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Developing Alternatives to Protect Domestic Sheep from Predation in South Africa

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ABSTRACT: South Africa has approximately 8,000 commercial small livestock farms and 5,800 communal/subsistence farmers throughout the country. Reported rates of small livestock loss to predation range from 3-13% and 0.5-19% from communal farming areas. A range of predators exist on the African continent, but in southern Africa major livestock losses are primarily due to black-backed jackal and caracal. South Africans have been managing caracals and jackals for over 300 years with no elimination of predation. During the aforementioned time frame, producers have used and/or developed a number of techniques including lethal, nonlethal, and integrated predator damage management to address predation losses. In the Karoo area of South Africa, one producer decided that a new way needs to be developed after losing over 60 lambs in a month, while practicing continuous removal of caracal and black-backed jackal. His integrated predator damage management system includes using a prototype nonlethal collar system for sheep and lambs. The collars are used to train dominant pairs of predators to avoid predation while maintaining their territories and keeping transient predators out of the area. The system has now gone into production in South Africa and is being distributed by its inventor.

KEY WORDS: black-backed jackal, *Canis mesomelas*, caracal, *Caracal caracal*, livestock predation, nonlethal management

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INTRODUCTION

The largest agricultural sector in South Africa is livestock farming (69%) (DAFF 2016). Among the livestock farms, South Africa has approximately 24.6 million sheep and seven million goats on 5,800 communal/subsistence farms and 8,000 commercial small livestock farms (Meisner et al. 2013). Accordingly, the country depends on livestock production as a significant contributor to food security, clothing, and employment. It is also essential to support the communal farmers and the working class as it often contributes to multiple livelihood objectives and provides an opportunity to improve an individual's economic status (Randolph et al. 2007, FAO 2009). Within this agricultural production system, mesocarnivores, especially caracals (*Caracal caracal*; Felidae) and black-backed jackals (*Canis mesomelas*; Canidae), cause definitive negative socio-economic impacts when they predate livestock or wildlife (Avenant and Du Plessis 2008, Bergman et al. 2013, Avenant et al. 2016, Turpie and Babatopie 2018). Losses due to predation are substantial and rising, identifying predator management as one of the key economic costs to the farming and game ranching industries (Bergman et al. 2013, Du Plessis et al. 2015, Turpie and Babatopie 2018).

South African farmers' perception is that predator numbers are increasing (Avenant and Du Plessis 2008, Du Plessis 2013, Drouilly et al. 2018). Factors causing the possible increase in predator numbers include poor fencing, limited human presence, and the possibility that continuous predator removal operations over large parts in South Africa, especially over the last three decades, has led to compensatory immigration and breeding (Avenant and Du Plessis 2008, Minnie et al. 2016, 2018b). These perceptions are in accord with the decline in government support for commercial sheep farmers, including for fencing and predator control operations (Bergman et al. 2013, Drouilly et al. 2018, Natrass and Conradie 2018); the expansion of protected areas; the increase in game; weekend and hobby farms (Reed and Kleynhans 2009, Du Plessis 2013); and an increase in farmer unemployment (Western Cape Department of Agriculture 2017). Many producers believe that mesocarnivores have to decrease drastically to reduce depredation to acceptable levels (Du Plessis et al. 2015). However, livestock predation by mesocarnivores is rooted in their ethological and ecological plasticity, which allows them to persist despite centuries of population reduction efforts (Bergman et al. 2013, Minnie et al. 2016, 2018a).

Caracal and black-backed jackal occur throughout South Africa (Avenant et al. 2016, Minnie et al. 2016). They are the most important native predators that cause livestock losses (Blaum et al. 2009, Strauss 2009, Van Niekerk 2010, Thorn et al. 2012, Bergman et al. 2013, Badenhorst 2014, Kerley et al. 2017), and are increasingly responsible for losses in the game ranching industry (De Waal 2009, Bergman et al. 2013, Schepers 2016). Herein, the authors review alternatives to mitigate mesocarnivore predation in South Africa, with a focus on caracals.

Caracal Status, Ecology, and Behavior

Adult caracal males may weigh up to 30 kg (average 7-20 kg; females 5-14 kg) and stand 45 cm at the shoulder (Skinner and Chimimba 2005). Due to caracals being predatory animals in southern Africa (Avenant et al. 2016, Avgan et al. 2016), farmers in most provinces can manage them on their own properties without a permit; in some areas they may need a caracal hunting permit (Avenant et al. 2016). The latest estimate is that there are between 45,000 and 150,000 caracals in South Africa and, despite management efforts, caracals are not currently threatened in southern Africa while there is evidence of range expansion in Namibia and South Africa (Avenant et al. 2016, Avgan et al. 2016). The home ranges of territorial caracals overlap both within and between sexes, with a single male's territory typically overlapping that of a number of females (Stuart and Stuart 2013). The size of these home ranges can vary markedly depending on environmental variables such as habitat characteristics; the size, type, density and composition of prey available; and the degree of predator management (Avenant et al. 2016). Caracals quickly replace conspecifics that have lost their territories (Tensen et al. 2018) and can disperse or recolonize a vacant territory by migrating over large distances (Norton and Lawson 1985, Du Plessis 2013).

Caracals have a specialized diet but are also opportunistic in their feeding behaviour (Kok and Nel 2004, Pohl 2015). Smaller mammals [from ~15 g mice to 4.5 kg hyrax (*Procavia capensis*)] form the bulk of their diet, but they also regularly kill prey more than twice their size, including adult sheep (Avenant et al. 2016). They also opportunistically consume a variety of invertebrates, reptiles, and birds. Prey switching commonly occurs in response to spatial and temporal fluctuations in prey abundance (Avenant et al. 2016). Females have been observed selecting for larger size prey species when they have young (Avenant and Nel 1998, Avenant et al. 2016). A change in prey availability may therefore result in a change in this carnivore's diet (Avenant and Nel 2002, Kok and Nel 2004) while a change in its social behaviour may allow for more frequent access to concentrated livestock (Melville and Bothma 2006). Studies have found that small livestock in the caracal's diet has increased during times of lower natural prey densities, but also during sheep lambing seasons; the latter which, in much of South Africa's summer rainfall season, also overlaps the natural prey low-density season (Avenant and Du Plessis 2008, Pohl 2015, Avenant et al. 2016) Although not common, caracals have also been found to engage in surplus killing (Stuart 1986, Brand 1989, Weisbein and Mendelssohn 1990, Stuart and Hickman 1991), and scavenging (Avenant et al. 2016, Drouilly et al. 2018). Avenant and Nel (1998, 2002) found that only non-territorial caracals scavenged, strengthening the belief that these individuals experience the highest energy stress as they constantly have to evade territorial individuals, but do not know where the areas of highest prey density are, and are the individuals most likely to feed on non-native prey, including small livestock. Accordingly, there are four general time periods when small livestock farmers have the highest risk of losing animals to caracal: when natural prey densities are at the lowest, when caracal females have young, during or just after lambing, and when territorial caracal(s) are displaced/taken out and more non-territorial individuals can spend more time in the empty territory(ies).

REVIEW OF PREDATION MANAGEMENT OPTIONS

Du Plessis et al. (2018) listed and discussed 29 known predation management options currently used for caracal and black-backed jackal in South Africa. Van Niekerk (2010) surveyed 1,424 farmers in the five major small livestock producing provinces of South Africa (Blaum et al. 2009, Du Plessis 2013, McManus et al. 2015, Minnie et al. 2016) and determined the most commonly used options were lethal management tools (i.e., shooting), often in combination with a number of nonlethal tools. These preferences, and their success, differed between the five provinces, with the type of farming (e.g., commercial vs. communal/subsistence); husbandry technique used; composition and density of natural prey; small livestock composition; natural habitat availability; substrate (e.g., sandy vs. rocky); topography and climate; season (e.g., the reproductive season of livestock, natural prey, and the carnivores); and financial capabilities of livestock owners all playing major roles (Du Plessis 2013, Avenant et al. 2016, Turpie and Babatopie 2018). Emotions and desperation also have a major effect, and farmers may revert back to unselective lethal techniques, even putting out poison, under some circumstances (Avenant and Du Plessis 2008, Du Plessis 2013, McManus et al. 2015). Few studies have, however, scrutinized the effectiveness and cost-effectiveness of different lethal and nonlethal methods. Of those, all suggest that most of these methods, on their own, are not very effective. Van Niekerk (2010), for example, found that in the Western Cape Province the use of professional hunters was largely ineffective, while kraaling small livestock at night was effective. Badenhorst (2014), in the North West Province, reported that specialist hunters, hunting with dogs, and guarding animals were successful in decreasing numbers of livestock losses while other lethal methods had no impact, while McManus et al. (2015), in a specific region in the Western Cape Karoo, reported that nonlethal methods were significantly cheaper and four times more effective than lethal methods.

Below, we rank and describe the use of the five most common lethal and nonlethal management techniques used in South Africa today, as listed by Van Niekerk (2010), to give more perspective to the adaptive predator management case study discussed herein.

Lethal Strategies

Shooting

Predator culling and shooting is the most commonly reported predation management method across all types of livestock farms in South Africa (Van Niekerk 2010, Badenhorst 2014, Schepers 2016, Du Plessis et al. 2018). The status quo is that South African state-supported predator removal programs have been abandoned (Bergman et al. 2013). Recent upsurges in livestock losses have made farmers question the wisdom of this policy. In several cases previously state-supported hunting clubs have been recreated as private operations to which neighbors contribute funds proportional to the number of caracals and black-backed jackals removed on their land (Avenant et al. 2016).

Take with Hunting Dogs

Hunting dogs have been used extensively in the past to capture problem predators in South Africa (Hey 1964, Pringle and Pringle 1979). The removal of caracals with a well-trained hunting dog pack has been found to be selective (Du Plessis et al. 2018) as dog packs can pick up the scent of a caracal from a dead sheep, track it down, chase it up a tree and then wait for the hunter to remove it (Hey 1964). The selectivity of using hunting dogs may be increased if employed soon after a predation event (Snow 2008), but the success can be affected by seasonality, climatic conditions, and topography (Hey 1964). Currently, it is illegal in South Africa to use hunting dogs to capture a predator although they can still be used to chase or point (i.e., dogs search for the target and bark when they find it) (NEMBA 2004).

Cage Traps

Individual caracals often make use of the same routes as conspecifics, irrespective of whether they are territorial or non-territorial individuals (Avenant and Nel 1998, Avenant and Steenkamp, pers. observ.). Compared to black-backed jackals, caracals are extremely curious and easy to lure into cage traps covered and set along these routes, to such an extent that many farmers leave their traps virtually untouched at the same sites, for years (Brand 1989, Avenant and Steenkamp pers. obs.). Cage trapping can also be very specific for caracals that cache and return to their kills, if the trap is set close to the kill site (Du Plessis et al. 2018). Cage trapping is therefore a relatively successful and inexpensive method for trapping caracal, that can be species selective and humane if non-target species are released and traps are checked on a daily basis (Brand 1989, NEMBA 2004, Du Plessis et al. 2018).

Foothold (Soft-Catch) Traps

Foothold traps have been very effective in capturing caracals (Rowe-Rowe and Green 1981, Brand 1989, Van Niekerk 2010, Viljoen 2015). The selectivity of foothold traps can be improved through use of pan tension devices, offset or padded jaws, and feline specific lures (McKenzie 1989, Kamler et al. 2008). Currently, only foothold traps with offset and/or padded jaws (soft-catch traps) are permitted in South Africa (NEMBA 2004).

Toxicants

The use of toxicants is growing in parts of South Africa (Van Niekerk 2010, Natrass and Conradie 2018). Toxicant collars only target predators that directly attack livestock. The use of toxicant collars in South Africa requires a valid permit and only sodium mono-fluoroacetate (Compound 1080) can be used within pouches attached to the collars (NEMBA 2004, Du Plessis et al. 2018). Collars have been used effectively on sheep when a loss to a caracal occurs, but should be removed as soon as the losses have stopped to prevent evasive, learned, behaviour (Avenant et al. 2009, Du Plessis et al. 2018).

Nonlethal Management Strategies

Exclusion Fencing

Fencing is often preferred as the leading nonlethal predation management method on livestock farms in South Africa (Van Niekerk 2010, Badenhorst 2014, Schepers 2016, Du Plessis et al. 2018). Fencing is often used to keep livestock out of areas preferred by predators. South African farmers either enclose their entire property, areas within their farms, or smaller pastures for lambing purposes (Du Plessis et al. 2018). Jackal-proof fencing (wire mesh or closely-spaced wire strand fences, with a minimum height of 1.3 m; Du Plessis et al. 2018) is less effective at excluding species that are able to climb or jump over fences (Viljoen 2015, Predator Management Forum 2016). Electric stranded-wire fences with short distances between strands, or woven wire fences supplemented with live strands, have protected livestock from caracal (Bowland et al. 1993, Van Rooyen et al. 1996).

Herding and Kraaling

The use of human herders is widely practiced by subsistence farmers in South Africa, as across the African continent (Ogada et al. 2003, Webb and Mamabolo 2004, Constant et al. 2015, Hawkins and Muller 2017, Du Plessis et al. 2018). In some high predation areas, kraaling has also become popular among those commercial small livestock farmers that have decreased their sheep numbers (Van Niekerk 2010, Avenant and Steenkamp pers. obs.). Herding is often used in association with kraaling (i.e., where livestock are kept in protective night enclosures) (Ogada et al. 2003, Webb and Mamabolo 2004, Van Niekerk 2010, Badenhorst 2014, Constant et al. 2015, Hawkins and Muller 2017).

Livestock Guard Animals

A variety of livestock guard animals are used in South Africa, with the most popular being dogs (*Canis lupus familiaris*), llamas (*Lama glama*), alpacas (*Vicugna pacos*), and donkeys (*Equus asinus*) (Du Plessis et al. 2018). Anatolian livestock guarding dogs have been proven to be an efficient form of nonlethal predator control against caracals (Herselman 2005, Leijenaar et al. 2015, Potgieter et al. 2016, Du Plessis et al. 2018).

Habitat Management

Habitat selection by caracals is driven in part by their selection of cover to use for ambushing prey (Norton and Lawson 1985), and the availability of prey species (Avenant et al. 2016). The management of caracal predation may, therefore, be partly dependent on the conservation of sufficient natural habitats to decrease their reliance on domestic prey. Management decisions that reduce vegetation structure and cover will have a negative impact on small mammal diversity and density (Blaum et al. 2007, Avenant 2011). Thus, ensuring the conservation of small mammals may have the benefit of providing an alternative food source to predators (Blaum and Wichmann 2007, Avenant and Du Plessis 2008, Blaum et al. 2009, Ramesh et al. 2017, Minnie et al. 2018a).

Nonlethal Collars

Nonlethal collars are today produced from plastic or metal and are used to protect livestock, primarily small livestock, against neck and throat bites (King 2006, Snow 2008, Du Plessis et al. 2018). Nonlethal collars work on the assumption that when a predator is not able to bite through the collar, it will eventually be discouraged and give up attacking livestock. They are considered effective when used over short time periods, as predators, especially black-backed jackal, quickly get habituated to this method (Du Plessis et al. 2018).

CASE STUDY

Adapting to an Integrative Predation Management Plan

The management of caracals is often directed intuitively, and based on assumptions, personal experience, or word of mouth within the farming community (Avenant and Du Plessis 2008). For many small livestock farmers in South Africa today, this means the eternal quest to eliminate caracals and black-backed jackals before and during their lambing seasons; a form of predator control that ignores "the effect that social structure has on territorial and breeding behaviour (and, as a result, its effect on population increase and its indirect effect on numbers, evenness, and diversity of prey species)" (Avenant and Du Plessis 2008). Mr. Eddie Steenkamp, a Dorper sheep farmer adjacent to the Karoo National Park in the Western Cape, South Africa, decided to explore alternative methods to end this eternal predation battle that he just could not win. Between 1986 and April 1996, he had lost an average of 150 lambs annually to predation, and at times up to 60 lambs per month (Avenant et al. 2009). Over the years he has learned that caracal was the predator, and that every year his losses peaked somewhere between May and September (end-autumn to early spring), overlapping with his lambing season. From (primarily popular) scientific publications (e.g., Avenant 1992), he had learned more about the ecology and behavior of caracal (e.g., that a natural network of overlapping territorial caracal may limit the time that conspecifics spend in that area), but also about the caracal's prey species. Amongst others he concluded that his end-autumn to early-spring losses aligned with the natural low prey density season for caracals. He wondered: Would it be possible to cut his losses over this specific period, while now protecting local territorial male and female caracals?

In 1994, he started the development of protective collars for his sheep and lambs, with his first attempt made from 1 mm HDPE plastic. These were not successful (not strong enough) as lambs were still killed by the throat, and he replaced it with a 50-mm-wide (car) latex inner tube around his lambs and adult sheep's necks, mainly for the human associated smell of it. This stopped predation only for about three months, and he resolved to adding a foreign sound: bells (i.e., a can with a small ball bearing enclosed), hung on the latex collar. For more than three years with this combination he had virtually no losses, and his PAL (Protect-a-Lamb) bell collars were registered [Protect-A-Lamb (Pty) Ltd. Reg. 9915037/07]. More farmers started applying the method, with varying success, presumably dependent on the farmers' diligence to apply unique farm management principles (Avenant et al. 2016), together with the prescribed instructions. When he could not get enough inner tube, he substituted it with polypropylene webbing and a small vapor block for the release of odors. Predation losses were low, but at times still occurred. This led to Steenkamp's third application, in early 1997: whenever predation occur, he would move the largest percentage of his stock to another pasture while replacing the bell collar of those that stayed behind with toxicant collars (Livestock Protection Collars, imported from the U.S.; since 2003 he has developed his own). As soon as the specific culprit(s) were taken and losses stopped for a week, the toxicant collars would be removed.

With this rotational, adaptive predator management system Steenkamp's lamb and young ewe losses decreased from 10.4% (of his total livestock number) in the early 1990s to 0.4% by 1997, and the number of predators removed declined from >40 to <5 per year (Avenant et al. 2009). Meticulous record keeping of sheep and lamb numbers, throughout, enabled the comparison of caracal impact on sheep production when predator management changed from eliminating predators to maintaining territorial caracals.

In 2013, Mr. Steenkamp incorporated his fourth invention, now focusing on protecting the territorial caracal/not having to lethally remove them during the lean season of low natural prey density. He added eight sharp nails into hard plastic collars, which also include reflectors, odor pads, and the PAL bell. Following five years of monitoring, these nail collars presumably cause an aversive response due to the perceived pain from the nails when biting the neck of the animal, "training" territorial individuals to avoid similar collars on other sheep and thereby keeping his protection against transient caracal in place. The system now uses three phases: Phase 1, PAL collared bells; Phase 2, PAL bells with the inclusion of reflectors, exposed nails and odor pads, and; Phase 3, the use of toxicant collars. From 2013 to 2018, Mr. Steenkamp lost an average of only 13 lambs a year, while fewer toxicant collars had to be used. Additional information on the Protect-A-Lamb system can be found at https://protect-a-lamb.co.za and at https://www.facebook.com/pages/category/Agricultural-Service/Protect-A-Lamb-Pty-Ltd-525353140871488/.

CONCLUSIONS

Due to excessive livestock losses in South Africa, farmers often resort to removing predators (Du Plessis et al. 2018). This may, however, be a cause of increased livestock losses as caracals quickly replace conspecifics that have lost their territories (Minnie et al. 2016, 2018a,b, Tensen et al. 2018). These transients that move into the new area may prey more opportunistically and are expected to be more prone to taking nonnative prey, including small livestock (Avenant and Du Plessis 2008). On the other hand, securing a defensive network of dominant territorial caracal individuals, together with supporting healthy prey populations, is expected to curb livestock losses (Avenant et al. 2018). Based on our case study, Mr. Steenkamp largely disallowed caracal predation through the protection of territorial caracal and preventing the habituation of conspecifics to his management methods.

DISCLAIMER

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