Project Update: September 2019

ABSTRACT

Estimates of wildlife abundance provide the foundation for understanding and managing wildlife populations. With this study, we aim to determine the density of African wolf (*Canis lupaster*) across the range of Ethiopian wolves using call-up methods We estimated the abundance in 32 calling station for a total of 192 calls (three calls at one stop during dawn and dusk). The average population density of African wolves in the study areas ranged between 0.3 and 0.5 individuals km^{-2}. The study showed more numbers of African wolves were recorded from GMCCA (0.52 km^{-2}) and BSNP (0, 35 km^{-2}).

INTRODUCTION

Reliable density estimates for top predators is necessary for the development of management plans and ecosystem monitoring (Carrillo et al. 2000). Predators including African wolves (*Canis lupaster*) and spotted hyena (*Crocuta crocuta*) are able to persist at high human densities and at high levels of landscape changes (Basille et al. 2009, Yirga et al., 2017). In human-dominated landscapes the predator density depends on the available of anthropogenic resources, unlike in the wild areas where they strongly depend on the available natural prey biomass (Khorozyan et al. 2008, Gehrt et al. 2010). Consequently, as predator populations increase, the damages caused by them also increase (Treves and Karanth 2003) which intensify conflict with humans. Principal predators in the Ethiopian highlands varied depending on the localities, African wolf is the serious sheep predator in the central Ethiopian highlands such as GMCCA and BSNP (Eshete et al. 2018, Atickem et al. 2017),

The African wolf (*Canis lupuster*) has been recently classified as a new species closely related to the grey wolf (*C. lupus*; Koepfli et al. 2015, Rueness et al. 2011, Gaubert et al. 2012. It is found in northern Africa and also throughout the Ethiopian Highlands often sympatric with the Ethiopian wolf (*Canis simensis*, Marino & Sillero-Zubiri 2017). In our previous study on seven collared African wolves, we provide an important data that

showed the African wolf can potentially displace Ethiopian wolf with numerical advantage (Gutema et al., 2017). The Ethiopian wolf is one of the rarest canids with less than 400 total individuals remains endemic to the Ethiopian Highlands (Marino and Sillero-Zubiri, 2011) and every potential threat that contribute for its decline counts.). Although the African wolf is confirmed to be found across the Ethiopian Highlands in sympatry with Ethiopian wolves (Viranta et al., 2017), their population density remain unknown.

Numerous direct and indirect methods were used to monitor carnivore density. Many carnivore species are shay and nocturnal which makes it difficult to be monitor through direct observation (Buckland *et al*. 1993 Hofer & East, 1995). The call up (playback) method becomes increasingly important for survey of nocturnal and shy carnivores such as African wolf, golden jackals (*Canis aureus*), spotted hyenas and lions (Hayward and Hayward 2010). Consequently, alternative methodologies to assess the density of carnivore species have been developed (Stander 1998, Balme et al. 2009).

With this study, we aim to estimate the density of African wolves in Ethiopian Highlands; the other important factor also could be to determine the distribution of African wolves in Ethiopian Highlands.

METHODS

Study area

The study was carried out at the four localities of Ethiopian Highlands where Ethiopian wolves occur, Bale Mountains National Park (BMNP), Arsi Mountains (AM), Guassa Menz Communiy Conservation Area (GMCCA), Borena Saynt National Park (BSNP), (fig. 1). We delineated the study area into three zones: core (section of the protected area where all human and livestock activities are prohibited), buffer zone (section of the protected area where controlled livestock grazing is permitted), and matrix zone (human-dominated areas adjacent to the protected area consisting mostly of farmland and settlements).

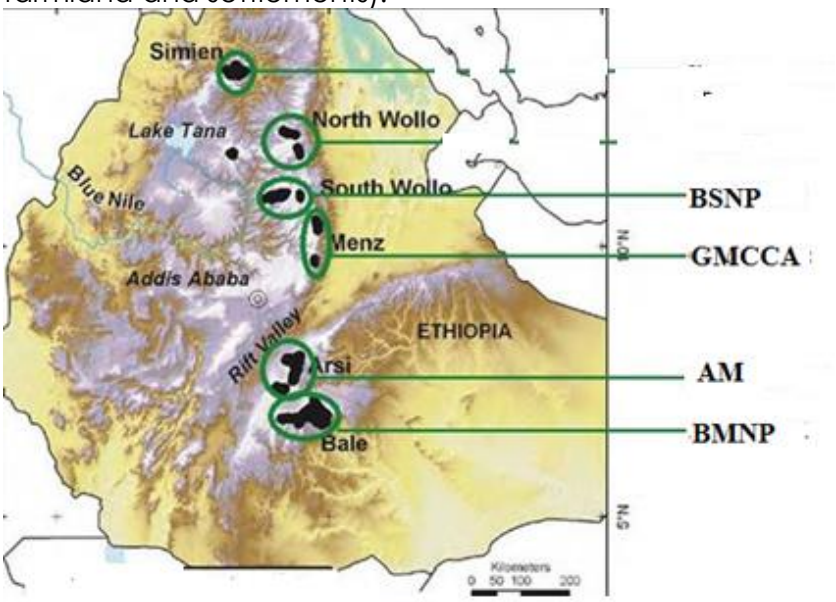

Figure 1. Study area Borena Saynt National Park (BSNP), Guassa Menz Community Conservation Area (GMCCA), Arsi Mountains (AM), Bale Mountains National Park (BMNP).

Calibration experiment

Call-ups require local calibration and habitat-specific predictive models (Ogutu and Dublin 1998). We conducted calibration experiments for the African wolves to estimate maximum response range (% of African wolves responding within range) before the formal data collection. Since we had the collared African wolves from GMCCA and BSNP, we did eight independent calibration experiments on 17 individuals of African wolves out of which 12 responded (0.71 probabilities). As soon as we see the African wolves, two or three observers stayed with the animals to record their reaction while the other drove away and conducted the broadcast at different distance (4.0, 3.5, 3, 2.8, 2.6, 2.5, 2.3, 2, and 1.8 km) (Yirga et al. 2017). The response of the African wolves (movement toward the call) was recorded communicating through mobile. Using 2 km as response distance yielded a sampling area of 12.6 km^2 around each calling station. Following the assumption that animals were evenly distributed over the sampling range (0–2 km) around each calling station site,

Density estimate

The population size of African wolf and spotted hyena was estimated using call up methods undertaken on 32 calling station (matrix=9, core=10 and Buffer=13) from September to November 2018 from 18:00 to 22:00 (evening) and 04:00 to 06:30 (morning). Continuous jackal howling and hyena sound 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 (fig, 2). The distance between neighboring calling stations along transects was 4–5 km based on our calibration result and other studies (Giannatos et al. 2005, Krofel 2008, Banea et al. 2012). Calling stations were selected according to topographical characteristics in order to optimise sound transmission and located in open areas to enable observation of responding African wolves (Banea et al. 2012, Šálek et al. 2014). We did not conduct fieldwork during windy or rainy nights. Each call consisted of two cycles of 15 min broadcast and 5 min silence, three times in one call station. Responding African wolves were counted in the dark, based on sounds and during several short counting sessions with a spotlight, taking the maximum number observed during any single counting session. Four observers counted responding the predators using powerful torches immediately after the last broadcast. Additionally, to validate our African wolf population estimates, we compared our result with radio telemetry data collected from GMCCA and BSNP.

To calculate density, we used data on the number of individuals responding the calling stations (number of individuals responding); the distance at which animals responded to the calls to calculate the area sampled around each station (sampling area), and the probability of animals approaching (Response probability) to calculate density estimates for the area, we used the following formula:

$Density$ = number of $individuals$ responding/$sampling\ area * response$ probability

To minimise the likelihood of duplicate counting, calling stations were at least 4 km apart. Neighboring stations were sampled consecutively on the same day to minimise the probability of duplicate counts. GPS coordinates of the exact locations of all calling stations were recorded. During calling three people in different direction to the wolves.

Figure 2.Calling african wolves on Guassa Community Conservation Area, Ethiopia.

RESULTS

We conducted eight calibration experiments on individuals of African wolves to estimate the response range and probability (supplementary Table S2) where 12 out of 17 responded at a radius of 2 km and no response was observed beyond this. Thus, each calling station covered an area of 12.6 km^2 with response probabilities of 0.71. We assumed that both the response range and the response probability were the same in all habitats irrespective of the landscape of the district. A total of 83 African wolves were recorded at call stations. Over the entire study period, African wolves were recorded 20 (62, 5%) of the total 32 calling station sites.

The GMCCA had the largest density with 0.52 individuals km^{-2} (fig.3) of AWs, however the maximum individuals (seven) in one calling station were recorded from Bale. And the mean density of African wolves in Ethiopian Highlands was estimated as 0.43 km^{-2}.

This study provides important new information that improves our understanding of the density of African wolves which live in human-dominated landscape in Ethiopian Highlands. In addition to giving valuable information for the data deficient African wolves, the study is significant for the conservation management plan of the endangered Ethiopian wolves. The results from the calibration experiments suggested that a broadcasting time of 60 min (accordingly, the 15-min long African wolves sound were separated by 5 min intervals of silence and repeated three times), was necessary to allow African wolves to approach from 2 km.

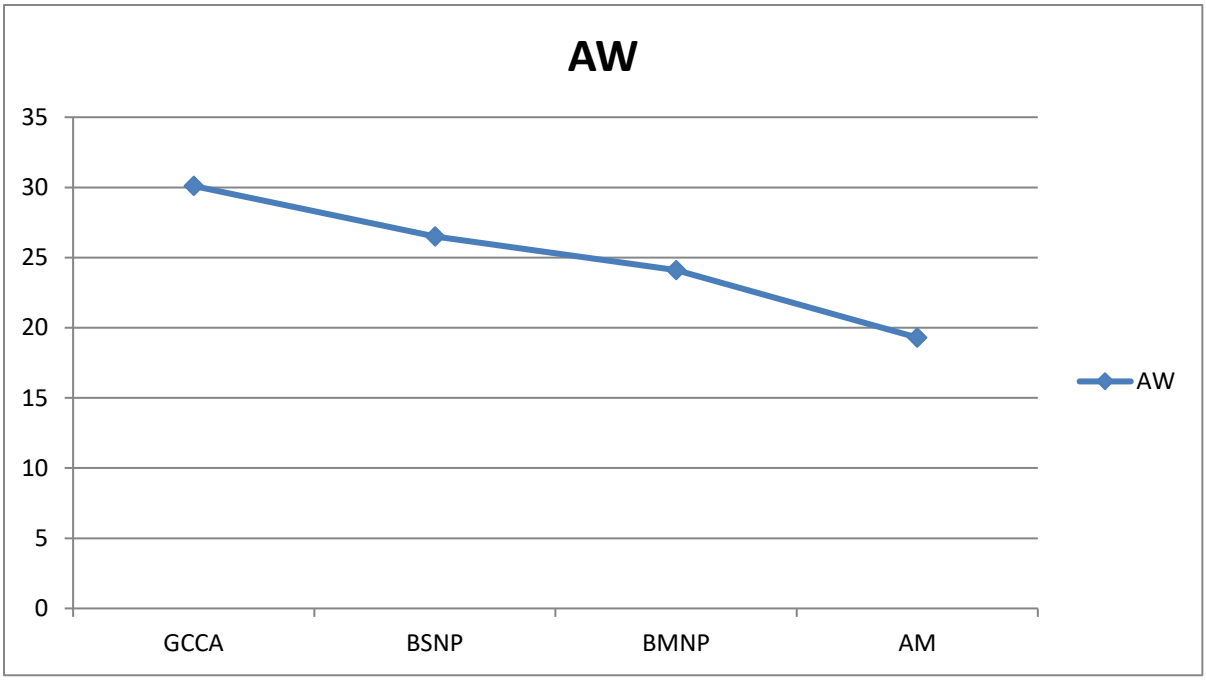

Figure 3. Density of African wolves (AW) per km^2 in Guassa Menz Community Conservation Area (GMCCA), Borena Saynt National Park (BSNP), Bale Mountains National Park (BMNP), Arsi Mountains (AM)

African wolves win the Ethiopian wolves depending on the difference of group size. In addition, the community attacks the African wolves through killing pups in the den site due to sheep predation. African wolves select den site usually under rocks (caves; fig. 4) and sometimes dig holes in a bushland

Identification of potential den site of African wolf is quite important for management human-African wolf conflict

Figure 4. Den site of African wolves: Under rock (A) and in a Bush (B)

REFERENCES

Atickem A, Simeneh G, Bekele A, Mekonnen T, Sillero-Zubiri C, Hill RA, Stenseth NC. 2017 African wolf diet, predation on livestock and conflict in the Guassa Mountains of Ethiopia. Afr. J. Ecol. ***55***, 632-639.

Basille, M., B. Van Moorter, I. Herfindal, J. Martin, J. D. Linnell, J. Odden, R. Andersen, and J.-M. Gaillard. 2013. Selecting habitat to survive: the impact of road density on survival in a large carnivore. PLoS ONE **8**:e65493.

Carrillo, E., G. Wong, and A. D. Cuarón. 2000. Monitoring mammal populations in Costa Rican protected areas under different hunting restrictions. Conservation Biology 14:1580-1591.

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

Eshete, G., J. Marino, and C. Sillero-Zubiri. 2018. Ethiopian wolves conflict with pastoralists in small Afroalpine relicts. African Journal of Ecology 56:368-374.
Gehrt, S. D., S. P. Riley, and B. L. Cypher. 2010. Urban carnivores: ecology, conflict, and conservation. JHU Press.

Hayward, M. W., and G. J. Hayward. 2010. Potential amplification of territorial advertisement markings by black-backed jackals (*Canis mesomelas*). Behaviour 147:979-992.

Khorozyan, I. G., A. G. Malkhasyan, and A. V. Abramov. 2008. Presence–absence surveys of prey and their use in predicting leopard (Panthera pardus) densities: a case study from Armenia. Integrative Zoology **3**:322-332.

Koepfli, K.-P., J. Pollinger, R. Godinho, J. Robinson, A. Lea, S. Hendricks, R. M. Schweizer, O. Thalmann, P. Silva, and Z. Fan. 2015. Genome-wide evidence reveals that African and Eurasian golden jackals are distinct species. Current Biology **25**:2158-2165.

Marino, J., C. Sillero-Zubiri, A. Deressa, E. Bedin, A. Bitewa, F. Lema, G. Rskay, A. Banyard, and A. R. Fooks. 2017. Rabies and Distemper Outbreaks in Smallest Ethiopian Wolf Population. Emerging infectious diseases **23**:2102.

Rueness, E. K., M. G. Asmyhr, C. Sillero-Zubiri, D. W. Macdonald, A. Bekele, A. Atickem, and N. C. Stenseth. 2011. The cryptic African wolf: Canis aureus lupaster is not a golden jackal and is not endemic to Egypt. PLoS ONE **6**:e16385.

Treves, A., and K. U. Karanth. 2003. Human-carnivore conflict and perspectives on carnivore management worldwide. Conservation Biology 17:1491-1499.

Yirga, G., H. Leirs, H. H. De Iongh, T. Asmelash, K. Gebrehiwot, M. Vos, and H. Bauer. 2017. Densities of spotted hyena (*Crocuta crocuta*) and African golden wolf (*Canis anthus*) increase with increasing anthropogenic influence. Mammalian Biology-Zeitschrift für Säugetierkunde 85:60-69.

Density of African wolves in four sites of the study area.

Site	Number of calling stations at 4 km interval	Positive response from each 8 calling station	Mean number of AW responded at each Call station	Probability from calibration	Expected at each station	Density 12.57 km^{-2}	Density km^{-2}
Guassa	8	6	4.4±2	0.71	6.2	6.2	.52
Borena	8	5	3.9±2.4	0.71	5.5	5.5	.46
Bale	8	5	3.7±2.8	0.71	5.2	5.2	.43
Arsi	8	4	2.8±2.3	0.71	3.9	3.9	.33
Mean	8		3.7±2.8	0.71	5.2	5.2	.43/km^2
	32	**20**					