Status of Lion (*Panthera leo*) and Spotted Hyena (*Crocuta crocuta*) in Nechisar National Park, Ethiopia

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ABSTRACT

Globally large carnivores are in decline due to a combination of habitat degradation and direct human persecution. A survey was conducted in Nechisar national park, Southern Ethiopia to investigate the population status of lion (*Panthera leo*) and hyena (*Crocuta crocuta*). Eleven callups were performed; a total of two adult male lions and six spotted hyenas responded. Estimates give a lion density of between 2 and 5 per 100 km^2 or a total population estimate of 7 to 23 lions and a hyena density of between 4 to 8 hyenas per 100 km^2 or a total population estimate of 17 to 34 hyenas. These estimates include extrapolation to a heavily encroached area where large carnivores are unlikely to occur. The lion population is probably limited to the visually confirmed four individuals. The carrying capacity of Nechisar national park, excluding livestock, is 21 lions and 48 hyenas. The resident agro-pastoral communities who are living with their livestock inside and adjacent to the national park are in conflict with carnivores. This might account for the low density of lion and hyena in the park, and perhaps might result in local extinction within a few years.

Keywords: Callups, Hyena, Lion, Nechisar, Density, Ethiopia.

1. INTRODUCTION

Globally large carnivores are in decline due to a combination of habitat degradation and direct human persecution (Woodroffe, 2001). Populations of large carnivores in Africa have decreased significantly over the last 30 years (Mills and Hofer, 1998). Large spatial requirements make large carnivores particularly vulnerable to conflict with humans (Michalski et al., 2006).

The African lion (*Panthera leo,* Linnaeus 1758) is listed as vulnerable with habitat loss and livestock conflict as main threats (IUCN, 2009). Estimates give a lion population of 23,000 to 39,000 individuals across Africa of which West and Central Africa consists of only about 10% (EWCA, 2012). Many estimates of lion subpopulations are based on educated guesses (Bauer and Van Der Merwe, 2004; IUCN SSC Cat Specialist Group, 2006), whereas effective conservation and management require accurate estimates of population sizes.

The lion is a national symbol and an important element of national identity for Ethiopia (EWCA, 2012). It is represented in old national flag, in coins and lion statues are common in cities and towns across Ethiopia (EWCA, 2012). Several companies also use a lion logo in the country. This shows that extinction of the lion in Ethiopia would be an important ecological and socio-cultural loss (EWCA, 2012). Presently lions are found only in a limited number in southern Ethiopia, approximately 1000-1477 lions (Chardonnet, 2002; Bauer and Van Der Merwe, 2004), with connectivity between East and Central Africa (EWCA, 2012).

Spotted hyenas (*Crocuta crocuta*) are listed as Least Concern on the IUCN global Red List of threatened species as the species remains widespread in Africa (Honer et al., 2008). They are widely distributed in Africa, with more continuous distributions over large areas of Ethiopia, Kenya, Tanzania, Botswana, Namibia, and South Africa (Honer et al., 2008). They are more abundant in human-dominated landscapes in northern Ethiopia (Yirga et al., 2013). The density and population size of lions and hyenas is not known in Nechisar National Park. The present paper is the result of a survey conducted to investigate the population status of lions and hyenas in Nechisar National Park.

1.1. Study area

The study was conducted in 2009 in Nechisar National Park (here after referred as Nechisar), located in southern Ethiopia and bounded by 330000 to 380000mE (longitude) and 640000 to 680000mN (latitude) (in UTM), with an area of 436 km^2 of land and 78 km^2 of water (Hillman, 1993). The mean annual rainfall is between 800 mm and 1000 mm in two seasons: the main rains in April and May and the small rains in September and October (Getachew, 2007). From west to east, Nechisar consists of groundwater forest that starts at the entrance on the outskirts of the town of Arba-Minch, then a rugged mountain range of basaltic volcanic origin separating the two lakes, and then a plain on a lower terrace of the lakes with savanna grassland stretching to the foot of the Rift Valley escarpment (Fig 1). Approximately 15% of the park consists of parts of Lake Abaya in the north and Lake Chamo in the south (Abiyot, 2009). Nechisar hosts the endemic Swayne's hartebeest (*Alceluphus buselaphus swaynei)* and other mammals such as Grant's zebra (*Equus quagga boehmi)*, Grant's gazelle (*Gazella granti*), Guenther's Dik-Dik

(*Rhynchotragus guentheri*), Greater kudu (*Tragelaphus strepsiceros*), lion (*Panthera leo*) and hyena (*Crocuta crocuta*). Recent extinctions include elephant (*Loxodonta Africana*), buffalo (*Syncerus caffer*), giraffe (*Giraffa camelopardalis*), painted dog (*Lycaon pictus*) and cheetah (*Acynonix jubatus*). There are likely to be leopards (*Panthera pardus*) on the edge of the park (eastern escarpment). It is also home to 40% of the country's bird species, including the endemic Nechisar Nightjar (*Caprimulgus solala*) (Desalegn, 2004).
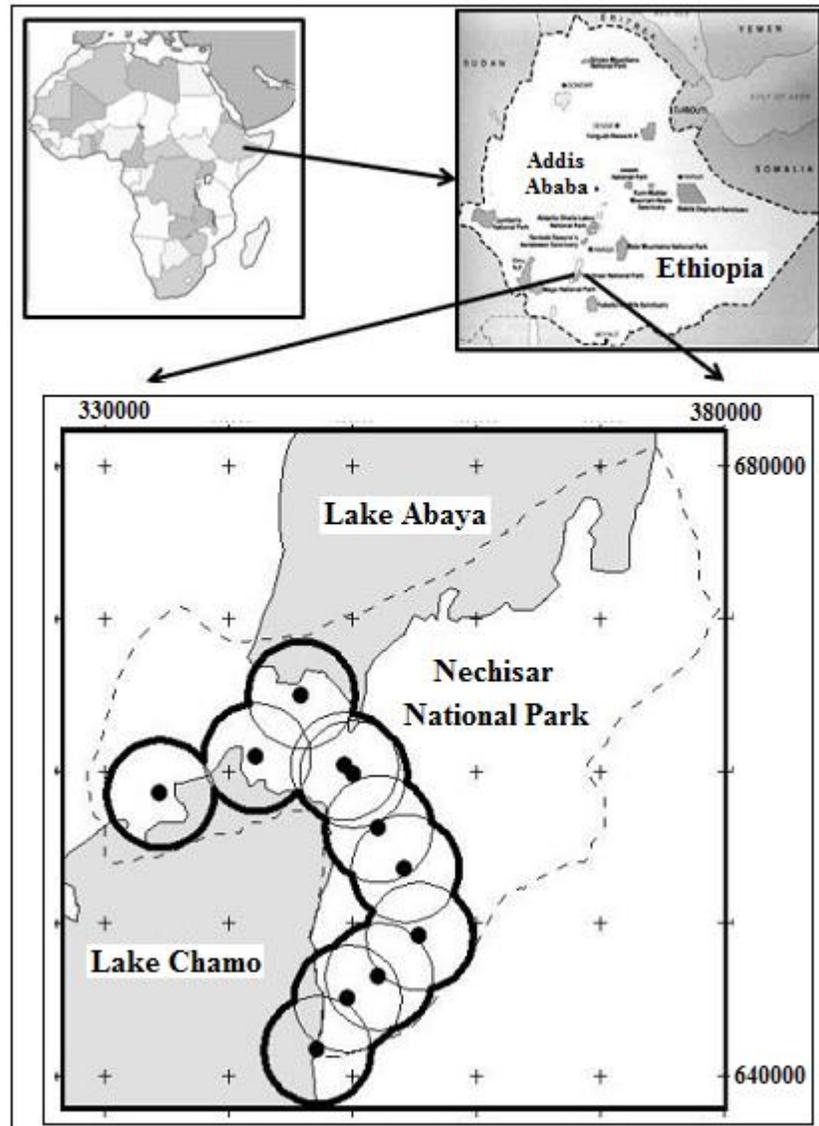

Figure 1.Nechisar National Park with UTM coordinates, showing the callup locations (points),

the effective ranges of callups (circles around points) and the area covered by callups (thick contour of the light circles), broken line indicates the boundary of Park.

2. METHODS

Population size of lions and spotted hyenas was established with calling stations following the protocol of Bauer (2007) in the national park between 18:00 to 24:00. Continuous buffalo calf distress and pig squeel sounds were played at full volume on an MP3 player connected to a megaphone (Monacor 45) positioned on top of a Toyota car. We spent an hour in each calling stations, which consisted of two cycles of 20 minutes broadcast and 10 minutes silence. The car was positioned in open areas to enable observation of responding carnivores and the speaker was turned 90 degrees after 5 min broadcast. Responding predators were counted in the dark based on sounds and eye reflection from torches. The fieldwork consisted of systematic coverage of 155 km^2 (excluding areas of overlap) of the park by 11 callups from 14 to 17 June 2009 as indicated on the map in figure 1. The Northeast of the park is intensively used by people and cannot be considered a functional part of the park anymore. Hence, the survey could not be conducted there because of large numbers of armed herders within audible range. It was expected that no or very few large carnivores are there (though it could not verified), therefore, the area is not excluded from the extrapolation of callup data. Callups require local calibration and habitat-specific predictive models (Mills et al., 2001; Ferreira and Funston, 2010), but this was impossible in view of the low density of lions and hyenas in Nechisar. It was conservatively assumed an effective range of 2.5 km, which may be an underestimate on the flat plains and an overestimate in the mountains between the two lakes. It was compensated for reduced range in the mountains by reducing the distance between callups. To minimize the likelihood of duplicate counting, calling stations were kept at least 6 km apart and neighboring stations were sampled consecutively, evening of the same day.

2.1. Estimation of predator abundance and density

Lion and hyena density is calculated by dividing numbers observed by the area thus calculated and extrapolated the ensuing density to the park's terrestrial area for lion and hyena estimates. The lion and hyena density in the park was estimated using the relation

$$D = (N/AS) R \qquad\qquad (1)$$

where D= density, N =total number of hyena/lion counted in the entire park, AS = the area sampled around a call-in station and R = response rate.

For response rate, an interval of 50-100% was used for hyena and 25-75% for lion, which encompasses the spectrum of values found in literature (Maddox, 2003; Ogutu et al., 2005; Kiffner et al., 2009). The lion and hyena population size in the park was estimated using the relation

$$P = (D X TA) \hspace{4cm} (2)$$

where P= Population size, D= density, TA = terrestrial area of the park.

The expected predator density of Nechisar for lions and hyenas was calculated through the formula provided by Carbone and Gittleman (2002); 90 kg of predator for every 10,000 kg of prey. The park archives were used for prey census data and used average adult female weight provided by Kingdon (1997), assuming that the higher weight of males is roughly compensated for by the lower weight of juveniles (Schaller, 1972).

Table 1. Wild prey biomass in Nechisar National Park (Sourse: 2006 census data from park archives and average adult female body mass from Kingdon (1997)).

Prey species	Scientific name	Count	Average adult female weight (kg)	Total weight (kg)
Zebra	*Equus quagga boehmi*	1468	215	315,620
Gazelle	*Gazella granti*	380	50	19000
Kudu	*Tragelaphus strepsiceros*	53	170	9010
Bushbuck	*Tragelaphus Scriptus*	18	40	720
Defassa	*Kobus ellipsiprymnus*	7	250	1750
Warthog	*Phacochoerus africanus*	10	60	600
Total prey biomass				**346,700**

3. RESULTS

Two male lions were encountered on our way to the second callup on the first day of the survey in the southern part of the park. These two lions responded to the second and third callup, they

stayed around the car throughout the broadcasts. This gives a lion density of between 2 and 5 per 100 km^2 or a total population estimate of 7 to 23 lions in Nechisar. A total of six hyenas responded to three different callups. This gives a hyena density of between 4 to 8 hyenas per 100 km^2 or a total population estimate of 17 to 34 hyenas in Nechisar. The prey biomass data for Nechisar gives a total wildlife biomass of 346,700 kg (Table 1). The carrying capacity of Nechisar, excluding livestock, is 21 lions and 48 hyenas.

4. DISCUSSION

Estimates show that a lion density is between 2 and 5 per 100 km^2 and a hyena density between 4 to 8 per 100 km^2. These estimates include extrapolation to a heavily encroached area where lions are unlikely to occur. Very few people ever see lions in Nechisar nowadays, the two males that were observed, were seen a few times since our survey. In addition, one female with a cub was recently observed by a game scout (Mengesha, pers. comm.). Considering the small size of Nechisar, our intensive efforts plus anecdotal information from some game scouts (Mengesha pers. Comm.), it is unlikely that there are any other male lions or prides. It is inferred that the population size of the observed four individuals is more appropriate than the estimate of 9 to 27 based on extrapolation of the callup response to the entire Nechisar. Since, that includes the northeastern sector where lions are not expected any more due to intensive human land use.

The prey biomass data for Nechisar (Table 1) gives a total wildlife biomass of 346,700 kg. Nechisar supports an additional 20,000 cattle, but these cannot be counted as prey. The carrying capacity of Nechisar, excluding livestock, was thus 21 lions and 48 hyenas. Based on the general observations in the field, it was noticed that most of the northeast of the park is now cultivated, presumably by Kore people. Cattle was also observed throughout the plains, which are also transiting through other parts of the park, presumably herded by Guji people. Most people own a modern rifle and carry it inside Nechisar. In the recent past, dead lions have been found with many bullet holes in the skin but without body parts removed (Mengesha pers. Comm.), indicating that there is indiscriminate killing of large carnivores motivated not so much by a quest for body parts but rather to prevent and/or retaliate for livestock attacks.

Most likely, the two males and the female with cub constitute one pride. Females are known to have a lower response probability (Ogutu and Dublin, 1998) and may well have been hiding its cub during the present survey. Lions in Nechisar are thus literally on the verge of extinction. The population could theoretically rebound, considering the carrying capacity of 21 lions, but this is unlikely under the present conditions. Medium or long term population persistence is an even more remote possibility as it would require a larger population size and much stronger Ethiopian conservation institutions.

For hyenas, the population estimate given here appears to be quite low, also compared to the carrying capacity. Hyenas, in contrast to lions, still occur widely in the surrounding landscape, and therefore re-colonization, dispersal and inbreeding do not pose problems. Hyena population persistence is thus more secure, even though the low densities do point in the direction of a management problem.

Calculation of carrying capacity was crude compared to the existing models (Hayward et al., 2007; Bauer et al., 2008), but it was preferred to use a simple model that could give an order of magnitude for lions and hyenas taking into account the nature of the available data. Comparing population size to carrying capacity, can give an indication of population status if no other mechanisms limit the population (Yukichika, 2008). The lion and hyena populations in Nechisar are lower than expected from natural prey availability. This would be even more accentuated if livestock had been included in the calculations of the carrying capacity. Bauer (2003) included livestock in his calculations since livestock effectively constituted a large share of lion diet due to high tolerance for lion depredation. In Nechisar, tolerance is very low; reportedly any lion that ventures anywhere near herds of livestock is pre-emptively shot. As a consequence, livestock is hardly ever consumed by lions and therefore it was decided to exclude livestock from carrying capacity calculations.

The results suggest that anthropogenic factors are currently driving the Nechisar lion and hyena populations to extinction which would be another case of local extinction within a protected area (Woodroffe and Ginsberg, 1998). Early records give the impression that wild dogs were widespread in the Nechisar (Duckworth et al., 1992; Hillman, 1993). Today no resident cheetah

and wild dogs are found, and lions may follow their path. The main threat to Nechisar are local human activities in the form of overgrazing, fire, forest clearance, cultivation, poaching and/or indiscriminate killing (Kirubel, 1985). Livestock conflict is a likely main cause for the decline in large carnivore population size, with Guji herders as key actors.

5. CONCLUSION AND RECOMMENDATIONS

The density and abundance of lions in Nechisar national park is extremely low. The problems of the local communities in this part of East African Rift Valley, such as poverty, high population density, agro-pastoral competition, land degradation and ethnic conflict, are at a spatial and complexity scale that is beyond the remit of Nechisar conservation. Conservation must be a priority in Nechisar and unless bold management interventions are made urgently lions will disappear soon. Knowledge of predator-human conflict and livestock husbandry practices would be very important. Assessing the effectiveness of depredation prevention measures is recommended. Awareness creation through public meetings, workshops and training might promote coexistence of predators and people.

6. ACKNOWLEDGEMENTS

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