

Management plan for brown hyena (*Hyaena brunnea*) populations in
South Africa

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<https://sanbona.com/blog/animals-at-sanbona/the-elusive-brown-hyena/>

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Executive Summary

Brown hyena, *Hyaena brunnea*, is a species that is found throughout the southern portion of Africa, including South Africa. The population of brown hyenas in South Africa has continuously been decreasing and is currently around 1,000 individuals. This drop in the population size has caused the brown hyena to be considered vulnerable on the International Union for Conservation of Nature (IUCN) red list. The main conservation issues the amount of funding going towards hyena's conservation is low. Also, the ecosystems that the brown hyena prefer live in have been turned into farmlands throughout South Africa. Another concern is the poaching of the species illegally, mainly to try and protect the farmers' livestock. The goal of this management plan is to increase and maintain a sustainable population of brown hyenas in South Africa. The objectives of the management plan are to decrease the number of negative interactions with brown hyenas, implement educational programs, increase tourism that focuses on hyenas, increase the population of prey species, and to increase the amount of protected land throughout South Africa. To decrease the negative interactions between the brown hyena and humans, hyena-proofed fencing will be distributed to all farmers to protect their livestock. Implementing educational programs will include the residents of South Africa, rather than just the students, so that everyone gets an understanding of the importance of brown hyenas. An increase in ecotourism will be accomplished by creating tours that just focus on the hyenas in the area and increasing the number of prey species will start with captive breeding of selective species. The increase in protected land will start to create more land that there are more protections for the brown hyena, so they are hunted or poached. If these actions are implemented there will be an increase in the population and they will be able to reach a sustainable number, but if nothing is done, then the population will continuously decrease until it reaches extinction.

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Introduction

The brown hyena, *Hyaena brunnea*, population was high throughout South Africa until the late 1980s to 1990s, when a drastic decrease in individuals caused the species to become near threatened. The cause of this decrease was mainly due to conflict with humans (Yarnell et al. 2016). When a hyena was spotted, they were typically shot or chased by dogs and eventually shot by the people in that area (Yarnell et al. 2016). There is still a population of brown hyena throughout South Africa, but only around 1,000 individuals are left (Wiesel 2015). Another reason for this decrease in the population size throughout South Africa are due to the increasing numbers of farms throughout the land (Kent and Hill 2013). Declining population numbers of brown hyena should be a cause for concern because they are a huge impact in the ecosystems around them. The brown hyena is a scavenger, which keeps the ecosystem free of carrion, and it can help return the nutrients back into the ecosystem by eating these dead animals (Owens and Owens 1978). Without a large population of brown hyenas in South Africa, there will be an overwhelming number of carrion throughout the plains. Due to a lack of research done on the brown hyena, a surrogate species was chosen to look at the survival rates and fecundity of the species. The surrogate species chosen was the spotted hyena (*Crocuta crocuta*), which is the closest relative in South Africa to the brown hyena (Mills 1984). However, there are some differences throughout their mating systems. The brown hyena has a hierarchy with an alpha female and alpha male will reproduce yearly, and the other females in the clan will try to mate, but it normally does not happen (Owens and Owens 1996). The clan will typically try and protect the cubs causing a rise in the survival rates compared to the spotted hyena (Owens and Owens 1996). The spotted hyena does not have the same hierarchy that the brown hyena has, all of the female spotted hyenas will attempt to mate, while in the brown hyena only the alpha female will

mate (Watts and Holekamp 2009). These differences may cause some differences in the data, but all data included is from the study on the spotted hyena. Current population models are showing a decrease in the brown hyena population, until there is no individuals remaining in about 15 years (Figure 1). Without any management taken place, the decrease in the population size of the brown hyena will eventually end with the extinction of the species. Survivorship of the sub adults and adult one stages of their lives are the most important for management (Appendix A). The elasticity matrix shows that the most important age groups for fecundity are the Adult 1 and 2 stages of their lives (Appendix B). Management of this plan has focused on increase the survival rates of sub adults and adult 1 stages by 50% (Figure 2), and the increase of the fecundity of the adult one and two stages by 45% (Figure 3). This management plan explores alternative methods to manage for the brown hyena, including educational programs and ecotourism to increase the amount of funding going toward hyena conservation.

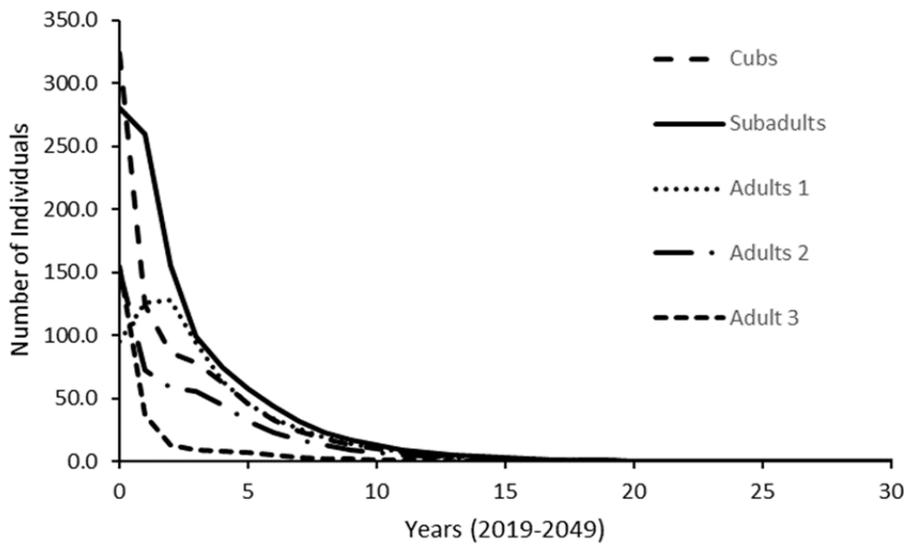


Figure 1. The current population model for the brown hyena at each life stage.

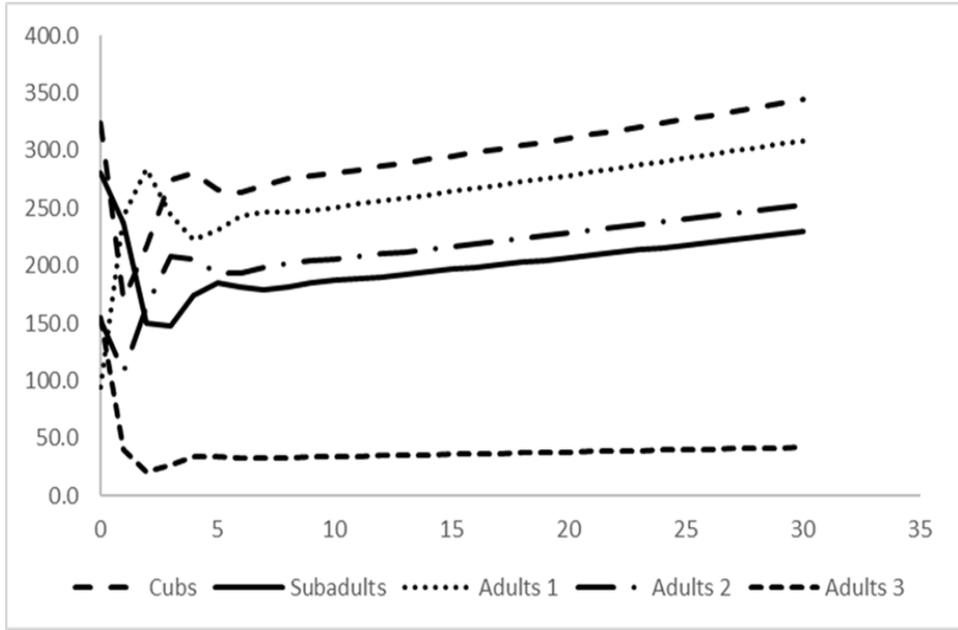


Figure 2. The projected population model for the brown hyena when increasing the survival rates of the sub adults and adult one stages.

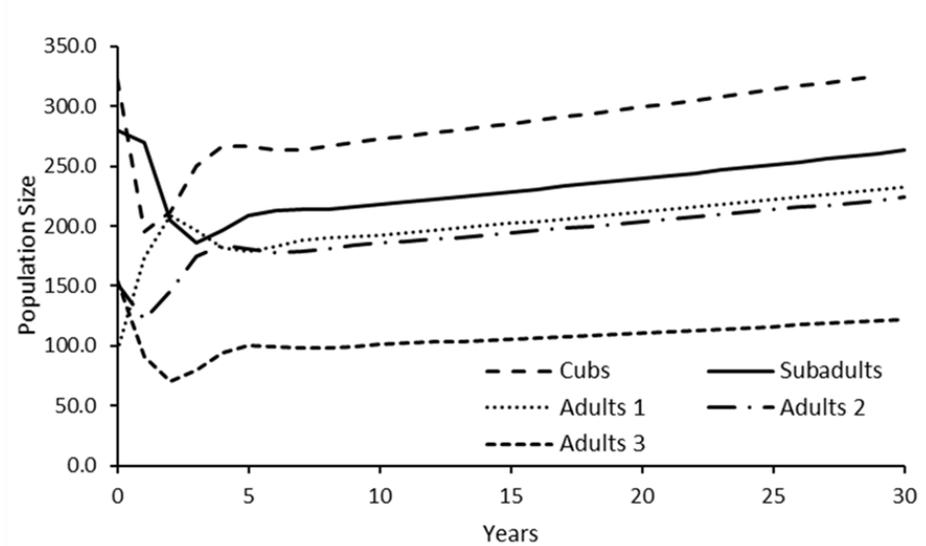


Figure 3. The projected population model for the brown hyena when increasing the survival rates and fecundity of the adult one and adult two life stages.

Natural History

The brown hyena is the second largest hyena and can reach up to 51 to 63 inches long and weigh between 75 to 160 pounds (Yarnell 2016). They can be distinguished from any other hyena by the long, shaggy hair, that is dark brown or black on the body and tan on the shoulders and neck. The neck hair can grow upwards of 12 inches, which is relatively long compared to the rest of the hair on the legs, face, and ears (Yarnell 2016). The forelegs are much larger than the rear legs, and have a horizontal stripping going on them, making it easier for them to climb a hill/mountain (Wiesel 2015).

Reproductive Success

The brown hyena has a social hierarchy, and the dominant individual in both sexes have had a huge impact on the reproductive success (Owens and Owens 1996). This hierarchy is not based on age, but rather who the strongest individual in the group is (Owens and Owens 1996). The male and female brown hyena are both on the same level in this hierarchy, so all the other individuals in the clan have the same amount of understanding for each of them. The dominate males and females both saw an increase in reproductive success (Owens and Owens 1996). Typically, courtship can last three to six nights, the average gestation period is about 97 days, and an average litter size of a female was 1-7 cubs (Owens and Owens 1996). There has been no documentation on the success rate of juveniles reaching adulthood. Due to a lack of information on the brown hyena, a surrogate species was chosen to assess the population models created. The species chosen was the spotted hyena, *Crocuta crocuta*, which was discussed in the introduction. The survival rate of the sub adults and adult one stages are the most important to manage for, but

the most important stages to manage for fecundity are the adult one and two stages (Figure 4; Appendix A and B).

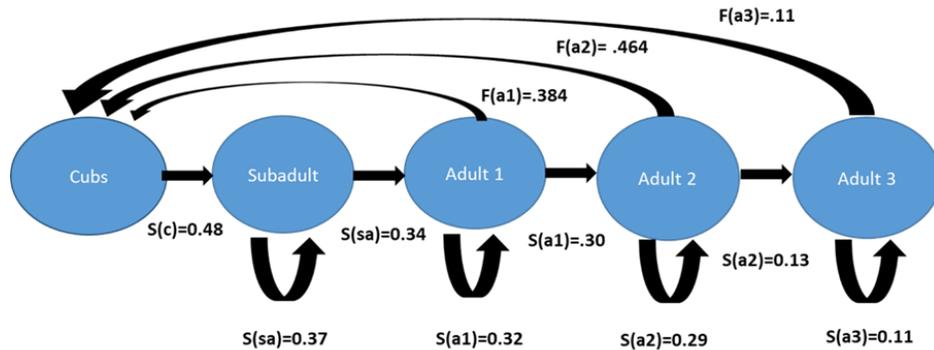


Figure 4. Life cycle diagram of the brown hyena with the probability of survival rates included in each life stage

Distribution

The range of the brown hyena is from southern Africa, into some of the arid parts in the southwestern section of Angola, southeastern Botswana, and the northern and western Cape regions of the Republic of South Africa (Wiesel 2015). 90 percent of the total population of brown hyenas live in Botswana (Wiesel 2015). The range that the brown hyena occupies has severely decreased since the early 1900s (Stuart et al. 1985). Brown hyenas can occupy many different types of habitat, but due to the increase in civilization in Africa, there has been less suitable habitat for the brown hyena. The areas where the brown hyenas are located are mainly the southern part of Africa (Figure 5).



<http://www.wild-about-you.com/GameBrownHyena.htm>

Figure 5. Current distribution of brown hyena in Africa

Diet

The brown hyena has a highly variable diet, based on where they are living. Brown hyenas that live near the coast of Namibia have been documented to have eaten things such as baby seals, fish, birds, African wild cats, and even sometimes jackals (Kuhn et al. 2008). Due to a decrease in suitable habitat for this species, they have also had to adapt to some new foods as well. If someone did not adequately fence their livestock in, and it escapes and is wandering around, then the brown hyena has been documented to have attacked and kill these cattle (Fourvel and Mwebi 2011). Normally this will only happen at night, because hyenas are normally nocturnal hunters, but if they are in a certain situation they may attack during the day. The diet of the brown hyena will depend on where they are located, and the impact that humans have had on the environment. They will also eat insects, fruits, bird eggs, and sometimes even other plant material (Wiesel 2015). Sometimes they will eat the fruits and plant material for water because they live in an arid environment and water becomes very scarce (Wiesel 2015). A brown hyena's diet is normally composed of eating small mammals, such as field mice (*Apodemus sylvaticus*), as well as eating young antelope (several species of African antelope), infant cattle, goats, and sheep (Eaton 1976). There have been a few cases where the brown hyena was documented eating other predator species, such as fox (*Vulpes vulpes*) and smaller hyenas (Eaton 1976). The overall best diet for a brown hyena has to be the small mammals and young antelope, as well as eating berries if necessary.

The age of the brown hyena can also affect what type of diet they will have. When a pup is born they will be on their mother's milk for up to 15 weeks (Owens and Owens 1978). After their teeth have grown in, they begin to go out and scavenge with the clan. They are dependent on the other clan members to show them where the food is, up until they are around two years old

(Owens and Owens 1978). During this time period they are normally scavenging for dead carcasses, but if there are very few prey species in the area than they might have to resort to eating insects, fruits, bird eggs, and other plants (Wiesel 2015). After the age of two they are normally able to find food by themselves.

The area that the animals live in will also have a huge impact on what their diet consists of. If the hyena is brought up on the coast then they will primarily eat baby seals, fish, birds and bird eggs (Kuhn et al. 2008), but if they grow up more towards the center of the country than they are more likely consume prey, such as small mammals and young antelope (Eaton 1976). If the clan is an area with high agriculture, mainly cattle, sheep, and goat farmers, then those may become part of the diet as well. There have not been many studies, but there were cases that found that a clan of hyenas have killed multiple cattle, sheep, and goats in one area (Fourvel and Mwebi 2011).

The diet of a brown hyena is highly variable, and they can adapt to eat a lot of different types of foods. The factors that affect what the clan of brown hyenas will eat is mainly based off of where they are, and what is available. They have been documented eating many different types of food, from meat to berries, which gives them a better chance of surviving. Water is also difficult to come by sometimes, which is why their diets will consist of eating berries and other plant materials.

Habitat/Cover

Brown hyenas live in a variety of different habitat types, from desert areas with less than 100 mm of rainfall each year, to open savannah-woodlands that can get up to 700 mm of rainfall (Yarnell 2016). They require some type of cover in which they can hide in during the day to stay

out of the heat (Yarnell 2016). This species is normally nocturnal, so they try and find areas that are rocky or mountainous areas with bush cover (Wiesel 2015). Brown hyenas will live in a wide variety of habitat but tend to choose habitats that have cover that can be used for hunting and sleeping. They use the cover to allow them to hunt, mainly on insects, bird eggs, and the occasional small mammal (Wiesel 2015).

The brown hyena normally will not use the cover to escape predators, because the only species that hunt them is their bigger relative the spotted hyena and lions (*Panthera leo*) (Eaton 1976). The cover is used to help them hunt, while looking for prey, and will allow them to stay out of the sun to cool off (Yarnell 2016). When there are pups, they will usually be in areas with high densities of bushes or tall grasses to try and keep the pups hidden (Owens and Owens 1978). They try and stay in areas like this until the pups are large enough to defend themselves. Once the hyenas have grown up and are able to defend themselves, they are able to travel and immigrate to new places (Owens and Owens 1978).

The most suitable habitat for the brown hyenas are the open savannah woodlands, with some mountain like areas around (Yarnell 2016). This type of habitat is filled with tall grasses and brushes that the hyenas can use to lay under to escape the heat from the sun. Humans have been moving into these areas and have been converting these large open areas into agricultural fields and pens (Fourvel and Mwebi 2011), which has decreased the amount of suitable habitat for the brown hyena.

The problem with this is the fact that it is taking land away from the hyenas, when they barely have any land left that is preserved. Another problem is the fact that they are eliminating the prey species that the brown hyena would normally be eating, and the decrease in the number of prey species is due to the increase in destruction of habitat by the farmers. (Fourvel and

Mwebi 2011). The destruction of the habitat and loss of prey species means that the brown hyenas need to resort to eating the cattle and other livestock in the area (Fourvel and Mwebi 2011). This is causing the farmers to take a turn and retaliate for all of their lost livestock by killing all of the hyenas they see (Eaton 1976). If this trend continues and there continues to be more and more agricultural fields created, than the species will continue to have to resort to eating the livestock, and eventually the farmers are going to end up killing all of the hyenas in the area. Another problem is if the environment keeps getting taken by humans and destroyed by humans, then soon there will be no area for the pups to grow up which will ultimately cause a decrease in the population size.

Species Needs **Background**

The population of the brown hyena has been drastically decreasing since 1986 in South Africa, and now they are a near threatened species with an estimated population size near 1,000 in South Africa (Wiesel 2015). The decrease in the population is caused by many different variables. The biggest reasons for this drastic decrease in population size is the decrease in prey species (Fourvel and Mwebi 2011), decrease in suitable habitat, and the increase in other large carnivores in South Africa as a competitor for food (Ray et al. 2005). There are three different types of hyenas in South Africa, the brown hyena, the spotted hyena, and the aardwolf (*Proteles Cristata*). The spotted hyena is the largest of these three hyenas followed by the brown hyena and then the aardwolf. Another cause for the decrease in the brown hyena was due to the increasing amount of interactions with the people in the area. The people will typically kill the animal as soon as it is spotted (Yarnell et al. 2016).

Ecological Factors

The brown hyena (*Hyaena brunnea*) is a scavenger species and fills an important role for the ecosystems (Fourvel and Mwebi 2011). They help to maintain certain species of rodents, and consume already dead animals. (Kuhn et al. 2008). This not only helps to keep the ecosystems by eliminating a rotting corps, but it also helps to reduce the amount of rodents in the area. The increase in other large carnivores has caused a decrease in the number of brown hyenas in the area because they are starting to fight and kill the brown hyena and compete for the same prey species as the brown hyena. Another cause for decrease in the population is due to a decrease in habitat suitability, since humans are turning the suitable areas into agricultural areas (Ray et al. 2005). Brown hyenas need an area with lots of high grasses and bushes to hide in when trying to mate. The brown hyena like when it is the wet season so the vegetation has time to grown, allowing for all of the resources to be utilized (Owens and Owens 1996). The increase in the amount of agricultural lands throughout South Africa, has caused an increase in interactions between the residents and the hyenas.

Economic Factors

Economic factors have many different impacts on the brown hyenas. One study found that the brown hyenas were the reason for 40% of all the deaths of livestock in South Africa in 2014 (Fourvel and Mwebi 2011). Most natives in South Africa do not want to help try and conserve this species. Due to the amount of livestock killed, it is hard to get funding for the brown hyena (Fourvel and Mwebi 2011). The African Wildlife Foundation is being used to try and gain funding towards the brown hyena conservation (Ray et al. 2005). Most of the funding is not being used for any hyenas though, the funding is going towards the other large carnivores in

South Africa (Ray et al. 2005). The funding in South Africa is not regulated very well, most of the funding goes towards larger carnivores, like lions, because most people do not think highly of the hyenas. The majority of the National Parks benefit the spotted hyena over the brown hyena drastically (Yarnell 2016). The parks that are meant to protect the brown hyena are not even in their range (Ray et al. 2005). Over 60% of the population in South Africa is not found in the areas where they are being protected (Yarnell 2016). Another problem is they are being hunted as a trophy animal (Yarnell 2016). With these trophy hunts happening, it does provide a certain percentage of money to the country, to put towards the conservation of the animals.

Sociocultural Factors

Brown hyenas are barely used in traditional medicines (Yarnell et al. 2016). Sometimes the glands and organs will be used by the natives, but this rarely happens (Yarnell et al. 2016). The main sociocultural issue with the brown hyena is their predation on livestock (Fourvel and Mwebi 2011). The native South Africans are farmers, and a lot of them have livestock, which they use to feed their families. When cattle or other livestock are killed, most people will instantly blame hyenas, even though they are more of a scavenger than a hunter (Kuhn et al. 2008). Most of the natives in South Africa believe that all hyenas are “evil” and they do not believe that they should live, therefore they end up killing them when they see them (Mills 1984).

Legal Factors

NEMBA § 57 states that it is illegal to kill any species that is threatened or endangered, but it is rarely enforced upon the South African people (Yarnell et al. 2016). It is relatively easy to obtain a permit in South Africa to hunt and kill brown hyenas. All a farmer must do to obtain a

permit is request one due to a decrease in the number of their livestock (Fourvel and Mwebi 2011). Most of the native South Africans that were farmers are able to obtain this permit in case they were ever in need of being able to kill a hyena. Other than the permit that you must obtain, there are not any major actions taken against people who do take hyenas (Yarnell et al. 2016).

Species Management

Goals and Objectives

Goal: Increase and maintain the population of brown hyena in South Africa from 2019-2039.

Objectives:

1. Decrease the number of negative interactions with brown hyenas in South Africa by 50% over the next 15 years.
2. Increase education to show the importance of brown hyena conservation to 75% of the South Africans over the next 15 years.
3. Increase the amount of money coming in from ecotourism by 50% to go towards brown hyena conservation over the next 10 years.
4. Increase the amount of protected land to 50% to help protect the brown hyena over the next 20 years.
5. Increase the survival and fecundity rates of brown hyena adults in South Africa by 40% over the next 20 years.

Actions:

Objective 1: Decrease the number of negative interactions with brown hyenas in South Africa by 50% over the next 15 years.

Action 1.1: Create and distribute hyena proof fencing for the farmers throughout South Africa. Most land is taken from the brown hyena is due to farming in South Africa, which is also decreasing the abundances of the prey species in the area (Fourvel and Mwebi 2011). This leads to a greater chance of the brown hyena entering onto the farm land and killing the livestock. They then become reliant on the livestock leading to the killing of the hyena (Fourvel and Mwebi 2011). By distributing a fencing that keeps the hyenas out of the pastures, it will create a barrier to keep the livestock in and the hyenas out.

The cost and effectiveness of this strategy has not been researched a lot, and may be a lot harder than originally anticipated. There must be more research done on this action before implementing it.

Action 1.2: Install an insurance plan for the farmers on their livestock. Give the farmers an insurance incentive to keep their livestock in their pens, rather than allowing them to wander freely. An insurance plan that can protect the farmers' livelihood will allow them to feel more comfortable with helping conserve land for the hyenas (Kent and Hill 2013). This insurance plan will allow the farmers to claim any money lost from the killing of their livestock by hyenas. They will be able to file for an insurance claim if their livestock has been predated on while inside the fencing only. If the incident happens outside of the created fences, then the insurance plan will become invalid.

Action 1.3: No action. If no action was taken to protect the farmers' livestock, there would still be a negative interaction between the brown hyena and natives. These negative interactions would continue to increase due to the increase in

agricultural conversion (Fourvel and Mwebi 2011, Kent and Hill 2013). Brown hyenas will be killed to try and protect the livestock, therefore there will be a decrease in the population of brown hyenas in South Africa.

Final Course of Action: Employ Action 1.1 and 1.2 to meet Objective 1

Assessment Protocol: To assess the negative interactions between the natives and the brown hyenas, a user-friendly multiple-choice survey will be sent out, to better understand the public's focus on brown hyenas (Appendix III). Surveys are an effective way of trying to figure out how much the public knows about a certain species (Vincent and Thompson 2002). The survey will first be sent out in 2019, to determine the amount of negative interactions in the population. In the year 2034, after performing Action 1.1, the same survey will be sent out to determine whether the negative interactions have decreased over the 15-year span, or not. If there is no improvement in the amount of negative interactions throughout South Africa, then other actions will need to be put into place.

Objective 2: Increase education to show the importance of brown hyena conservation to 75% of South Africans over the next 15 years.

Action 2.1: Use wildlife educators to focus on changing the perception of the brown hyena in the natives, to alter their negative emotions towards them. Using educators to try and change the attitude of people has been shown to be more effective than just increasing the knowledge of the people by using flyers and pamphlets (Ray et al. 2005). The educational programs would be open to the entire community, allowing anyone to be able to attend. Educational programs are already being offered at the schools within South Africa (Ray et al. 2005), so we

will need to get the older people of the community to join. The way we can increase the amount of people from the communities to join, we will need to implement meetings and gatherings throughout the towns. By improving the native South Africans perspective on the brown hyena, it will allow the population to continue to increase.

Action 2.2: Create and hand out flyers and pamphlets. Sending out pamphlets and flyers will allow everyone the opportunity to see the importance of brown hyena conservation. Pamphlets and flyers are not the most useful way of portraying the information to the communities (Gutierrez and Jacobson 1994), these flyers and pamphlets will also have the dates that meetings will be held for anyone to join. The pamphlets and flyers will also have some information on it about the brown hyena, and some of the importance, but will also encourage them to join the meetings to learn more.

Action 2.3: No action. The native South Africans will continue to kill all of the brown hyenas in the area. They will do this because they think that the brown hyena will possibly harm them and their livestock (Fourvel and Mwebi 2011). They will continue to believe that the hyenas are the cause for all of the killings of the livestock in the area. The population of the brown hyenas will continuously decrease due to the lack of information provided on them.

Final Course of Action: Employ Action 2.1 and 2.2 to meet Objective 2

Assessment Protocol: Similar to Objective 1, Objective 2 will be assessed by sending out a user-friendly survey to determine the knowledge of brown hyenas

throughout South Africa (Appendix C). The first survey will be randomly sent out to the South Africans in 2019. The final survey will be sent out in 2034, after properly trying to educate the South Africans of the importance of the brown hyena. If the educational programs are not successful at informing at least 75% of the people surveyed, then other actions will need to be taken. Other ways of informing the public of the importance of the brown hyena, such as brochures, will need to be put into place to try and inform the public.

Objective 3: Increase the amount of money coming in from ecotourism by 50% to go towards brown hyena conservation over the next 10 years.

Action 3.1: Use the ecotourism opportunities already present in many of the national parks in South Africa, to provide funding for the brown hyena conservation. Ecotourism is present in all of the National Parks in South Africa (Ray et al. 2005). Ecotourism will provide a lot of the funding for the conservation of the hyenas throughout South Africa. Distributing the money that is already coming in from the ecotourism can help increase the amount of funding that goes towards the hyena conservation. With an increase in the amount of funding going towards brown hyena conservation, it will help spread awareness about the brown hyena.

Action 3.2: Create a promotional area that just focuses on the hyena conservation. Using a tour of the area to site see some brown hyenas, will cause an increase in the funding going towards brown hyena conservation. Many people are more interested in seeing the animal in the wild than sitting in a room talking about the species (Gutierrez and Jacobson 1994). With this increase in tourism going

straight towards the conservation of wildlife, it will allow the country to invest more into protecting the species.

May be harder to create a tour to find the brown hyenas, due to the fact that they are normally nocturnal and are the shyest out of all of the hyenas. Finding a clan of brown hyenas prior to creating the tour is the easiest way of doing this.

Action 3.3: No action. The amount of money allocated to conservation of the brown hyena is already extremely low (Eaton 1976). With no other efforts going towards trying to improve the amount of funding going towards the conservation efforts, then the brown hyena will not get the conservation it needs.

Final Course of Action: Employ Action 3.1 and Action 3.2 to meet Objective 3

Assessment Protocol: Objective 3 will be completed if 50% of the ecotourism proceeds go towards brown hyena conservation over the next 10 years. We will set up tours specifically to see the hyenas, and all of the proceeds will go towards the conservation of the brown hyena. We will also set up a section for the Eco tourists to visit to see if they know anything about the brown hyena. Questions such as what the current status of the hyena, and their responsibilities throughout an ecosystem (Appendix D). A lack of awareness for the brown hyena has been prevalent throughout all of Africa (Kent and Hill 2013). With there not much known about the brown hyena, most people will not understand their vulnerability. If Objective 3 is not met brochures may need to be sent to airports to give travelers an idea of how important the brown hyena is to the ecosystems.

Objective 4: Increase the amount of protected land by 50% to help protect the brown hyena over the next 20 years.

Action 4.1: Create or expand existing protected suitable land for the brown hyena in South Africa. The expansion of the farms in South Africa have affected the space and areas the brown hyenas have been able to occupy (Kent and Hill 2013). When the farms expand, it decreases of the suitability of the land for the brown hyena. This also affects the brown hyenas because they are interacting with the natives more often (Kent and Hill 2013). Most of the protected land is not suitable for the brown hyena, because it is mainly higher elevations in the mountains that the hyena will not occupy (Mills 1982). Increasing the suitable habitat that is protected from being turned into farmland will help to increase the population of brown hyenas in South Africa.

Action 4.2: Ensure there is proper enforcement of the protected land by local governments and rangers. The number of brown hyenas illegally taken has been increasing over the last 10 years, due to a low amount of law enforcement present (Kent and Hill 2013). With a low amount of enforcement, the populations will continue to decrease and will not be able to increase. If proper enforcement is taken on the protected land, then the population of the brown hyenas will be able to increase.

The exact number of the amount of brown hyenas taken illegally is hard to get, due to them being poached. An increase in the amount of poachers in South Africa has been seen, and the amount of wildlife illegally harvested has also been increased.

Action 4.3: No action. One of the largest declines in the brown hyena population is due to the emergence of farms, decreasing the suitability of the habitat for the brown hyena (Kent and Hill 2013). Therefore, if nothing is done to protect more land for the brown hyena, the population will continue to decrease, and it is unlikely that this decrease will ever be reversed.

Final Course of Action: Employ Actions 4.1 and 4.2 to meet Objective 4

Assessment Protocol: To achieve Objective 4 we will need to increase the amount of protected area to at least 147,000 km². The current amount of land that is protected in South Africa is about 98,000 km² (Ray et al. 2005). With this increase in the amount of area protected, it will give the brown hyena a better chance of surveying in the wild because they will not have as many threats around them. This will also give the brown hyena more area to try and find a spot to mate to raise their young. Enforcement of the laws protecting the brown hyena will also need to be established. More rangers will be sent out to these national parks and surrounding areas to try and eliminate the threat of poaching. If this is not met, we will need to continuously try and push to create more areas to be protected for the brown hyena.

Objective 5: Increase the survival and fecundity rates of brown hyena adults in South Africa by 40% over the next 20 years.

Action 5.1: Increase the survival rates for the sub adults and adults by increasing the amount of food available for them to survive. Most of the brown hyenas in this early stage of life die due to a lack of food available for them (Kuhn et al.

2008). By increasing the population of small mammals in the area, as well as other foods, such as fruits and berries, there will be more food available for the brown hyenas. Most of the food that is eaten by the sub adults is fruits and berries (Owens and Owens 1978). Besides fruits and berries, sub adults will also tend to scavenge and eat animals that are already dead (Owens and Owens 1978). By increasing the survival rate of the sub adults and adult one stages, the population numbers for other stages of life will also increase (See Figure 2). To increase the population size of prey species, such as field mice and shrews, there will need to be captive breeding sites. Once the shrews and mice are old enough to be released they will be banded and set out into habitat that is suitable for the brown hyena.

Action 5.2: Protect prey species habitat by creating and distributing hyena proof fencing, see action 1.1. These fencing will keep the livestock safe while they are in the pen, and also create a barrier that they cannot escape. By creating this barrier, it is decreasing the likelihood of the habitat, that is suitable for the prey species, being destroyed.

Action 5.3: Increase the survival rates and fecundity of the by adult one and two stages by focusing on increasing food availability and decreasing the of the cubs lost and killed. One of the main reasons the cubs end up dying is due to the lack of nutriment by their mother (Watts and Holekamp 2009). By increasing the survival rates of the cubs, it will also add to the life stages (Figure 3). The implementation of camera traps to keep track of the cubs will also be used. To increase nutriment for the females, prey species will need to continue to increase, as seen in action 5.1.

Action 5.4: No action. If no action is taken, then the decrease in the population will continue to happen. If the population continues to drop, then the species may become extinct within the next 15-20 years (Appendix I, Figure 3).

Final Course of Action: Employ Action 5.1, 5.2, and 5.3 to meet Objective 5.

Assessment Protocol: To assess the increase in survival rates of the adult one and sub adult species we will first need to capture sub adults and a younger group to radio collar. After radio collaring the individuals, there will need to be a group of individuals tracking them and assessing their health for the next 5 years. Radio collars will not affect the animal too much if the right size is put on (Woodroffe 2001). The correct size radio collar will need to be used on each of the individuals that are being tracked.

To assess the amount of prey species throughout the brown hyenas' habitat, a mark recapture technique will take place. Mark-recaptures is an effective way to determine the population size of small mammals in a certain area (Krebs and Boonstra 1984). We will do the mark-recapture test in the beginning of the study in 2019. We will determine the population size using the Lincoln-Peterson Index Model. In the year 2034, we will determine the population size using the same technique. If the number of prey species does not increase, we will need to look into what had failed in the introduction of the shrews and mice.

To assess the amount of habitat that had been preserved from the fencing given to the farmers, we will need to do a vegetation analysis. In 2019, when the farmers are given the fencing, there will be a vegetation survey taken as well. In

the year 2029, another vegetation survey will be taken to see if it has improved or gotten worse. If it has not improved, there will need to be more focus on the vegetation for the prey species.

To assess the increase in survival rates and fecundity of the adult one and two stages we will need to radio track, and keep a close eye on those of them who mate. Camera trap will be used to keep track of how the cubs are doing. Camera traps are an effective way to keep track of a shy or young individual in a group (Kelly 2008). The camera trap will need to be checked every month or two, to keep an eye on the young individuals.

Conclusion

The goal of this management plan is to increase and maintain a population of brown hyenas in South Africa. Public opinion of the brown hyena may shift the course of this 20-year management plan. Education to landowners and the communication of their needs throughout this plan will help with future studies on the brown hyena. The biology of this species is studied at a moderate rate, but some future studies focusing on areas such as reproduction will need to be conducted. If this plan will receive support from the landowners, the South African government, and conservations organizations, such the WWF, the brown hyena can become an example of conservation success and the knowledge can be used for other species that have conservation needs.

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Appendix

Appendix A

Sensitive matrix for a stage-based population model put to use in Microsoft Excel. The five stages are broken down by the different ages of the hyena. The matrix shows that most important area for management are the sub adults (.3609) and the adult one (.3936).

	Sensitivity matrix				
	F(Cubs)	F(Subadults)	F(Adult 1)	F(Adult 2)	F(Adult 3)
Cubs	0.2416	0.2339	0.1890	0.1258	0.0259
Subadults	0.2788	0.3609	0.2917	0.1941	0.0400
Adults 1	0.3040	0.3936	0.3180	0.2117	0.0436
Adults 2	0.1951	0.2525	0.2041	0.1358	0.0280
Adults 3	0.0315	0.0408	0.0330	0.0219	0.0045

Appendix B

Elasticity matrix for a stage-based population model used in Microsoft Excel. Matrix shows that the most important stage to manage for is adult one (.098) and adult two (.078).

	Elasticity matrix				
	<i>F(Cubs)</i>	<i>F(Subadults)</i>	<i>F(Adult 1)</i>	<i>F(Adult 2)</i>	<i>F(Adult 3)</i>
Cubs	0	0	0.097988513	0.078808167	0.003850783
Subadults	0.180647463	0.18029403	0	0	0
Adults 1	0	0.180647463	0.137398882	0	0
Adults 2	0	0	0.08265895	0.053183379	0
Adults 3	0	0	0	0.003850783	0.000671586

Appendix C

Brown Hyena, *Hyaena brunnea*, Informational Survey

Survey created to determine the awareness that the residents of South Africa have on the brown hyena.

1. Did you know that the brown hyena is a threatened species?

Yes

No

2. Do you know the importance of brown hyenas as a scavenger in the ecosystems?

Yes

No

3. Do you know the primary diet of a brown hyena?

Yes

No

If yes, what are they known to eat?

4. How many interactions with hyenas have you had?

0

1-3

3-5

5+

If you have had an interaction with a brown hyena how would you describe it?

5. Would you be willing to donate towards the conservation of brown hyenas?

Yes

No

If yes, how much? _____

Appendix D

Brown Hyena Conservation Survey

1. Where are you from?

Please list country and state (If possible) _____

2. What are you doing in South Africa?

- a) Vacation
- b) Business
- c) Visiting family
- d) Education
- e) I live here

3. What is the current status of the brown hyena?

- a) Threatened
- b) Endangered
- c) Extinct
- d) Not listed
- e) Unknown

4. What role do hyenas play in the ecosystem?

- a) None
- b) Scavenger
- c) Pest
- d) Unknown

5. Have you ever had an interaction with a hyena?

- a) Yes
- b) No

If yes, how many interactions and what was it like:

6. Would you be willing to donate to the conservation efforts for the brown hyena?

- a) Yes
- b) No

If yes, how much are you willing to donate _____

7. Would you like to learn more about brown hyena conservation?

- a) Yes
- b) No