial males spend most of their time in the core area. Floaters encompass on average three territories and visit the respective core areas frequently, i.e. typically once or twice per 10 days. They do not mark these sites, but sniff the markings sites to check for opportunities to eventually take over the territory (Melzheimer *et al*. 2018, 2020). Females visit these areas rarely and sniff and mark (Melzheimer *et al*. 2018). These core areas function as communication hubs (CHs) of the cheetah population. The CHs cover only 5% to 10% of the area and are regularly distributed across the landscape with a mean distance of 23 km, thus functioning as a large communication network (Melzheimer *et al*. 2020). The high local cheetah activity in these CHs makes them hotspots for livestock depredation and thus are important areas concerning the cheetah-farmer conflict (Melzheimer *et al*. 2020). See below under "Actions" how the CHs can be used as a key to reduce livestock losses.

Young adult males typically disperse and cover large distances before settling down. They are not considered as floaters. Dispersers have been reported to move up to 200 km from their natal home range (Marker *et al*. 2008b).

Based on individuals known from birth, free-ranging female cheetahs in the Serengeti National Park (SNP) in Tanzania are reported to live up to 13.5 years, whereas males live up to 9.3 years (Kelly *et al*. 1998). Other studies reported that longevity in the SNP may reach up to 14 years 5 months for females and 11 years 10 months for males (Durant *et al*. 2010). Cheetahs give birth throughout the year and have litters of 1 to 6 cubs, with typical litter sizes of 3 or 4 cubs (Caro 1994, Marker *et al*. 2003b, Wachter *et al*. 2011, Mills & Mills 2014). On freehold farmlands in central Namibia, female cheetahs have several birth peaks distributed throughout the year; in the rainy season in February and March, in the cold dry season in June and July, and in the hot dry season in October and November (Marker-Kraus *et al*. 1996, Marker *et al*. 2003b). In the SNP, where cheetahs coexist with lions and spotted hyaenas, cub survival from birth to independence at 14 months of age is only 23% (Laurenson 1992, 1994), whereas on freehold farmland in east-central Namibia, an ecosystem without lions and spotted hyaenas, cub survival is 79% (Wachter *et al*. 2011). In central Namibia, average litter size at independence (14–18 months) has been recorded as 2.4 cubs (Marker *et al*. 2003b) and 3.2 cubs (Wachter *et al*. 2011), both higher than the 1.8 cubs reported in the SNP (Laurenson 1992, 1994).

THREATS

Across their entire range, cheetahs suffer from several threats, including conflict with livestock and game farmers, inadequately regulated trophy hunting, illegal trade, keeping free-ranging cheetahs in captivity, competition with other large carnivore species, decline of natural prey, climate change, habitat loss and habitat fragmentation. Human-wildlife conflict (HWC) is particularly pronounced in southern Africa due to perceived or actual predation on livestock and game (Durant *et al*. 2015, RWCP & IUCN/SSC 2015, Dickman *et al*. 2018, Durant *et al*. 2018, Marker *et al*. 2018a, 2018b, Schmidt-Küntzel *et al*. 2018, Tricorache *et al*. 2018).

In Namibia, cheetahs benefited from the removal of lions, leopards and spotted hyaenas from freehold farmlands, and from a subsequent reintroduction of prey species onto game farms (Marker-Kraus *et al*. 1996). Despite these apparently conducive conditions on farmlands, conflict with livestock and game farmers is the major threat to the cheetah population in Namibia, like elsewhere in southern Africa. Other factors such as landscape fragmentation due to the

erection of game fences, also poses an increasing threat to the cheetah population (Marker-Kraus *et al*. 1996, Marker *et al*. 2003c, Portas *et al*. 2017, Dickman *et al*. 2018).

Conflict with livestock and game farmers

Cheetah survival in the wild in Namibia is mostly threatened by human removal of cheetahs of prime breeding age, with males and females having an 80% and 86% chance, respectively, of dying between the age of independence and six years (Marker *et al*. 2003b). Since most cheetahs live on unprotected land (Durant *et al*. 2017), they are particularly vulnerable to indiscriminate removal by livestock and game farmers. Individual farmers have been reported to opportunistically kill cheetahs, mainly as a preventative measure (in 91% of cases) and not necessarily due to actual livestock depredation (Marker-Kraus *et al*. 1996, Marker *et al*. 2003c). Overall, a minority of intolerant farmers is responsible for >70% of all cheetah persecution on freehold farmlands, whereas the vast majority of farmers are tolerant or semi-tolerant towards the species (Weise *et al*. 2017). Between 1980 and 1991, 6,293 cheetahs were reported to have been killed or removed alive (CITES 1992). Between 1980 and 1993, an average of 26.1 cheetahs were removed per game farm, and 12.6 per livestock farm (n=157 total farms, Marker *et al*. 2003c). In addition, the proportion of

Table 2.1: The number of cheetahs reported taken into captivity or killed between 1960 and 2017, by district

District	Gaerdes[a] 1960-1973	DVS[b] 1986-1994	CCF[c] 1991-2017
Windhoek	296	146	26
Otjiwarongo	102	251	63
Okahandja	109	176	68
Outjo	45	118	16
Omaruru/Karibib	211	85	41
Grootfontein	54	87	20
Otavi	No removals reported	63	0
Keetmanshoop	No removals reported	24	0
Mariental/Maltahöhe	98	50	0
Gobabis	No removals reported	94	50
Unknown regions	No removals reported	No removals reported	127

[a] Gaerdes (1974), summarised in Marker-Kraus *et al*. (1996)
[b] Directorate of Veterinary Services in Marker-Kraus *et al*. (1996)
[c] Cheetah Conservation Fund, unpublished

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female cheetahs removed on game farms (42%) was higher than on livestock farms, where females only represented 26% of caught cheetahs (Marker *et al*. 2003c). Cheetah removals by district have been documented in Namibia from 1960 to 2017 (Table 2.1).

The MEFT has collected information on cheetah removals from the late 1970s to the mid-1990s and reported an average number of 553 cheetahs killed per year (Nowell 1996). The number decreased from 1986 to 1995, when an average number of 297 cheetahs per year was reported (Nowell 1996). More recently, the MEFT recorded that the total number of cheetahs killed from 1997 to 2004 was 1,679, which averages 240 animals per year. Of these, 1,088 were killed as "problem animals", whereas 591 were hunted as trophy animals. The actual number of cheetahs removed as "problem animals" is likely to be higher than the number reported to the MEFT (Marker-Kraus *et al*. 1996).

Weise *et al*. (2017) reported a removal rate of 0.3 adult cheetahs/100 km^2 per year on Namibian freehold farmland due to human-wildlife conflict (where removal refers to cheetahs killed or taken into captivity). This annual removal rate corresponds to approximately 27% of the total estimated population, using the density estimate from freehold farmland in central Namibia (Portas *et al*. 2017). Weise *et al*. (2017) infer that, considering the recruitment of cheetahs for this area, such a loss could only be compensated if densities are at a minimum of 0.67 adult cheetahs/100 km^2. For large parts of the country, lower cheetah densities are reported, which suggests that such a removal rate in those areas would not be sustainable.

Trophy hunting

Since 1992, Namibia has been allowed a limited trade of 150 cheetahs annually (CITES 1992), with almost 1,200 free-ranging cheetah trophies legally exported from Namibia between 2003 and 2013 (CITES trade database). Trophy hunting alone may not be a direct threat to the Namibian cheetah population, however when combined with removals (see Table 2.1), particularly removals of adult females, it is questionable whether the population is large enough to remain viable (Berry *et al*. 1997, Crooks *et al*. 1998, Cristescu *et al*. 2018). Typically, trophy hunting of cheetahs involves hunting from a hide at cheetah marking trees where territorial males are most likely to be encountered. This leads to a bias in the offtake towards territorial males, which entails a faster turnover in the territory tenure, with unknown implications on the mating system. In addition, females are sometimes hunted by mistake, potentially leaving orphan cubs.

Illegal trade

In addition to legal trade, there have also been reports of illegal trade of live captured wild cheetahs between Botswana, Namibia and South Africa, and of an illegal pet trade in which cheetahs are funneled through the Horn of Africa for sale into Middle Eastern markets (Tricorache *et al*. 2018). Even within Namibia, cheetah cubs are sometimes taken from the lairs and kept as pets (L Marker pers. obs. 2018) despite legislation prohibiting this (Ministry of Environment and Tourism 2012).

Competition with other large carnivore species

Cheetahs, particularly cubs, are vulnerable to predation by other large carnivores such as lions, spotted hyaenas and leopards (Laurenson 1994, Marker *et al*. 2018b). Several cases of leopards killing cheetahs have been reported in central Namibia (Krengel and B Wachter pers. obs. 2010, L Marker pers. obs. 2016), and such reports from farmers appear to be increasing. This rise is hypothesised to be linked to an increasing leopard population. While data to support this hypothesis is lacking, especially at the national level, farmers do report more leopard sightings.

Climate change

The majority of cheetahs are found in semi-arid environments, thus regions in southern Africa where temperature increases and changes in precipitation patterns are expected due to climate change (Nghikembua *et al*. 2018). With increasing temperatures, higher evapotranspiration is expected, causing more water stress, lack of surface water and possibly reducing primary productivity, which in turn would result in lowered grazing carrying capacity (Midgley *et al*. 2005, Ministry of Environment and Tourism 2008). This would lead to a loss of grassy savanna habitat in some parts of southern Africa where cheetahs are found. Consequently, cheetahs may suffer from reduced prey availability, and competition for available resources may be intensified. Ultimately, poor rangelands harbour more HWC as farmers become less tolerant towards any further economic losses. Varied precipitation patterns and rising temperatures also have the potential to change the ecology of vectors responsible for wildlife diseases such as fleas and ticks (Nghikembua *et al*. 2018, Roach 2008, Seijan *et al*. 2016).

Habitat loss and fragmentation, and human population growth

Pressure on cheetah populations is expected to grow in future as the human population grows, leading to greater competition for available resources and increased direct conflict. In addition, there is a current trend across the country to erect game fences, motivated by an increase of farmers that breed valuable game species, exotic species or different morphs of native antelope species. These game fences limit the movement of wildlife and aim to keep carnivores away. Some of these fences are electrified and even have mechanical methods to deter carnivores. Some game farmers have a lower tolerance for cheetahs than livestock farmers and induce higher mortality of cheetahs within their game-fenced areas, particularly of females and cubs (Marker *et al*. 2003c). Road mortalities have also been reported across the country (L Marker, J Melzheimer, B Wachter and F Weise pers. obs.).

Genetic variability

In addition to the main threats mentioned above, cheetahs have relatively low genetic diversity, which was assumed to have originated approximately ten thousand years ago (O'Brien *et al*. 1983, 1985). This low diversity has been apparent at several genetic markers over the past 35 years (reviewed in Schmidt-Küntzel *et al*. 2018), and was recently confirmed through a whole genome study (Dobrynin *et al*. 2015). Despite the low diversity levels, no major inheritable physical abnormalities are known to be an issue for the cheetah. Male cheetahs have poor sperm quality (Wildt *et al*. 1983, 1993) for which a genetic basis was found recently (Dobrynin *et al*. 2015), however this does obviously not hinder reproductive performance in the wild (Laurenson 1992, 1994, Wachter *et al*. 2011). Females have a high reproductive performance and resume quickly their oestrus cycle and become pregnant again, if they have lost their litter (Laurenson *et al*. 1992, Wachter *et al*. 2011). In contrast, captive females have a poor reproductive performance and only a few captive facilities successfully breed cheetahs (Marker-Kraus and Grisham 1993). It has been demonstrated that this is not due to stress levels in captivity but due to the phenomenon of asymmetric reproductive aging (Wachter *et al*. 2011, Ludwig *et al*. 2019). This phenomenon arises when first pregnancies of females are substantially delayed and their frequent oestrogen fluctuation induces pathologies of their reproductive tracts (Wachter *et al*. 2011, Ludwig *et al*. 2019).

Low levels of genetic diversity might impact the ability of the cheetah to adapt to changes in the environment or to newly emerging diseases (Castro-Prieto *et al*. 2011a, Schmidt-Küntzel *et al*. 2018). They are therefore at a potential disadvantage relative to species with more diversity, and it is important to preserve the current levels of diversity through viable population numbers and connectivity of populations (Schmidt-Küntzel *et al*. 2018). Currently the Namibian cheetah population is not showing signs of fragmentation at the genetic level (Marker *et al*. 2008c), however genetic data takes generations to show the effects of fragmentation, and fragmentation risk may thus be underestimated.

The adaptive immune system of cheetahs has limited potential because it is linked to immune genes for which only a few alleles have been detected (Castro-Prieto *et al*. 2011a). However, cheetahs have a strong constitutive innate immune system as shown with functional immune tests (Heinrich *et al*. 2016, 2017). Thus, it appears that cheetahs can compensate with their constitutive innate immunity for their limited adaptive immunity (Heinrich *et al*. 2016, 2017), which likely explains the good health status of the free-ranging Namibian cheetah population (Munson *et al*. 2005, Thalwitzer *et al*. 2010). Captive cheetahs, however, are known to be susceptible to diseases (Evermann *et al*. 1988), although this might be due to captive holding

conditions. Captive cheetahs are often kept together in groups that do not correspond to the composition in their natural social system, thus contact rates and stress levels, both factors increasing susceptibility to diseases, are higher compared to the wild (Wielebnowski *et al*. 2002, McEwen & Wingfield 2010). It is, therefore, possible that their immune system cannot always adequately cope with the unnatural conditions in captivity.

CONSERVATION STATUS

The cheetah is the most threatened large felid species in Africa. It is currently categorised as Vulnerable by the IUCN, with the global population estimated at approximately 7,100 adults and subadults, which are confined to less than 9% of their historical range (Durant *et al*. 2015). Durant *et al*. (2017) and Weise *et al*. (2017) recently called for the species to be uplisted to the Endangered status. While the number of mature individuals has not dropped below 2,500 individuals, which is a criterion for an Endangered status (IUCN 2012a), the cheetah is susceptible to dramatic changes over short periods of time. The species was predicted as being at risk of a population decline of 50% or more over three generations, which is another criterion for the Endangered status (IUCN 2012, Durant *et al*. 2017). This prediction is mainly based on the high percentage (77%) of the range-wide population occurring outside of protected areas (Durant *et al*. 2017). In Namibia, the situation is even more extreme, with over 90% of cheetahs residing outside of protected areas (Marker *et al*. 2018b). This exacerbated vulnerability in Namibia also supports the up-listing of Namibian cheetahs from Vulnerable to Endangered status.

ACTIONS

Because cheetahs have large range requirements and occur at low density, conservation planning is needed on a wide geographical scale (RWCP & IUCN/SSC 2015). Decreasing the conflict with humans, maintaining large contiguous areas of suitable habitat with healthy populations of ungulates, and establishing ecological corridors are priorities to conserve the cheetah population in Namibia. Overall, conserving the cheetah now and for future generations includes a complex web of governmental, social, economic and environmental challenges.

We consider the following actions, based on management, awareness and research, as key for the conservation of the cheetah population in Namibia. These correspond with the "Activities" in the logframe in Table 3.4. of the Namibian conservation action plan for cheetahs (Ministry of Environment and Tourism 2013b) developed during a national workshop in 2013 but not yet endorsed.

Management

- Maintain a large contiguous population of cheetahs within Namibia, connected to the populations in the other southern African countries.
- Ensure that all large-scale infrastructure development, including fencing and road building, allows the free and safe movement of cheetahs.
- Review policies to ensure the free movement of wildlife in Namibia and to revert the increasing trend of high and/or electrified game fences.
- Detect areas of high persecution of cheetahs (population sinks) and focus efforts to reduce the number of cheetahs killed.
- Reduce human-wildlife conflict by promoting methods of livestock protection such as herding, the use of kraals and guard dogs and assessing the effectiveness of livestock husbandry (Marker-Kraus *et al*. 1996, Dickman *et al*. 2018).
- Reduce human-wildlife conflict by identifying the communication hubs (CHs) of cheetahs on farmland and avoiding them as grazing areas for affected livestock (Melzheimer *et al*. 2020). CHs are characterised by high cheetah densities because they are constantly visited by the territorial males and often by the floaters. Thus, they represent areas of high livestock predation risk. Farmers can adapt their livestock grazing management according to the locations of CHs and shift the breeding herds away from the CHs into the surrounding matrix (Melzheimer *et al*. 2020). It was demonstrated that this shifting reduced the losses of cattle calves by more than 80% (Melzheimer *et al*. 2020). This is because cheetahs did not follow the breeding herds but preyed on the available game species in the CHs. Also, the location of the CHs remained stable when the corresponding territory changed ownership, thus the management adaptations of farmers have a long-lasting effect (Melzheimer *et al*. 2020). CHs are therefore "problem areas" rather than cheetahs in the CHs being "problem animals". CHs can be identified with the help of GPS-collared cheetahs or by finding the most actively used marking sites of the cheetahs.
- Focus efforts on improving tolerance towards cheetahs in livestock and game farming areas through awareness among the farming community, to reduce the number of indiscriminately trapped animals (Marker-Kraus *et al*. 1996, Marker *et al*. 2003c, Weise *et al*. 2015b, Dickman *et al*. 2018). In this sense, we recommend developing policies to ensure that cheetahs are not killed as a preventive measure and the practice of illegal and unselective killing methods is penalised.

- Improve the reporting to the MEFT of livestock and valuable game preyed on by cheetahs, and cheetahs killed by farmers, by working closely with the different Namibian Farmers' Associations, communal and freehold conservancies.

- Continue to develop a comprehensive protocol for translocations and reintroductions, and evaluate their efficacy (RWCP & IUCN/SSC 2015, Boast *et al*. 2018). Translocations of conflict-related cheetahs to reduce human-wildlife conflict have not proven successful to date. Weise *et al*. (2015b) showed that post-release survival and site fidelity of translocated cheetahs are low. Also, the significant financial costs of translocations and the failure to reduce stock losses both corroborate the ineffectiveness of the method (Weise *et al*. 2014, Boast *et al*. 2015, Melzheimer *et al*. 2020). The translocation of conflict-related cheetahs should be a last management option, whereas conflict mitigation methods focusing on techniques that promote coexistence of predators and humans should be prioritised (Weise *et al*. 2014, 2015b, Boast *et al*. 2015). However, translocation and reintroduction of perceived "non-problem" cheetahs on farmlands can be successful (Marker *et al*. 2008b). As a conservation management strategy, translocation of cheetahs might best be used to facilitate the structured reintroduction of the species into suitable patches of recovered historical range (Hayward & Somers 2009, Boast *et al*. 2018). However, given the scarcity of such areas in Namibia, and considering the large numbers of cheetahs trapped on Namibian farms annually, such reintroductions may have little potential for success.

- Develop economic benefits for coexisting with cheetahs on farmland through ecosystem stewardship and farmer certifications linked to programs such as predator-friendly farming management practices or subsidies related to the coexistence with large carnivores (Marker 2002, Wykstra *et al*. 2018).

- Update the 2013 Namibian conservation action plan for cheetahs, in line with the recently reviewed regional strategy for southern Africa, to put in place a comprehensive roadmap to secure the survival of cheetahs in Namibia (Ministry of Environment and Tourism 2013b).

Awareness

- Improve knowledge on the conservation of cheetahs across Namibia through media, education and capacity programs and transfer the relevant information within and between all involved parties (i.e. government, hunting industry, communal and freehold conservancies, farmers, NGOs and researchers).

- Promote continuous, healthy and diverse populations of ungulates across Namibia by ensuring the retention of wildlife-friendly land use.

- Promote predator-friendly livestock and game farming techniques.

Research

- Survey areas in the country that are data deficient in terms of cheetah distribution and local density. While there is a good overall understanding of the cheetah population in the country, specific information on distribution, local abundance and density of cheetahs in currently unsurveyed areas is still needed (Weise *et al*. 2017, Portas *et al*. 2017). In particular, the southern and north-western part of the country, and the north-eastern communal areas lack information.

- Conduct surveys every five years across Namibia to monitor the population and obtain research-based information on population trends.

- Continue to measure the perceived versus actual losses caused by cheetah and to identify the causes of livestock losses.

- Continue to identify communication hubs of cheetahs to determine areas of high predation risk for livestock.

- Obtain countrywide numbers of dead and killed cheetahs and the cause of death, i.e. road kill, shot on sight, shot after livestock predation, poaching, disease, inter- and intra-species competition.

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