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Population status and anthropogenic disturbances of forest elephants (*Loxodonta cyclotis* Matschie, 1900) in Nki National park and its environs, east region, Cameroon

Sylvie Nguedem FONKWO[1*], Ndi Collins FAI[1] and Tonjock Rosemary KINGE [2]

[1]*Department of Zoology, Faculty of Science, The University of Bamenda, P.O BOX 39, Bambili, Cameroon.*

[2]*Department of Plant Sciences, Faculty of Science, The University of Bamenda, P.O BOX 39, Bambili, Cameroon.*

[*] *Corresponding author; E-mail: snguedem@gmail.com; Phone: +237-677693571*

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ABSTRACT

African elephants play important roles in both the natural and human worlds: ecologically as a keystone species, economically as drivers of tourism and culturally as icons of the African continent. Increasingly, elephant populations are threatened by poaching for ivory, human-elephant conflict, habitat loss and fragmentation, and isolation of populations. This study was carried out to estimate the population of forest elephants and determine the human threats to their population. Data was collected along eleven 2 Km line transects and reconnaissance walk as well as administration of semi-structured questionnaires. Results obtained indicated a mean dung pile of 6.0 boli/Km^2. Elephant density, thus, was 0.14 elephant/km^2, translated to 428 (217-897) individual elephants. The main threats on elephant population with their percentage acceptance were identified to be non-respect of law enforcement (94.4%), hunting for bushmeat (92.5%), hunting for ivory (91.6%), lack of a management plan (73.8%), logging (68.2%) and road construction (43.0%). It was therefore concluded that there is a reduction in elephant population in the park from 565 in 2015 to 428 in 2021. Thus, it is recommended that increased law enforcement, surveillance and the setting up of constant and long-term monitoring programs be carried out in the park.

Keywords: Estimated density, human threats, *Loxodonta cyclotis*, Protected area, Critically endangered species, mammals.

INTRODUCTION

Forest elephants lack information on population structure and threats due to insufficient research as compare to savanna elephants. This serves as a hindrance to assessing the effect of exploitation of ivory on the continental elephant population (Roca et al., 2001). Given the conservation status and

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the recently documented information on population decline of African forest elephant there is need to study this species (Meyer et al., 2017; Palkopoulou et al., 2018). Forest elephants (*Loxodonta cyclotis*) population are under serious decline with about 62% between 2002-2011 across the central African forests as a result of poaching for illegal ivory trade (Maisels et al., 2013).

South-East of Cameroon represent a stronghold of forest elephant population that is recognized as a priority for conservation efforts (Brittain, 2013). A study of the population trends of forest elephants across the region is necessary to alert protected area (PA) management, Government body and conservation strategies aimed at preserving this megafauna species from going extinct. For the Government and protected area managers to make reliable decisions, a consistent estimates of population size, density, distribution and trends in these estimates, at regional and local level are necessary. In addition, proper knowledge on the anthropogenic and ecological factors that influence the distribution and population density of this species within its environment is vital for adaptive management strategies (Stokes et al., 2010).

In 2005, an estimate of elephant population in Nki National park was 3000 which drastically dropped to 565 individual elephants by 2015 (WWF Cameroon, 2016). This drastic reduction in their population is due to human activities and according to Nzooh et al. (2016), human activities are focused on elephant poaching for ivory where 3- 4 elephants were killed averagely per day in the Cameroon Tridom (Boumba-Bek National Park, Nki National Park and Ngoyla-Mintom Forests) in 2011, 2012, and 2015. Considering this mean estimate, there was a 93% drop in elephant population in Boumba-Bek National Park from 2011 to 2015, 78% in Nki National Park from 2005 to 2015 and 72% in Ngoyla-Mintom Forests from 2011 to 2015 (Nzooh et al., 2016).

The lack of accessibility and visibility into the forest serves as an obstacle to determine the number and distribution of elephants in the forest. Information on the population status of forest elephants in Nki National Park dates as far back as 2016 but little is known on their anthropogenic disturbances. A full knowledge of the population status and threats faced by forest elephants will help in the development of conservation and management strategies of this critically endangered species. This study was set to i) determine the relative density of elephants' population, ii) observed population abundance of forest elephants and iii) evaluate human threats on their population in the Nki National Park.

MATERIALS AND METHODS

Description of study area

Nki National Park (NNP) is situated between latitudes 2°05'N to 2°50'N and longitudes 14°05'E to 14°50'E. It covers a surface area of about 309,362 hectares (3,093.62 Km^2) (Nyenty, 2016). It is situated in the East Region of Cameroon between Ngoyla Sub-Division in the Upper-Nyong Division, Moloundou Sub-Division in the Boumba-and-Ngoko Division and Salapoumbé Division (Figure 1).

Floristic results of NNP revealed by Nkongmeneck, 1998 and Ekobo, 1998 shows the presence of 8 different types of vegetation disseminated in an evergreen, mixed and semi-deciduous forest. These include: mono dominant forests of *Gilbertiodendron dewevrei*, mixed forests of *Gilbertiodendron dewevrei* and *Raphia regalis,* forests dominated by *Raphia regalis*, forest clearings and swampy grasslands with or without salt licks, swampy forests of *Raphia spp*, forests of *Mapania spp,* forests of *Baphia leptobotrys*, forests with undergrowth dominated by the family of *Marantaceae*.

The wildlife of this region is estimated at 34 species of which large mammals are made of 11 species of primates, 12 species of

ungulates and sub-ungulates including elephants and 4 species of carnivores (Ekobo, 1998).

Data collection

A total of eleven, 2 Km transects were established and approximately 40.16 Km recce walkways were surveyed in Ikwa area of Nki National park and 107 semi-structured questionnaires were administered in nine villages surrounding Nki National Park from the 18th of March to the 28th of May 2021. For this length of time, research team went to the field in Nki National Park twice collecting information on elephant population density and anthropogenic activities that will provide insight into the importance of human pressure and disturbance in diminishing elephant population. The Line Transect Survey Method (Buckland et al., 2001; Tchamba et al., 2015) was used. A total of 11 random transects of 2 km each were surveyed precisely in Ikwa in the Nki National Park. Along these transects, there were two important aspects in data collection: One was the finding and recording of dung piles along transect lines; and the other was the regular checking of dung piles to categorize their state of decay. Each time a dung pile was found along a transect, its state of decay was categorized according to the MIKE's System' for dung-pile classification namely: S1: all boli are intact; S2: one or more boli (but not all) are intact; S3: no boli are intact, but coherent fragments remain (fibres are held together by faecal material); S4: no boli are intact; only traces (e.g., plant fibres) remain; no coherent fragments are present (but fibres may be held together by mud); S5: no faecal material (including plant fibres) is present (Hedges and Lawson, 2006). Perpendicular distance from the center of each individual dung pile to the line transect was measured in meters using a measuring tape. The data collection protocol also involved recording their feeding signs, tracks, burrows, scrubbings, digging, wallows and threats.

One hundred and seven (107) semi-structured questionnaires (Djossa et al., 2013) were administered to villagers in nine (9) villages around the Park. These villages were Dimako, Lelene, Lamson, Ngoyla-village, Mabam-Baka, Mabam-Ndjem, Nkondong II, Djadom and Bareko II. The questionnaires administered were based on demography, detectability, occupancy, abundance, distribution and threats to elephants.

Statistical analysis

Elephant dung density was obtained through the program, DISTANCE; which allows the selection of different models and also includes a range of different options, as prepared by Burnham *et al*. (1980). Densities were analyzed following line-transect analysis guidelines and were computed using the software Distance v 7.3 (Meredith, 2008).

The density of dung-piles, D, was gotten as,

$D = n.f(0)/2L$

Where: n = The number of droppings

L = The total length of the transects in which they were recorded

The methods for estimating the variance of D and the confidence limits are given by Meredith (2008). F(0) is the probability density function of detected distances from the line, evaluated at zero distances. The calculation is done automatically by the program Distance v7.3. Density (D) is estimated for the surveyed area and the population size (N) is computed based on the size of the entire habitat area. Often an encounter rate n/L is computed as an index for sample size considerations or even as a crude relative density index.

After obtaining the dung pile density from the Distance Software, elephant density was calculated using the formula below as described by Buckland et al., (2001).

$E = (D * r)/Y$

Where:

E = Elephant density;

D = Dung pile density i.e. number of dung/sample area

r = Daily rate of dung pile decay and;
Y = Defecation rate or number of dung piles produced per elephant per day.

The defecation rate (Y; droppings produced per day per elephant) of 19 and rate of dung decay; r of 67.299 (SE 7.258) days; 0.01486 per day by CITES MIKE, (2012) survey in Boumba-Bek National Park were used.

Threats on elephants were analyzed on four point Likert scale (Likert, 1932). This was done by summing nominal values and dividing by the total number of scaling items.

That is $\frac{4+3+2+1}{4} = \frac{10}{4} = 2.50$

Therefore, any factor with a mean of 2.50 and above was "Agreed" to be a threat to elephant while mean less than 2.50 was "Disagreed".

Also, descriptive statistics and Chi square test ($\chi 2$) computed at 95% confidence interval with the probability value $p < 0.05$ was used to compare proportions between various variables of threats

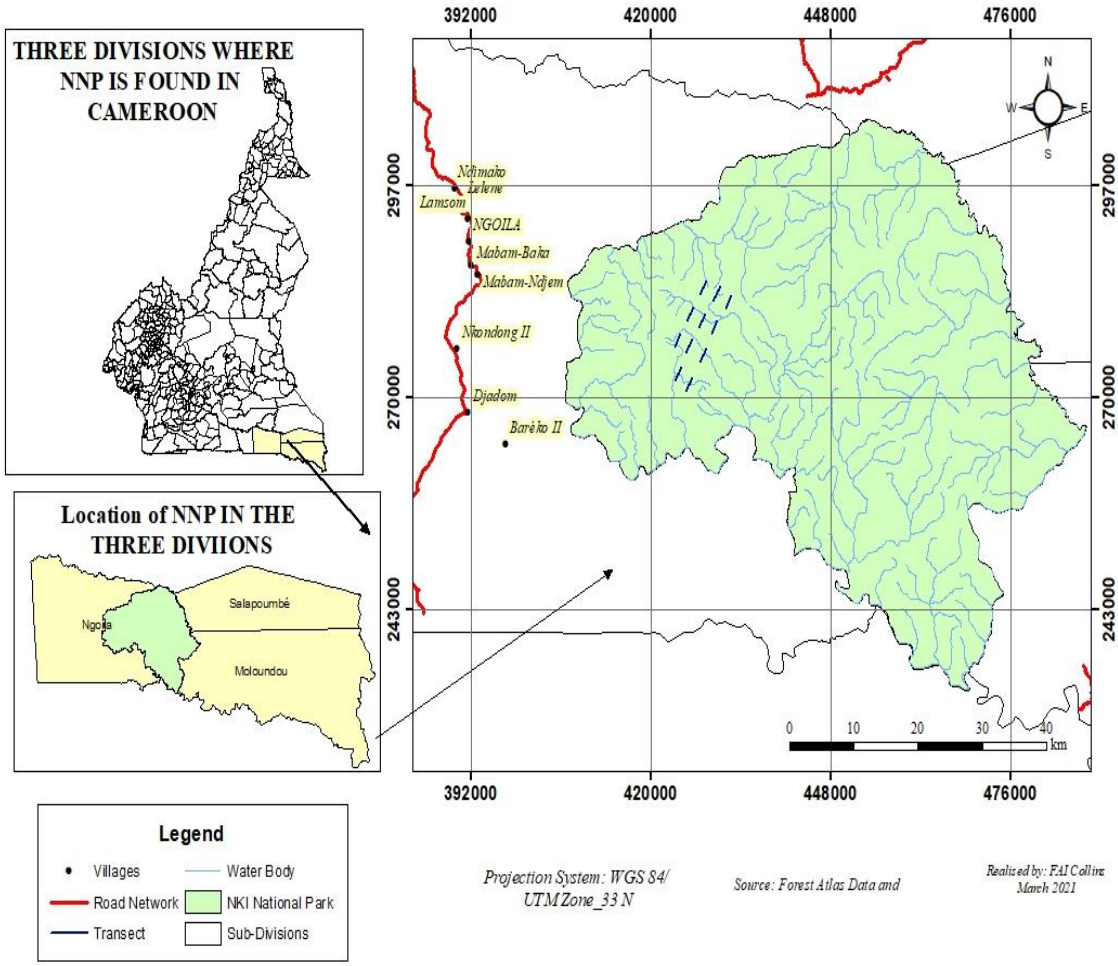

Figure 1: Map of Nki National Park (Njoka, 2021).

RESULTS

Estimated elephant density

A total of 132 dung piles were detected and the mean dung pile was 6.0 boli. Average perpendicular distance was 139 cm. Dung density was estimated at 177 (85-372) dung/km^2. Elephant density, thus, was 0.14 (95% c.l 0.07-0.29; CV 32.8%) elephant/km^2, translated to 428 (95% c.l 217-897) individual elephants in Nki National Park (Table 1).

Signs and direct observed of elephants in Nki National Park

About 386 elephant signs were recorded during the survey. Dung piles including other indicators such as elephant tracks, live elephants, wallowing sites, foot prints, diggings, scrubbings and foraging signs were also observed (Table 2). Amongst the elephant signs, tracks was the most reoccurring signs with 43.0% (n=166), followed by dung piles with 34.2% (n=132) and the least sign was scrubbings with 0.5% (n=2). For direct observation, 0.5% (n=2) were observed.

Threats on elephants

From the factors cited to affect elephants, 6 of them were agreed to be threats to elephant population in Nki National Park. These threats had means above the cut-off point of 2.5. The threats that were agreed to affect elephant population included road construction, hunting for bush meat, hunting for ivory, logging, lack of a management plan and non-respect of law enforcement. Among these accepted threats, only road construction was significantly different from other levels of acceptance ($\chi 2 = 321.0$, $p = 0.029$) (Table 3).

Main threats according to percentage acceptance

The factors accepted to be threats on elephant population were ranked according to level of acceptance. From the factors agreed to reduce elephant population, non-respect of law enforcement was the most accepted threat 101 (94.4%). This was followed by hunting for bushmeat 99 (92.5%), then closely by hunting for ivory 98 (91.6%). In that order, lack of a management plan 79 (73.8%), logging 73 (68.2%) and the least affected threat on elephant was road construction 46 (43.0%) (Table 4).

Table 1: Estimated elephant density.

Parameter	Value
Number of dung piles	132
Distance surveyed (Km)	22
Dung density/Km^2 (95% c.l)	177 (95-372)
% CV dung density	34.4
Elephant density (95% c.l)	0.14 (0.07-0.29)
% CV animal density	32.8
Number of elephants (95% c.l)	428 (217-897)

c.l= Confidence interval, CV=Coefficient of variation

Table 2: Direct observation and signs of elephants found in Ikwa-Nki National Park.

Signs	Number of elephant signs (n)	Percentage (%)
Dung piles	132	34.2
Tracks	166	43.0
Foot prints	60	15.5
Wallows	12	3.1
Feeding signs	9	2.3
Diggings	3	0.8
Scrubbings	2	0.5
Live elephants	2	0.5
Total	**386**	**100.0**

Table 3: Human threats reducing elephant population.

THREATS	Strongly agree n(%)	Agree n(%)	Disagree n(%)	Strongly disagree n(%)	Significant difference	Mean ± SD	Conclusion (cut-off mean ≥ 2.5)
Road construction	32 (29.9)	24 (22.4)	29 (27.1)	22 (20.6)	$\chi2 = 321.0$ $p = 0.029$	2.62 ± 3.87	Agreed
Hunting for bush meat	68 (63.6)	33 (30.8)	6 (5.6)	0 (0.0)	$\chi2 = 214.0$ $p = 0.410$	3.58 ± 6.78	Agreed
Hunting for ivory	82 (76.6)	16 (15.0)	9 (8.4)	0 (0.0)	$\chi2= 214.0$ $p = 0.410$	3.68 ± 7.26	Agreed
Logging	40 (37.4)	33 (30.8)	17 (15.9)	17 (15.9)	$\chi2 = 321.0$ $p = 0.396$	2.91 ± 4.71	Agreed
Agriculture	11 (10.3)	25 (23.4)	28 (26.2)	43 (40.2)	$\chi2= 321.0$ $p = 0.164$	2.02 ± 2.23	Disagreed
Human settlement expansion	8 (7.5)	26 (24.3)	29 (27.1)	44 (41.1)	$\chi2= 321.0$ $p = 0.295$	1.98 ± 2.05	Disagreed
Forest fire	19 (17.8)	23 (21.5)	27 (25.2)	38 (35.5)	$\chi2 = 321.0$ $p = 0.040$	2.21 ± 2.78	Disagreed
Mining	11 (10.3)	40 (37.4)	32 (29.9)	24 (22.4)	$\chi2 = 321.0$ $p = 0.396$	2.36 ± 2.88	Disagreed
Lack of management plan	46 (43.0)	33 (30.8)	19 (17.8)	9 (8.4)	$\chi2 = 321.0$ $p = 0.396$	3.01 ± 5.21	Agreed
Non respect of law enforcement	75 (71.0)	25 (23.4)	2 (1.9)	4 (3.7)	$\chi2= 321.0$ $p = 0.092$	3.58 ± 6.97	Agreed

SD=Standard deviation

Table 4: Percentage acceptance of main threats to elephants.

Threats	Number of respondents	Level of acceptance N (%)
Non respect of law enforcement	107	101 (94.4)
Hunting for bush meat		99 (92.5)
Hunting for ivory		98 (91.6)
Lack of management planning		79 (73.8)
Logging		73 (68.2)
Road construction		46 (43.0)

N=Total number of respondents

DISCUSSION

Estimated elephant density in Nki National Park

The population density estimate of elephants is one of the key factors that used to check if their population is threatened or not. Ekobo (1998) carried out a survey on elephant population density in Nki National Park and found out that the estimated density was 2,178 individuals. This was followed by a survey carried out by WWF, Cameroon (2016) in the same park with a population density of 565 (355-898) individuals. Comparing these results with those of the present study [428 (217-897)], using the same method, it shows that there has been a drop in the estimated density of elephant population in Nki National Park. This drop might be due to hunting pressure for ivory as reported by Nzooh et al., (2016) where his survey results showed a 78% drop in elephant population in Nki National Park. This present study also showed a 91.6% acceptance by respondents that hunting for ivory is a threat to forest elephants.

Comparing these present results with those from other National Parks in Cameroon and out of Cameroon, the estimated density of elephants (0.14 individual/km^2) in Nki National Park is higher than that of Boumba Bek (0.06 individual/ km ^{2}) (Nzooh et al., 2016) and Korup National Park (0.04 individual/Km^2) (Kupsch et al., 2014) though the estimated density of elephants in this study is lower than that of Minkebe National Park in Gabon (0.74 individuals/Km^2) (Poulsen et al., 2017), Noubale-Ndoki National Park in the Republic of Congo (0.55 individuals/Km^2) (Stokes, 2010) and that of Okomu National Park in Nigeria (0.15 elephants/Km^2) (Amusa et al., 2017). The difference in the estimated density of elephants in the various protected areas might result from the difference in methodology and vegetation. It might also be as a result of the duration of data collection. However, all the authors argued that there was a decline in the elephant population and the primary reason for this decline is due to poaching.

Threats on elephants in the Nki National Park

Six major threats were reported by respondents to affect elephants in Nki National Park but poaching for bushmeat and ivory (92.5% and 91.6% respectively) were the highest threats according to the respondents. Poaching of elephants may be supported by the fact that the financial incentives for poaching are great and the increasing value of ivory due to the influence of the international markets makes finding alternatives increasingly difficult as reported by Brittain (2013). It may be due to this reason that there is great disrespect for law enforcement in the park though there exist a management plan.

In this study, a high likelihood of elephant occupancy attracts a higher level of threats from poaching and correlates with a decline in elephant population. This is in line with Blanc et al. (2007) who reported that poaching for ivory is rife in regions of high elephant occupancy and relative abundance but contradicts the findings of Yackulic et al. (2011) who found that hunter access was negatively correlated with elephant density. The demand for ivory and the involvement of the international market in Cameroon was a strong theme throughout the qualitative data obtained by Brittain (2013) in the East region of Cameroon. This is still the case today as a very high percentage, 98 (91.6%) of the respondents of this study accepted poaching for ivory as one of the main threats to elephant population.

In this study, the threats that were recorded to affect forest elephant population were non-respect of law enforcement, poaching for ivory and bushmeat, lack of a management plan, logging and road construction. Other researchers have stated that, the main threats to elephants in West and Central Africa is the high poaching pressure for ivory, which has had a devastating effect on their populations (Beyers et al., 2011; Bouche et al., 2011; CITES 2012, 2013; CITES/IUCN/TRAFFIC 2013; Maisels et al., 2013; UNEP et al., 2013). Elephant poaching has greatly been facilitated by rapidly growing, extensive road network throughout Central Africa (Blake et al., 2008; Yackulic et al., 2011; Vanthomme et al., 2013). Though there is no logging concession unit in Nki National Park, the passage of roads through the Park to logging concession units along the peripheries of the Park has been a threat to these elephants. UNEP/CITES/IUCN/TRAFFIC (2013) cited poor governance as one of the major factors depleting elephant population in Central Africa. This is also the observed situation in Nki National Park as there are inadequate patrols throughout the park by rangers which makes poaching very rampant.

Conclusion

The findings of this study show that the density of elephants in the Nki National Park is 0.14 elephants per Km^2 with a total abundance of approximately 428 (217-897) individual elephants in the Park. There are six threats in Nki National Park that affects elephant population: non-respect of law enforcement, poaching for ivory and bushmeat, lack of a management plan, logging and road construction. Forest Elephants in Nki National Park face the same threats such as poaching for ivory, hunting for bushmeat and habitat loss just as the African forest elephants in other countries. The continuous drop of elephant population as compared to previous population in Nki National park can lead to extirpation. For this reason it is paramount that the remaining population should be monitored constantly to provide accurate and précised data in the status of these population.

COMPETING INTERESTS

The authors declare that they have no competing interests.

AUTHORS' CONTRIBUTIONS

FCN was the field investigator and drafted the manuscript. TRK and FSN designed the study and supervised the work. All authors read and approved the final manuscript.

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