A conservation assessment of Felis nigripes

Chapter · December 2016

CITATIONS
2

READS
1,038

3 authors:

Beryl Wilson
McGregor Museum
28 PUBLICATIONS **66** CITATIONS
SEE PROFILE

Alexander Sliwa
Cologne Zoo
73 PUBLICATIONS **550** CITATIONS
SEE PROFILE

Marine Drouilly
Panthera
53 PUBLICATIONS **208** CITATIONS
SEE PROFILE

Felis nigripes – Black-footed Cat


Black-footed Cat Working Group

Regional Red List status (2016)	**Vulnerable C2a(i)*†**
National Red List status (2004)	Least Concern
Reasons for change	Non-genuine: New information
Global Red List status (2016)	Vulnerable C2a(i)
TOPS listing (NEMBA) (2007)	Protected
CITES listing (1975)	Appendix I
Endemic	No

*Watch-list Data †Watch-list Threat

Black-footed Cats are very successful hunters with one vertebrate prey animal caught, on average, every 50 min (about 10–14 rodents or small birds caught in a night). This represents about 250–300 g of food or 20% of the cat's body weight, but record intakes can reach 450 g per night.

Taxonomy

Felis nigripes Burchell 1824

ANIMALIA - CHORDATA - MAMMALIA - CARNIVORA - FELIDAE - *Felis* - *nigripes*

Common names: Black-footed Cat, Small-spotted Cat (English), Klein Gekolde Kat, Swart-poot Kat, Miershooptier (Afrikaans), Tsetse (Sesotho), Sebala-bolokwane, Sebala-molokwane, Sebala, Sebalabala, Sebala-manokwane, Kêkêtlane (Tswana), Ingwe Yeziduli (Xhosa)

Taxonomic status: Species

Taxonomic notes: Two subspecies have been described and these persist in theory (Meester et al. 1986). *Felis n. nigripes*, the nominate genotype form described by Burchell, was first described from near Kuruman in the Northern Cape. Its range includes present-day southeastern Namibia, Botswana, Northern Cape, North West, Gauteng, Limpopo and marginally into Mpumalanga. *Felis n. thomasi* Shortridge 1931 is described from a specimen collected near Grahamstown in the Eastern Cape. Its range includes the present-day Eastern Cape, westwards to the southern regions of the Northern Cape and the Free State.

However, Smithers (1971) doubted the validity of two subspecies, and his thought is shared by Sliwa (2013) who suggests that the species may be polymorphic in the centre of its range but does exhibit some geocline variations towards the extremes of its range. The northern race typically tends to be paler with less distinct striping, whereas the southern race has a more tawny appearance with bolder patterning. However, since there are no obvious geographical or ecological barriers between the ranges which are the leading causes of genetic drift and speciation (Hoskin et al. 2005), it is likely that the subspecies status is invalid (Wilson 2016).

Assessment Rationale

Black-footed Cats are endemic to the arid regions of southern Africa, occurring widely across the western reaches of the assessment region, and have a relatively restricted and patchy distribution. The historical paucity of data has led to inconsistencies and perpetuated inaccuracies in current literature, which in turn has affected the accuracy of conservation measures. The naturally rare, cryptic colouring, small size and secretive nocturnal nature of this species has contributed considerably to the lack of information. Black-footed Cats are known to occur at low densities and it is difficult to establish population sizes. The stronghold of the species is suspected to be in the central Karoo region where highest densities are reached, whereas other regions (Kalahari, North West Province, northern KwaZulu-Natal Province, Free State Province, and the Lowveld) are suspected to have medium or low densities. Using density estimates of 0.03 km^2, 0.02 km^2 and 0.01 km^2 for high, medium and low density areas respectively, we converted kernel densities to isopleths to calculate population size. Estimated population size ranges from 7,526–11,905 individuals, of which 5,269–8,334 are considered to be mature (using a 70% mature population structure), where no subpopulation is suspected to comprise more than 1,000 mature individuals as the species is patchily distributed. However, defining subpopulations for this species needs further work. We also caution that these estimates will be confounded by uneven sampling across the range, thus leading to inaccurate density isopleths. This is a first attempt and should be refined as more data from across the range become available.

There is a general suspected continuing decline due to loss of prey base due to bushmeat poaching (especially Springhare *Pedetes capensis*), persecution (direct or incidental), road collisions and predation by domestic pets. Continuing decline is also inferred from a long-term study on Benfontein Game Farm, Northern Cape, where estimated density declined from 0.17 cat / km^2 in 1998–1999 to 0.08 cat / km^2 in 2005–2015. Additionally, *c.* 50% of radio-collared individuals are lost annually to a combination of natural mortality and predation from abundant Black-backed Jackals (*Canis mesomelas*),

Recommended citation: Wilson B, Sliwa A, Drouilly M. 2016. A conservation assessment of *Felis nigripes*. In Child MF, Roxburgh L, Do Linh San E, Raimondo D, Davies-Mostert HT, editors. The Red List of Mammals of South Africa, Swaziland and Lesotho. South African National Biodiversity Institute and Endangered Wildlife Trust, South Africa.

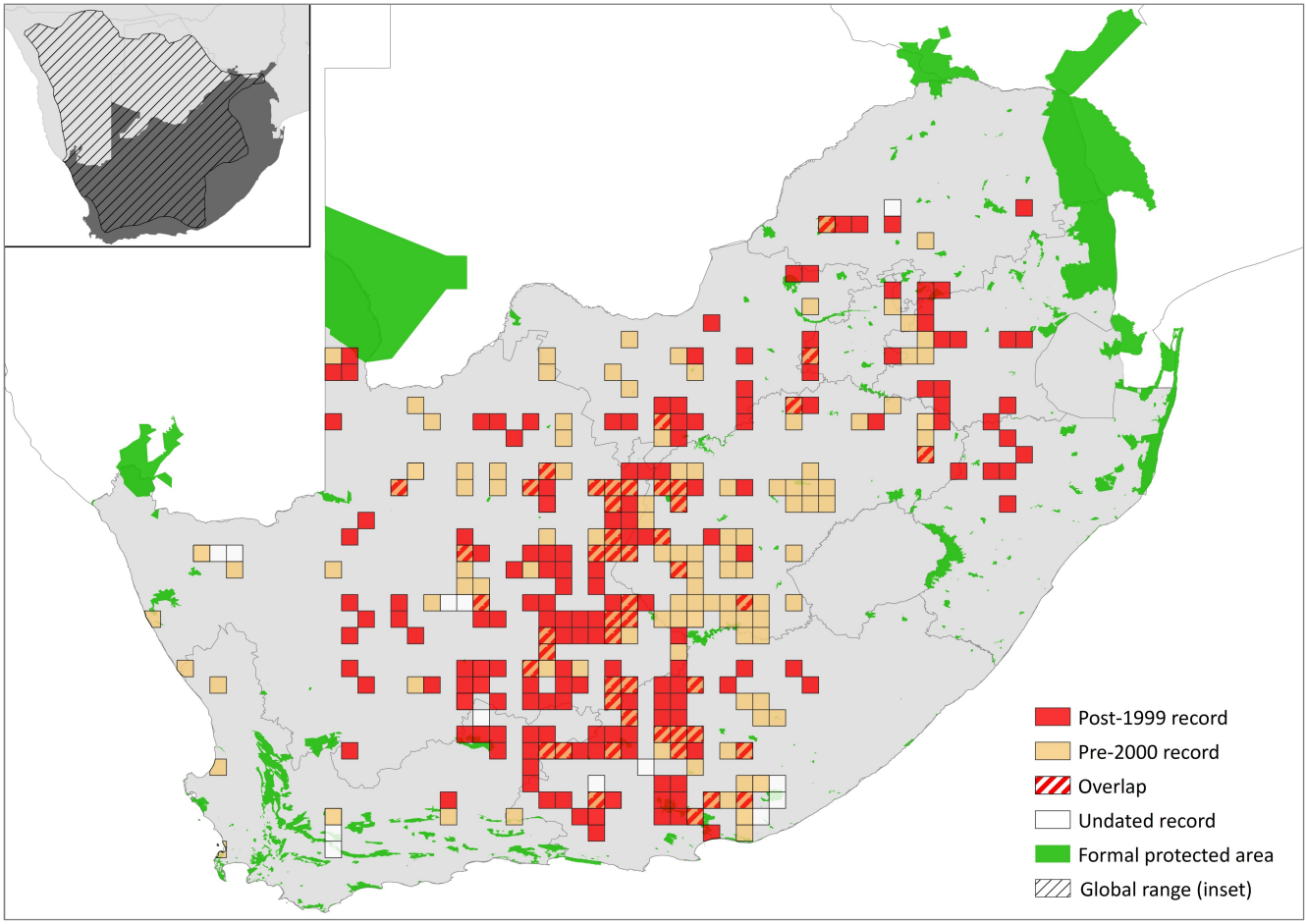

Figure 1. Distribution records for Black-footed Cat (*Felis nigripes*) within the assessment region

Table 1. Countries of occurrence within southern Africa

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

Caracals (*Caracal caracal*) or domestic pets. An emerging threat may be increasing interspecific competition, including intraguild predation, by overabundant mesopredators (for example, Black-backed Jackals).

Thus, we list this species as Vulnerable C2a(i), as population size is estimated to be fewer than 10,000 mature individuals, where no subpopulation is suspected to be more than 1,000 mature individuals, and there is an inferred continuing decline. We note that this is a precautionary assessment given the low density estimates used in the analysis, the lack of systematic field surveys across the range and the lack of a robust subpopulation definition. This species should be reassessed once such data are available. Key interventions include the establishing of large conservancy areas and sustaining viable Springhare subpopulations in areas where alternative refuge systems are unavailable.

Regional population effects: There is likely to be some dispersal across regional borders as the range is continuous across southern Africa. However, the dispersal capability (*c*. 20 km; B. Wilson unpubl. data) of this species is likely to be limited by the species' small size, the degree and length of isolation from other subpopulations caused by human influences and the presence of competing larger carnivores and large areas of unsuitable habitat. It is likely that these aspects may be even greater in the subpopulations outside the region which will limit these as potential future source subpopulations and thus limit the rescue effect.

Distribution

Black-footed Cats have the most restricted distribution of any of the African felid species (Nowell & Jackson 1996). The species is endemic to the arid grasslands, dwarf shrub, and savannah of the Karoo and Kalahari in southern Africa. The majority of the range occurs within the boundaries of South Africa, thinning out northwards into Botswana, Namibia and Zimbabwe (Table 1). The species is found primarily in Namibia and South Africa, but also Botswana (where there are historical records but only limited recent ones), marginally in Zimbabwe and likely marginally in extreme southern Angola (Sliwa 2013).

In South Africa, where the majority of research effort has taken place, recent records suggest range expansions in virtually all directions from previous literature (Wilson 2016). It is unlikely that true range extensions have occurred but is rather an artefact of reporting bias as a result of recently increased citizen scientist reports combined with increased research effort (Wilson 2016).

On the eastern side of its range, occurrence records are confirmed to just west of the Kruger National Park, into northwestern KwaZulu-Natal, and new data suggest that the species occurs further south and southwestwards in the southern Cape and more westwards in the Northern Cape than previously realised (Wilson 2016). The occurrence of the species in Swaziland (M. Reilly & A. Monadjem pers. comm. 2014) and Lesotho (N.L. Avenant pers. comm. 2014) is considered highly unlikely and certainly no records exist to date.

Apart from Addo Elephant National Park and Mountain Zebra National Park in the Eastern Cape Province, and SA Lombard Nature Reserve in North West Province, there appears to be no consistent sightings of Black-footed Cats in formally protected areas, despite considerable research effort and game drive reporting (Wilson 2016). This is likely due to unsuitable habitat or the presence of a higher density of mesopredators which increases competition and incidences of intraguild predation. They probably occur in Karoo National Park. However, further field surveys are needed to determine in which protected areas subpopulations of the species are resident. Their presence has now been confirmed through video evidence in 2016 from Tswalu Kalahari Reserve, Northern Cape Province (W. Panaino unpubl. data).

The current extent of occurrence in South Africa is roughly about 930,000 km^2 (Wilson 2016). However, we suspect that area of occupancy is considerably lower, due to sensitivity to environmental disturbances and threats (Sliwa 2013).

Population

The Black-footed Cat is naturally rare compared to the other small cats of southern Africa (Sliwa 2013). Camera trapping for this species is particularly difficult due its secretive behaviour and small size. For example, in over 790 records, only one was from a camera trap (B. Wilson unpubl. data). Black-footed Cats move quickly and do not habitually use game tracks or roads like other animals. Since 2006, there has been extensive effort to establish the historical and current distribution of the species (Wilson 2016). Prior to 2000, there are only 251 distribution records including fossil specimens. Since then, more than 545 records have been collected with an emphasis on locality data. Throughout its entire range there are only *c.* 692 verifiable locality records which can be reliably mapped (Wilson 2016). As such, it is difficult to determine density, and thus a population estimate, for this species. High-density estimates come from two study sites at Benfontein and Nuwejaarsfontein in the Northern Cape with over 17,000 fixes and 1,600 hours of observation of radio-collared individuals (Sliwa 2004; Sliwa et al. 2010): for Benfontein (near Kimberley), between 1998 and 1999, density (based on radio-collared individuals) was estimated at 0.17 cat / km^2 but only 0.08 cat / km^2 between 2005, whilst at Nuwejaarsfontein, density was estimated at 0.06 cat / km^2 from 2009–2014 (Sliwa 2004; Sliwa et al. 2014). However, these two sites may represent exceptionally high densities due to favourable climate and human management, and low-quality habitat densities are probably much lower (Sliwa 2013). Thus, we suspect that densities of 0.03 cat / km^2 represent more realistic densities across larger scales and represent viable subpopulations in the long term (B. Wilson and A. Sliwa unpubl. data).

Using these density estimates, population size was calculated by converting kernel densities based on verified records (both historical and recent) to high (0.03 cat / km^2), medium (0.02 cat / km^2) and low density (0.01 cat / km^2) isopleths across the entire range of the species in the assessment region. The population sizes from the density bands were then summed to produce an overall population estimate. The best estimate yielded an estimated 11,905 individuals within the assessment region, of which 8,334 are mature (assuming a 70% mature population structure, Table 2). These estimates were calculated by clipping the range-wide heat map to South Africa (Figure 2). This was considered a more biologically realistic method than calculating a separate heat map for South Africa, as the latter method conserves linkages and isopleth distributions across borders rather arbitrarily delineating isopleths for the assessment region.

However, calculating the heat map for the assessment region alone produces similar population estimates, ranging from 7,526–11,066 individuals (5,269–7,747 mature individuals), depending on how the records are clustered in the isopleths. Additionally, no subpopulation is suspected to have more than 1,000 mature individuals. However, the definition of a subpopulation for this species needs further work depending on dispersal rates and distances, connectivity and genetic subpopulation structure, although small home range sizes of the species – minimum estimate for females 7.1–8.6 km^2 (Sliwa 2004; Kamler et al. 2015) – may suggest small subpopulation sizes. Unpublished data suggest dispersal distance of 20 km (A. Sliwa unpubl. data), and we suspect that clusters within 50 km of each other and distances of 100 km apart would separate subpopulations. This would mean a cluster within an area of 1,963 km^2 ($A = \pi r^2$) or 2,500 km^2 ($A = a^2$) would yield subpopulation sizes of 334 and 425 individuals (using 0.17 cat / km^2) respectively.

These estimates of course suffer from lack of consistent search effort and thus density zones may be confounded by field surveys that differ in methodology and single records may represent substantially higher density areas, reflecting the lack of field surveys conducted in the region. As such, population estimates are likely to be underestimates. This may especially be the case for the global estimate, where areas outside the assessment region may be significantly under-sampled, although it is likely that they exhibit lower densities anyway, as is the case in Namibia (M. Küsters, pers. comm.). Given that the

Table 2. Summary of population size estimates for Black-footed Cat (*Felis nigripes*) both within the assessment region and globally. Estimates are based on converting existing records into density isopleths and summing the resultant population sizes.

	Area (km^2) / mature population size			
	High density	Medium density	Low density	**Total mature**
Assessment region	124,975 / 2,624	179,654 / 2,515	456,293 / 3,194	8,334
Global	124,975 / 2,624	179,654 / 2,515	652,482 / 4,567	9,707

assessment region is fairly well-sampled, the population estimate is likely to be more robust and the analysis represents a replicable first-step methodology that can be improved with further field surveys and ecological studies. It should also be noted that estimates of population sizes are sensitive to the relative size of the high-density clusters, thus a more conservative estimate would yield a lower population size, while a less conservative estimate would yield a larger population size. For example, increasing the high-density isopleth to cover 70% of the records (up from 50%), yields a global population estimate of 16,853 individuals (11,797 mature). We also note that the density estimates used for the isopleths are precautionary and replicated studies in different regions should be conducted to properly calibrate the density bands.

There is a higher density in the central part of South Africa, along a north–south axis with decreasing frequency of records either west or east of this region and northwards in the range (Wilson 2016) (Figure 2).

A decline is suspected over the general range, with only some central areas indicating stable subpopulations. However, it is difficult to demonstrate decline in a species that is so hard to census. Preliminary evidence comes from the long-term study area Benfontein in the Northern Cape, where the density in years 1998–1999 was 0.17 cat / km^2 (Sliwa 2004), and over the past 10 years (2005–2015) was only 0.08 cat / km^2, which is documented in capture reports (for example, Sliwa et al. 2014). Local subpopulations may also be low or even absent in areas where Black-backed Jackals and Caracals are abundant due to interspecific competition, including intraguild predation (but see Kamler et al. 2015), which may be especially true of juveniles. About 50% of all radio-collared cats are lost to larger predators (Black-footed Cat Working Group unpubl. data).

Current population trend: Declining. Inferred from decline in density from long-term study area.

Continuing decline in mature individuals: Yes, caused by indirect persecution, predation and disease transmission.

Number of mature individuals in population: 5,269–8,334 based on extrapolating density across EOO.

Number of mature individuals in largest subpopulation: Unknown, but it is certainly unlikely that any cluster numbers more than 1,000 mature individuals.

Number of subpopulations: It is not currently possible to determine the extent or number of subpopulations.

Severely fragmented: No. Habitat is largely connected across its range but may be patchy in parts.

Habitats and Ecology

The Black-footed Cat is one of the world's smallest cats, with females weighing an average of 1.3 kg and males larger at 1.93 kg (Sliwa 2013). The conspecific and more common African Wildcat (*Felis silvestris*) is considerably larger (females 3.9 kg; males 5.1 kg) (Sliwa et al. 2010). Unlike most cat species, these cats are predominantly ground-dwellers and will not readily take to trees. They

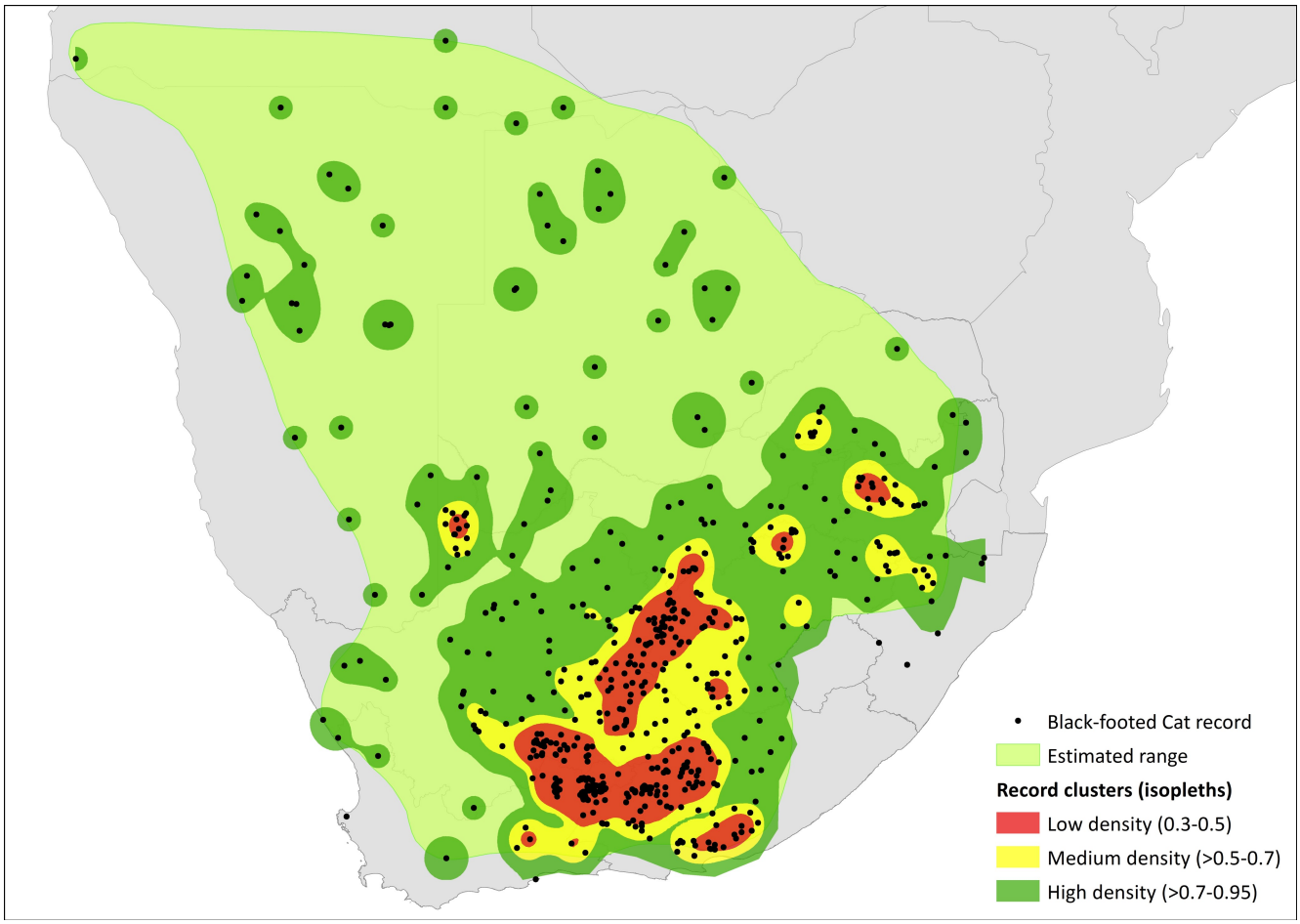

Figure 2. Heat map of distribution records for Black-footed Cat (*Felis nigripes*); isopleth bands containing the percentage of distribution records are shown on the left of the figure

lead a solitary existence except when with kittens or during brief mating periods. Black-footed Cats are extremely secretive in nature. They are strictly crepuscular and nocturnal and are active throughout the night, even hunting at temperatures of –8˚C (Olbricht & Sliwa 1997). During the day, the cats make use of dens. The species prefers hollowed out abandoned termite mounds when available (especially for the kittens, Figure 3), but will use dens dug by other animals such as Springhares, Cape Ground Squirrels (*Xerus inauris*) and Aardvark (*Orycteropus afer*). It is a specialist of open, short grass areas with an abundance of small rodents and ground-roosting birds. It inhabits dry, open savannah, grasslands and Karoo semi-desert with sparse shrub and tree cover and a mean annual rainfall of between 100 and 500 mm at altitudes up to 2,000 m asl. It is not found in the driest and sandiest parts of the Namib and Kalahari Deserts (Sliwa 2013).

Black-footed Cats mate year round but with a distinct season from late winter (August) over the summer months up to March. Up to two litters a year may be produced, with one to four kittens (normally two) born after 63–68 day gestation inside a burrow or hollow termitarium (Olbricht & Sliwa 1997; Skinner & Chimimba 2005). Births are timed to coincide with rains and food availability. Kittens are independent after 3–4 months, but remain within the range of their mother for extended periods (Sliwa 2013). Whilst they are reported to live up to 16 years in captive situations, life expectancy in the wild is about five years (Black-footed Cat Working Group unpubl. data), although two monitored individuals lived at least seven years (Sliwa et al. 2014).

As with most small cat species, Black-footed Cats are obligate carnivores. During a 6-year field study on the game farm in central South Africa, 1,725 prey items were observed consumed by 17 free-ranging habituated individuals (Sliwa 2006). Average prey size was 24.1 g. Eight males fed on significantly larger prey (27.9 g) than 9 females (20.8 g). Fifty-four prey species were classified by their average mass into eight different size classes, three for mammals, three for birds, one for amphibians/reptiles, and one for invertebrates. Small mammals (5–40 g) constituted the most important prey class (39%) of total prey biomass followed by larger mammals (> 100 g; 17%) and small birds (< 40 g; 16%). Mammals and birds pooled comprised 72% and 26% of total prey biomass, respectively, whereas invertebrates and amphibians/reptiles combined constituted just 2% of total prey mass consumed. Heterotherm prey items were unavailable during winter, when larger birds and mammals (> 100 g) were mainly consumed. Small rodents like the Large-eared Mouse (*Malacothrix typica*), captured 595 times by both sexes, were particularly important during the reproductive season for females with kittens. Males showed less variation between prey size classes consumed among climatic seasons. This sex-specific difference in prey size consumption may help to reduce intra-specific competition (Sliwa 2006). In terms of interspecific competition, Sliwa et al. (2010) found that Black-footed Cats captured smaller prey on average than African Wildcats, although both captured approximately the same number (12–13) of prey animals per night.

Of 17 radio-collared Black-footed Cats (7 males, 10 females) studied at Benfontein Game Farm, Northern Cape Province, from 1997 to 1998, the home ranges of adult resident males averaged 16.1–20.7 km^2 while those of females were 8.6–10 km^2, where male home ranges

Figure 3. A Black-footed Cat protected in a hollowed-out termitarium

Figure 4. A male Black-footed Cat (*Felis nigripes*) actively hunting

overlapped with those of females by 60–67% (Sliwa 2004). Despite this overlap, all individuals hunted solitarily. Similarly, annual home range sizes of Black-footed Cats were 7.1 km^2 for an adult female, and 15.6 and 21.3 km^2 for two adult males monitored at Benfontein Game Farm, Nothern Cape Province, from 2006 to 2008 (Kamler et al. 2015). Since range size is dependent on available prey resources, in more arid regions these home ranges can be considerably larger. Both sexes spray mark, particularly during mating season, when spray marks are deployed in proportion to intensity of use and may play a role in social spacing (Molteno et al. 1998; Sliwa et al. 2010). Adults travel an average of 8.42 ± 2.09 km per night – a greater distance than the African Wildcat (5.1 ± 3.4 km per night) despite their smaller size (Sliwa et al. 2007).

Ecosystem and cultural services:

- A Khoisan legend tells of a Black-footed Cat that took down a Giraffe (*Giraffa camelopardalis*) by piercing its jugular (Sunquist & Sunquist 2002), which serves only to emphasis the ferocity and courage contained in such a tiny cat.
- This species has the potential to be an iconic flagship species of southern Africa, particularly in the Karoo region.
- Individuals can consume large amounts of rodents each year (Figure 4), making this species highly beneficial to agricultural and livestock farmers where rodents are considered problematic.

Table 3. Use and trade summary for the Black-footed Cat (*Felis nigripes*)

Category	Applicable?	Rationale	Proportion of total harvest	Trend
Subsistence use	Yes	No reports of bushmeat poaching. However, skins are probably used on a small scale.	Small	Unknown
Commercial use	Yes	Some illegal trophy hunting.	Unknown, but probably negligible.	Unknown
Harvest from wild population	Yes	As above	Unknown, but probably negligible.	Unknown
Harvest from ranched population	No	-	-	-
Harvest from captive population	No	-	-	-

- As an enigmatic species, it is a highly prized species to be seen in the wild by mammal watchers and felid enthusiasts.

Use and Trade

The Black-footed Cat is accidentally killed in indiscriminate trapping, hunting (rifle and dogs) and poisoning events aimed at other damage-causing carnivores. However, as a protected species these incidents are never reported for fear of persecution (Wilson 2016). At least one specimen record reported to B. Wilson was of a Khoisan man in the Kalahari wearing a skin as part of a loincloth. He indicated that he obtained the skin from a roadkill from the neighbouring Botswana area. Similarly, there are anecdotal reports of skins in households in the central Karoo (M. Drouilly pers. obs. 2014). Also one flat skin was obtained from a sheep guard close to the farm Biesjiesfontein in the Victoria West area in 2012, likely killed by his hunting dogs (A. Sliwa pers. obs. 2012).

Applications have been made for legal hunting permits in the Northern Cape and the Eastern Cape provinces, but these have never been granted. However, several South African taxidermists have acknowledged having mounted hunted animals (Wilson 2016), indicating that there is some interest in the hunting industry for the species. Recently, there has been an increased interest for this species in the trophy industry as witnessed by permit applications and requests made to taxidermists (Wilson 2016).

In the 1970s, there was a demand for the species by overseas zoos and export permits were granted for cats to be caught and exported from the Eastern Cape Province. During further investigations, it was revealed that many of these cats actually came from the then-Cape Province (now part of the Northern Cape Province) (Olbricht & Sliwa 1997). More recently, it has become an acknowledged fact that this species does not thrive in captivity and the demand for wild-caught individuals has diminished considerably (Sliwa & Schürer 2006). Zoos now maintain and exchange animals between institutions. To increase genetic diversity in these captive populations, *in vitro* fertilisation attempts have been made using oocytes of a captive females and semen collected from a wild-caught male during annual field research trips conducted by the Black-footed Cat Working Group (BFCWG) (Herrick et al. 2010), but without generating a viable embryo.

Whilst even predator-proof fencing is not an effective barrier for Black-footed Cats, the effects of wildlife ranching are currently unknown and further research is required to conclusively determine if this land-use practice differs from other farming practices. Since larger carnivores are often introduced and managed, the presence of these is likely to have a negative effect on Black-footed Cats due to intraguild predation. This is perhaps the reason why this species does not occur in formally protected wildlife areas like the Kgalagadi Transfrontier Park and Kruger National Park but may be reported in peripheral areas. Effectively, large areas of intensive wildlife ranching could amplify the island habitat effect that already prevents movements between subpopulations, further threatening the species. This hypothesis should be tested.

Threats

Following 22 years of reach effort by the Black-footed Cat Working Group, the threats to the species have become more apparent (Wilson 2016). Additional and previously unknown threats including, but not limited to, intraguild predation, diseases, declining Springhare populations and unsuitable farming practices have now been realised. All of these suggest that the species is becomingly increasingly threatened. New distribution data clearly indicate that the majority of the distribution occurs outside of formally protected areas (Figure 1). Indeed, the majority of protected areas are suspected to be too small to adequately conserve a viable subpopulation. Essentially, this means the conservation of the species relies on the cooperation of private landowners and managers, particularly in large conservancy areas. However, whilst the geographical distribution of the species may be greater than previously documented, the actual occurrence of the species is highly fragmented and patchy within this area (Wilson 2016), which may have resulted in the creation of island subpopulations resulting in limited dispersal opportunities and restricting genetic exchange between some subpopulations (Wilson 2016). Habitat loss or changes have previously been considered the most severe threat to the species. Habitat degradation that results in the loss of prey base is a serious threat, but changing agricultural practices may, in some instances, actually benefit the species by providing artificially high rodent populations for prey and fewer apex carnivores to compete with.

Perhaps the most serious long-term threat for Black-footed Cats is the loss of key resources, such as den sites and prey, from anthropogenic disturbance or habitat degradation (for example, from overgrazing). They are unable to create or maintain their own dens or burrows and rely on those made by other species. Thus, the localised removal of a sympatric species, Springhare with whom they have a crucial inquilistic relationship, can be detrimental to their continued existence in a region (B. Wilson unpubl. data; Olbricht & Sliwa 1997; Sliwa

Table 4. Threats to the Black-footed Cat (*Felis nigripes*) 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 Hunting & Collecting Terrestrial Animals*: bushmeat poaching and direct persecution of sympatric *Pedetes capensis*. Current stress *1.2 Ecosystem Degradation*: causes loss of available den sites.	Butynski 1973, 2013	Indirect	Regional	Possibly increasing with rise in bushmeat poaching in southern Africa.
2	*2.3 Livestock Farming and Ranching*: habitat degradation from overgrazing resulting in loss of prey base.	Avenant & du Plessis 2008	Indirect	Local	Unknown
3	*8.2 Problematic Native Species/Diseases*: persecution of large carnivores leads to mesopredator release. Current stress *1.2 Ecosystem Degradation*: removal of apex predator leads to mesopredator release, especially *Canis mesomelas*.	Kamler et al. 2015	Empirical	Local	Possibly increasing due to increase in Black-backed Jackal numbers.
4	*5.1 Hunting & Collecting Terrestrial Animals*: incidental persecution through poisoning, pesticides or traps intended for other problem animals.	Wilson 2016	Empirical	Regional	Unknown
5	*8.1 Invasive Non-Native/Alien Species/Diseases*: predation by feral dogs and Anatolian shepherd dogs.	Wilson 2016	Empirical	Regional	Unknown
6	*4.1 Roads & Railroads*: mortalities from road collisions.	Wilson 2016	Empirical	Regional	Unknown
7	*5.1 Hunting & Collecting Terrestrial Animals*: illegal trophy hunting.	Wilson 2016	Empirical	Regional	Unknown
8	*8.2 Problematic Native Species/Diseases*: AA-amyloidosis outbreaks.	Terio et al. 2008	Indirect	Local	Possibly increasing with increased contact with other small carnivores, domestic animals and climate change.
9	*11.1 Habitat Shifting & Alternation*: climate change may alter prey densities/distributions, facilitate disease transmission and increase the frequency of flooding and droughts.	Wilson 2016	Anecdotal	-	-

2013). Springhares are often considered a problem or damage-causing species requiring some control measures by farmers. Although a rodent, Springhares are long-lived with a slow reproductive rate and they do not recover easily from a severe reduction in numbers. In Botswana, the unregulated subsistence hunting of Springhares for bushmeat has resulted in the eradication of the species in some regions (Butynski 1973, 2013), and with them, in all likelihood the Black-footed Cats (Wilson 2016). Bushmeat hunting may be increasing in both scope and scale within southern African savannahs (Lindsey et al. 2013).

The impact of mesopredators may be increasing across South African rangelands (Avenant & du Plessis 2008). In general, numbers of Black-footed Cats and other larger carnivores are negatively related due to intraguild predation (Sliwa et al. 2009, 2014). Annually, the BFCWG loses about 50% of all radio-collared cats to larger predators (BFCWG unpubl. data). The BFCWG believes that the most vulnerable individuals (kittens and subadults – below 1 kg) are the more likely victims of predation but since these individuals are difficult to monitor (too small to fit a radio collar) the actual rate of loss is unknown. Similarly, during a study over 2006–2008 on Benfontein Farm, Northern Cape Province, two Black-footed Cats were killed by predation; one was killed by Black-backed Jackals (Kamler et al. 2015; Wilson 2016) and the other by a Caracal (Wilson 2016). Thus, although Black-footed Cats can co-exist with Black-backed Jackals by using burrows during the day (see above for synergistic interaction) and also taking refuge in them at night during danger (A. Sliwa pers. obs.), and by partitioning activity and diets (Kamler et al. 2015), increasing Black-backed Jackal abundance caused by anthropogenic disturbance and loss of apex predators is likely to increase Black-footed Cat mortality. The BFCWG also has evidence of cats killed by traditional herding dogs and the popularity of Anatolian shepherd dogs with sheep farmers is potentially a new emerging threat (Sliwa et al. 2014; Wilson 2016).

Black-footed Cats are also lost through indirect persecution, such as accidental poisonings (for example locust spraying, predator control lures/baits) and general predator persecution throughout most of their range in South Africa (Nowell & Jackson 1996; Sliwa 2013).

The extent of road mortality on cat subpopulations is not known. The incident rate recorded in the Endangered Wildlife Trust's Road Collision Database is limited to a few records (W. Collinson unpubl. data). However, 3% out of 790 locality records throughout the species' entire distribution area were road collision casualties (Wilson 2016).

Although an inherited trait, and previously thought to be limited only to inbred captive populations, Black-footed Cats show a high prevalence for AA-amyloidosis (Olbricht & Sliwa 1997; Terio et al. 2008). This is a disease

characterised by fibrillar protein depositions in many organs as a result of chronic inflammatory processes usually cumulating in renal failure. About 70% of the documented deaths of captive cats internationally are as a result of this disease. However, the presence of amyloid in free-ranging subpopulations was detected by Terio et al. (2008) from samples provided by the BFCWG. This provides additional evidence for a species predilection and supports the existence of a possible familial type of amyloidosis in the species. Habitat fragmentation and subpopulation isolation can only exacerbate this disease at subpopulation levels, whilst at the same time, the disease is a major reason why currently global captive breeding programmes are not self-sustainable (A. Sliwa pers. comm.). As wild subpopulations become genetically isolated, reduced genetic variability threatens population viability by increasing susceptibility to disease and reducing reproductive fitness. An additional consequence of habitat fragmentation and population isolation is increased contact with other carnivores and the pathogens they carry. Because Black-footed Cats share their territory, prey base, and infectious disease susceptibility with many small carnivores, and even domestic dogs and cats, this provides numerous opportunities for disease transmission (Lamberski et al. 2009).

Black-footed Cats are also vulnerable to natural disasters such as flooding of dens and den collapses (Sliwa et al. 2009). The long-term effects of climate change cannot be overlooked and may lead to changes in range, changes in timing of breeding events, increases in severe weather such as flooding and droughts, as well as increased disease patterns or risks of the spread of pathogens from parasites.

Fortunately, unlike the African Wildcat, this species does not hybridise easily with other cat species. The only confirmed hybrid cases (Black-footed Cats and domestic cats) were under captive conditions (Leyhausen 1979). None have been recorded from the wild (A. Sliwa & B. Wilson pers. obs.).

Current habitat trend: Previously believed to be restricted mostly to panveld and short grass areas, Black-footed Cats occupy a wide range of open arid and semi-arid habitats where they favour any vegetation cover that is low and not too dense, and they have even been sporadically recorded on fallow agricultural fields and in extremely overgrazed areas (Wilson 2016). They are therefore not restricted by habitats throughout most of their distribution in southern Africa. However, overgrazing from livestock farms leads to bush encroachment which reduces the habitat suitability for their normal prey items. The species is highly adaptable and reports of individuals utilising open agricultural areas suggests that the cats may respond to seasonal fluctuations of rodent populations associated with sowing and harvesting activities. However, given the unpredictable nature of these events, and associated risks due to the proximity to humans and their domestic carnivores, the benefit to resident cats is uncertain. Also there is no research as to how these human-dominated landscapes are used by Black-footed Cats and whether these specific records are due to the fact that they are exposed and highly frequented by human observers (A. Sliwa pers. obs.).

Conservation

Black-footed Cat presence in formally protected areas remains low to non-existent, particularly in those large enough to maintain subpopulations; for example, Kgalagadi Transfrontier Park. It is unclear in how many protected areas they occur. However, the major Karoo protected areas – Karoo, Mountain Zebra and Addo Elephant National Parks – may each protect a small but not self-sustaining population. Hunting of this species is banned in South Africa and Botswana and it is protected across most of its range excluding Namibia and Zimbabwe (Nowell & Jackson 1996). Although the Black-footed Cat has been recorded at least marginally in all of the South African provinces, the effectiveness of local protection measures remains in question.

Key interventions for the species include:

1. Judicious management of larger predators and mesopredators in areas where farming practices have resulted in unnatural population increases: this is a holistic approach that includes only controlling true problem animals, and ensuring that fields are not overgrazed or overstocked so as to sustain natural small mammal prey. The effect should be to reduce unnaturally high mesopredator density. Improved sheep-farming practices (for example, synchronised breeding events, kraaling at night, and shepherd systems, lethal control of only proven problem mesopredators) should also be trialled.
2. The establishment of large conservancy areas to create viable Black-footed Cat subpopulations and facilitate ecological separation between Black-footed Cats and larger carnivores (Kamler et al. 2015). The fragmentation of suitable habitats and potential isolation of subpopulations makes the formation or maintenance of dispersal corridors important in the prevention of inbreeding and prevalence of inherited diseases such as AA-amyloidosis. Despite its small size, individuals have very large home ranges, and to conserve subpopulations and create corridors, the emphasis should be on the establishment of large conservancy areas with suitable conditions for the species. This is particularly important in areas where the prospects of a formally protected area are unlikely.
3. Similarly, conservancies and private lands with low apex predator density can be targeted as possible sites for Black-footed Cat stewardship.
4. Human activities that lead to habitat degradation and the loss of prey species need to be addressed, particularly in the Karoo region which is likely to be the remaining stronghold region for the species. For example, conservation success may partly depend on sustaining Springhare numbers, with whom they are inquilistic, by decreasing persecution and bushmeat hunting, especially in areas where alternative refuge systems, such as termite mounds, are unavailable (Wilson 2016). This should also be achieved by creating awareness to the presence and needs of the species among landowners to reduce accidental persecution, whilst providing information about the special needs of Black-footed Cats that would enable them to be actively involved in the protection of the species.

Table 5. Conservation interventions for the Black-footed Cat (*Felis nigripes*) 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	*2.1 Site/Area Management*: form conservancies.	-	Anecdotal	-	-	-
2	*2.1 Site/Area Management*: reduce stocking rates and overgrazing to sustain natural prey base.	-	Anecdotal	-	-	-
3	*5.3 Private Sector Standards and Codes*: identify private lands with low apex predator density as stewardship sites.	-	Anecdotal	-	-	-
4	*3.1.1 Harvest Management*: decrease offtake of Springhare to sustain den site creation for Black-footed Cats.	-	Anecdotal	-	-	-
5	*4.3 Awareness & Communications*: inform private landowners of Black-footed Cat occurrence and habitat requirements.	-	Anecdotal	-	-	Black-footed Cat Working Group
6	*5.4 Compliance & Enforcement*: enforce penalties on those illegally harvesting, persecuting, trading or breeding Black-footed Cats.	-	Anecdotal	-	-	-

5. This may also include generally raising public awareness of the cryptic species and encouraging citizen scientists to submit distribution records through the promotion of citizen science platforms. This has been done previously with the use of posters created by the BFCWG requesting the public to report sightings of the species, the bulk of the data having been used to establish a more accurate geographical distribution of the species (Wilson 2016).
6. Other interventions can involve applying stiffer legal penalties to people involved in deliberate persecution, illegally keeping or trading, or illegally hunting the species.

In the long term, the creation of a Biodiversity Management Plan for the species as an interim or pre-emptive conservation measure should be investigated which could be linked to the already existing international and national *ex situ* management plans. Currently there is no consistent and self-sustaining breeding and survival of cats in South African facilities and some only maintain their stocks by receiving rescued/confiscated individuals from the wild. We suggested the establishment of a national breeding studbook for Black-footed Cats, which would then allow a better overview on the stocks, which could then also feed to the international studbook, maintained by Wuppertal Zoo in Germany since 1991.

Recommendations for land managers and practitioners: Currently, there are no conservation plans for Black-footed Cats and the urgency to create such plans is undermined by the paucity of data at a national level. It is anticipated that the numbers will decrease over the next 20 year period, but during this period, available data should give a clear picture as to the areas of range that are most affected, and the best possible interventions needed.

- Currently, at an international level, due to its already low numbers, it is one of the species listed in the American Association of Zoos and Aquariums Species Survival Plan program developed in 1981. However, the as-yet undetermined subspecies status (*F. n. nigripes* and *F. n. thomasi*) may undermine and place in jeopardy the international holdings and *ex situ* management strategies for the species as a whole. A number of zoos have captive individuals and an international stud book is maintained for the species. Success in captive conditions is fraught by failure of individuals to thrive due to their highly specialised needs and the effects of inbreeding and/or AA-amyloidosis. Thus, *ex situ* conservation efforts are not recommended until such time as expertise exists in South Africa.
- Translocation of individuals without the monitoring of the released cats to determine survival rates is not advocated or advised as displaced individuals may suffer a high mortality rate. Systematic monitoring in areas identified as under-sampled should be established to improve population estimates and scan for stewardship sites.
- The presence/absence of the species in formally protected areas must be ascertained.

Research priorities: The Black-footed Cat has been extensively studied for more than 20 years near the Kimberley area, along the Free State–Northern Cape border. The BFCWG focuses on the ecology, reproductive biology, geographical range, habitat preferences, health and conservation of the species. This provided information about the diet (Sliwa 2006; Sliwa et al. 2010), home range size and social organisation (Sliwa 2004), ecological relationships between the species and other sympatric carnivores (Kamler et al. 2015). More recently, the BFCWG extended this study to include farms south of De Aar, Northern Cape Province, in a different habitat type with different farming practices in place. However, there is little information for elsewhere within its range and the following are considered research priorities.

- Fine-scale distributional studies across the distributional range. This will hopefully lead to more accurate subpopulation estimates. Long-term monitoring of subpopulation trends are also needed throughout the species' geographic range, particularly in ecologically distinct areas and under varying farming practices. Kitten mortality and survival rates also need to be quantified.

- Similarly, studies on changes in density across a spectrum of habitat quality are needed to refine conservation plans and subpopulation estimates. Fine-scale determination on what habitat characteristics and prey populations are required for female Black-footed Cats to successfully raise their kittens is also needed.
- The impacts and extent of persecution (both direct and indirect) and the efficacy of education and awareness programmes targeted at landowners.
- Genetic investigation into the subspecies status is needed as the results may have conservation implications.
- Investigation into causes and extent of AA-amyloidosis in wild populations.
- The effects of Black-backed Jackals and Caracals, and possibly other apex carnivores, need to be quantified.
- The degree of inquilism and dependence on Springhare burrow systems for refuge, and thus long-term survival of cats following of the removal of Springhare subpopulations, needs to be determined.
- Studies into the dispersal abilities and survival of subadult Black-footed Cats in different habitats. Effects of electric fences on local movements and dispersal patterns must be understood to assess the effects of long-term geographical isolation on subpopulation structure. This will enable us to define and delineate subpopulations more accurately.
- Monitoring of the success of re-introduced individuals into new areas with/without other individuals present.
- The range and impact of transmittable diseases from sympatric carnivores on Black-footed Cats.
- The numbers of Black-footed Cats being removed for the trophy industry.

Other research projects include:

- WAZA Conservation Project 06016 – Cologne Zoo (Germany); McGregor Museum (Kimberley, South Africa); San Diego Zoo Safari Park (USA); Wuppertal Zoo (Germany), http://www.waza.org/en/site/conservation/waza-conservation-projects/overview/blackfooted-cat-research.
- Distribution and Conservation Status of the Black-Footed Cat *Felis nigripes* in Namibia http://www.rufford.org/projects/martina_kusters. Martina Küsters; bfcat@mail.com or kusters.m@hotmail.com.

Encouraged citizen actions:

- Report sightings (live or dead) to BFCWG – bfc.sightings@gmail.com or via http://black-footed-cat.wild-cat.org/contact.
- Create conservancies, particularly in the Karoo region.

References

Avenant NL, du Plessis JJ. 2008. Sustainable small stock farming and ecosystem conservation in southern Africa: a role for small mammals? Mammalia **72**:258–263.

Butynski TM. 1973. Life history and economic value of the springhare (*Pedetes capensis* Forster) in Botswana. Botswana Notes and Records **5**:200–213.

Butynski TM. 2013. *Pedetes capensis* Southern African Springhare. Pages 619–623 in Happold DCD, editor. Mammals of Africa. Volume III: Rodents, Hares and Rabbits. Bloomsbury Publishing, London, UK.

Herrick JR, et al. 2010. In vitro fertilization and sperm cryopreservation in the black-footed cat (*Felis nigripes*) and sand cat (*Felis margarita*). Biology of reproduction **82**:552–562.

Hoskin CJ, Higgie M, McDonald KR, Moritz C. 2005. Reinforcement drives rapid allopatric speciation. Nature **437**: 1353–1356.

Kamler JF, Stenkewitz U, Sliwa A, Wilson B, Lamberski N, Herrick JR, Macdonald DW. 2015. Ecological relationships of black-footed cats (*Felis nigripes*) and sympatric canids in South Africa. Mammalian Biology – Zeitschrift für Säugetierkunde **80**:122–127.

Lamberski N, Sliwa A, Wilson B, Herrick J, Lawrenz A. 2009. Conservation of Black-footed cats (*Felis nigripes*) and prevalence of infectious diseases in sympatric carnivores in the Northern Cape Province, South Africa. Pages 243–245 in Wibbelt G, Kretzschmar P, Hofer H, Seet S, editors. Proceedings of the International Conference on Diseases of Zoo and Wild Animals. Leibniz Institute for Zoo and Wildlife Research (IZW) and European Association of Zoo and Wildlife Veterinarians (EAZWV), Berlin, Germany.

Leyhausen P. 1979. Cat Behaviour: The Predatory and Social Behaviour of Domestic and Wild Cats. Garland STPM Press, New York, USA.

Lindsey PA, et al. 2013. The bushmeat trade in African savannas: impacts, drivers, and possible solutions. Biological Conservation **160**:80–96.

Meester JA, Rautenbach IL, Dippenaar NJ, Baker CM. 1986. Classification of southern African mammals. Transvaal Museum Monographs **5**:1–359.

Molteno AJ, Sliwa A, Richardson PRK. 1998. The role of scent marking in a free-ranging, female black-footed cat (*Felis nigripes*). Journal of Zoology **245**:35–41.

Nowell K, Jackson P. 1996. Wild Cats. Status Survey and Conservation Action Plan. IUCN SSC Cat Specialist Group, Gland, Switzerland and Cambridge, UK.

Olbricht G, Sliwa A. 1997. In situ and ex situ observations and management of black-footed cats (*Felis nigripes*). Pages 81–89 in Olney PJS, Fisken FA, editors. International Zoo Yearbook 35: Felids. The Zoological Society of London, London, UK.

Shortridge GC. 1931. *Felis (Microfelis) nigripes* thomasi subsp. nov. Records of the Albany Museum **4**:1.

Skinner JD, Chimimba CT. 2005. The Mammals of the Southern African Subregion. Third edition. Cambridge University Press, Cambridge, UK.

Sliwa A. 2004. Home range size and social organisation of black-footed cats. Mammalian Biology–Zeitschrift für Säugetierkunde **69**:96–107.

Data Sources and Quality

Table 6. Information and interpretation qualifiers for the Black-footed Cat (*Felis nigripes*) assessment

Data sources	Field study (unpublished), indirect information (expert knowledge), museum records
Data quality (max)	Estimated
Data quality (min)	Suspected
Uncertainty resolution	Maximum / minimum values
Risk tolerance	Precautionary

Sliwa A. 2006. Seasonal and sex-specific prey composition of black-footed cats *Felis nigripes*. Acta Theriologica **51**:195–204.

Sliwa A. 2013. *Felis nigripes* Black-footed Cat. Pages 203–205 in Kingdon J, Hoffmann M, editors. The Mammals of Africa. Volume V: Carnivores, Pangolins, Equids and Rhinoceroses. Bloomsbury Publishing, London, UK.

Sliwa A, Herbst M, Mills M. 2007. Prey consumption and distances covered by black-footed cat (*Felis nigripes*) and African wildcats (*Felis silvestris*) – a comparison of two small felids from South African arid lands. In Hughes J, Mercer R, editors. Felid Biology and Conservation: Conference Abstracts. Wildlife Conservation Research Unit, University of Oxford, Oxford, UK.

Sliwa A, Herbst M, Mills M. 2010. Black-footed cats (*Felis nigripes*) and African wild cats (*Felis silvestris*): a comparison of two small felids from South African arid lands. Pages 537–558 in Macdonald D, Loveridge A, editors. The Biology and Conservation of Wild Felids. Oxford University Press, Oxford, UK.

Sliwa A, Schürer U. 2006. International Studbook for Black-footed Cat (*Felis nigripes*), Vol. 14 – 2004/2005. Zoologischer Garten der Stadt Wuppertal, Wuppertal, Germany.

Sliwa A, Wilson B, Lamberski N, Lawrenz A. 2009. Report on surveying and catching Black-footed cats (*Felis nigripes*) on Benfontein Nature Reserve / Nuwejaarsfontein. Black-footed Cat Working Group, Kimberley, South Africa.

Sliwa A, Wilson B, Lamberski N, Tordiffe A. 2014. Report on surveying, catching and monitoring black-footed cats (*Felis nigripes*) on Benfontein Nature Reserve, Nuwejaarsfontein and Taaiboschpoort Farms in 2013. Black-footed Cat Working Group, Kimberley, South Africa.

Smithers RH. 1971. The mammals of Botswana. Museum Memoir No. 4. The Trustees of the National Museums of Rhodesia, Salisbury.

Sunquist M, Sunquist F. 2002. Wild Cats of the World. University of Chicago Press, London, UK.

Terio KA, O'Brien T, Lamberski N, Famula TR, Munson L. 2008. Amyloidosis in black-footed cats (*Felis nigripes*). Veterinary Pathology Online **45**:393–400.

Wilson B. 2016. Geographical distribution and status of the black-footed cat *Felis nigripes*. M.Tech. Dissertation. Tshwane University of Technology, Tshwane, South Africa.

Assessors and Reviewers

Beryl Wilson[1†], Alex Sliwa[2†], Marine Drouilly[3]

[1]McGregor Museum, [2]Cologne Zoo, [3]University of Cape Town

[†]Black-footed Cat Working Group

Contributors

Lizanne Roxburgh[1], Jaco Vivier[2], R. John Power[3], Matthew F. Child[1], Michael Hoffmann[4], Kristin Nowell[†]

[1]Endangered Wildlife Trust, [2]The Vale Farm, [3]North West Provincial Government, [4]International Union for the Conservation of Nature

[†]IUCN SSC Cat Specialist Group

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