# Ecology and conservation of spotted hyena (Crocuta crocuta Erxleben 1777)in human dominated landscapes in Northern Ethiopia

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# 4

# Hyena (*Crocuta crocuta*) Coexisting at High Density with People in Wukro District Northern Ethiopia

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## Abstract

We surveyed the density and abundance of hyena in the highly degraded and prey depleted Wukro district, northern Ethiopia, with a human population density of 98 persons per square kilometer. A total of 117 hyenas responded to callups, giving a hyena density of 52 hyenas per 100 km$^2$ or a total population of 535 hyenas in the district. We quantified the economic impact of hyena predation on livestock using semi-structured interviews with randomly selected households. Respondents indicated a total loss of 203 domestic animals to hyena depredation over the past five years. Average annual depredation per household was 0.13 livestock, worth US$ 6.1. The diet of hyenas was assessed in three sub-districts by scat analysis and showed that 99% of prey items were of domestic origin, with only three of 211 scat containing hair of the Ethiopian hare (*Lepus fagani*) and porcupine (*Hystrix cristata*). We conclude that hyenas in northern Ethiopia live at high density, eat almost exclusively anthropogenic food and are not dependent on conservation areas.


## 4.1 Introduction

The literature suggests that large carnivores occur at low densities, with large home ranges and a high propensity for conflict with humans (Hemson, 2003; Loveridge et al., 2007; Croes et al., 2011). Generally there is little tolerance within local communities in Africa towards large carnivores. As a rule, carnivores risk being killed in retaliation for livestock attacks and they consequently avoid villages and urban areas (Croes et al., 2011). Few studies are available demonstrating coexistence between hyenas and local communities. The present work covers a remarkable case of coexistence between hyena and local communities.

Hyena is a common, large carnivore occurring throughout sub-Saharan Africa (Frank et al., 1995; Mills & Harvey, 2001). It is present in a large range of habitats, including semi-desert, savanna and open woodland, dense dry woodland, and in montane habitats, such as in the Aberdares, Mt Kenya, and the Ethiopian highlands, up to 4,100 m in altitude (Sillero-Zubiri & Gottelli, 1992; Smith & Holekamp, 2010). It is absent from, or present only at very low densities in extreme desert conditions and tropical rainforests, where the striped hyena (*Hyaena hyaena*) occurs (Smith & Holekamp, 2010). Hyenas breed throughout the year and they eat carrion as well as a

wide range of live prey (Mills, 1990; Sillero-Zubiri & Gottelli, 1992; Hofer & Mills, 1998; Holekamp et al., 1999).

A tentative estimate of the total hyena population in Africa is between 27,000 and 47,000 (Mills & Hofer, 1998). The largest known populations occur in the Serengeti ecosystem, Tanzania (Kruuk, 1966; Schaller, 1972; Ray et al., 2005) and the Kruger National Park, South Africa (Ray et al., 2005). In protected areas of southern Africa, most populations are considered to be stable, whereas many populations in East, Central and West Africa, even in protected areas, are considered to be declining, mostly due to incidental snaring and poisoning (Hofer & Mills, 1998). The decline of hyena populations in some areas is mainly due to habitat loss, persecution and disease, and this makes hyenas dependent on the continued existence of conservation areas (Mills & Hofer, 1998).

In northern parts of Ethiopia, grazing and ox-drawn ploughing may have induced land degradation through the loss of vegetation cover for more than 2000 years (Mengistu et al., 2005). The natural forest habitat of the region has been overexploited and covers only about 0.2% of the total land area (Sara, 2010). The natural prey base for carnivores has been greatly depleted due to habitat degradation and fragmentation, and hyenas are almost entirely dependent on anthropogenic food (Abay et al., 2011). This is, however, starting to change with the establishment of exclosures (partially protected areas of a few hectares dotted across the landscape) and a general ecological restoration program, which may change the situation in the future (Nyssen et al., 2009). The establishment of exclosures to keep livestock outside is a common ecological restoration practice in Ethiopia (Mengistu et al., 2005).

Survival of hyenas in Ethiopia is largely dependent on the management of livestock conflicts and waste disposal (Yirga et al., unpublished data). Hyenas can be encountered in many parts of Ethiopia, but their density and population size is not known. Based on regular sightings of hyenas, it was hypothesized that our study area has moderately high densities of hyena, in spite of the absence of native prey. We estimated population size and density of hyenas and assessed conflict with people in the degraded and prey-depleted Wukro district, northern Ethiopia.

## 4.2 Study area

Research was conducted in Wukro district, located in the eastern zone of Tigray regional state of Ethiopia, a completely human-dominated landscape. Geographically the district is located at 13° 36' North and 39° 36' East, with an area of approximately 1,138 square km at an altitude of 1800 to 3069 m a.s.l (Sara, 2010). The annual temperature and rainfall of the district ranges from 17 to 28 °C, and 350 to 450 mm, respectively. The district has a population of 112,235 persons, giving a human population density of 98 persons per square km (Office of Agriculture and Rural Development of Wukro district, 2010). There are 24,583 households with an average household size of five persons. About 95% of the population of the district depends on rain-fed agriculture, practicing mixed farming. The average land holding per household is about 0.5 ha. The main crops grown in the district are barley, wheat, teff, maize and sorghum. The livestock population of the district comprised approximately 21,908 oxen, 30,588 cows, 15,431 goats, 82, 950 sheep, 9416 donkeys, 1,333 mules, 79 horses, 54 camels, and 47,265 poultry in 2009 (Sara, 2010). The average annual household income of the district was approximately US$ 871. The area is generally a severely degraded landscape with some acacia (*Acacia etbaica*, *Acacia saligna* and *Dodonaea angustifolia*), eucalyptus (*Eucalyptus camaldulensis* and *Eucalyptus globulus*) and African olive (*Olea africana*) vegetation and hardly any large or medium-sized natural prey. There are a few established 'exclosures' in the district; these are very small protected areas mainly for environmental rehabilitation in sensitive areas. Three sub-districts were selected for hyena scat collection and for semi-structured interviews, namely Awaleo, Hadnat, and Tsaedanaele (Fig. 4.1).

## 4.3 Methods

### 4.3.1 Abundance assessment

The population size of hyenas was established with calling stations (Abay et al., 2011) from 17 to 19 January 2011 between 18:00 and 22:00. Continuous gnu-hyena distress and hyena sounds were played at full volume for about an hour on an MP3 player connected to a megaphone (Monacor 45) mounted onto the roof of the vehicle 2.2 m above ground. Each callup consisted of two cycles of 20 minutes of broadcasting and 10 minutes silence. The speaker was turned 90 degrees after each 5 min of broadcasting. Calling stations were selected along the main roads and located in open areas to

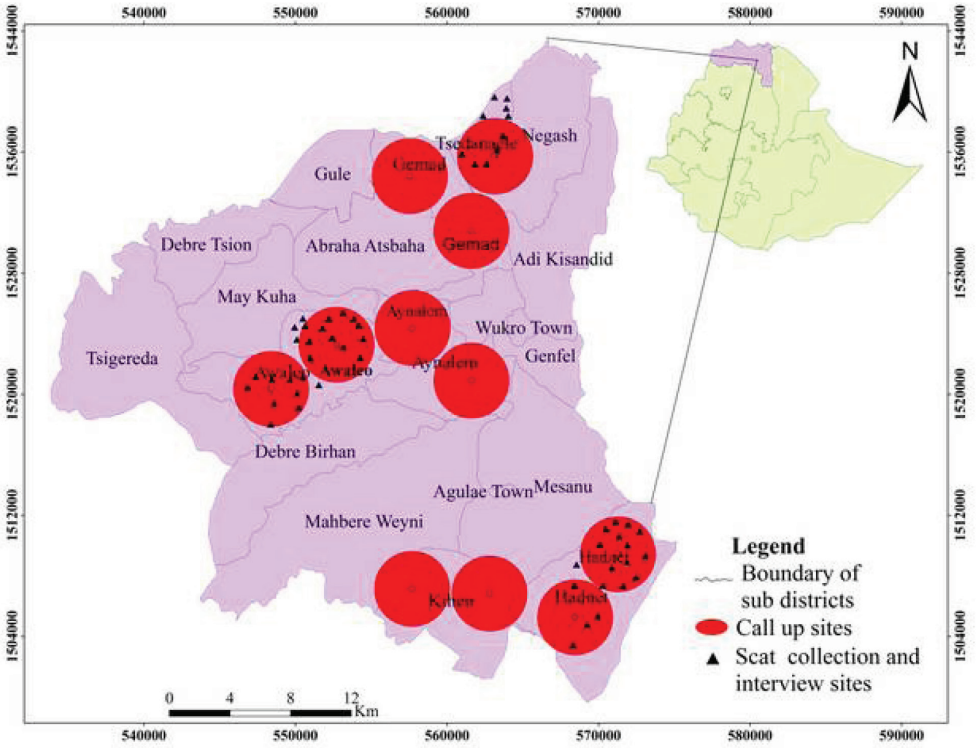


Figure 4.1
**Map of Wukro district with UTM coordinates, showing the callup locations (points), scat collection and interview sites**

enable observation of responding hyenas. Responding spotted hyenas were counted in the dark, based on sounds and with a spotlight during several short counting sessions, taking the maximum number observed during any single counting session. Four observers counted responding predators using powerful torches immediately after the last broadcast.

Callups require local calibration and habitat-specific predictive models (Ogutu & Dublin, 1998; Mills et al., 2001; Ferreira & Funston, 2010). We conservatively assumed an effective range of 2.8 km and a response rate of 83% ,which was estimated based on 18 calibration experiments for 102 hyenas conducted to estimate the distance within which hyenas heard and responded to the playbacks in a similar landscape in the region (Yirga et al., unpublished data). About 26% (270.8 $km^2$) of the total area of the district was covered by 11 randomly placed callups, as indicated in Fig. 4.1. Finally, hyena density was calculated by dividing the number of spotted hyenas

observed by the area covered by callups. Then, the resultant density was extrapolated to the total area of the district. To minimize the likelihood of duplicate counting, calling stations were at least 8 km apart. Neighboring stations were sampled consecutively on the same day to minimize the probability of duplicate counts. GPS coordinates of the exact locations of all calling stations were recorded.

### 4.3.2 Semi-structured interview

We interviewed 312 randomly selected heads of households from three sub-districts (Awaleo, n = 104; Hadnat, n = 127, and Tsaedanaele, n = 81), which constituted 14% of the total households of each sub-district. Selection was done by numbering the households and drawing the numbers from a randomized table. Respondents were asked questions relating to the number of livestock owned and number of livestock lost to predation and disease from 2005 to 2010. To quantify the economic cost of livestock depredation, the species, age, number, and sex of livestock losses were recorded. Estimates of current average market prices of different classes of livestock species by age and sex were obtained from traders. Prices were translated to US$ at the exchange rate of the time of the study (March 2011) and expressed as annual average per household.

### 4.3.3 Scat analysis

A total of 211 hyena scats were collected from three study sites during walking transects: Awaleo (n = 83), Hadnat (n = 70) and Tsedanaele (n = 58). Scat samples were put into plastic bags to avoid cross-sample contamination. Following the method of Ramakrishean et al. (1999), hairs were extracted from scat and compared under a microscope with hair in our reference collection to establish prey species composition. Our reference collection, collected during the study period, contained hair of all domestic and wild species in the study area and included human hair. Hairs were analyzed on form, length and color with the naked eye as well as on scale patterns using a microscope at 10x magnification. Scat analysis is based mainly on identification of mammalian hairs, and is a valuable technique (Mills, 1992) as most prey species can be reliably determined, field collection is rapid, costs are low and the scats can be stored and processed at a convenient time. We tested for differences between species and between sites with $\chi^2$ test using JMP-5 Software.

## 4.4 Results

### 4.4.1 Spotted hyena density and abundance

A total of 117 hyenas responded to 11 different callups. Assuming an 83% response rate, this gives a hyena density of 52 hyenas per 100 $km^2$ or a total population of 535 hyenas in the district. Also, 10 jackals (*Canis aureus aureus*) responded to three different callups; three in Awaleo, three in Hadnat and four in Qihan sub districts.

### 4.4.2 Livestock losses

A total of 203 livestock were depredated by spotted hyena over the past five years, mainly goats (26.6%) and donkeys (23.2%), worth US$ 9,538 (Table 4.1). The average annual depredation per household was 0.13 livestock worth US$ 6.1, which was about 0.7% of the average annual income of households of the district. The estimated economic loss caused by animal disease was approximately 1.6 times higher.

Table 4.1
**Stock number and estimates of economic loss by hyena and disease in Awaleo, Hadnat and Tsedanaele sub-districts (n = 312), northern Ethiopian**

| Species | Stock | Depredation | US$ | Disease | US$ |
|---|---|---|---|---|---|
| Goat | 315 | 54 | 1486 | 79 | 1997 |
| Donkey | 223 | 47 | 3452 | 21 | 1661 |
| Cattle | 761 | 41 | 3749 | 80 | 7511 |
| Dog | 180 | 37 | 130 | 21 | 79 |
| Sheep | 698 | 22 | 715 | 86 | 3029 |
| Cat | 153 | 2 | 6 | 13 | 38 |
| Camel | 3 | 0 | 0 | 1 | 293 |
| Poultry | 918 | 0 | 0 | 277 | 667 |
| Mules | 4 | 0 | 0 | 0 | 0 |
| **Total** | **3,255** | **203** | **9,538** | **578** | **15,275** |

### 4.4.3 Diet of spotted hyena

The diet of hyenas showed only prey items of domestic origin except in Hadnat and Awaleo, where Ethiopian hare *(Lepus fagani*) and porcupine (*Hystrix cristata*) were observed (Table 4.2). There was a significant differ-

ence in species frequency ($P < 0.01$, $\chi^2 = 23.65$, $df = 10$) but no significant difference among sub-districts. Cattle, donkey, goat and sheep, in decreasing order, were most common species of livestock in the scats analyzed and were positively correlated with the stock number during the study period ($R = 0.31$, $P < 0.05$). About 11% of the hairs from the scats were not identified. Our reference hair collection also included natural prey species, but these did not match the unidentified hairs.

Table 2
**Diet of hyena in three sub-districts (Awaleo, Hadnat and Tsedanaele) based on analysis of 211 scats expressed as the number of prey items observed and relative frequency of occurrence in 2011**

| Prey species | Count | | | Relative frequency (%) | | |
|---|---|---|---|---|---|---|
| | Awaleo | Hadinat | Tsedanaele | Awaleo | Hadinat | Tsedanaele |
| Donkey | 17 | 13 | 16 | 20.5 | 18.6 | 27.6 |
| Poultry | 0 | 0 | 0 | 0.0 | 0.0 | 0.0 |
| Cattle | 35 | 28 | 23 | 42.2 | 40 | 39.7 |
| Goat | 7 | 8 | 5 | 8.4 | 11.4 | 8.6 |
| Sheep | 3 | 3 | 5 | 3.6 | 4.3 | 8.6 |
| Human | 0 | 4 | 0 | 0.0 | 5.7 | 0.0 |
| Horse | 0 | 3 | 0 | 0.0 | 4.3 | 0.0 |
| Dog | 10 | 0 | 4 | 12.1 | 0.0 | 6.9 |
| Cat | 0 | 0 | 0 | 0.0 | 0.0 | 0.0 |
| Hare | 0 | 1 | 0 | 0.0 | 1.4 | 0.0 |
| Porcupine | 2 | 0 | 0 | 2.4 | 0.0 | 0.0 |
| Unidentified | 9 | 10 | 5 | 10.8 | 14.3 | 8.6 |
| **Total** | **83** | **70** | **58** | **100** | **100** | **100** |

## 4.5 Discussion

### 4.5.1 Hyena abundance

A total of 117 hyenas responded to callups, leading to a density estimate of 52 hyenas per 100 $km^2$. This confirms that a moderately high density of hyenas persists in human-dominated landscapes, outside of conservation areas. It is even higher than densities found in some protected areas. For example, according to Graf et al. (2008) the hyena population density in Hluhluwe-iMfolozi Park is about 33 hyenas per 100 $km^2$ and this population

was the second-largest protected population in South Africa. Trinkel (2009) reported a hyena density of 2 hyenas per 100 km$^2$ in Etosha National Park, Namibia and Sillero Zubiri and Gottelli (1992) reported the highest known density: 134 hyenas per 100 km$^2$ in Aberdares National Park in Kenya.

In the present study, anthropogenic food seems to have substantial impact on hyena density and supports a viable population of spotted hyena. The natural ecosystem of the area is affected by anthropogenic activities, which have ultimately depleted native prey species. Carnivore densities in natural ecosystems generally reflect the abundance of their prey (Bertram, 1975; Fuller & Sievert, 2001). Various researchers have reported a positive relationship between carnivore and natural prey abundance elsewhere (Van Orsdol et al., 1985; Laurenson, 1995; Hofer & East, 1995; Stander et al., 1997; Karanth et al., 2004; Hetherington & Gorman, 2007; Croes et al., 2011). However, maintaining viable populations of large carnivores in various ecosystems of the world would require that they coexist in a landscape with people (Linnell et al., 2001; Conover, 2002; Woodroffe et al., 2005). In the context of prey-depleted northern Ethiopia, waste management would immediately impact hyena abundance, with possible impacts on their viability (Yirga et al., 2012). It is likely that hyenas get most of their food from scavenging on waste, as livestock depredation figures were remarkably low during the study period. We previously reported that spotted hyenas get their food from scavenging on urban and rural waste; depredation accounted for less than 20% of food intake in nearby Debri and Aynalem (Abay et al., 2011). Many large carnivores readily use anthropogenic food sources, which often leads to conflict (Woodroffe & Ginsberg, 1998; Beckmann & Berger, 2003; Packer et al., 2005). Hyenas can easily be observed feeding on urban waste as they concentrate around garbage dumping places (Yirga pers. obs.). We conclude that in our study area, a population of 535 hyena lives close to communities without any reports of retaliatory killing. This demonstrates a rare case of coexistence, where hyenas benefit from waste disposal and human communities benefit from the waste clearing service by spotted hyenas. It also demonstrates the high adaptability of hyenas, which in our case specialize entirely in waste consumption.

Efficient and reliable methods of rapid assessment of a carnivore's abundance are crucial to determine conservation priorities. Playbacks have proved to be an efficient technique for estimating spotted hyenas abundance in Wukro district; they are easy to carry out, fast, relatively cheap, and effective for monitoring spotted hyena populations. The method has been used to assess density and abundance of other carnivores such as lions

(Ogutu & Dublin, 1998; Mills et al., 2001; Bauer, 2007). Reliable estimators are precise and unbiased (Norton-Griffiths, 1978), and reliability could be optimized by making suitable choices of sample size and design, and counting animals correctly (Caughley, 1974; Eltringham, 1980; Burnham et al., 1980).

### 4.5.2 Livestock losses

The economic loss of livestock predation by spotted hyenas is remarkably low compared to other areas (Holmern et al., 2007; Kissui, 2008; Yirga & Bauer, 2010). We found losses of about 0.7% while other studies found losses of about 19% of the average annual income of households (Holmern et al., 2007; Kissui, 2008). However, even this could be considerable in relation to the local standard of living. Food insecurity and poverty are severe; a majority of households chronically depends on food aid for part of the year. The estimated economic loss caused by animal disease was 1.6 times higher. Livestock depredation is not considered a major loss factor compared to diseases. From studies done across Africa, it appears that disease as a loss factor is 3-6 times larger in magnitude than livestock depredation (Mizutani, 1993; Karani et al., 1995; Rasmussen, 1999; Frank et al., 2005). From a development perspective, improving veterinary care would be much more effective and efficient than conflict mitigation. In many parts of Africa, people coexist with large carnivores without receiving any benefits (O'Connell-Rodwell et al., 2000).

The decline of prey populations is one of the major reasons for carnivores to shift their diets to livestock (Woodroffe et al., 2005; Kolowski & Holekamp, 2006), possibly because of hunting efficiency. In Hato Pinero commercial cattle ranch in Venezuela, the highest depredation rates have been recorded in areas where prey abundance and diversity are relatively low (Polisar et al., 2003). A primary financial impact of spotted hyena presence in our study area was depredation on donkeys. Unlike the other livestock species, donkeys are kept outside the compound at night, and weak donkeys are abandoned altogether (Yirga et al., 2012). This may explain their prominent place in the predation statistics of hyena.

## 4.6 Conclusion

Our research shows a population of hyena coexisting with humans, both at fairly high densities. In stark contrast to the literature, hyenas in northern Ethiopia eat almost exclusively anthropogenic food and are not dependent on conservation areas. The cost to people is marginal and apparently tolerable as this coexistence is remarkably peaceful.

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