Human-Lion conflict around Nairobi National Park: Lion (Panthera leo melanochaita, Hamilton Smith, 1842) Population Structure, Landscape Use and Diet, in a Semi-Fenced Park

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Summary

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Lion (*Panthera leo melanochaita*) Population Structure, Landscape use and Diet in a Semi-Fenced Park

Keywords

Lion (*Panthera leo melanochaita*), population structure, lion diet, human–lion interactions, lion depredation mitigation, Nairobi National Park, Kenya

Apex predators like lions play an important ecological role in the African savannah ecosystem. Besides being a keystone species, the lion is also a flagship species and a symbol of power for both the government and business section, for the latter especially in the tourism industry. According to a population assessment in 2013, there are 32,260 remaining lions living in the wild in Africa. East Africa has the largest lion population (56.9% of the total) compared to other regions in Africa. Of the estimated 32,260 lions in Africa, only 6.2% are found in Kenya.

Kenya has declared 8 percent and 11 percent of the land area as national parks and conservancies for species conservation respectively. This land mass is assigned for the conservation of wildlife including large carnivores. Within this designated land for conservation of wildlife, there are six lion conservation units (LCU). The lion population in Kenya suffers from human-induced threats (habitat destruction and fragmentation, prey depletion and retaliatory killing) and climate variability (erratic and unpredictable seasons), which have caused lion numbers to decline.

In order to better understand the threats lion populations are facing, in support of better conservation and protection measures for the remaining lion populations in Kenya, continuous research on lion ecology and the subsequent monitoring of the lion populations within specific lion conservation units is required. The lion population in Nairobi National Park (NNP) has suffered from urban pressure, retaliatory killing and lack of habitat connectivity. This has resulted in intensified human–lion interactions around NNP in recent decades and the subsequent retaliatory killing of lions due to conflicts with livestock owners. During the years prior to the start of my research in 2012, the park has lost six lions as a result of retaliatory killing.

My research aims i) to analyze factors influencing livestock depredation by lions around Nairobi National Park, ii) to study the impact of climate variability on lion ecology and lion-livestock conflicts and iii) to investigate mit-

igation measures used by livestock farmers to prevent livestock depredation around NNP. My research covered lion population structure, lions home ranges, movements and landscape use, diet and prey choice and the effectiveness of administrative measures (park fence) and methods of communities' livestock husbandry practices to prevent and mitigate conflicts.

Reliable estimates of both prey and lion populations to sustain the lion population are important for management. My study revealed that despite considerable human-induced mortality, the NNP lion population has been fluctuating between 34 and 43 lions (including cubs) over the past decades. The lions in NNP have adapted to a high level of human disturbance by surviving in small prides and forming small groups with a high reproduction rate, to compensate for increased mortality.

Lion populations can recover quickly if retaliatory killing is mitigated and/or prevented. The park has an annual average mean male to female ratio of 1:1.56, which was stable during the years of my research (2012-2018). This ratio allows NNP lions to reproduce and compensate mortality, resulting in a relatively stable population. The mean pride size was 2.8±2.4 including cubs (< 1 year) during 2012-2018. The largest group size observed was 17 lions with cubs. The mean group size of adults and sub-adults (1-2 years, excluding cubs (< 1 year) was 1.6±0.17. This is smaller than the group size observed by other authors in the Serengeti, where a group size of 2.6 was observed. In NNP there was no difference between group size in the dry season and in the wet season. I also observed that the females in the northern and middle pride synchronized their denning seasons to the months of September and February.

A comparison of NNP pride male tenure with other parks revealed that Queen Elizabeth National park in Uganda had an average male tenure of 7.5 years (Van Orsdol. 1981), the Ngorongoro Crater 3 years (Hanby et al. 1987) and the Serengeti 2 years (Hanby et al 1987). I observed that NNP pride male tenure was long during 2012-2018 (up to 4.5 years) due to a stable coalition of two pride males. My results suggest that the long period of pride male tenure and synchronized female birth has increased cub survival, which compensates for enhanced mortality due to conflicts.

Most scientific literature suggests that lions require an extensive home range to survive, especially during the wet season. By contrast, my research shows that lions' home ranges in the semi-fenced NNP are very small compared to other protected areas and show no difference between wet and dry season.

The smaller size of lion home ranges in NNP could partly be explained by avoidance of the urban fringe of the park due to urban disturbance (noise, light, dust), which reduces their space even further. With high wild prey densities and low natural mortality, lions are able to use a small home range of 34 km^2 and survive, in spite of the fences.

Previous studies have used microscopic prey hair morphology analysis from lion scats, in combination with prey transect counts and prey carcass counts to determine lion diet and prey choice. In my research, I was able to demonstrate the application of DNA-metabarcoding as an additional method to determine the diet and feeding ecology of lions. This novel technique has the capacity to reveal the wider feeding spectrum of lions, including cryptic small prey species like rodents and birds, which are often not observed in carcass counts, nor revealed by microscopic hair morphology.

In NNP, lions mostly depend on wild prey species and partly on livestock depredation. They depredate especially on livestock outside the park when there is low wild prey density in the park during the wet season. However, I observed that they also make excursions outside the park during the dry season.

Although NNP lions mostly depend on medium-sized (50-200 kg body mass) prey, I found that 2% and 9% of the diet consisted of very small prey (<5 kg), based on microscopic hair morphology analysis and DNA-metabarcoding respectively. This finding is probably a result of spatial-temporal fluctuation of herbivores in the park and extreme climate variability, forcing lions to switch their diet between prey species of different weight class, depending on availability. I found a correlation between extreme climate events caused by El Nino and the presence of very small prey in the lions' diet. Based on microscopic analysis of prey hair morphology, but also based on DNA analysis, I also found the presence of livestock prey hair items in lion scats. Despite reports of human fatalities as result of lion attacks, there was no evidence to support this either in hair morphology analysis or in DNA-metabarcoding.

My research revealed the role of the park fences and the livestock bomas equipped with flashlights in the buffer zone in reducing human–lion interactions and quantified the costs incurred by farmers through livestock depredation. The function of any fences either for the park, or for the livestock bomas is to prevent interaction between lions and livestock. Lions in NNP have more access to livestock through the unfenced section of the park as opposed to the fenced section and thus increase the cost to livestock farmers. I calculated that the livestock farmers incur an annual loss of 39,820 USD due to livestock depredation. Given the importance of the buffer zone for lions, I suggest that complete fencing of the park is not a viable option and instead we should look for alternative solutions such as habitat connectivity and compensation for livestock losses due to depredations. The Kitengela corridor in this respect remains of vital importance for the lion population in NNP.

My study revealed new insights into the effectiveness of construction materials for bomas (wood, chain-link, acacia branches and barbed wire). I compared the materials used in bomas installed with modern LED flashlights. The bomas with wooden fencing materials, reinforced with chain-link perimeter fencing of above 2.5 meters were less vulnerable to lion attacks compared to other fencing types. I also concluded that the farmers with roof-covered bomas are likely to incur more livestock losses and injuries during lion attacks than open roof bomas where livestock could escape from the boma during lion attacks. Roof-covered bomas suffer more to "mass-killing" of livestock than open roof bomas.

My study shows that the LED flashlight technique is very effective (96%) in reducing nocturnal livestock depredation at bomas by lions. However, I also found that lions adapt their behavior and engage more in diurnal attacks outside bomas after the installation of flashlight technology. My research has resulted in a number of recommendations for the management of Nairobi national Park, such as keeping the Southeastern border of the park non-fenced, building a green wall at the urban fringe of the park and investing in the Kitengela corridor.