Canis mesomelas – Black-backed Jackal


Emmanuel Do Linh San

Regional Red List status (2016)	**Least Concern**
National Red List status (2004)	Least Concern
Reasons for change	No change
Global Red List status (2014)	Least Concern
TOPS listing (NEMBA) (2007)	None
CITES listing	None
Endemic	No

Black-backed Jackals play a vital role in predator–prey interactions and ecosystem functioning. This role may be even more pronounced in areas where large carnivores have been extirpated (e.g. farmlands) leaving Black-backed Jackals (and Caracals) to fulfil the role of apex predators.

Assessment Rationale

The Black-backed Jackal is endemic to sub-Saharan Africa and is widespread. It is considered a generalist canid with an opportunistic lifestyle and occupies most habitats within the assessment region. Black-backed Jackals are the dominant predators of livestock in the assessment region and are thus widely persecuted in an attempt to reduce population size and associated livestock losses. However, despite centuries of population reduction efforts, Black-backed Jackals still persist on farmlands and in most conservation areas. Therefore, these population control efforts appear ineffective, but may result in temporary and localised reductions in population size. Further, lethal control in combination with other management practices may result in local extirpations. Although no accurate population estimates are available, we estimate that there are more than 10,000 individuals in the assessment region, and anecdotal evidence suggests that Black-backed Jackal population size and distribution may have increased over the last 15 years. Therefore, due to this resilience, irrespective of concerted control efforts, we infer that this species will persist, and list it as Least Concern.

Regional population effects: The Black-backed Jackal's range within the assessment region is continuous with the rest of its southern African range and we suspect that dispersal across geo-political boundaries occurs. Black-backed Jackals appear to have few dispersal barriers (Ferguson et al. 1983; Minnie 2016) and may disperse over long distances, exceeding 100 km (Bothma 1971; Ferguson et al. 1983; Humphries et al. 2016; Minnie 2016). Thus, there is no reason to believe that trans-regional and trans-boundary movements will decrease in the future.

Taxonomy

Canis mesomelas Schreber 1775

ANIMALIA - CHORDATA - MAMMALIA - CARNIVORA - CANIDAE - *Canis* - *mesomelas*

Synonyms: *achrotes*, *arenarum*, *elgonae*, *mcmillani*, *schmidti*, *variegatoides*

Common names: Black-backed Jackal, Silver-backed Jackal (English), Rooijakkals, Swartrugjakkals (Afrikaans), Phukubjê (Pedi), Phokobjê (Pedi, Tswana), Phokobje, Phokojoe, Phokojwe (Sotho), Imphungushe, Jakalasi, Mpungutje, Impungutjee (Swazi), Hungudzwa, Jajaja, Mhungubya, Phungubya (Tsonga), Phokobyê, Phokojê, Phokojwê, Sekgêê (Tswana), Phungubwe, Phunguhwe, Phunguhwe i re na Mutana Mutswu (Venda), Impungutye (Xhosa), Ikhanka, Impungushe, Inkanka (Zulu)

Taxonomic status: Species

Taxonomic note: Meester et al. (1986) assigned all southern African material to the nominate subspecies, *Canis mesomelas mesomelas*.

Distribution

The Black-backed Jackal is endemic to sub-Saharan Africa (Loveridge & Nel 2004). It occurs in two geographically isolated populations: one in East Africa and another in southern Africa. The two populations are separated by the Mozambican Gap (from the Zambezi river to Tanzania; Kingdon 1977). According to Ansell (1960), Black-backed Jackals are absent from much of equatorial Africa. This disjunct distributional pattern occurs in other arid-adapted African endemics (e.g. Aardwolf *Proteles cristatus* and Bat-eared Fox *Otocyon megalotis*; Loveridge & Nel 2004), and suggests that these two populations were once connected during the drier conditions of the Pleistocene (Loveridge & Nel 2004, 2013; Skinner & Chimimba 2005). The northern subspecies, *C. m. schmidti*, occupies southern Ethiopia, southern Sudan, Somalia, Kenya, Uganda, and northern Tanzania. The range of the southern subspecies, *C. m. mesomelas*, extends from the southern part of South Africa to the southwestern part of Angola, northern Botswana, central Zimbabwe, and southwestern Mozambique (Hoffmann 2014). Recent molecular research suggests that these two subspecies may in fact warrant species status owing to divergence in mitochondrial

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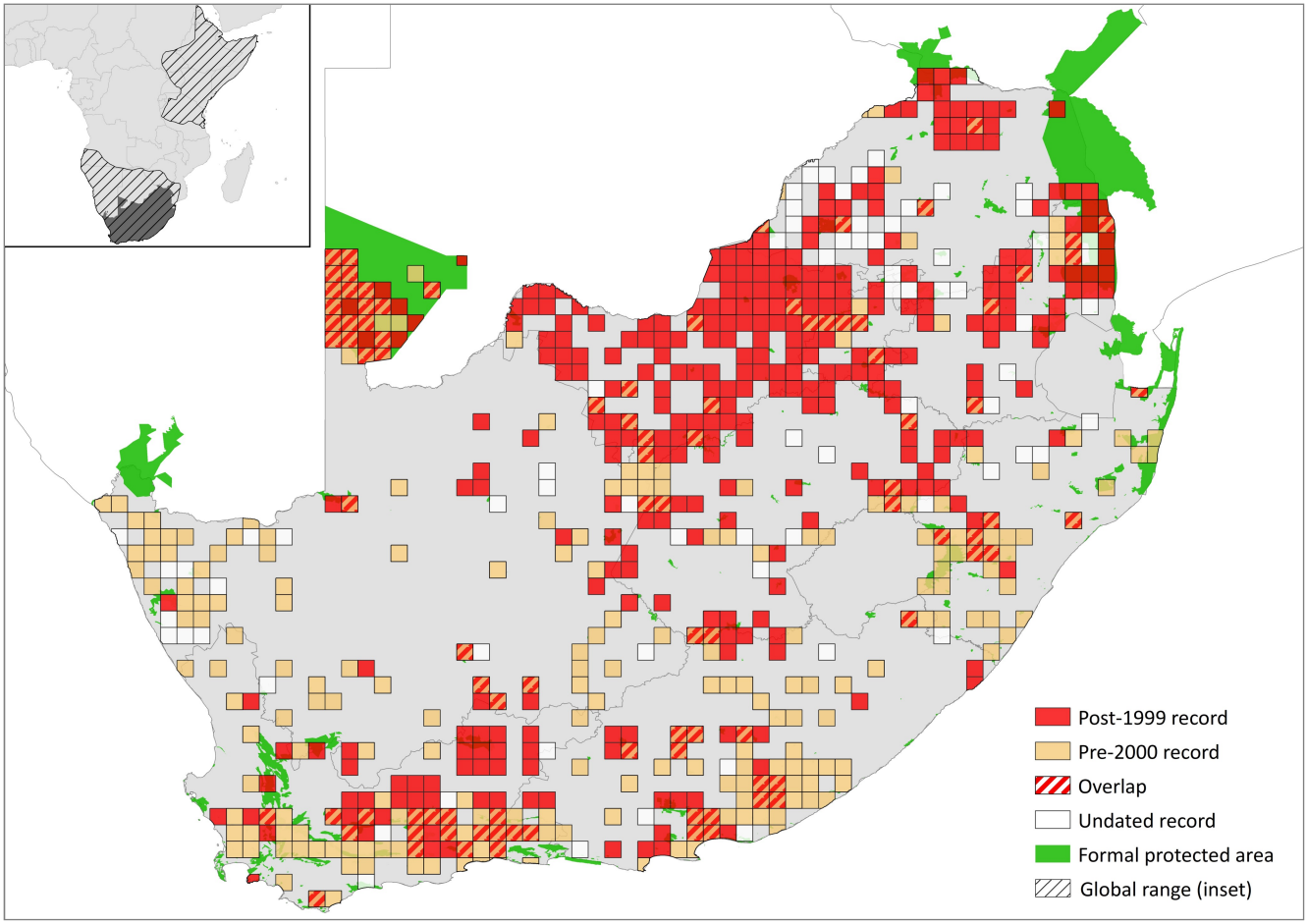

Figure 1. Distribution records for Black-backed Jackal (*Canis mesomelas*) within the assessment region

Table 1. Countries of occurrence within southern Africa

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

lineages, but additional research on a wider geographical scale is required in support of this hypothesis (Atickem et al. 2017). However, if this hypothesis is supported and the current and "new" species exhibit reduced distributional ranges and lower population densities, it may require a revision of their conservation status (Atickem et al. 2017).

In the assessment region, Black-backed Jackals historically occurred throughout Swaziland, in several locations in Lesotho, and throughout South Africa – except for the Southern Coast Forests around Knysna, Western Cape Province (Skinner & Chimimba 2005), and the Highveld of the former Transvaal Province until the early 1950s (van der Merwe 1953).

Currently, they occur throughout most of Lesotho, Swaziland and South Africa. They are widespread across most conservation and livestock farming areas (Figure 1; Loveridge & Nel 2004). The previous assessment indicated that they did not occur along the coast and the immediate interior between Storms River and Port Elizabeth. However, based on predator–livestock conflict reports from small stock farmers (Minnie 2009; DEDEA problem animal control register 2011 – G. Ferreira pers. comm. 2012), it seems that the population is expanding into this area. They appear to be absent from highly developed cities, towns and settlements. However, abundance in urban areas may be underestimated due to a lack of survey effort. Recently, vocalisations have been recorded in residential areas in Midrand, Gauteng Province (Z.J.K. Madikiza pers. comm. 2014). Other generalist canids (e.g. Red Foxes *Vulpes vulpes*: Soulsbury et al. 2007; Coyotes *Canis latrans*: Gese & Bekoff 2004) persist successfully in urban areas (i.e. they are urban exploiters). This may also be the case for Black-backed Jackals as, similar to several other canids, they are dietary generalists with a high reproductive output and are behaviourally flexible. These attributes may assist them in becoming successful urban exploiters.

Black-backed Jackals experience local fluctuations in density with the possibility of local extirpations based on the intensity of predator control programmes (Beinart 1998). Their local densities may also fluctuate according to the presence of other sympatric predators, most notably Caracal (*Caracal caracal*; Ferreira 1988). This may result in fluctuations of their distributional range, which is highlighted by the expansion of the population into previously extirpated areas such as the Baviaanskloof Mega-Reserve, the mountains east of Cradock, and the areas south of the N2 between Humansdorp and Cape St Francis in the Eastern Cape Province.

Population

Several authors in southern Africa have estimated local population size. For example, in the Drakensberg Mountains, KwaZulu-Natal Province, Rowe-Rowe (1982) estimated densities of 0.34–0.40 individual / km^2. In the Free State and Northern Cape provinces, estimated densities were 0.02 individual / km^2 on game farms that actively managed Black-backed Jackals compared to 0.33 to 0.43 individual / km^2 on game farms that did not (Klare et al. 2010; Kamler et al. 2013). Further, on the game farms that did not actively manage jackals, jackal density varied depending on prey diversity and abundance (Klare et al. 2010). Thus, Black-backed Jackal densities likely vary depending on the dispersion and abundance of resources, as well as the intensity and frequency of predator management. Local population density may also be influenced by the density and composition of the carnivore community (e.g. African Lion *Panthera leo*, Leopard *Panthera pardus*, Spotted Hyaena *Crocuta crocuta*, and Caracal). Apex predators may facilitate scavenging opportunities for Black-backed Jackals resulting in increased local densities, but may also increase the risk of predation (i.e. interspecific competition) resulting in reduced local densities (Brassine & Parker 2012; Minnie 2016). Consequently, it is expected that Black-backed Jackal population density should vary greatly in the assessment region.

The regional variation in population density relative to local resource abundance (amongst other factors) is exemplified by the Black-backed Jackal populations on the Namibian coast. Nel et al. (2013) compared jackal densities between three areas that differ markedly in resource availability. Densities varied from 0.07 individual / km^2 along the Skeleton coast (low food resources), to 2.91 individuals / km^2 at Sandwich harbour (intermediate), reaching a maximum of 13.05 individuals / km^2 at Cape Cross (high). Due to a localised increase in resource abundance in the latter area, jackals were non-territorial with widely overlapping home ranges.

To date, no accurate population estimates for the Black-backed Jackal within the assessment region exist, and extrapolating local population densities to the entire assessment region is inappropriate and may result in extremely inaccurate population estimations. However, owing to the minimum densities mentioned above and the wide distribution of this species in the assessment region, there are likely over 10,000 mature individuals in the population. Anecdotal evidence suggests that numbers have increased over the last 15 years in some areas (Avenant & du Plessis 2008; du Plessis 2013). Thus, owing to this species' wide distributional range and persistence in the face of persecution, it is expected that the population will not decline in the future. However, lethal control in combination with other management practices may result in local extirpations (Walton & Joly 2003; Blaum et al. 2009; Kamler et al. 2013). Individuals from neighbouring areas will re-establish territories in these vacant areas (i.e. compensatory immigration; Minnie 2016).

Current population trend: Stable, based on extent of occurrence, wide habitat tolerance and persistence despite concerted population reduction efforts.

Continuing decline in mature individuals: Unknown, but probably not.

Number of mature individuals in population: The exact number is unknown, but is expected to be more than 10,000 mature individuals.

Number of mature individuals in largest subpopulation: Unknown

Number of subpopulations: The existence of genetic subpopulations have been documented for Black-backed Jackals in the North West and Gauteng provinces (James et al. 2017) and in the Western Cape and Eastern Cape provinces (Minnie 2016). However, the number of subpopulations in the assessment region is unknown.

Severely fragmented: No. Black-backed Jackals have a broad habitat tolerance and can exist in agricultural and rural landscapes.

Habitats and Ecology

Black-backed Jackals are relatively unspecialised and well-suited for an opportunistic lifestyle in a wide variety of habitats (Loveridge & Nel 2013). They have a wide habitat tolerance, occupying habitats including Highveld grassland (Morwe 2013), montane grassland (Rowe-Rowe 1982), scrubland (Skinner & Chimimba 2005), savannah (Wyman 1967; Kingdon 1977; Lamprecht 1978; Moehlman 1983; Fuller et al. 1989; Estes 1991), woodland savannah mosaics (Smithers 1971; Loveridge & Macdonald 2002) and farmland. The Black-backed Jackal has long been perceived as an arid-adapted species (Loveridge & Nel 2013). However, it also occurs in more mesic areas (mean annual precipitation > 1,000 mm; Rowe-Rowe 1982, 1992; Loveridge & Nel 2013) with recent expansions into the more mesic South Coast area (Western Cape), where it was previously absent (see **Distribution** above). It shows a preference for open habitats, but will occupy dense vegetation (Hoffmann 2014).

Until recently, they were considered generalist omnivores (*cf.* Hayward et al. 2017), consuming whatever resource is readily available (Loveridge & Macdonald 2003; Kok & Nel 2004; Klare et al. 2010; Fourie et al. 2015; Pohl 2015) and scavenging when the opportunity arises. However, they actively hunt small- to medium-sized mammalian prey (Kamler et al. 2010, 2012a; Klare et al. 2010), but also prey on the fawns/lambs of larger ungulates (Klare et al. 2010). Although the diet is dominated by mammals, they supplement their diet with fruit, birds, reptiles, amphibians, insects, and fish (Do Linh San et al. 2009; Brassine & Parker 2012; Kamler et al. 2012a; Morwe 2013; van de Ven et al. 2013; Minnie 2016). The predominance of small- to medium-sized mammals may reflect an optimal foraging strategy, as Black-backed Jackals prefer to prey on mammals with a body mass of 14–26 kg (Hayward et al. 2017). Additionally, they significantly prefer small ungulates (< 30 kg) which hide their young (e.g. Springbok *Antidorcas marsupialis* and Common Duiker *Sylvicapra grimmia*; Hayward et al. 2017). Consequently, they have a wide dietary niche that expands and contracts in relation to the local availability and dispersion of resources (Kaunda & Skinner 2003; Klare et al. 2010; Kamler et al. 2012b; Morwe 2013; Pohl 2015; Drouilly et al. *in press*). Additionally, in the presence of larger carnivores, such as Cheetah (*Acinonyx jubatus*), Lions, and Leopards, scavenged food sources may contribute substantially to their diet (e.g. Fourie et al. 2015; Minnie 2016), but incongruences in the literature indicate that this might not be the case throughout the assessment region (e.g. Brassine & Parker 2012; Yarnell et al. 2013; Drouilly et al. *in press*).

Photo 1. Black-backed Jackal (*Canis mesomelas*) pups are born between the end of winter and the end of spring, and litter size varies between one and nine (Emmanuel Do Linh San)

In a stable social system, they are monogamous (Moehlman 1987), with the dominant mated pair defending a mutually exclusive breeding territory (Loveridge & Nel 2004). Pair formation may increase hunting success (Lamprecht 1978) and is critical for territorial defence and successful pup rearing (Moehlman 1987). Social structure varies and may consist of family groups (1–8 individuals; Rowe-Rowe 1978, 1984) incorporating the dominant pair and their offspring (Ferguson et al. 1983; Loveridge & Macdonald 2001), as well as subadults that have delayed dispersal to assist in raising their siblings (i.e. helpers; Moehlman 1979; Rowe-Rowe 1982; Ferguson et al. 1983). Additionally, the territorial pair may tolerate subordinate individuals on the fringe of its territory (i.e. floaters; Ferguson et al. 1983). Territorial relaxation/collapse may occur during periods of high resource abundance (e.g. at seal colonies in Namibia; Jenner et al. 2011; Nel et al. 2013), where the dominant pair allows other individuals into its territory (Macdonald 1979; Rowe-Rowe 1982; Ferguson et al. 1983; Hiscocks & Perrin 1988; McKenzie 1990; Oosthuizen et al. 1997; Loveridge & Macdonald 2001, 2003).

Black-backed Jackal mating peaks during winter (Skead 1973) and gestation lasts for 60–70 days (Bernard & Stuart 1992; McKenzie 1993; Walton & Joly 2003). Parturition usually occurs from winter to early spring (Bothma 1971; Bernard & Stuart 1992; McKenzie 1993). Importantly, temporal variation in this reproductive pattern may occur in response to resource availability and abundance (Fairall 1968; Rowe-Rowe 1978; Bernard & Stuart 1992; McKenzie 1993; Bingham & Purchase 2002; Walton & Joly 2003). Females usually have one litter per year, with a litter size of 1–9, depending on the female's body condition (Minnie et al. 2016) and social status (Loveridge & Nel 2013). Additionally, populations experiencing high levels of anthropogenic mortality may produce larger litters relative to populations that are lightly managed or unmanaged (i.e. compensatory reproduction; Minnie et al. 2016).

Pups usually remain in the den from August to November, emerge after 3 weeks, and are weaned at 8–9 weeks of age (Ferguson et al. 1983). They start foraging with their parents at 3 months of age, but remain in close proximity (≤ 2 km) to the den until 6 months of age (Ferguson et al. 1983; Moehlman 1987). When they are approximately 7 months old, they start moving further from the den.

They become sexually mature at 11 months, but only start reproducing at 2 years of age (Ferguson et al. 1983; Moehlman 1987). However, populations that are lethally managed may compensate for increased mortality and reproduce at younger ages (i.e. compensatory reproduction; Minnie et al. 2016). Young individuals can stay in the natal territory and assist with rearing the next litter (i.e. helpers), or disperse in search of mates and a territory (Ferguson et al. 1983; Moehlman 1987). According to Rowe-Rowe (1992), adults seldom live beyond 7 years.

Home range size varies considerably, with ranges between 4 and 33 km^2 being reported. Humphries et al (2016) estimated mean resident home ranges (95% FK) across seasons for adult males, adult females and juvenile males; these were 11.4 ± 4.3 km^2, 5.6 ± 0.36 km^2 and 2.15 ± 0.45 km^2, respectively. While in the Kalahari Gemsbok National Park (Northern Cape) home ranges averaged between 2.56 and 8.8 km^2 (Ferguson et al 1983). Variations in home range size may be attributed to variation in food availability, as individuals occupying areas with higher prey density tend to have smaller home ranges (e.g. Ferguson et al. 1983). Further, seasonal variation is apparent and home range size decreases during the whelping season (Loveridge & Macdonald 2001).

Home range size also varies between social classes, with territorial adults having smaller home ranges than subadults (e.g. Ferguson et al. 1983). This may be due to subordinate individuals dispersing in search of mates and territories, whereas dominant pairs are resident (Ferguson et al. 1983; Humphries et al. 2016). In general, the home ranges of dominant pairs do not overlap (< 10 %) with other mated pairs (Ferguson et al. 1983). However, the home ranges of subordinate individuals may overlap extensively with both subordinate and dominant individuals (Ferguson et al. 1983; Rowe-Rowe 1982).

Ecosystem and cultural services: Black-backed Jackals play a vital role in predator–prey interactions and ecosystem functioning. This role may be even more pronounced in areas where large carnivores have been

Table 2. Use and trade summary for the Black-backed Jackal (*Canis mesomelas*)

Category	Applicable?	Rationale	Proportion of total harvest	Trend
Subsistence use	Yes	A source of meat in some areas. Body parts used for cultural purposes and traditional medicine.	Unknown, but probably minimal.	Unknown
Commercial use	Yes	Hunted for trophies and skin.	Unknown	Unknown
Harvest from wild population	Yes	Hunted for trophies and skin.	Unknown	Unknown
Harvest from ranched population	-	-	-	-
Harvest from captive population	-	-	-	-

extirpated (e.g. farmlands) leaving Black-backed Jackals (and Caracals) to fulfil the role of apex predators. Consequently, they may regulate populations of smaller carnivores and prey (du Plessis 2013; Bagniewska & Kamler 2014). Given their preference for small- to medium-sized ungulates, they may regulate the populations of species falling within this preferred prey weight range (e.g. Springbok: Klare et al. 2010; Morwe 2013; Blesbok *Damaliscus pygargus phillipsi*: du Plessis 1972).

Black-backed Jackals consume small rodents, thus it is conceivable that they may regulate these populations. For example, Bagniewska and Kamler (2014) showed that they may suppress prey populations such as Cape Ground Squirrels (*Xerus inauris*) and hares (*Lepus* spp.). However, little evidence in support of this prey regulation hypothesis exists (Swanepoel et al. 2017). Thus, the role of this species in regulating crop pests and the spread of diseases by these pests (many of these rodent species act as disease vectors), as well as other herbivores which may compete with livestock for grazing (e.g. Hyrax *Procavia capensis*: Pohl 2015) is unclear.

Black-backed Jackals may also suppress smaller carnivore populations via lethal (intraguild predation; e.g. Yellow Mongoose *Cynictis penicillata*, African Striped Weasel *Poecilogale albinucha*, Small-spotted Genet *Genetta genetta*, and Bat-eared Fox: Klare et al. 2010; Kamler et al. 2012a; Bagniewska & Kamler 2014; Drouilly et al. *in press*) and non-lethal (competition; e.g. Cape Fox *Vulpes chama*: Kamler et al. 2013) interactions.

Further, anecdotal evidence suggests that the competitive interactions between Black-backed Jackals and Caracals on livestock farms may produce concurrent fluctuations in population densities (du Plessis 2013). When Black-backed Jackal densities are reduced due to human persecution, Caracal densities apparently increase (Pringle & Pringle 1979; Ferreira 1988). In the northeastern part of the assessment area (northern Limpopo, Mpumalanga, and KwaZulu-Natal provinces), they occur in sympatry with Side-striped Jackals (*Canis adustus*). Here, Black-backed Jackals may aggressively exclude Side-striped Jackals from preferred habitats, as observed in Zimbabwe (Loveridge 1999).

The Black-backed Jackal is a common character in Bushmen, Hottentot, and Bantu folklore and is often portrayed as a trickster (Stewart 2004). Jackals in general are seen as sly and greedy and depict both the weaknesses and strengths of human nature (Stewart 2004). Character traits such as vanity, greed, naïvety, selfishness, and cruelty are often synonymous with jackals (Stewart 2004). In most cases, the trickster is a small creature that poses no threat to larger animals and often outwits enemies that have a competitive advantage (Stewart 2004). Additionally, the Black-backed Jackal is also seen as an important ancestral spirit manifestation for both isiXhosa and isiZulu people (P. Bernard pers. comm. 2015). Traditional healers have spirit animal guides and these are shown in a dream to the healer. It is then incumbent on the healer to incorporate the skin of the animal guides into their traditional garb. Black-backed Jackal skins are often incorporated into the head-gear (known as *isidlokolo*) of a traditional healer if the animal is that healer's animal guide (P. Bernard pers. comm. 2015).

Use and Trade

No significant trade in Black-backed Jackal products exists (Hoffmann 2014). However, infrequent trade has been documented, including trophy hunting (L. Minnie pers. obs. 2013) and the sale of skins in the curio trade, but this should have little effect on population persistence. The extent of use of Black-backed Jackal products is unknown but it has been recorded. For example, body parts are used for cultural purposes (Avenant 2004) such

Table 3. Possible net effects of wildlife ranching on the Black-backed Jackal (*Canis mesomelas*) and subsequent management recommendations

Net effect	Unknown
Data quality	Unknown
Rationale	Black-backed Jackals prey on valued ungulate species on wildlife ranches. Consequently some ranchers actively manage Black-backed Jackal population to reduce population size.
Management recommendation	To date, no assessment of the effectiveness of various Black-backed Jackal management strategies on wildlife ranches has been conducted. However, suggested management actions may include: 1) Concentrating management interventions prior to, or during lambing/fawning periods; 2) Fencing off valuable or vulnerable species; 3) Using a combination of management strategies and rotating between these; 4) Switching to ungulate species that are less susceptible to jackal predation; and 5) Increase the number of alternate prey (e.g. medium-sized mammals) which may dilute predation on ungulates.

as traditional medicine (Hoffmann 2014; Williams & Whiting 2016) and in certain areas the meat is consumed (Avenant 2004; L. Minnie pers. obs. 2013). The impacts of use and trade on Black-backed Jackal populations is presumed to be negligible. Additionally, several researchers have used (e.g. Bingham & Purchase 2002; Brassine 2011; Minnie 2016), or are currently using dead Black-backed Jackals for research purposes. These specimens are collected from farm and reserve managers who killed them, presumably to reduce predation impacts on valued ungulate species and livestock. This retaliatory killing of Black-backed Jackals is probably the largest threat to population persistence.

The recent trend in the conversion of livestock farms to wildlife ranches may represent a land use change that provides a more natural habitat for Black-backed Jackals than livestock farms. This may be ascribed to a more "natural" prey base (e.g. indigenous ungulates vs. introduced livestock) on some ranches. In some cases, ranch managers do not manage Black-backed Jackal populations, but lethal management appears to be on the increase (e.g. De Waal 2009; Klare et al. 2010; du Plessis 2013; Pirie et al. 2017) as wildlife ranching is in conflict with predators (Thorn et al. 2012; Schepers 2016; Pirie et al. 2017). These populations are managed to reduce predation on valued ungulate species (e.g. high-value colour morphs and trophy animals), and the value of ungulate species may be directly proportional to retaliatory killing (Pirie et al. 2017). The variation in intensity of lethal control between land uses (i.e. game ranch vs. livestock farm) has not been rigorously quantified. However, it appears that in some cases ranch managers have a more negative attitude towards predators than livestock farmers (Pirie et al. 2017). Thus, it is not possible to discern the net effects of wildlife ranching on the Black-backed Jackal.

Threats

Within the assessment region, Black-backed Jackals are hunted, trapped and illegally poisoned for their role as livestock and ungulate predators. Persecution occurs in most livestock farming areas and in some game farming areas (Beinart 1998; van Niekerk 2010; du Plessis 2013; Badenhorst 2014; Minnie 2016; Schepers 2016; Pirie et al. 2017), and is widespread across the assessment region (Photo 2). Historically, hunting clubs and jackal-proof fencing was subsidised by the government to assist farmers with Black-backed Jackal population control (Stadler 2006; Bergman et al. 2013). These hunting clubs killed a large number of individuals (e.g. Gunter 2008; Bothma 2012; Conradie 2012). For example, Oranjejag killed an average of 786 Black-backed Jackals per year in the Free State Province between 1959 and 1991 (Bothma 2012). Culling subsequently declined after the abolishment of government subsidies, but a recent (2009 onwards) resurgence in culling operations over large areas has occurred (van Niekerk 2010; du Plessis 2013). Full-time damage-causing animal hunters are now commonplace (du Plessis 2013). The intensity of lethal management presumably fluctuates with actual and perceived predation rates, but currently we suspect that it is increasing.

While it is still unknown how many Black-backed Jackals are killed annually within the assessment region, population control efforts appear largely ineffective and probably only succeed in producing a temporary reduction in local population size (Avenant & du Plessis

Photo 2. Predator control on farmlands in the central Karoo involving Black-backed Jackal (*Canis mesomelas*) and Caracal (*Caracal caracal*) (Nathalie Houdin & Denis Palanque, The Karoo Predator Project)

Table 4. Threats to the Black-backed Jackal (*Canis mesomelas*) 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*: hunting, trapping and poisoning Black-baked Jackals due to their role as livestock and ungulate predators.	Minnie 2009	Empirical	Local	Unknown. May be increasing owing to high levels of perceived/actual predation on livestock and valued ungulate species.
		Deacon 2010	Empirical	Regional	
		Brassine 2011	Empirical	Local	
		Murison 2014	Empirical	Local	
		Minnie et al. 2016	Empirical	Local	
2	*4.1 Roads & Railroads*: mortality from road collisions.	C.J. Tambling pers. comm. 2011	Observed	Local	Unknown
		Collinson et al. 2015	Empirical	Local	
3	*5.1.1 Hunting & Collecting Terrestrial Animals*: trophy hunting, curio trade, traditional medicine, cultural use and for food.	Avenant 2004	Observed	Local	Unknown, but the impact is considered relatively low.
		L. Minnie pers. obs. 2013	Observed	Local	
		Hoffmann 2014	Inferred	International	
		Williams & Whiting 2016	Inferred	Local	

2008; Minnie et al. 2016). In fact, despite concerted population reduction efforts for more than 350 years, Black-backed Jackals still persist (Stadler 2006; Bergman et al. 2013; Kerley et al. 2017). This persistence may be ascribed to their highly adaptable nature and their high reproductive potential and dispersal abilities (du Plessis et al. 2015; Minnie et al. 2016). Black-backed Jackal populations that are subject to high levels of anthropogenic mortality may start reproducing at younger ages and produce larger litters (i.e. compensatory reproduction; Minnie et al. 2016). This is attributed to a disruption in the normal, mutually exclusive, territorial structure – due to high levels of lethal management – which allows younger individuals to reproduce (Minnie et al. 2016). Further, the variation in management intensity within the assessment region results in the formation of a source-sink system, which allows for compensatory immigration (Minnie 2016). Here, compensatory immigration occurs when individuals from unmanaged or lightly managed areas (e.g. conservation areas) disperse into the vacant territories in managed areas (e.g. livestock farms; Minnie 2016; Minnie et al. 2016). The combination of compensatory reproduction and dispersal is likely the reason for their persistence in the face of severe anthropogenic mortality, and may continue to negate population reduction efforts.

Black-backed Jackals are also persecuted for their role as diseases vectors (e.g. canine distemper virus, rabies virus and anthrax; Bellan et al. 2012), mostly in the central southern African part of their distributional range (Loveridge & Nel 2004). This thus represents a major cause of mortality within these areas. The efficacy of these management programmes is questionable and McKenzie (1993) suggests that it may actually promote disease transmission via increased dispersal and agonistic interactions associated with a source–sink system. However, the impact of these diseases on Black-backed Jackal populations within the assessment region is unknown.

Urbanisation and human population growth have resulted in habitat transformation, which has been associated with the decline of several species. Although there are no accurate estimates of Black-backed Jackal population densities in the assessment area, it appears that agricultural habitat transformation does not pose a serious threat to Black-backed Jackals in the assessment area, as they are still widespread in these areas. Conversely, habitat transformations associated with agricultural expansion may contribute to the success of opportunistic species by providing anthropogenic food subsidies (Oro et al. 2013). Anthropogenic food subsidies such as road kill, naïve livestock and illegal garbage dumps have been related to artificially inflated population sizes of Golden Jackal (*Canis aureus*; Yom-Tov et al. 1995) and Coyotes (Fedriani et al. 2001). This may also be the case for Black-backed Jackal populations. Thus, anthropogenic habitat transformation may have improved the extent and quality of habitats available to this species.

Current habitat trend: Stable

Conservation

Black-backed Jackals are widely distributed and occur in most protected areas within the assessment region. Additionally, a large proportion of the population occurs outside protected areas, particularly in livestock farming areas. The Black-backed Jackal is not included in the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) Appendices nor is it included in the South African Threatened or Protected Species (TOPS) Regulations. Therefore, it has no legal protection outside protected areas. The largest threat to the Black-backed Jackal is lethal management actions aimed at reducing population size and associated livestock and ungulate losses. Although temporary reduction and local extirpations in response to lethal management actions have been documented (e.g. Blaum et al. 2009; Kamler et al. 2013; Walton & Joly 2003), Black-backed Jackals have persisted in these farming areas despite extensive lethal management (> 350 years; Stadler 2006; Avenant & du Plessis 2008; du Plessis 2013; Kerley et al. 2017) and are expected to persist into the

future. Thus, no active conservation efforts are currently required. However, the response of Black-backed Jackal populations to management interventions, as well as the effectiveness of these management interventions in reducing livestock and ungulate predation, is unknown. Thus, it is extremely important to accurately monitor Black-backed Jackal populations throughout the assessment region to determine distribution and abundance, as well as the impact of predator management actions on local populations. This will provide the necessary baseline information to make informed conservation and management decisions. Additionally, conservation efforts aimed at reducing human–wildlife conflict are urgently required.

Recommendations for land managers and practitioners: Several predator and livestock management techniques have been employed to reduce predation on livestock. However, the efficacy of these techniques in reducing predation as well as the impacts on Black-backed Jackal populations are unknown, and likely vary tremendously throughout the assessment region. Thus, we cannot provide effective recommendations for land managers, until these methods have been systematically evaluated. However, we suggest some management actions that, according to anecdotal evidence, have been successful in certain areas (Table 5). Du Plessis (2013) reviewed the management actions used to reduce livestock predation by Black-backed Jackal and suggested that non-lethal, preventative and exclusion techniques are the most conservation-friendly. Lethal management should be avoided, if possible, as Black-backed Jackal populations compensate for increased mortality by producing larger litters at younger ages (Minnie et al. 2016). However, when lethal management is employed, it should be applied selectively to ensure that the territorial structure of Black-backed Jackals remains intact. This may reduce compensatory immigration from neighbouring areas (Minnie 2016). Avoiding these compensatory life-history responses (reproduction and immigration), which may negate population reduction efforts (Minnie et al. 2016), may assist in the effective management of Black-backed Jackal predation on livestock and valued ungulate species. Further, Black-backed Jackals are highly adaptable and it has been suggested that they habituate to specific methods. Thus, we suggest using a combination of management strategies and rotating between these to reduce the chances of Black-backed Jackals learning to bypass these measures. Finally, it is of the utmost importance that land managers keep accurate records of the population trends and the efficacy of management interventions, which will assist in effective adaptive management.

The following management programmes, information centres and collaborative initiatives should be of interest to managers, game ranchers and farmers, who seek information and assistance with regards to the management of conflicts between Black-backed Jackals and humans:

- *Canis–Caracal Programme (CCP)*, run by the African Large Predator Research Unit (ALPRU), University of the Free State (UFS): aims at finding solutions to reduce the widespread impact of predation on the livestock industry (national). Contact details: Prof. H.O. de Waal, Department of Animal, Wildlife and Grassland Sciences and African Large Predator Research Unit (ALPRU), PO Box 339, Internal Box 70, University of the Free State, Bloemfontein, 9300, South Africa. Email: dewaalho@ufs.ac.za.
- *Predation Management Information Centre (PMIC)*: collating and analysing reliable information on predation and predation management methods, which will be made available continuously to a management information system (MIS). A team of dedicated staff members handles calls and enquiries. Experts in the team are available to provide advice to farmers. The centre is also responsible for the management of information and resources. Aim: to generate information that can be used to reduce the widespread impact of predation on the livestock industry. A collaborative initiative between the UFS and the Predation Managemetn Forum (PMF). Contact details: Email: PredationMC@ufs.ac.za. Telephone: 051 401 2210 (on week days from 08:00–16:00).
- *Scientific Assessment on Livestock Predation in South Africa (PredSA)*: a collaborative initiative between the Centre for African Conservation Ecology, Nelson Mandela University, Department of Environmental Affairs, Department of Agriculture, Forestry and Fisheries, Red Meat Research Development Planning Committee, National Wool Growers Association, Cape Wools and Mohair Trust. Contact details: Prof. Graham Kerley, Centre for African Conservation Ecology (ACE), PO Box 77000, Nelson Mandela Metropolitan University, Port Elizabeth, 6031, South Africa. Email: graham.kerley@nmmu.ac.za.

Research priorities: Black-backed Jackals have been cited as the dominant predators of livestock in the assessment region (e.g. van Niekerk 2010; du Plessis 2013; Minnie et al. 2016; Kerley et al. 2017) and cause large financial losses to the livestock production industry (van Niekerk 2010). Given this dominant role in livestock predation, it is expected that adequate research would have been conducted. However, this is not the case, as most research was spatially and temporally isolated with a limited scope, and mostly confined to protected areas (du Plessis et al. 2015). Importantly, many research groups are currently addressing these priority knowledge gaps. Below we highlight the thematic areas where research needs to be prioritised and we suggest some applied research questions that need to be addressed to reduce human–carnivore conflict.

Ecology: A prerequisite for adaptive management is a sound ecological understanding of the focal species. Without this information it is difficult to predict the efficacy of management interventions and the effects thereof on the behaviour and ecology of target animals. Most importantly, there is a severe lack of accurate population estimates for Black-backed Jackals throughout the assessment region. Thus, a more systematic and regular monitoring programme is required to understand local fluctuations in population densities and to provide important baseline information.

Potential research questions:

- What drives distribution and variation in local densities?
- How do seasonal fluctuations in resource availability influence density and social structure?
- What are the environmental drivers of predation?

Table 5. Conservation interventions for the Black-backed Jackal (*Canis mesomelas*) ranked in order of effectiveness with corresponding evidence (based on IUCN action categories, with regional context) **table continues on page 10*

Rank	Intervention description	Evidence in the scientific literature	Data quality	Scale of evidence	Demonstrated impact	Current conservation projects
1	*2.1 Site/Area Management*: directing ecological and management research to inform management actions.	Gunter 2008	Inferred	Local	Strategic direction for future research, and increasing awareness.	National Museum, Bloemfontein (NMB); Centre for Environmental Management (CEM), University of the Free State (UFS); Canis–Caracal Programme (CCP), UFS; Endangered Wildlife Trust (EWT), Carnivore Conservation Programme; Neil Viljoen Predation Management; Scientific Assessment of Livestock Predation in South Africa (PredSA), Centre for African Conservation Ecology (ACE), Nelson Mandela University (NMU); Predation Management Forum (PMF)
		Strauss 2009	Inferred	Local		
		van Niekerk 2010	Inferred	Local		
		du Plessis 2013	Inferred	National		
		Badenhorst 2014	Inferred	Local		
		Pohl 2015	Inferred	Local		
2	*3.1 Species Management*: Use holistic management regimes, focussing both on livestock and predator management. Use a combination of site-specific methods and rotate between methods to prevent habituation.	Avenant & du Plessis 2008	Anecdotal	Local	-	NMB; CEM, UFS; CCP, UFS; EWT; Neil Viljoen Predation Management; ACE, NMU; School of Biology and Environmental Sciences (SBES), University of Mpumalanga (UMP)
		Avenant et al. 2009	Anecdotal			
		du Plessis 2013	Anecdotal			
3	*2.1 Site/Area Management*: Livestock guarding dogs appear successful in certain situations. But, guard dogs also kill Black-backed Jackals.	Marker et al. 2005	Empirical	Local	-	Cheetah Conservation Fund
		du Plessis 2013	Anecdotal			
		Potgieter et al. 2013, 2016	Empirical			
		McManus et al. 2014	Empirical			
		Leijenaar et al. 2015	Anecdotal			

- What is the level of dispersal between various land uses and what drives this dispersal (*sensu* Minnie 2016)?
- To what extent, and under which conditions do Black-backed Jackals display compensatory reproduction (*sensu* Minnie et al. 2016)?
- Can "problem individuals" (i.e. sections of a population that consume more livestock/ungulates than others) be identified?
- What is the ecological role of the Black-backed Jackal (i.e. impacts on associated predator and prey populations)?

Predator and livestock management techniques: Relatively little research has focussed on the role of Black-backed Jackals as predators of livestock (Beinart 1998; van Sittert 1998; du Plessis 2013) and ungulates, as well as the various predator and livestock management methods employed to reduce livestock predation (e.g. du Plessis 2013; McManus et al. 2014). This limits our ability to effectively manage livestock and ungulate predation. Most information on these methods is contained in popular literature (du Plessis 2013). Therefore, research needs to focus on accurately assessing the efficacy of various management methods. Preferably this should be conducted within an adaptive management framework, which will assist in developing effective management regimes aimed at reducing human–carnivore conflict. Additionally, quantitative information on the extent of livestock and wildlife predation across the assessment region is required to substantiate reported losses, and provide scientifically defensible grounds for management decisions.

Potential research questions:

- What are the spatial and temporal patterns of predation on livestock/ungulates?
- Which factors drive variation in local predation patterns?
- What is the viability and efficacy of various management methods?
- Which variables influence the local efficacy of various management methods?

Table 5 (continued). Conservation interventions for the Black-backed Jackal (*Canis mesomelas*) 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
4	*4.3 Awareness & Communications*: Collecting and disseminating information on the efficacy of holistic management.	-	Anecdotal	-	The Predation Management Forum (PMF), consisting of livestock and game farming associations, disseminates information on environmentally sustainable management practices. Anecdotal evidence suggests that some farmers' perceptions have been swayed and they are adopting more holistic management strategies.	CCP, UFS; NMB; CEM, UFS; The Karoo Predator Project, Institute for Communities and Wildlife, University of Cape Town; PMF; PredSA
4	*2.1 Site/Area Management*: livestock herding (e.g. eco-rangers or herders).	-	Anecdotal	-	-	-
4	*2.1 Site/Area Management*: frightening devices.	-	Anecdotal	-	-	-
4	*2.1 Site/Area Management*: isolating vulnerable livestock (e.g. during lambing periods).	-	Anecdotal	-	-	-
4	*2.1 Site/Area Management*: concentrating management interventions prior to, or in, lambing periods.	-	Anecdotal	-	-	-
4	*2.1 Site/Area Management*: switching to livestock breeds that are less susceptible to predation.	-	Anecdotal	-	-	-
4	*2.1 Site/Area Management*: increase the number of alternate prey (e.g. medium-sized mammals) which may dilute predation on livestock.	-	Anecdotal	-	-	-

Economics: Even though Black-backed Jackals are the dominant predators of livestock in the assessment region, surprisingly little information on the extent of this predation is available (see Strauss 2009; van Niekerk 2010). Thus, researchers need to focus on estimating the extent of predation, the economic consequences of this, as well as the economic costs of employing various livestock and predator management techniques.

Potential research questions:

- What are the direct and indirect economic costs of predation?
- What are the short- and long-term costs and benefits of various management techniques?

Social: In many cases, the perception of the landowner is more important in driving management decisions than the actual predation impact (e.g. Minnie et al. 2015). However, there is a paucity of information on the perceptions of various stakeholders towards Black-backed Jackals, predation and associated management actions. Understanding these perceptions and their drivers may assist in developing sustainable management strategies. Without this information, the acceptance of any proposed management interventions is unlikely (du Plessis 2013).

Potential research questions:

- Who are the interested and affected parties?
- What drives the perceptions of these stakeholders?

Considering the interrelatedness of these various aspects, it is important that all stakeholders – including ecologists, social scientists, economists, wildlife managers, farmers, ranchers and government officials – contribute to the development of a sustainable, adaptive management strategy. Future research should be conducted systematically, as a combined effort, to ensure that the priority knowledge gaps are filled (see du Plessis 2013).

Ongoing research projects and research foci:

- Centre for African Conservation Ecology (ACE), Nelson Mandela University and University of Mpumalanga (UMP): Diet, reproduction, population structure, regional dispersal and the impacts of lethal management on population structure.
- Centre for Wildlife Management, University of Pretoria: Diet and social structure.
- Cheetah Conservation Fund: Livestock guarding dog programme.
- Endangered Wildlife Trust: Human–carnivore conflict.


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- Institute for Communities and Wildlife in Africa, University of Cape Town (UCT): Human–carnivore conflict and economics.
- Karoo Predator Ecology And Coexistence Experiment Project, Cape Leopard Trust: Human–carnivore conflict.
- Karoo Predator Project, UCT: Diet, spatial ecology and human–carnivore conflict.
- National Museum Bloemfontein and Centre for Environmental Management, University of the Free State: Ecology, socio-economics and effects of management on ecosystem integrity.
- North-West Parks: Diet, social structure, space use and interactions with top-predators.
- UMP and Rhodes University: Diet, human–carnivore conflict and livestock management techniques.
- University of Fort Hare and ACE: Diet and interactions with top-predators.
- University of the Free State and African Large Predator Research Unit: Human–carnivore conflict and diet.

Encouraged citizen actions:

- Report sightings on virtual museum platforms (for example, iSpot and MammalMAP), especially outside protected areas.
- Record and report predation on livestock and ungulate species.
- Individuals actively managing this species should report all the dead animals (trapped, shot or poisoned), as well as confirmed predation events, including photographs and GPS coordinates, to the national Predation Management Information Centre (PMIC; email: PredationMC@ufs.ac.za).
- Livestock farmers can assist by encouraging scientific research on their properties.
- Use holistic predator and livestock management methods. Additionally, employ these methods in an adaptive management framework to ensure the collation of information.
- Livestock farmers can actively monitor and record the effectiveness of management methods within an adaptive management framework. Through liaison with the scientific community, results can be accurately recorded and analysed to determine best-management practices.

Data Sources and Quality

Table 6. Information and interpretation qualifiers for the Black-backed Jackal (*Canis mesomelas*) assessment

Data sources	Field study (literature), indirect information (literature)
Data quality (max)	Estimated
Data quality (min)	Estimated
Uncertainty resolution	Maximum/minimum values
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.*