Impact by bomas on the distribution of spotted hyena (*Crocuta crocuta*) in the Mara Region, Kenya

Påverkan av bomas på spridningen av fläckig hyena (Crocuta crocuta)i Mara regionen, Kenya

Elin Netti Hirsch

Sveriges Lantbruksuniversitet **Skara 2009** **Studentarbete 256**
Institutionen för husdjurens miljö och hälsa
Etologi och Djurskyddsprogrammet

Swedish University of Agricultural Sciences ***Student report 256***
Department of Animal Environment and Health
Ethology and Animal Welfare programme

ISSN 1652-280X

Impact by bomas on the distribution of spotted hyena (*Crocuta crocuta*) in the Mara Region, Kenya

Påverkan av bomas på spridningen av fläckig hyena (Crocuta crocuta)i Mara regionen, Kenya

Elin Netti Hirsch

Examensarbete, 15 hp, Etologi- och Djurskyddsprogrammet

Handledare: Jenny Yngvesson

Summary

The aim of this study is to find out if, and in what way the Maasai pastoralists affect the spotted hyena (*Crocuta crocuta*) through Bomas (Maasai settlement) and keeping of livestock. The study was carried out in the Maasai Mara National Reserve and the adjoining group ranch, Koyake GR, in South-western Kenya.
Data was assembled through transect driving, with instantaneous scan sample during two seasons, December 2003 and May-June 2004. Study area contained 12 bomas with three different type of transects each: T1 (0.5 km from boma), T2 (3 km from boma) and T3 (5.5 km from boma), to create a gradual decline in human and livestock impact. Results show that there are differences in the hyena's utilisation of transect type during the day and during the night. The spotted hyena tend to avoid transects close to the boma during the day time, but go there during the night time. This could be an indication of impact from human activity. As previous studies demonstrate, hyenas tend to avoid pastoralists on foot with livestock. Results found here indicate that hyenas also avoid Maasai settlements during day time. The conflict between and impact of Maasai pastoralists, may not be large at the moment, since the behaviour plasticity of the hyena reduces this impact through adaptations. But change is on its way, pastoralism and group ranch system is gradually being replaced by private owned land and cultivation. Due to these changes in utilisation of the land that have occurred after gathering of the data it would be very interesting to conduct the same study again, to see if the impact has increased.

Sammanfattning

Syftet med denna studie är att undersöka om och på vilket sätt masaier påverkar den fläckiga hyenan (*Crocuta crocuta*) genom bomas (masai bosättningar) och den pastorala boskapsskötseln. Studien utfördes i Maasai Mara National Reserve och angränsande grupp ranchen Koyake GR, i sydvästra Kenya. Data samlades in genom transekt körning med scan momentan sampling under två säsonger, december år 2003 och maj-juni år 2004. Studieområdet omfattade 12 stycken bomas med vardera tre olika typer av transekter: T1 (0.5 km från boma), T2 (3 km från boma) och T3 (5.5 km från boma). Dessa avstånd valdes för att åstadkomma en gradvis minskning av påverkan från människor och boskap. Resultaten visar att det finns skillnader i hyenornas användande av de olika transekttyperna över dygnet. Den fläckiga hyenan tenderar att undvika transekter nära bomas under dagtid för att sedan gå dit under natten, vilket kan ses som att hyenor undviker mänsklig aktivitet. Tidigare studier har visat att hyenorna tenderar att undvika pastoralister med boskap till fots. Resultaten av denna studie visar även att hyenorna undviker masai bosättningarna under dagtid. Konflikten mellan och påverkan av masaier är inte stor för tillfället, hyenornas beteendeplasticitet reducerar för tillfället denna påverkan genom beteende adaptioner. Men förändringar är på väg, pastoralism och grupp ranch system byts ut mot privatägd mark och kultivering. På grund av dessa förändringar i utnyttjande av land sedan insamling av data, skulle det vara väldigt intressant att göra om samma studie igen, detta för att undersöka om en ökning av påverkan har skett.

Contents

Introduction

Maasai Mara, part of the Mara-Serengeti ecosystem spanning across the Kenya-Tanzania border, is characterized by a high density of wildlife and famous for the annual wildebeest (*Connochaetes taurinus*) migration (Ogutu *et al*., 2008a). Roughly about 7000 km^2, the area contains three major rivers (Mara, Talek and Sand River) and a great variety of vegetation (Oindo *et al*., 2003), mainly savannah (Kiringe *et al*., 2007). Maasai Mara has high rainfall, permanent water sources and rich grassland productivity (Seno & Shaw, 2002). Dry season in the Maasai Mara spans between July and October and the wet season from November to June, with short rains in November-December and longer rains March to June (Ogutu *et al*., 2008b).

The Mara region belongs to the East African rangelands (Kolowski & Holekamp, 2006). Rangelands cover about 80 % of Kenya's land surface (Ottichilo *et al*., 2000), and consists of a large variety of vegetation, from savannah and pastoral grazing lands (as Kenya's group ranches) to cultivated areas (Homewood, 2004). Of the Kenyan wildlife, 85 % is found in the rangelands and over 70 % is found outside of protected areas (Ottichilo *et al.*, 2000). Protected areas only represent 8 % of Kenya's total land surface (Ottichilo *et al.*, 2000) and it is therefore essential to understand local community's attitudes towards wildlife and conservation (Groom & Harris, 2008).

Cooper *et al*. (1999) have distinguished three separate periods of prey availabilities in the Talek area, part of Koyake GR. Pre-migration, the first six months of the year when the ungulate density is fairly constant and consisting mostly of Thompson's gazelle (*Gazella thomsonii*) but also topi (*Darnaliscus korrigum*) and a few herds of zebra (*Equus burchelli*). July to September, the time of the migration when arriving wildebeest and zebras double the prey availability. And finally the post-migration from October until January, with three months of reduced prey densities.

The spotted hyena

The spotted hyena (*Crocuta crocuta*) has an incredible behavioural plasticity, occurring in a wide variety of ecosystems throughout sub-Saharan Africa, they can be nocturnal or active during the day and breed any time of the year (Van Meter *et al*., 2009). The fact that the spotted hyena inhabits most of its historical range, and with relative stable populations, has been ascribed to this behavioural and ecological plasticity (Kolowski & Holekamp, 2009).

The spotted hyena is an opportunistic predator hunting whichever species is locally most abundant (Cooper *et al*., 1999). Regional densities of hyenas are positively correlated with prey biomass densities (Ogutu *et al*., 2005). The most common prey are small and medium sized mammalian herbivores, such as various antelope, zebra (*Equus grevyi*), cape buffalo (*Syncerus caffer*) and juvenile rhinos (*Diceros bicornis*), hippos (*Hippopotamus amphibius*) and giraffes (*Giraffa camelopardalis tippelskirchi*) (Mills & Hofer, 1998). No overall species preference was found by Hayward (2006) in an analysis of 15 studies (14 published and one unpublished) on the spotted hyena's choice of prey. Detection of prey is by sight, sound and smell and they find carrion by sound of other carnivores feeding, the smell, or during day light by watching vultures descend on carcasses (Mills & Hofer, 1998).

Hyenas can travel over vast distances and Kolowski *et al*. (2007) showed that hyena from the Maasai Mara travel in average 12.4 km per night. Length of travel is thought to be dependent on home range size and prey availability.

The Maasai people and their livestock

As a nomadic pastoralist people (Zepple, 2006) largely dependent on livestock herding and living in the Mara-Serengeti Ecosystem, the Maasai have coexisted with wildlife for centuries (Thompson & Homewood, 2002). Maasai economy is traditionally heavily dependent on livestock production and centered around the boma (Muchiru *et al*., 2009). Boma, the Swahili word for enclosure, is a circular fence costomarily made from thorn, surrounding the Maasai village, with the family huts functioning as an inner fence (Muchiru *et al*., 2009). Livestock are taken in at night, cattle into the boma, young and small stock into smaller enclosures (Lamprey & Reid, 2004; Muchiru *et al*., 2009) or rooms inside the huts (original observation by the Author), a husbandry leading to a high concentration of faeces inside the boma. Data presented by Muchiru *et al*. (2009) show that abandoned bomas bear a higher standing crop than surrounding areas for a century or more with an increased biomass, representing nutrient rich islands in the otherwise nutrient poor savanna, influencing both plants and grazing animals.

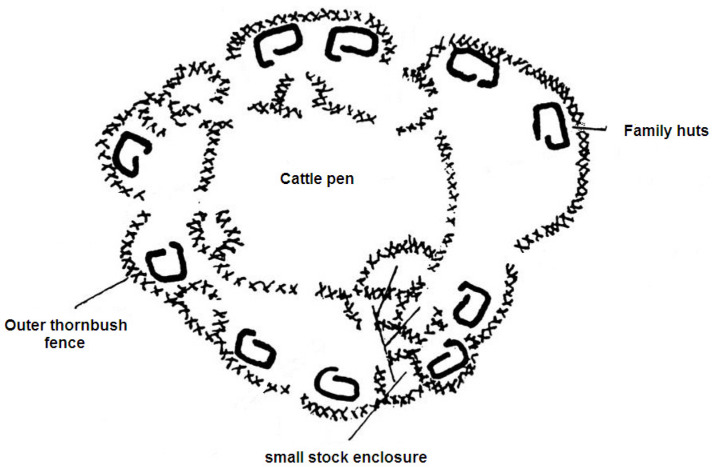

Figure1. *On the left side, a sketch over a traditional boma illustrating placement of livestock enclosures and family huts, modified from Kolowskie & Holekamp, 2006. On the right side an actual picture of a boma, showing the circular thorn fence and family huts, photo used with permission by the photographer Agnes Willén.*

Pastorialism and wildlife goes well together, but a change is on the way. As an early land reform in the late 1960's, the group ranch system divided the previously open Maasai land into smaller units under corporate title, with the intent among others to stabilize the ongoing environmental degradation (Mwangi, 2007). Merely ten years later there were demands for individual title units. Subdivision of land into individual land titles as a replacement for group ranches leads to possible fencing of ones own land (Seno & Shaw, 2002). Already land is under cultivation and fences are beeing erected on key wildlife grazing land (Ogutu *et al*., 2005). This change also mean that Maasai people are getting less nomadic, with a possible risk for overexploitation of the land.

The biggest threat to wildlife in the Maasai land is human encroachment through cultivation, leading to less grazing areas for wildlife outside of the reserves (Seno & Shaw, 2002) and more severe competition with livestock (Ogutu *et al*., 2005). Maasai Mara NR was ranked most vulnerable of Kenya's 50 protected areas, with main threats being wildlife poaching, bush meat hunting, and negative impact from tourism and human changes in the use of surrounding land (Kiringe *et al*., 2007). Grazing is not allowed inside the MMNR but still occurs, sometimes in the dry season exceptions are made and grazing is allowed in certain areas. But grazing also take place illegally, mostly at night (Kolowski & Holekamp, 2006), though if exposed, the herder will be fined.

Human activity is the main cause for large carnivore species declining globally, some species are already limited to protected areas (Romañach *et al*., 2007). Resolving the human-wildlife conflict could therefore be an important solution for keeping viable wildlife populations not only in reserves but also outside of protected areas (Ogada *et al*., 2003). Since predators, including hyenas, kill livestock and sometimes cause extensive damage, predator management is crucial in areas that also contain farmed animals (Mills & Hofer, 1998). It is not uncommon for African carnivores to share land with livestock, which by themselves are unlikely to cause any disturbance. However in East Africa livestock is guarded and herders pose a direct threat to the carnivores (Kolowski & Holekamp, 2009).

No direct impact on spotted hyena from tourist vehicles has been observed, but the hyenas actively avoid pastoralists tending livestock by foot (Kolowski & Holekamp, 2009). Measurement of faecal glucocorticoids show that increased activity by pastoralists is a possible source of stress to the hyenas in the Talek area in Koyake GR (Figure 2) (Van Meter *et al*., 2009) analogous with shown alternations of behaviour in spotted hyenas in the vicinity of pastoralists and their livestock (Kolowski *et al*., 2007). In their study of anthropogenic influences on spotted hyenas, Kolowski & Holekamp (2009) concluded that vegetation as cover is important in the coexistence of hyenas and livestock and that an increase in grazing pressure in and around the Mara would reduce this vegetation and thereby intensify the hyena's reaction to livestock.

Knowledge about the hyena's activity patterns and behaviour can help us predict their motion patterns, and thereby help reduce the conflict with humans and livestock. Similar ideas are discussed by the Scandulv project for the wolf (*Canis lupus*) in Scandinavia (Sand *et al*., 2008). Worldwide there is the problem of human encroachment into wilderness and increasing wildlife conflict. Keeping the animals' natural shyness towards humans is an important part of reducing the risk of wildlife attacks on human and human related objects. Even so, modifications in husbandry, guarding practises and the behaviour of the producers must change if conflict with carnivores is to be solved (Treves & Karanth, 2003).

Aim

This study is an attempt to find out if, and in what way, the Maasai pastoralists affect the spotted hyena (*Crocuta crocuta*) through Bomas (Maasai settlement) and keeping of livestock.

Research questions

Studies demonstrate that hyenas avoid pastoralists on foot (Kolowski & Holekamp, 2009) and suggest a stress response with increased pastoral activity (Van Meter *et al*., 2009). But do the hyenas also stay clear of the Maasai settlements? Human activity seem to be the determining factor if there is an effect on hyenas or not, therefore it is assumable that during days with a higher human activity there is also a greater impact on hyenas, than during nights when there is less activity. Consequently it is presumable that there are differences between utilisation of the different types of transects during the day and night time.

Hypotheses

Day

$H0_1$: There is no variation in hyenas use of the different types of transects during the day
$H1_1$: There is a variation in hyenas use of the different types of transects during the day

Night

$H0_2$: There is no variation in hyenas use of the different types of transects during the night
$H1_2$: There is a variation in use of the different types of transects during the night

Materials and Methods

The 24 hour of the day was divided into day time, defined as the hours between 06:00 to 17:59, and night time from 18:00 to 05:59.

Study area

The study was carried out in the Maasai Mara National Reserve (MMNR) and the adjoining group ranch, Koyake GR, in South-western Kenya (1°20´S, 35°08´E). The reserve borders the Serengeti National Park in Tanzania, and is a part of the same ecosystem. The study area covered ground rich in grass, both within and outside the park, hence the effect of livestock grazing was evident. In order to describe seasonal variations and its changing conditions two seasons were chosen. The observations were conducted during December 2003 and May-June 2004, because of the great difference in grass quality and grass availability between the seasons.

Selection of transects

Transects were defined as areas a 1000 m long and 300 m wide (i.e. 0.3 km²), with central points of 0.5 km (T1), 3 km (T2) and 5.5 km (T3) away from bomas. The central points were selected to create a gradually reduced impact of humans and livestock. The transect areas consisted of open grassland with no or few trees and shrubs, and topography chosen to allow good visibility.

12 bomas was considered sufficient to answer the question of effect of bomas on wildlife. In total 36 transects, three per boma, were included in the study. When the transect closest to the boma (T1) was selected, the following ecological features were recorded; soil type, termite hills, stones and vicinity to permanent water, shrubs and woodlands. Thereafter, the

T2 and T3 transects of the focal boma were chosen in order to match the same ecological criteria as T1, as closely as possible.

Recording method

Observations were made from the roof of a car, equipped with a GPS. The car followed the central line of the transect (hereafter called transect line), alternating the starting point between both ends. To prevent startling the animals on the first part of the transect, observations started when the car was 200 meters from the start or end point, aligned with the transect line. When there was a boma, river, hill or other physical obstacle that did not allow driving directly to the transect, the transect was approached from the side, usually in a 45° angle.

Data collection was systematically carried out on the three types of transects (T1, T2 and T3) every second hour evenly spread over day and night on both occasions. For each observation recordings of exact time, light intensity, weather, temperature, humidity, and phase of the moon were taken.

All animals encountered on the transect were included in the data collection. The number of hyenas on the transect was counted and noted. The distance from the car to the animal was recorded with Leica© Range master CRF 1200. The presence of people, cars, and livestock were recorded when within 300 m from the transect line. To record the impact of man and its livestock in the transect areas, a herd or gathering was recorded as one unit, independent of the number of individuals.

Position of the animals

The position of the animals was recorded in detail to enable calculation of number of animals per area unit. The distance between the car and an animal (or a cluster of animals) was measured. To calculate the distance between the transect line and the animal at a 90° angle, a protractor was used to determine the angle between the animal's position and the transect line. This angle, together with the distance between the car and the start point of the transect (not of the drive), was used to calculate the exact position of the animals on the transect. Calculations were made using sines law:

$$a = \sin v \times b$$

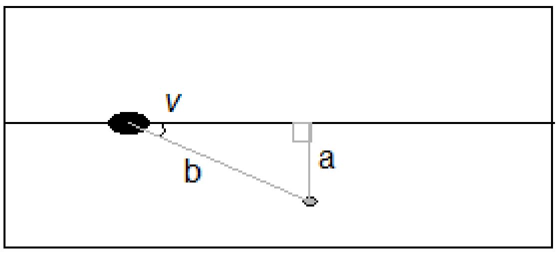

Figure 1. *Sketch of a transect area, explaining how to calculate the distance between the transect line and the observed animal. Using the law of sines with the measured angle* v *and the distance* b *from car to animal, the distance* a *was calculated.*

Animals found to be more than 150 m from the transect line were excluded from the data, as they were not present within the transect area. If the centre of a cluster of animals were located outside the transect all animals in the cluster were excluded. Likewise, when the cluster centre was located inside the transect all animals were included.

Minimising the impact of recorders on animals' behaviour

To minimize the impact of the observers, a flexible way of driving and observing was adapted. Larger groups of animals on areas with short grass seemed to be less affected than single animals in high grass which had to be recorded from a greater distance.

To test if animals were missed due to human and/or environmental factors, the mean distance of all animals were calculated. If all animals were seen, they should be evenly distributed over the transect, and the mean value of distance from the transect line should be approximately 75 meters.

Statistical analysis

The collected data was sorted in Microsoft Excel® and analysed in MiniTab®. The data was tested for normal distribution using the Anderson-Darling test and were found not to be normal distributed. The non-parametric Kruskal-Wallis rank sum test was used to test for statistical significance.

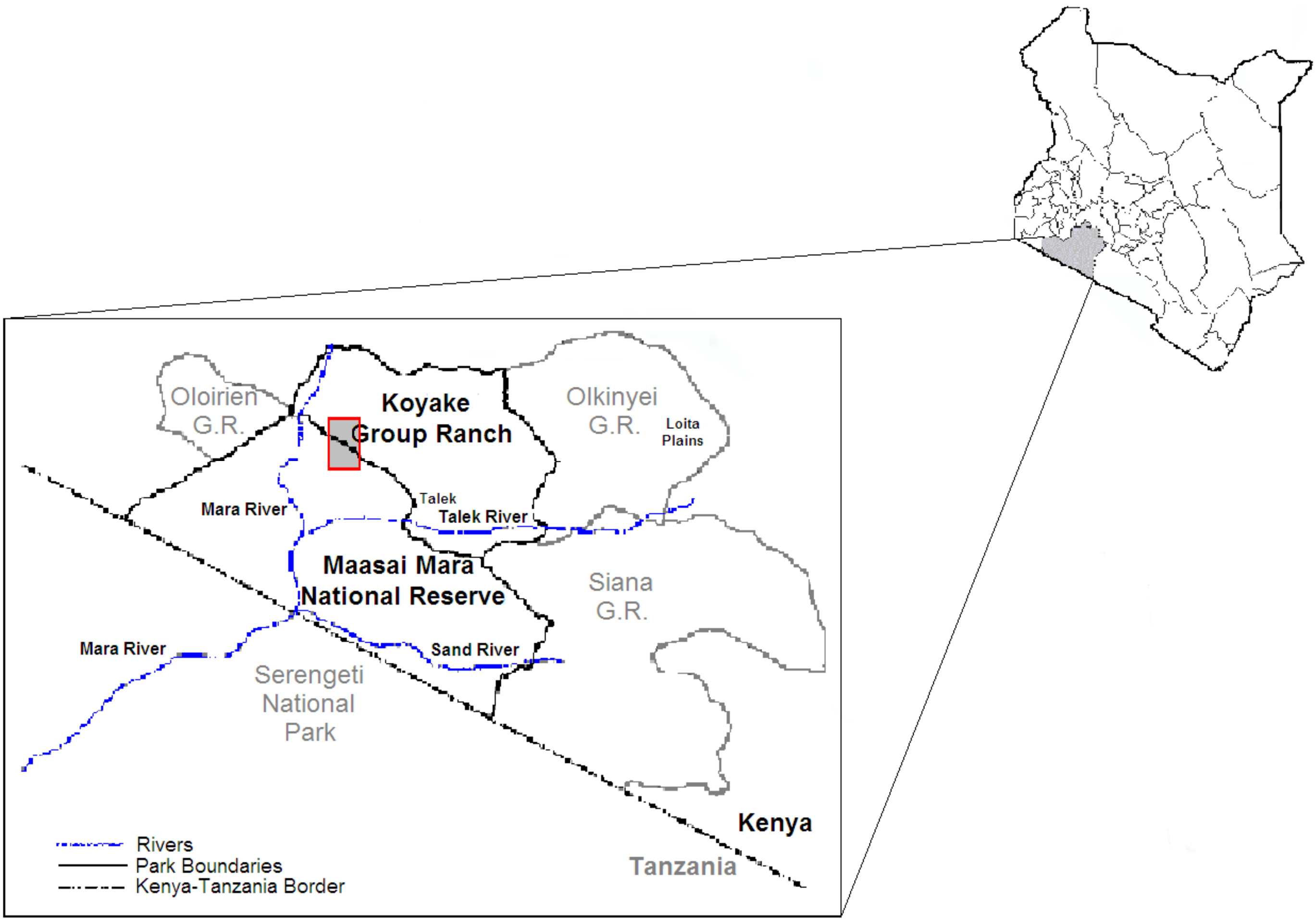

Figure 2. *Map showing Maasai Mara National Reserve and adjoining group ranches, with the study area marked in grey, fringed by a red rectangle. The map is modified from Seno & Shaw (2002) and Oindo* et al. *(2003).*

Results

Activity at night time in and around bomas is in this article considered to be lower then during the day. Maasai people living as pastoralists most often have no electricity and as a consequence follow the natural hours of day. Therefore differences in intensity of Maasai activity between day and night time has different impact on hyenas.

General

The combined sum of observed hyenas on each transects multiple drives where divided with the number of times the transect had been driven. This was done to calculate the probable number of hyenas observed on that specific transect, if driven one time. To get an estimate of hyenas/ km^2 this number was divided with 0.3, because each transect was 1 km long, and 300 meter wide resulting in a 0.3 km^2 transect area.

A plot of observations on all transects per type and boma, revealed no clear pattern between observations of spotted hyenas and the 12 bomas, this was the same for both seasons. All bomas had one observation for at least one of the three types, and in December boma 2, 3 and 11 hade observations for all types. The seasons are similar in that there are no (December) or very few (May-June) hyenas in T1 during the day. There are also more observations of hyenas during night (66 observations in total) than day (24 observations) time.

When testing if animals have been missed during observations, e.g. due to animals hidden by tall grass, mean value of the distance between the animals and transect mid line was calculated. Results indicate that animals had been missed during observations for both seasons and mostly, animals furthest from the transect line, as the mean distance was below 75 meters. However, statistical analysis using Kruskal-Wallis of *meter to transect* (distance from observed animal to transect line), for the three different type of transects during both seasons showed no significant difference. For December 2003 day time (H = 2.00 DF = 2 P = 0.368) and night time (H = 2.00 DF = 2 P = 0.368). For May-June 2004 day time (H = 1.15 DF = 2 P = 0.563) and night time (H = 3.21 DF = 2 P = 0.201).

Day

Combining both seasons transects per type over the day reveals a significant difference (H = 6.17 DF = 2 P = 0.046 (adjusted for ties)) in hyenas per km^2. This difference show that distance to boma has an effect on distribution of hyenas during the day. Further testing show that the statistical difference lies between T1 and T3 (H = 5.68 DF = 1 P = 0.017 (adjusted for ties)) but not for T1 and T2 (H = 0.57 DF = 1 P = 0.452) or T2 and T3 (H = 0.92 DF = 1 P = 0.338).

Night

There is a difference between observations of hyenas during night when the two seasons are combined for the three type of transects. Significant difference (H = 13.81 DF = 2 P = 0.001) was found when testing the three types together showing that distance to boma also has an effect during the night time. Further analysis showed that significant differences were between T1 and T2 (H = 13.32 DF =1 P = 0.000) and T1 and T3 (H = 6.75 DF =1 P = 0.009). No significance was found between T2 and T3 (H = 0.54 DF = 1 P = 0.464).

Day against Night

Large differences were found between Day and Night during plotting of the data. This seemed interesting therefore to get a more lucid picture, means were made of hyenas per km^2 for each transects and then type, for day or night time. When working with non-normal distributed statistics it is customary to use median as a measurement for an average. For this present data however it would be pointless because most medians are zero. The reason for this is that data was collected over vast areas containing few wild animals, resulting in more samples of zero than that of any hyenas. Therefore mean is used for the graphic display of the data.

Calculations of mean gave a probable number of hyenas one would see if driving each type of transect during day or night time. This data was made into a chart (Figure 3) revealing that T1 transects differed from T2 and T3 and furthermore, that T1 had the clearest difference in hyenas/km^2 day and night. The two seasons combined show significant differences between Day and Night when comparing the three types of transects ($H = 12.76$ $DF = 1$ $P = 0.000$). In T1, there was a significant difference between utilisation in day and night ($H = 23.78$ $DF = 1$ $P = 0.000$), with hyenas only coming to this type during the night. The fewest observations (Figure 3) were made in T2, which had an overall small usage and no significant difference between day and night ($H = 0.82$ $DF = 1$ $P = 0.364$). T3 was moderately used but also here, there were no significant difference ($H = 0.15$ $DF = 1$ $P = 0.703$).

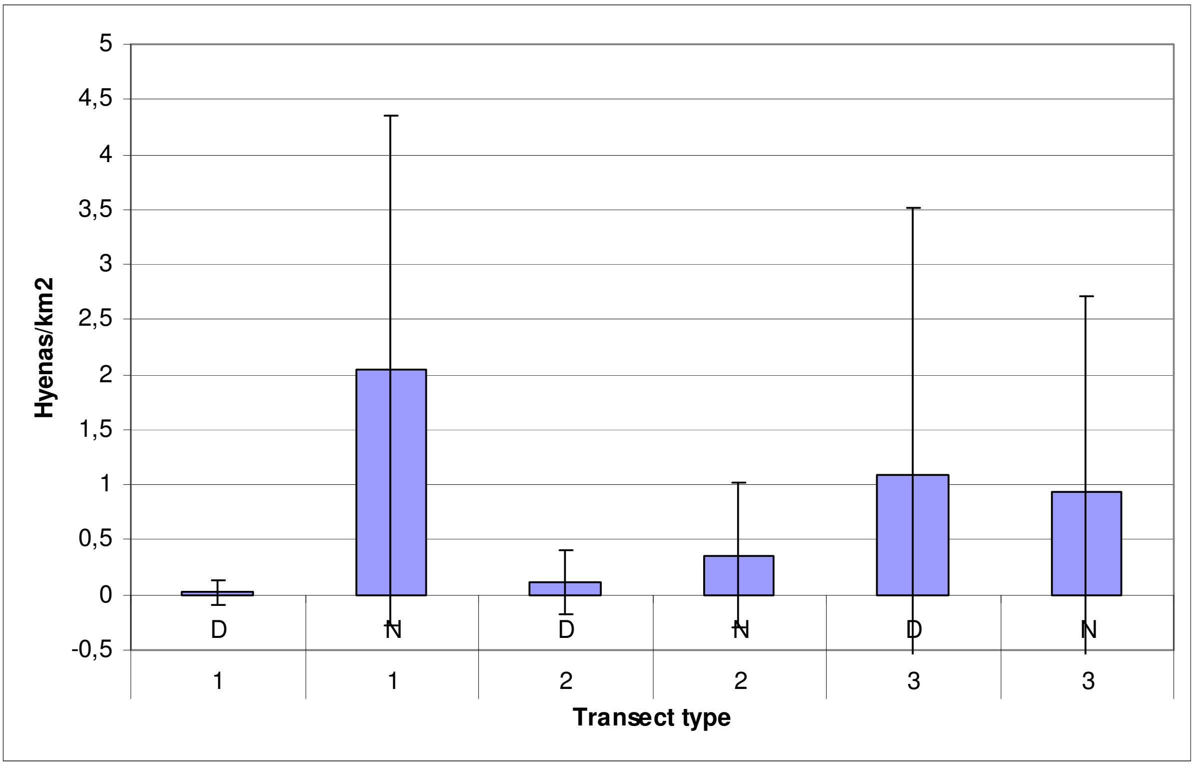

Figure 3. *Chart showing the mean and standard deviation of hyenas/km^2, for the three different type of transect: T1, T2 and T3 divided over the day (06:00-17:59 h) and night (18:00-05:59). Mean ± StDev for Day: T1: 0.023 ± 0.113, T2: 0.116 ± 0.283 and T3: 1.088 ± 2.427and Night: T1: 2.037± 2.312, T2: 0.361 ± 0.651 and T3: 0.935 ± 1.768. D denotes day and N denotes night on the x-axis.*

Discussion

The aim of this study was to find out if, and in what way, the Maasai pastoralists affect the spotted hyena through bomas (Maasai settlement) and keeping of livestock. This was done through statistical testing of differences within and between the day and night time, on three different type of transects. The day was divided as to show differences between high human activity (day time) compared to lower human activity (night time). Comparisons were made between the T1 (0.5 km from boma) and T2 (3 km from boma) and T3 (5.5 km from boma), for both day and night time. This comparison was chosen because an affect on hyenas would be visible through modification in behaviour regarding utilisation of the T1 transects over the day.

General

Seasons are combined, to get a more general picture over the year, but also to be able to reduce the number of statistical tests necessary and hereby reduce risk of mass significance. To be able to compare with other studies hyenas per transect was converted into hyenas per km^2, giving a probable number of hyenas one would see per km^2 of transect. Kruskal-Wallis one way analysis of variation is a test by ranks which means that it can be considered a less powerful, but more robust, test than the parametrical alternative ANOVA (McDonald, 2008). As data was not normally distributed the non-parametric Kruskal-Wallis test was the correct choice here. Graphically however, mean values are shown. As medians in many cases were zero, mean values give more information, though medians were used for all statistical analyses.

Previous studies have shown that pastoralists and their cattle have an effect on the spotted hyena. This present study also considers the effect from the bomas. Results found agree with previous findings and also indicate that boma has an affect. Different reasons for this are possible but it is nonetheless clear through differences in utilisation of T1 transects during the day and night time, that hyenas avoid transects closest to bomas during the day when the Maasai activity is largest. These changes in the behaviour and distribution of the spotted hyena can be seen as a consequence of the larger impact of pastoralists and their cattle close to bomas during the day. Behavioural and distributional changes made possible because of the behavioural plasticity of the hyena.

This study has data collected from two seasons, a short time compared to most similar studies which are projects running over multiple seasons and years (e.g. Holekamp *et al*., 1997; Cooper *et al*., 1999; Kolowski *et al*., 2007) conclusions should therefore be interpreted with care. Data do however tell us about the two seasons during which the sample was collected, and should be seen as a snapshot of this period.

Day

Results indicate that the null hypotheses can be rejected which mean that there is a difference in use of the different type of transect during the day. The strongest difference was between T1 and T3, the type closest to boma (T1) and the type furthest away from boma (T3). That the difference was largest between these two types further confirm that bomas and livestock affect hyenas leading to a change in distribution and behaviour. Other studies have found similar results and demonstrate changes in behaviour (Kolowski & Holekamp, 2009) and indications of stress in the hyena’s (Van Meter *et al*., 2009).

Night

Results concerning the night time additionally show that there is a difference between hyenas use of transects and indicate that the null hypothesis can be rejected. During night time there were significant differences between T1 and T2 and T1 and T3, with hyenas mostly coming close to bomas (T1) during the night.

Day compared with night

There was a significant difference between day and night time for T1 transects. The chart (Figure 3) made for comparison between day and night reveals that hyenas seem to change transect type over the day, from T3 during the day to T1 during the night. This together with results of differences in use of transect types during the day time and night shows that there is either something that the spotted hyena is avoiding in this type during the day, or that there is something that the hyenas want there during nights only.

Reasons for avoiding T1 during days seems most likely to be caused by human activity which hyenas avoid (Kolowski & Holekamp, 2009) and which can be linked to a stress response in hyenas (Van Meter *et al*., 2009). Lack of prey is another possible reason for not being there during day time. Livestock are taken out for grazing in the morning around 08:00 or 09:00 h, the animals are then returned before sunset (Kolowski & Holekamp, 2006). Most wild prey come close to the boma only in the night time (J. Jung pers. comm. 2009), and because densities of hyenas have been found to be positively correlated with prey biomass densities (Ogutu *et al*., 2005), there is a likely connection.

Reasons for coming to boma during the night only can be a consequence of the fact that most attacks (Kissui, 2008) or all attacks (Kolowski & Holekamp, 2006) on livestock take place at night. Highest depredation rates are in March, April and May (Kolowski & Holekamp, 2006) and according to Cooper *et al*. (1999), prey densities are at its lowest during September to January. This is an indication that hyenas do not only take livestock as a substitute for wild prey when there are few of those, instead this suggest that livestock is part of the hyena diet, even though studies show that depredation increases when natural prey decreases (Kolowski & Holekamp, 2006). No incidences of livestock being killed by hyenas were observed in Talek during a seven year study (1988-1995) even with large numbers of cattle trespassing into the Maasai Mara (Cooper *et al*., 1999). More recent studies however expose hyenas as a primary predator for livestock (Kolowskie & Holekamp, 2006 for years 2003-2004; Kissui, 2008 for years 2004-2005).

Retaliatory killing of hyenas is known to take place in Maasai land (Ogada *et al*., 2003). Kolowski & Holekamp (2006) confirmed four deaths of hyenas caused by retaliation, during the period March 2003 until April 2004. Kissui (2008) however, found reports of 71 hyenas killed by poisoning in the Maasai steppe, Tanzania, during a study period of 19 months in 2004-2005. The only dissimilarity is that they took place on different sides of the Kenya-Tanzania border (anecdotal information). Increase in human-wildlife conflict may lead to less grazing areas for wildlife (Ogutu *et al*., 2003) leading to less wild prey for hyenas causing an increase in livestock predation by hyenas. If more livestock are taken by hyenas, more hyenas will certainly be killed by herders.

But all changes can not be seen as bad. For one, lions are chased away from bomas by Maasai pastoralist leading to less competition over prey and less risk of being killed by lions for hyenas close to the boma. Ritual killings of lions (*Ala-mayo*) has been part of

Maasai culture, therefore motivation for killing a lion might be brought on by culture more than retaliation (Kissui, 2008). Human settlements also generate an easily accessible food source, in the shape of garbage, and hyenas are known to foraging close to bomas (Kolowski & Holekamp, 2006). These waste products attract hyenas and as a result link bomas and humans to food. For wild carnivores, association of food and humans can be hazardous. It increases the risk of humans being injured by the wild animal and the animal as a result getting injured or killed by hyenas. Eating garbage in itself can also cause injuries to the animal.

Results

When all transects for both seasons are combined there is a difference in total number of observations of hyenas made during the day (24 observations) and night time (66 observations). Possibly, this could be explained by the fact that hyenas are easier to spot in darkness, e.g. if in hiding or in tall grass, because the light beam from the searchlight used during nigh time observations reflects in their eyes. Different species of animals have different colour of reflection and are therefore also easily distinguished from each other.

The risk of mass significance should always be in the back of ones mind when numerous statistical tests are performed on the same data sample. The reason for this is risk of false significance, that a test will show significance even if in reality it is not. When performing multiple tests on the 0.05 level of significance, there is a risk of finding false significant result by pure chance.

Day and Night

For differences between the transects over the Day and the Night time, four tests were performed for each part of the day, leading to eight tests. Because the significances where far below 0.05 significance level with Night, $P < 0.01$ and Day, $P < 0.02$ (adjusted for ties), the risk of mass significance is considered acceptable.

Between day and night

Statistical testing of the differences between day and night for the three different type of transects found significance far below 0.05 significance level, with all three types of transects combined ($P = 0.000$) and within T1 ($P = 0.000$) and no significances for the other types of transect. Also here the risk of mass significance for these four tests can be seen as satisfactory.

Future research

Results show that there are differences in utilisation of the three type of transects during day and night. Hence it would be very interesting to carry out a more specific study on the spotted hyena comparing transects with large disturbances (like T1) with other (further inside the Mara Reserve) having a very small or even nonexistent impact from pastoralists and livestock. This would function as a more certain control having that hyenas in average travel 12.4 km/day in the Mara (Kolowski *et al.*, 2007). Other reasons to perform the same study again would be to see possible alterations of hyena behaviour in the Mara since the beginning of discontinuation of the group ranch system in the vicinity of Maasai Mara, during the years since the gathering of this data. This would give an indication of what would come about if all group ranches were to be dissolved and turned into private owned land.

Conclusions

Data presented here show that hyenas avoid Maasai settlements during day, but not night, which goes in line with previous studies about human impact on the spotted hyena. This avoidance leads to behavioural changes in the hyenas made possible by their behavioural plasticity (Van Meter *et al*., 2009), which results in these alterations in distribution. Reasons discussed here for these changes are avoidance caused by high human disturbances during the day time and prospect of predation on livestock during the night time. Together with expanding human populations around the Maasai Mara NR (Kolowski & Holekamp, 2009), changes in utilisation of land towards more cultivation (Ogutu *et al*., 2005) will lead to an increase in human-wildlife conflict with potential enhancement in human related mortality in hyenas. To reduce this conflict, knowledge about hyena behaviour is needed to minimise predation on livestock and thereby reduce the conflict and retaliatory killings of hyenas. Predation was found by Ogada *et al*. (2003) to increase with number of livestock, if animals roam far from buildings or close to cover and when carcasses are left exposed. Knowing this can help pastoralists act accordingly and thereby make possible for hyenas and Maasai people to coexist.

The human-hyena conflict in the Mara is present. This conflict is bound to increase with the more resident lifestyle of Maasai pastoralists and changes from group ranch system to private owned lands and cultivation. Even though the Mara rangeland appears to be able to withstand grazing from large populations of both wild and domestic herbivores (Lamprey & Reid, 2004), an expanding human settlement around the Maasai Mara National Reserve will likely see a decrease in wildlife populations, through increased competition over resources. This human encroachment into wilderness is increasing worldwide, diminishing lands for wildlife. Human population growth wears away at grazing areas, increasing competition between livestock and herbivores resulting in a shrinking prey base for large carnivores (Ogutu *et al*., 2005). Changes in policies concerning wildlife are needed and urgently, if wild animals are to be seen anywhere else but in captivity.

Acknowledgements

Firstly I would like to thank Jens Jung for making this Bachelor thesis possible by giving me permission to use his data. Thank you. I would also like to thank my supervisor Jenny Yngvesson for her invaluable help in the making of this report. Thanks to all the Maasai workers in Kenya for driving us around and explaining both about the wildlife in the Mara and traditions of the Maasai people.

Special thanks to all my family and friends for keeping my spirits up when I needed it, and most of all to my father Ika Hirsch for help with the proofreading!

References

Cooper, S. M., Holekamp, K. E. & Smalea, L., 1999. A seasonal feast: long-term analysis of feeding behaviour in the spotted hyaena (*Crocuta crocuta*). African Journal of Ecology 37, 149–160

Groom, R. & Harris, S., 2008. Conservation on community lands: the importance of equitable revenue sharing. Environmental Conservation 35:3, 242–251

Hayward, M. W., 2006. Prey preferences of the spotted hyaena (*Crocuta crocuta*) and degree of dietary overlap with the lion (*Panthera leo*). Journal of Zoology 270, 606–614.

Holekamp, K. E., Smalea, L., Berg, R. & Cooper, S. M., 1997. Hunting rates and hunting success in the spotted hyena (*Crocuta crocuta*). Journal of Zoology, London 242, 1-15

Homewood, K. M., 2004. Policy, environment and development in African rangelands. Environmental Science & Policy 7, 125–143

Kissui, B. M., 2008. Livestock predation by lions, leopards, spotted hyena, and their vulnerability to retaliatory killing in the Maasai steppe, Tanzania. Animal Conservation 11, 422-432

Kiringe, J.W., Okello, M.M. and Ekajul, S.W., 2007. Managers' perceptions of threats to the protected areas of Kenya: prioritization for effective management. Oryx 41:3, 1–8

Kolowski, J. M. & Holekamp, K. E., 2006. Spatial, temporal, and physical characteristics of livestock depredations by large carnivores along a Kenyan reserve border. Biological Conservation 128, 529-541

Kolowski, J. M., Katan, D., Theis, K. & Holekamp, K. E., 2007. Daily Patterns of Activity in the Spotted hyena. Journal of Mammalogy, 88:4, 1017–1028

Kolowski, J. M. & Holekamp, K. E., 2009. Ecological and anthropogenic influences on space use by spotted hyenas. Journal of Zoology 277, 23-36

Lamprey, R. H. & Reid, R. S., 2004. Expansion of human settlement in Kenya's Maasai Mara: what future for pastoralism and wildlife? Journal of Biogeography 31, 997–1032

McDonald, J.H. 2008. Kruskal–Wallis test and Mann–Whitney U test, 153-160. In: Handbook of Biological Statistics. Sparky House Publishing, Baltimore, Maryland.

Mills, M. G. L. and Hofer, H. (compilers), 1998. Hyaenas. Status Survey and Conservation Action Plan. IUCN/SSC Hyaena. Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK. vi + 154 pp.

Muchiru, A. N., Western, D. & Reid, R. S., 2009. The impact of abandoned pastoral settlements on plant and nutrient succession in an African savanna ecosystem. Journal of Arid Environments 73, 322–331

Mwangi, E., 2007. The Puzzle of Group Ranch Subdivision in Kenya's Maasailand. Development and Change 38:5, 889-910

Ogada, M. O., Woodroffe, R., Oguge, N. O. & Frank, L. G., 2003. Limiting Depredation by African Carnivores: the Role of Livestock Husbandry. Conservation Biology 17:6, 1521-1530.

Ogutu, J. O., Bhola, N. & Reid, R., 2005. The effects of pastoralism and protection on the density and distribution of carnivores and their prey in the Mara ecosystem of Kenya. Journal of Zoology, London 265, 281–293

Ogutu, M. O., Piepho, H.-P., Dublin, H. T., Bhola, N. & Reid, R. S., 2008a. El Niño-Southern Oscillation, rainfall, temperature and Normalized Difference Vegetation Index fluctuations in the Mara-Serengeti ecosystem. African Journal of Ecology 46, 132–143

Ogutu, M.O., Piepho, H.-P., Dublin, H. T., Bhola, N. & Reid, R. S., 2008b. Rainfall influence on ungulate population abundance in the Mara-Serengeti ecosystem. Journal of Animal Ecology 77, 814-829.

Oindo, B. O., Skidmore, A. K. & De Salvo, P., 2003. Mapping habitat and biological diversity in the Maasai Mara ecosystem. International Journal of Remote Sensing 24:5, 1053-1069

Ottichilo, W. K., Grundblatt, J., Said, M. Y. & Wargute, P. W., 2000. Wildlife and livestock population trends in the Kenya rangeland. In: Wildlife conservation by sustainable use (Eds Prins, H. H. T., Grootenhuis, J. G. & Dolan, T. T.). Boston, Kluwer Academic Publishers

Romañach, S. S., Lindsey, P. A. & Woodroffe, R., 2007. Determinants of attitudes towards predators in central Kenya and suggestions for increasing tolerance in livestock dominated landscapes. Oryx 41:2, 185- 194.

Sand, H., Liberg, O., Aronson, Å., Forslund, P., Pedersen, H. C., Wabakken, P., Brainerd, S., Bensch, S., Karlsson, J. & Ahlqvist, P., 2008. Den Skandinaviska Vargen en sammanställning av kunskapsläget från det skandinaviska vargforskningsprojektet SKANDULV 1998 – 2008: Slutrapport till Naturvårdsverket, Grimsö forskningsstation, SLU.

Seno, S. K. & Shaw, W. W., 2002. Land Tenure Policies, Maasai Traditions, and Wildlife Conservation in Kenya. Society and Natural Resources, 15, 79- 88

Thompson, M. & Homewood, K., 2002. Entrepreneurs, Elites, and Exclusion in Maasailand: Trends in Wildlife Conservation and Pastoralist Development. Human Ecology 30:1, 107-136.

Treves, A. & Karanth, K. U., 2003. Human-Carnivore Conflict and Perspectives on Carnivore Management Worldwide. Conservation Biology 17:6, 1491-1499

Van Meter, P. E., French, J. A., Dloniak, S. M., Watts, H. E., Kolowski, J. M. & Holekamp, K. E., 2009. Fecal glucocorticoids reflect socio-ecological and anthropogenic stressors in the lives of wild spotted hyenas. Hormones and Behaviour 55, 329-337.

Zeppel, H., 2006. East Africa: Wildlife and Forest Ecotourism, the Maasai and Community Lands. In: Indigenous Ecotourism: Sustainable Development and Management. (Ed Zepple, H.)CABI Publishing

Vid **Institutionen för husdjurens miljö och hälsa** finns tre publikationsserier:

* **Avhandlingar:** Här publiceras masters- och licentiatavhandlingar

* **Rapporter:** Här publiceras olika typer av vetenskapliga rapporter från institutionen.

* **Studentarbeten:** Här publiceras olika typer av studentarbeten, bl.a. examensarbeten, vanligtvis omfattande 7,5-30 hp. Studentarbeten ingår som en obligatorisk del i olika program och syftar till att under handledning ge den studerande träning i att självständigt och på ett vetenskapligt sätt lösa en uppgift. Arbetenas innehåll, resultat och slutsatser bör således bedömas mot denna bakgrund.

Vill du veta mer om institutionens publikationer kan du hitta det här:
www.hmh.slu.se

DISTRIBUTION:
Sveriges lantbruksuniversitet
Fakulteten för veterinärmedicin och husdjursvetenskap
Institutionen för husdjurens miljö och hälsa
Box 234
532 23 Skara
Tel 0511–67000
E-post: hmh@slu.se
Hemsida: www.hmh.slu.se

Swedish University of Agricultural Sciences
Faculty of Veterinary Medicine and Animal Science
Department of Animal Environment and Health
P.O.B. 234
SE-532 23 Skara, Sweden
Phone: +46 (0)511 67000
E-mail: hmh@slu.se
Homepage: www.hmh.slu.se