

A Comparison of Lion Home Range Sizes in Two Management Blocks in a Semi-Arid Savannah National Park of Zimbabwe

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Abstract: A comparison of home range sizes of 4 collared lions, *Panthera leo* was carried out in two management blocks of Hwange National Park during the wet season. Home range sizes and utilization distribution were determined. Female lions' home ranges significantly differed in the Main Camp and Ngamo Blocks (t -calculated= 3.37; 2d.f; t -critical= 2.92). Intersex variations in home ranges were observed in the Main Camp block (t -calculated= 7.82; 2d.f; t -critical= 2.92). Lions spent most of the time inside the park but some moved outside the park. Solitary lions encroached in human settlements more than prides and there were interactions between the solitary male and female lions from Main Camp block. Main Camp lions had larger range sizes than Ngamo lions and males exhibited larger ranges than females. The encroachment of lions into communal areas has important implications for park management and human-wildlife conflict.

Keywords: lions, home range, management, Hwange National Park

1. Introduction

The home range of an animal is the area where an animal moves about in pursuit of its routine activities [13]. An understanding of home ranges is essential in understanding spatial ecology and the diversity of factors affecting habitat utilization by animals. The ranging behaviour of an animal is likely to be affected by a number of ecological, behavioural and demographic factors [9]. Lions have been noted to have large home range sizes which change over time with the stage of life of the lion (juvenile, sub-adult/adult). Lion home range sizes have also been observed to differ with habitats [7; 14; 1; 9] largely due to temporal and spatial fluctuations in food availability and changes in environmental conditions.

The African Lion (*Panthera leo*) is Africa's largest cat and is an important species both ecologically and economically. Large carnivores at the apex of the trophic level occur at low densities and have large ranges [12]. Ecologically, lions are top predators and are major indicators of the quality of the environment [10]. They require vast tracts of habitats for maintaining viable populations [3]. However, large carnivores compete and conflict with human interests making their conservation programs difficult to implement. Lions disappear as a result of the degradation of the habitat and the disappearance of prey species. [1] Estimated that the world lion population has been reduced by approximately 30% over the past decade largely due to human-lion conflict and increased trophy hunting.

Lion population density affects home range size because larger prides have larger home ranges than smaller ones. Density effects may be felt through its effect on

availability of resources like water, food and mating partners. Water has been pointed out as the major factor that fashions lion movement [6; 9]. Trophy hunting of lions affects the lion's home range size because lions react to shooting by moving a great distance from their normal home range thus increasing its home range size [4]. Intersex differences in home range sizes are exhibited with males having larger home range sizes than females [5]. These differences are manifestations of separate selection pressures: female reproductive success is closely tied to an ability to exploit resources, whereas male reproductive success is coupled with an ability to find and mate with females. Thus, female ranging behaviour is expected to be configured around the distribution of resources while that of males is expected to be largely influenced by the distribution of females [9].

Our study investigated differences in lion behaviour between two blocks in a large semi-arid savanna national park, determine intersex variations in home range size and to assess the degree of lion encroachment into neighbouring villages as an indicator of potential human-lion conflicts.

2. Materials and Methods

A. Study site

The study was carried out in Hwange National Park (HNP) which occupies 14 651 sq.km in the north-west of Zimbabwe (between latitudes 18°30' and 19°50' and longitudes 25°45' and 27°30'). It is bounded to the west by

Botswana; to the north by Matetsi and Deka Safari Areas; to the north east by State Forest Land and farms and to the south east by Tsholotsho Communal Land. The Park vegetation is largely woodland and scrubland (predominantly *Baikiaea plurijuga*, *Terminalia sericea*, *Combretum* spp. and *Colophospermum mopane*) and less than 10% of the entire area comprises of open grassland or bushed grassland. Mean monthly temperature ranges from 17.2 to 30.4°C. The region receives an average of 650 mm of rainfall from November to April. Precipitations are restricted to a single rainy season which lasts from October–April.

Fauna

The diversity of herbivores range from the mega herbivores which include Elephant (*Loxodonta africana*) and giraffe (*Giraffe camelopardalis*) to meso-herbivores

which include the common duiker (*Sylvicapra grimmia*), Impala (*Aepyceros melampus*) and Warthogs (*Phacochoerus africanus*) among other herbivores. The carnivores include the Lion (*Panthera leo*), spotted hyena (*Crocuta crocuta*), Leopard (*Panthera pardus*) and cheetah (*Acinonyx jubatus*).

B. Management units

HNP is divided into three management units, namely Main Camp, Sinamatella and Robins Camp. The Main Camp management unit covers 10 000km² of HNP and it is further sub-divided into seven sub-blocks which are Main Camp, Ngamo, Shapi, Central, Dzivanini, Shakwanki and Mtoa blocks. The study focused on two blocks in the Main Camp management unit (Figure 1- M is the Main Camp Block and N is representing the Ngamo block).

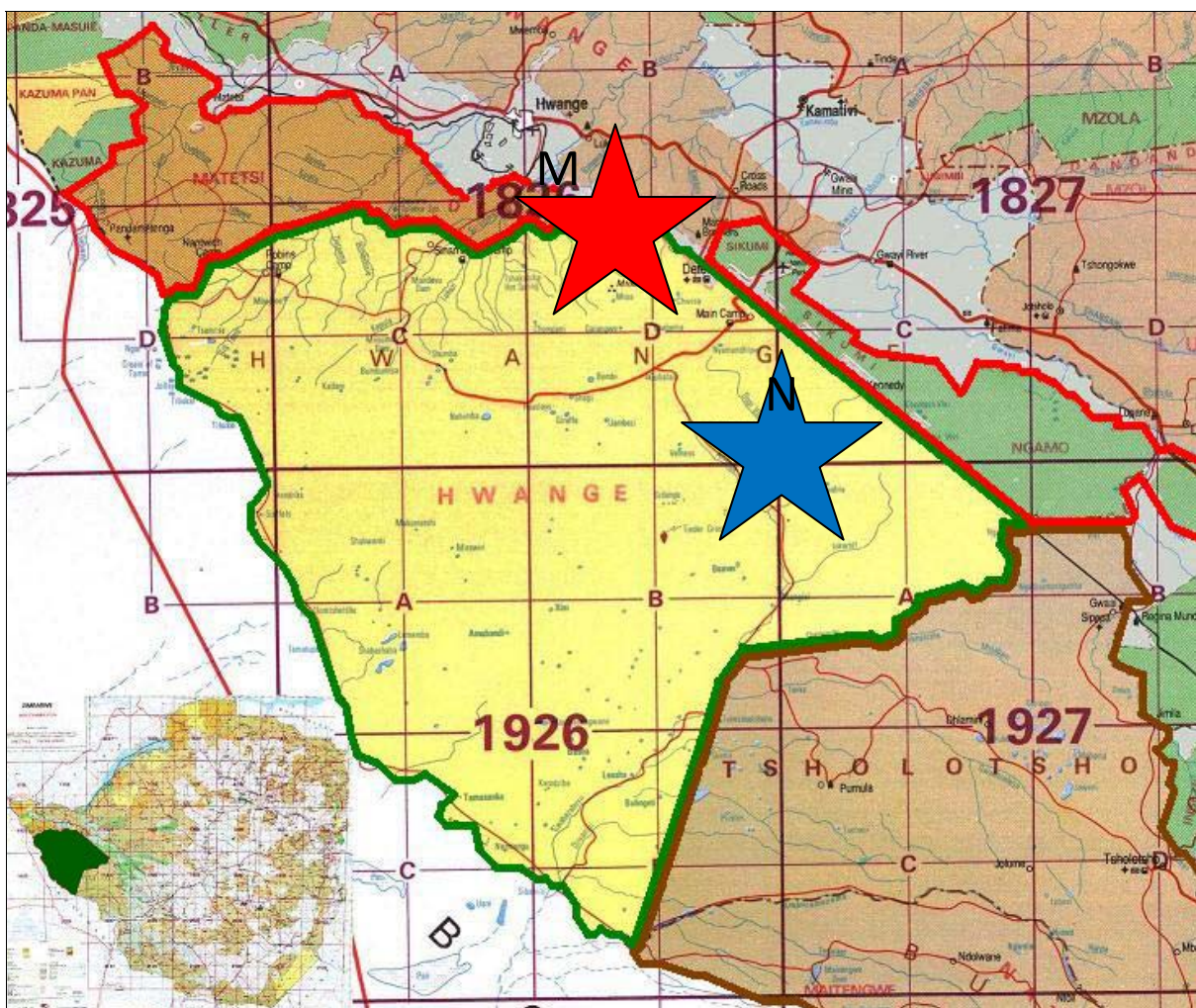


Figure 1: Map showing Hwange National Park and surrounding land uses.

Adjacent to the Main Camp block is Sikumi forestry land, where the main activities are sport hunting and conservation of the indigenous flora. This forestry land acts as a buffer between the park and the Mabale communal area where subsistence agriculture is the main activity. Adjacent to the Ngamo block is the Ngamo forest lands and Tsholotsho communal area. The forest land is a sport-hunting concession and in the communal area, subsistence agriculture is the predominant activity and wildlife is utilised under the

Communal Areas Management Programme for Indigenous Resources (CAMPFIRE).

3. Methods

Radio-collared lions were used to collect data on lion movement. Two types of collars were used- the Global Positioning System (GPS) collars and Very High Frequency (VHF) collars. The GPS collars were used for the Main Camp study lions. This type of collar downloads movement

data into satellites that can be downloaded from computers using software. The VHF collars were fitted on the Ngamo study lions. To download data from this type of collar, the lion has to be radio-tracked first using a tracker and communication receiver so that data can be downloaded some meters (30m) from the lion. Lion movement data was collected for a period of four months (February-May), during the wet season. Lion locations were obtained at different times of the day and night and an aircraft was used to locate radio-collared lions every morning.

General Information about the Study Lions

The study population consisted of 8 collared lions, 4 (2 males and 2 females) from Ngamo and 4 (2 males and 2 females) from the Main Camp block. These lions were randomly chosen to represent different lion social organizations. The study population consisted of collared solitary males and females, group males and females and females with cubs. The F1 lioness in Main Camp block was solitary and the F2 female was in a pride of 2 females and 5 cubs. The M1 male in Main Camp was solitary and the M2 male was with another male lion probably a brother. The F1 Female in Ngamo had 4 cubs and a juvenile female and the F2 lioness in Ngamo was in this same pride. The two females (the adult female and the juvenile female) in the Ngamo block were in the same pride when they were collared in January 2011.

A. Analysis of Home Ranges

The data was imported into Ranges 7 software for estimating the home range sizes of lions and their utilization distribution from radio-tracking data. The mapping of GPS fixes and home ranges and the delineation of animal movement paths was done using ArcView 3.2 G.I.S software. Lion ranges were defined and displayed using fixed kernel contour techniques (KC). Home ranges were delineated using 95% kernel home ranges for point distributions, and 50% kernels

Main Camp results

A. Main Camp females

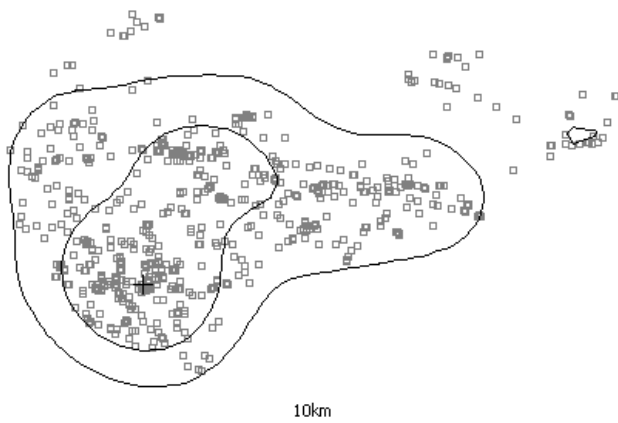


Figure 2: Kernel contours and home range sizes for the Main Camp F1 lion. [Home range size: 95% = 247.60km² and 50% = 76.80km²]

to delineate core areas. In this study, areas defined by the 95% kernel that fell outside the park boundary were of particular interest as they indicated the level of spatial overlap which could be a potential source of human-wildlife conflict. Zero encroachment outside the park meant the lions were not causing any conflict with the local people, while any encroachment outside the park meant the lions were causing a threat to villagers and their livestock.

The data was analyzed separately for the males and females and also spatially. The significance of differences in home range size between blocks and sexes was calculated using the Student's t-test.

As observations are based on a single season of study and on a comparison of two blocks only, in one management unit, the conclusions should be viewed as preliminary, and a stimulant for more work in this area.

4. Results

B. Home range size results

The results show kernel contours displaying utilization distribution from GPS data of each study lion and lion home range sizes at 95% and 50% harmonic mean of their home range area. Mean home range for the females in the Main Camp Block was 277.25km² and 177.2km² for the Ngamo lionesses. The mean home range for the males in Main Camp was 585.2km² and 348km² for the Ngamo lions. Mean core size for the Main Camp females was 93.47km² and 56.6km² for the Ngamo lionesses. For the males, the mean core size for the Main Camp lions was 159.44km² and 70km² for the Ngamo lions. The same value was observed for the Ngamo females because when the animals were collared in January 2011, the juvenile which was 18months old was expected to disperse from the parent/sister pride, but it did not disperse resulting in the Ngamo lionesses having similar home ranges during the study period.

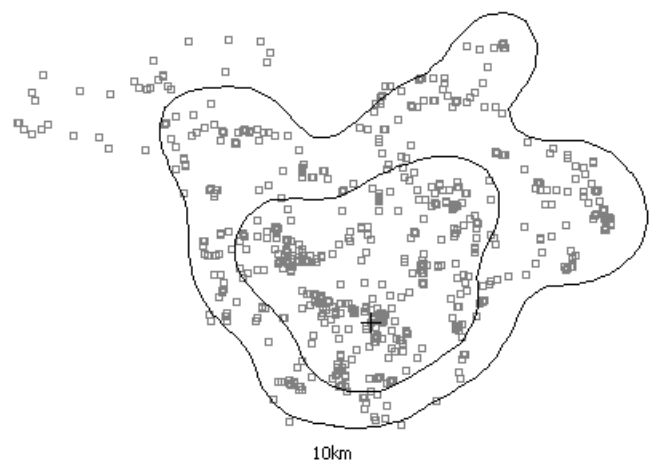


Figure 3: Kernel contours and home range sizes for the F2 lions. [Home range size at: 95% = 306.90km² and 50% = 110.14km²]

Main Camp males

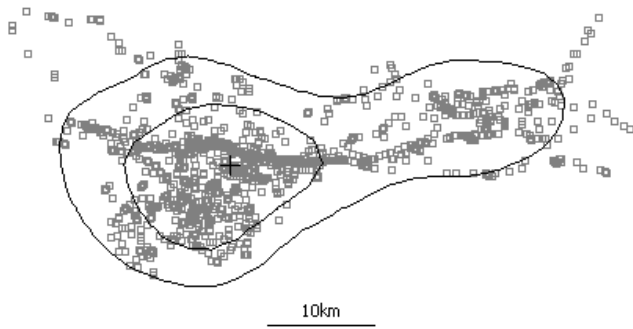


Figure 4: Kernel contours and home range sizes of the Main Camp M1 lions. [Home range size at: 95%=11.10km² and 50%=171.98km²]

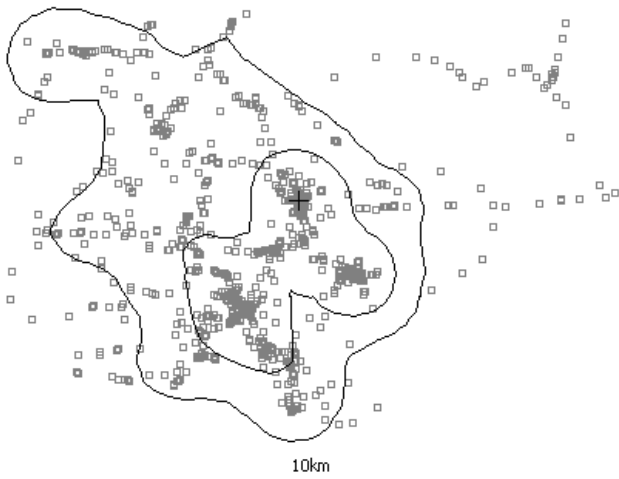


Figure 5: Kernel contours and home range sizes of the Mani Camp M2 lions. [Home range size at: 95%=559.30km² and 50%=146.9km²]

B. Ngamo block results

C. Ngamo females



Figure 6: Kernel contours and home range sizes for the Ngamo juvenile female. [Home ranges size at: 95% = 177.20km² and 50%= 56.60km²]



Figure 7: Kernel contours and home range sizes of the Ngamo F1 lions. [Home range size at: 95% = 177.20km² and 50%= 56.60km²]

D. Ngamo males

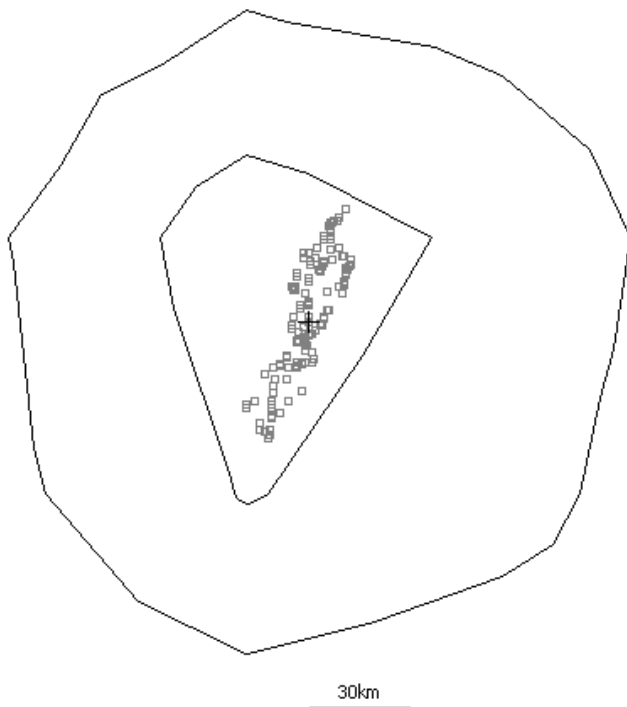


Figure 8: Kernel contours and home range sizes for the Ngamo M1 lions. [Home ranges size at: 95%= 267.30km² and 50%= 47.90km²

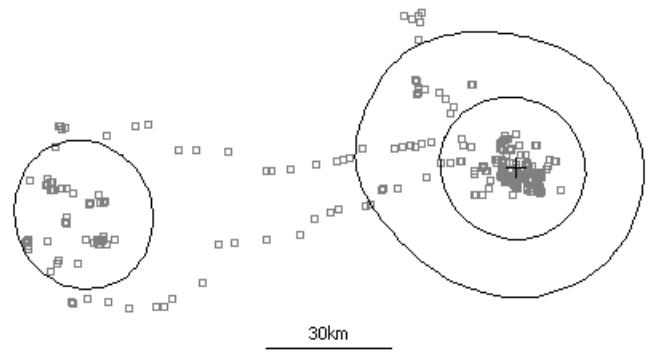


Figure 9: Kernel contours and home range sizes for the Ngamo M2 lions. [Home range size at: 95%= 428.70km² and 50%= 92.03km²

Table 2: Summary of Home range estimates for the African Lions in the Two Blocks

	Group size	No. of fixes	95% kernel home range (km ²)	50% kernel core (km ²)
MC- F1	1	1022	247.6	76.8
MC- F2	7	1023	306.9	110.14
MC- M1	1	2160	611.1	171.98
MC- M2	2	1495	559.30	146.9
N- F1	6	374	177.2	56.6
N- F2	6	374	177.2	56.6
N- M1	2	108	267.3	47.9
N- M2	1	721	428.7	92.03

MC- Main Camp Block

N- Ngamo Block

F- Female

M- Male

5. Comparison of Means

A comparison of the mean home ranges at the 5% level of significance using the t-test for the males and females and between the blocks showed significant differences in the female home ranges between Main Camp and Ngamo blocks (t-calculated= 3.37; 2d.f ; t-critical= 2.92). There were also significant differences in mean home ranges between males and females in the Main Camp Block (t-calculated= 7.82; 2d.f; t-critical= 2.92). It was thus concluded that intersex home range variations exist within the Main Camp Block.

A. Encroachment results

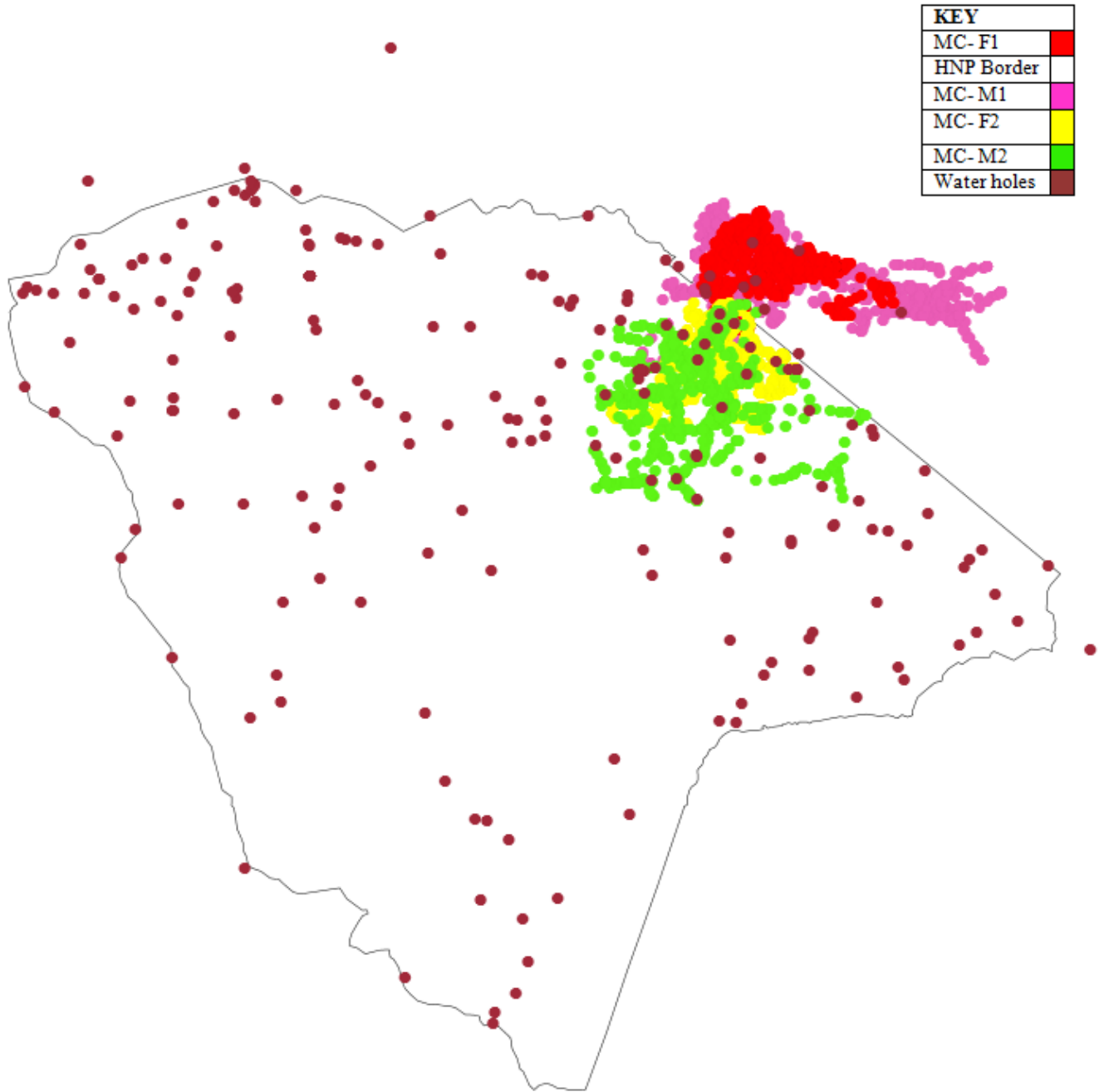


Figure 10: Spatial movements of the Main Camp lions.

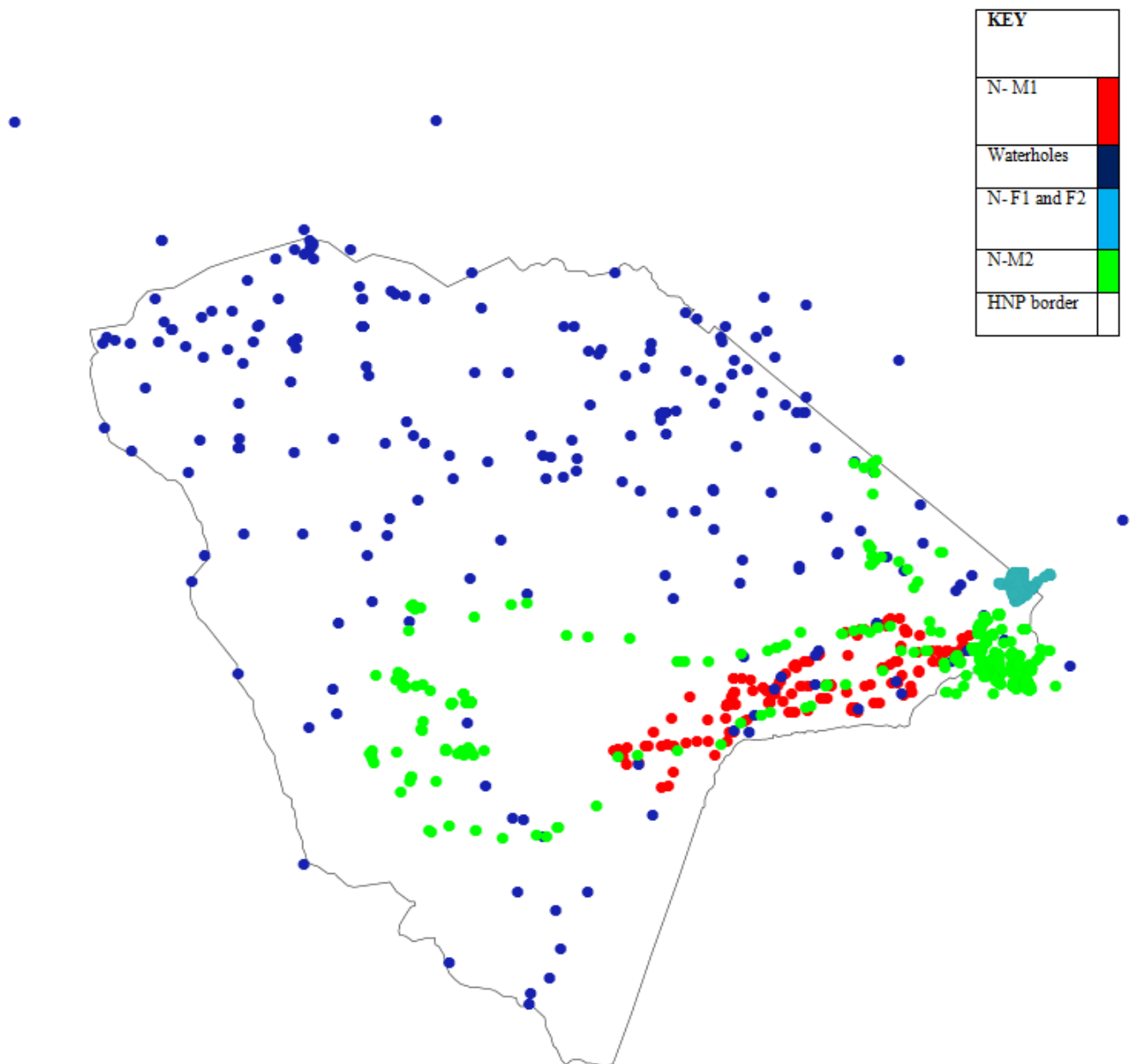


Figure 11: Spatial movements of the Ngamo study lions.

Analysis of lion encroachments out of the park revealed that the solitary lions encroached out of the park into the neighbouring Sikumi forestry land and further into the Mabale communal villages posing great threats to the livestock of the locals. The encroachment was however more extensive for the MC- M1 lion than for the MC-F1 lion. There was an overlap of ranges between the two solitary lions; implying social interactions probably during mating and hunting. The prides stayed exclusively within the park.

The Ngamo female with 4 cubs and the juvenile collared female showed some minimal encroachment outside the park into the protected Ngamo forestry land (fig. 11). The only threat the lions were exposed to was being shot by hunters in that area. N-M2 minimally encroached into the neighbouring Tsholotsho communal lands where it was at a risk of being snared, poisoned or killed by the villagers. Furthermore it could be shot by the sport hunters resulting in the vacuum effect which contributes to a cascade of lion decreases in the park. As lions encroached into neighbouring settlements

from both blocks, we reject H_0 and conclude that lion encroach into neighbouring settlements from the Main Camp and Ngamo blocks.

6. Discussion

[8] Observed home ranges of $647.3 \pm 274.4 \text{ km}^2$ for male lions and $324.4 \pm 189.8 \text{ km}^2$ for lionesses, [5] also found that male ranges were larger than those of females. In the Serengeti, home ranges of pride lionesses have been observed to range between 20 and 400 km^2 [11]. Radio collared lions in the current study showed a similar relationship to these studies with males having large ranges than females in both blocks. Lions from the Main Camp block had larger home ranges than those from the Ngamo block, which may be attributed to the fact that the Main Camp block receives more tourists than the Ngamo block, so the increase in human pressure in Main Camp (around water points, camping sites and roads) may be driving prey to long distances, therefore increasing lion ranges as they move great distances in search of prey.

The Main Camp block is home to a large number of carnivores than the Ngamo block (or any other block in HNP) [8] including lions, which means the ratio of prey to lion is smaller in the Main Camp block than in the Ngamo block. To acquire prey, the Main Camp lions have to move great distances than the Ngamo ones. Main Camp lion prey species are now familiar with the lion predation methods and exhibit anti-predation mechanisms. According to the optimal foraging theory, when prey becomes difficult to hunt, lions will move widely in search of prey that is easier to handle, resulting in large home range sizes.

The social organization of lions may have affected the observed results. The lions in prides had smaller home ranges than solitary lions. [5] Observed that larger prides were more successful in hunting prey than smaller prides and solitary lions (advantages of co-operative behaviour in relation to hunting). Larger prides do not have to travel great distances to search, encounter and successfully hunt prey than smaller prides and solitary animals. This may explain the larger range sizes for the Main Camp lions. The non-dispersion of the Ngamo juvenile female resulted in the Ngamo pride have a higher average pride size than Main Camp lions.

The intersex variations in home range sizes observed in both blocks may be due to differences in prey preference. [13] Proposed that males specialize and have been seen to be more successful in hunting larger prey and females in hunting medium-sized prey, thus males may encounter more problems in getting prey than females. In this study, 3 of the 4 study females had cubs which they constantly monitored so as to prevent encounters with infanticidal males. This may have reduced their range sizes. According to [13], a solitary lion has a large range size than a social lion. The only solitary female in the study (MC- F1) had a home range size larger than all other females, but smaller than that of all the study males even the pride ones. This is in agreement with [14] observations that male ranging behaviour is not affected by coalition size but is more driven by resources than by social factors as is the case with females.

[2] Found a positive correlation between the times a lion spent outside the park and livestock predation, and concluded that the greater the time spent outside the park, the greater the likelihood of human-lion conflict. In this study there were lion encroachments outside the park from both blocks. Encroachments were however significantly greater for Main Camp lions than for Ngamo lions. The Ngamo females had little movement as they seemed to have monopolized a single water point at the park border. In addition, their encroachment was into the adjacent protected Ngamo forestry land and this movement is of no consequence to villagers' livestock. Thus there was no possibility of a conflict with villagers, but they were at a greater risk of becoming prey to foreign hunters in the Ngamo forestry lands.

The Ngamo solitary male had a small degree of encroachment into the adjacent Tsholotsho communal area. This may result in livestock predation, and potential lion-livestock conflict. The lion could also be shot by CAMPFIRE hunters creating a territorial vacuum, which might lead to the vacuum effect. A vacuum effect occurs

when male lions are shot on the border of the National Park creating a territorial vacuum which is successively filled by lions from further inside the protected area [8]. When this process (vacuum effect) continues more males are drawn from the park into the border where they can easily be snared, hunted and poached leading to a continued decrease in lion populations.

In the Main Camp block movement outside the park border was displayed by the solitary lions (both the male and the female), which encroached into the adjacent Sikumi forest area and across into the neighbouring Mabale village settlement. This may result in livestock depredation leading to human-wildlife conflict and the snaring and poisoning of the lions. The MC-M1 lion could also be shot at the Sikumi forestry land, leading to the creation of the vacuum effect and the subsequent movement of territorial males from the core of the park to fill the created vacuum territories at the park border.

In the study it is only the solitary lions that encroached into neighbouring villages, while the pride lions stayed within the park or protected area boundaries. This may be because it is difficult for a solitary lion to successfully hunt prey compared to a pride, hence the solitary lions may have encroached into neighbouring villages where they could encounter and successfully hunt prey (livestock) that is easier to catch [2]. The solitary lions may also have been driven out of the park by the prides or more superior territorial males and had failed to establish themselves with another pride in the park.

7. Conclusion

Our study showed that the Main Camp lions have larger range sizes than Ngamo lions, and males exhibited larger ranges than females. There are possibilities of future human-lion conflicts, as noticed by encroachments outside the park from both blocks. These conflicts may be greater for the Main Camp lions as they showed more pronounced encroachments into neighbouring villages. Encroachments have potential negative impacts on the livelihood of the neighbouring villagers. The capturing of lions that are greatly encroaching into neighbouring villages (like the MC-M2, MC- F1 and N-M2) and relocating them to other areas where conditions sustain new populations would be a long-term solution to prevent the extirpation of lion populations. As observations were done in one season, the conclusions should be viewed as preliminary.

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