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**Abundance and Distribution of Buffalo (*Syncerus
caffer*) in Borgu Sector of Kainji Lake
National Park, Nigeria**

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ABUNDANCE AND DISTRIBUTION OF BUFFALO (*SYNCERUS CAFFER*) IN BORGU SECTOR OF KAINJI LAKE NATIONAL PARK, NIGERIA

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ABSTRACT: The study was undertaken to derive information on the abundance, distribution and problems faced by Buffalo (*Syncerus caffer*) in the Borgu Sector of Kainji Lake National Park. Line transects was established using a stratified random sampling procedure. The data collected were analyzed using the formula; Total Population $\hat{Y} = R \cdot Z$ and the program DISTANCE. The result gathered revealed that Borgu Sector of Kainji Lake National Park habitat contains 2545 Buffalo (*Syncerus caffer*) /397002 km² throughout the year, having a density of 0.54 individuals per sq km. The finding on the distribution of the Buffalo (*Syncerus caffer*) indicates that they are clumped in distribution, having average cluster size of 8.1. There are variations between the habitats in terms of species distribution as well as a high significant difference ($P \leq 0.001$) between the habitat types in both buffalo composition and distribution. The present population number of Buffalo (*Syncerus caffer*) indicates that buffalo in Borgu Sector- Kainji Lake National Park is having a promising future in the area if properly protected. There should therefore be an extended monitoring programme in all the sectors of the park; as it will go a long way to check illegal activities such as over grazing, poaching and illegal mining.

Key Words: Abundance, Distribution, *Syncerus caffer*, Borgu Sector- Kainji Lake National Park

1. INTRODUCTION

The African Buffaloes are the heaviest species within the Antelope family (*Bovidae*) with males achieving a body weight of up to 800kg and females up to 750kg (Megaze, *et al* 2012). Buffalo is listed as Near Threatened in the IUCN Red List Category & Criteria (I.U.C.N, 2019). Cornelis *et al.* (2014) estimated the numbers of savanna buffalo at >513,000, representing an overall decline of 18% over 15 years, 1999-2014, when compared to the

figures estimated by East in 1999. Estimates for the three Savanna Buffalo subspecies were: *Syncerus caffer aequinoctialis* > 23,000 (-61%); *S. c. brachyceros*: >17,000 (-15%); *S. c. caffer*: >473,000 (-14%). There are very few figures available for Forest Buffalo, but it is suspected to be declining across its range due to forest loss and high rates of bush meat extraction (I.U.C.N, 2008). The total population estimate of African Buffalo *Syncerus caffer* in Chebera Churchura National Park, Ethiopia was 2,617 individuals, and the mean population

density was estimated to be 2.15/km² (Megaze *et al.* 2012).

The African buffalo is an extremely large animal. Buffaloes exhibit a herd size of 50 to 500 heads comprising mainly females and juveniles. Adult males are either solitary or to form bachelor herds, depending on season, and occupied a space of less than 500 m² (Megaze, *et al.* 2012).

Buffalos are key animal in the international sport hunting industry and are perhaps the most sought after amongst the “Big Five” species. Buffalo bulls have a reputation for being extremely dangerous, particularly when wounded (Ryan, *et al.* 2006). Most American hunters seek the largest horn measurements in order to gain a place in the trophy record books (Ryan, *et al.* 2006). African buffalo (*Syncerus caffer*) have a large distributional range across the savannas of Africa (Sianga, *et al.* 2017). Because of their large body size and large groups, buffalo are able to fend off predators, thereby enabling them to forage in wooded vegetation with relatively low visibility and high predation risk (Sianga, *et al.* 2017). The buffalo inability to efficiently feed on short grasses constrain them to foraging in vegetation with sufficient height and biomass of forage (Codron *et al.* 2008). Buffalo generally avoid heavily grazed regions of short grassland (Bhola *et al.* 2012), preferring woodlands dominated by tufted and leafy perennial grasses during the wet season and often relying on more productive riverine vegetation during the dry season (Sianga, *et al.* 2017; Fynn, *et al.* 2014; Macandza, *et al.* 2012). Clearly grass leaves constitute the bulk of the diet of buffalo in the rainy seasons. While buffalo may obtain their protein by eating small quantities of browse in dry the seasons. For instance, plants foods such as the leaves of *Asparagus africanus*, *Acacia* seeds and pods, seedlings of the shrub *Capparis tomentosa* as well as the bark and leaves of *Securinea virosa* are eaten by buffaloes during the dry seasons in the wild. Buffaloes were found to prefer *Acacia* shrub and *Combretum*-dominated woodlands in South Africa (Ryan, *et al.* 2006). They occasionally browse on *Combretum* and woody shrubs during the dry season (Macandza, *et al.* 2004; Megaze *et al.* 2012).

Population size or density is a state variable of interest in many models of population and community ecology, and of disease dynamics (Keeling and Rohani, 2008). Many ecological studies and species conservation efforts require reliable estimates of abundance. For example, estimates of abundance are needed for estimating harvest quota, determining conservation status and for evaluating the effect of management actions on a population (Mills, 2007; Nomani, *et al.* 2012). Thus, the importance of

accurate and precise estimates of abundance cannot be overemphasized.

Information on the population dynamics of buffalo in Kainji Lake National Park, is minimal, thus the study on the present status of African buffalo in Kainji Lake National Park will help us to know in which habitat type the abundance is greatest and in which they are less. The objectives of this work is to determine the abundance Buffalo (*Sycerus caffer*) in Kainji Lake National park, ascertain its distribution and also examine the threats to Buffalo Population in the area.

2. MATERIALS AND METHOD

2.1. The Study Area

Kainji Lake National Park is located between latitudes 9°40'N and 10°30'N and longitudes 30° 30'E and 50° 50'E. It lies at the extreme west of the wooded savanna region and in area generally referred to as the middle belt of Nigeria, characterized by relatively sparse population and abundant wild animals (Aremu *et al.*, 2002).

The park covers a total area of 5340.82sq.km. It is made up of two non-contiguous sectors, the Borgu and Zugurma sectors which cover an area of 3,970.02sq.km and the Zugurma sector that occupies a relatively smaller area of 1,370.80sq.km.

2.2. Study Design

Transect method according to AWF (1996) was employed. Five transect were identified in the study area. Route length is 20km each, covering a total of 100km of all terrestrial areas of the park. The selected tracks include;

1. Gilbert Child track in *Terminalia macroptera*/ Riparian vegetation
2. Mora Tasude Track in mixed *Afzelia africana* woodland / Riparian vegetation
3. Shehu Shagari in *Afzelia africana* woodland / Riparian vegetation
4. Zoure Track in *Terminalia macroptera* woodland, and
5. Mamudu Lapai track in *Afzelia africana* / *Isobelenia tomentosa* woodland. The project was carried out for a period of six (6) months. December- May, 2017-2018. Each site was visited five (5) days in the month.

2.3. Data Collection Techniques

Line transects was established using a stratified random sampling procedure (Plumptre & Reynolds 1994).

Counts were carried out along routes following the existing park jeep tracks. Each route traversed on the habitat types. Transects was traversed at approximately 10 km/h, using both a four-wheel drive and foot walk. Transects were 5km apart from each other, decreasing the likelihood that Buffalo was counted on more than one transects. The researcher and two field assistants aided with binoculars, traversed the transect stopping at intervals to observe and count all groups of Buffalo seen from transect. For each buffalo encounter, the number as well as perpendicular distance was determined, using a range finder. All surveys were carried out during the early morning from 06:00 h to 11:00 h and/ or in the late afternoon between 15:00 h and 18:30 h.

2.4. Data Analysis

Description statistics (tables, and chart), the Total population Density was calculated using the formula by (Norton-Griffiths, 1978), where Total Population $\hat{Y} = R.Z$

N = total number of units from which sample was drawn

n = number of units sampled

Z = area of census zone

z = area of each sample unit

y = number of animals counted in each sample unit

Thus Av. Density; $R = \text{total animals counted} \div \text{total area searched}$, given as $\sum y \div \sum z$ and also the programme DISTANCE 7.0 (Thomas, *et al.* 2010) was used to estimate the abundance and distribution of *Syncerus caffer*, by meeting the minimum statistical requirement of 60 – 80 sightings used to calculate population density & abundance (Thomas *et al.* 2010). Choosing the best fitting detection function model was based on i) the shape of the curve describing the probability of detecting

animals in relation to the recorded perpendicular distances, ii) the lowest AIC (Akaike Information Criteria) value, and the highest chi-square goodness of-fit (Thomas *et al.* 2010). Analysis of Variance [ANOVA] was used to test if species distribution differed between habitat types.

3. RESULT

The result from this study is presented below; table 1 shows the total population estimate of buffalos censured in all the study area (No/km²). The number of buffalo species counted is totaled 641 at an observation point of 80 times across transects. The result gathered revealed that Bogu Sector of Kainji Lake National Park habitat contains 2545 *Syncerus caffer* /397002 km² throughout the year.

Table 2 shows the absolute population density/abundance of *Syncerus caffer* of Borgu sector Kainji Lake National Park. The result shows that the density of buffaloes in the area is 0.54 ± 0.15 per sq km. Figure 1 shows the Quantile–quantile (q–q) plots corresponding to fits of a half normal model to line transect data. If the fit was perfect, all the red dots would lie exactly on the blue line. In this result; a large number of dots between 0.1 and 0.4 as well as 0.6 and 0.8 are well away from the line. There is no clear evidence of rounding in the observations at the beginning of the observations (0.0 - 0.4). While the figure 2 shows the perpendicular distance in meters. From the result, the histogram (blue) shows the distribution of the observations. The curve (red) is the fitted detection function. The result shows that the frequency of observations is highest at distance between 24 and 40m, while it recorded fewer and fewer observations as the distance get farther, up to 120m.

Table 1: Total population estimate of Buffalos censured in all the study area

Parameters	Estimate
Total population of Buffalos /3970.02 km ²	641
Av. Density	0.00641
Total population of Buffalos /3970.02 km ²	2545

Table 2: Absolute population density/ abundance (No/km²) of *Syncerus caffer* in Kainji Lake National Park

Parameters; Half-normal/Cosine	Point Estimate	Standard Error	%CV	95% Confidence Interval	
DAIC	0	-	-	-	-
AIC	738.05	-	-	-	-
DCV = Coefficient of Variation for D	0.288	-	-	-	-
Effort: = total length of the transects	100.0000	-	-	-	-
# samples = number of transects	5	-	-	-	-
Width = the max perpendicular distance obs.	107.6600	-	-	-	-
# observations	80	-	-	-	-
Encounter rate :	0.5	-	-	-	-
Chi-p	0.53644E-06	-	-	-	-
f(0) - 1/u = value of pdf at zero for line transects f(0)	0.13303E-01	0.35596E-02	26.76	0.78812E-02	0.22455E-01
P - probability of observing an object in defined area p	0.69822	0.18683	26.76	0.41365	1.0000
ESW - for line transects, effective strip width = W*p	75.171	20.114	26.76	44.534	126.88
D - estimate of density of animals	0.53858	0.15501	28.78	0.30778	0.94246
N - estimate of number of animals in specified area	2138	615.4	28.78	1221.8	3741.6
DS - estimate of density of clusters	0.53212E-01	26.83	78.81	0.31484E-01	0.89936E-01
E(S) - estimate of expected value of cluster size	10.121	1.0543	10.42	8.2303	12.447

Source: Field survey study

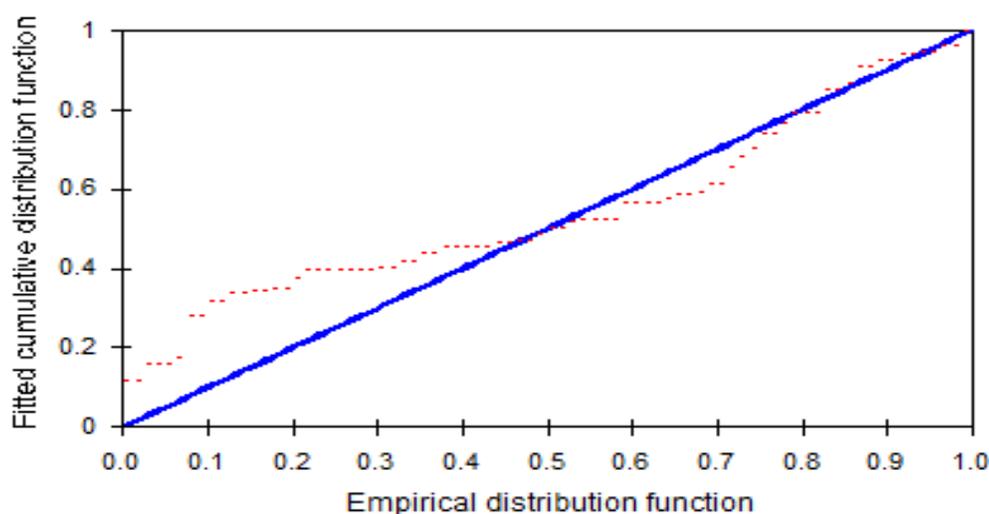


Figure 1. Empirical distribution function of Buffalos in the transect

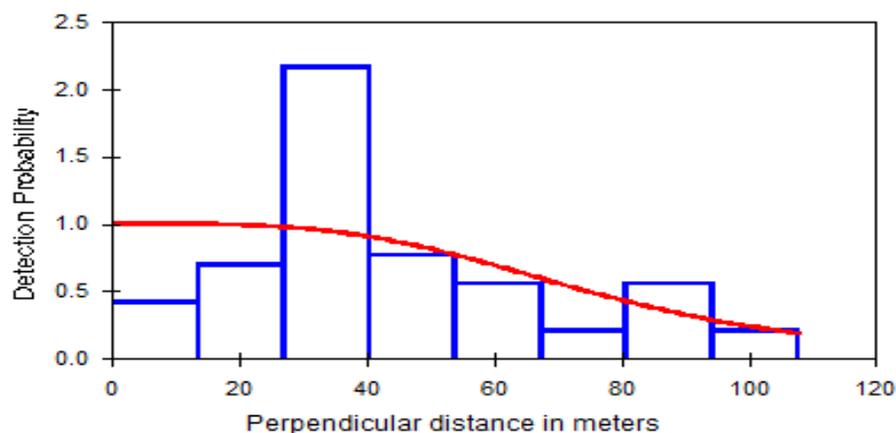


Figure 2. Perpendicular distance in meters

The figure 3 shows the Number of Buffalos counted in each transect. The fig shows that Mora Tasude Track and Zaure Track have the highest number of Buffalo having 216 and 176 respectively. While Shehu Shagari Track and Gilbert Child tracks has the least with 48 and 96 buffalo respectively. Table 2 shows the population structure of buffalo in Kainji Lake National Park. The table shows that adult buffalo are more in number in range 4 having 53.23%, while the young are more in number in range 5 having 42.41%.

Table 3 shows the population structure of Buffalo in Kainji Lake National Park. The table shows that adult Buffalo are more in number in the month of March having 83 male and female adult on 44 young ones only,

while the month of April had the least no of adult recorded 55adult and 21 young.

Figure 4 shows the similarity in Buffalos distribution between the habitats types. The figure shows that Shehu Shagari Track and Gilbert Child Track are similar in Buffaloes composition and distribution, while Mora Tasude Track and Zaure Track are similar are similar in Buffaloes composition and distribution recorded.

Table 4 shows the threats to Buffalo population in Kainji Lake National Park (%). The table shows that Mora Tasude Track is highly affected having a total of 23.33% illegal disturbance in the area, while the Gilbert Child Track has the least disturbance of 16.67%.

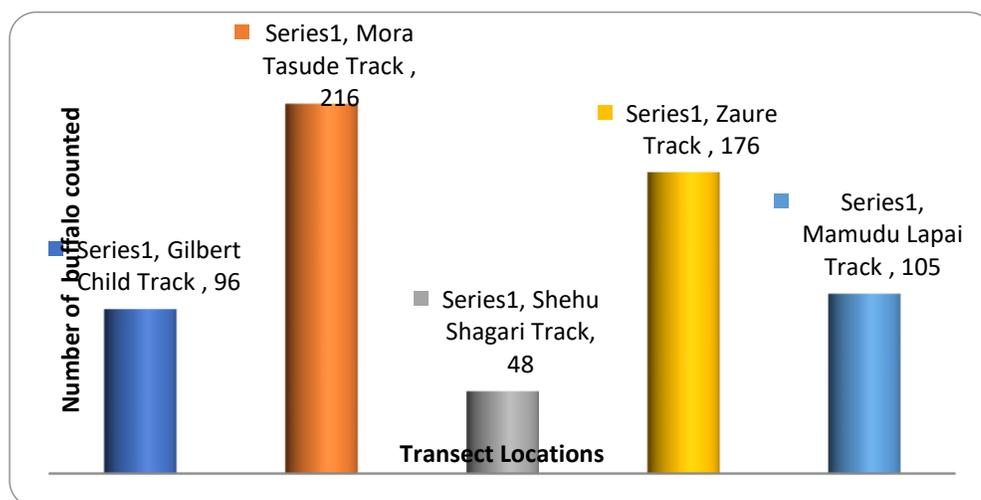


Figure 3. Number of Buffaloes counted in each transect

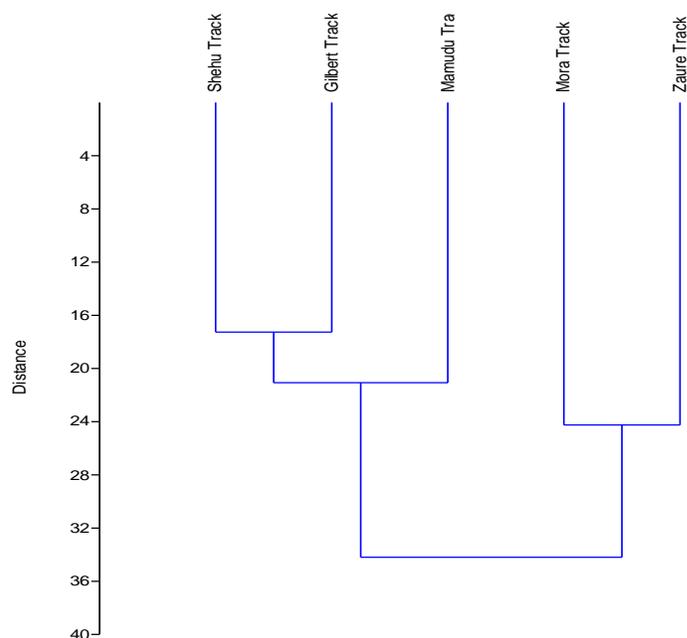


Figure 4. Dendrogram showing similarity in Buffalos distribution between Habitats (m)

Table 3. Population structure of Buffalos in Kainji Lake National Park

Months	Sum	Adult	Young	Mean	Stand. Dev
December	87	63	24	43.5	27.58
January	117	72	45	58.5	19.09
February	113	66	47	56.5	13.44
March	127	83	44	63.5	27.57
April	76	55	21	38	24.04
May	121	69	52	60.5	12.02

Source: Field survey

Means Not Significant ($P > 0.05$)

Table 4. Threats to Buffalo Population in Kainji Lake National Park (%)

Transect	Problems identified							Total	%
	Cattle grazing	Poaching	Disease	Predation	Tree logging	Wild fire	Illegal Mining		
Gilbert Child	X	X	X	X	-	X	-	5	16.67
Mora Tasude	X	X	X	X	X	X	X	7	23.33
Shehu Shagari	X	X	X	X	X	X	-	6	20
Zaure	X	X	X	X	X	X	-	6	20
Mamudu Lapai	X	X	X	X	X	X	-	6	20

Source: Field survey

4. DISCUSSION

4.1. Population density/ abundance (No/km²) of *Syncerus caffer*

The findings indicate that the total population of *Syncerus caffer caffer* in Kainji Lake National Park as estimated is 2545 /397002 km². This finding is a bit lower when comparing with the report of Megaze *et al.* (2012) that the total population of buffaloes in Chebera Churchura National Park, Ethiopia was 2,617 individuals.

The estimate obtained from DISTANCE, Table 2 shows the detection probability more especially the perpendicular distance and variability of density per sq km. The findings indicate that there is sizable number of buffaloes in the park having a density of 0.54 ± 0.15 per sq km of the study area. There is high variation between the habitat types as indicated in the model Coefficient of Variation for D per sq meter having a positive value D CV= 0.288. The best fit was obtained with a Half-normal/Cosine - Detection Function and Cosines Adjustments having Akaike Information Criteria (AIC) value, 738.05. The findings is precise, having a low Confidence Limit of 0.31 ± 0.94 and 28.78% Coefficient of Variation for D indicates that the result can be use by the park authority in drawing up its management plan, as it is in accordance with AWF (1996) assertion that in practical terms sample estimate with larger CL is an imprecise result and may not be used in conservation planning but a lower confidence limit should be used.

The findings also indicate that Buffalo are clumped in distribution, having expected cluster size of 10.1 ± 1.0 . There are variations between the ranges in terms of species distribution. Most of the variance in the density is due to variance in the encounter rate (59.1). For instance, the transects include data collected from the High and Low animal concentration areas, which have different encounter rates, the woodlands with few animals have fewer encounter rate than areas with high number of animals.

The findings in figure 1, indicates that the data show evidence of too few detections close to the transect line, relative to what would be expected under the half-normal model as presented by Buckland *et al.*, (2001) which stated that in the plot of the fit of a detection function model to the data, if they follow the same distribution, then a plot of the quantiles of the first variable against the quantiles of the second should follow a straight line (dash line and solid line). But here the fitted cumulative distribution function (cdf) is shifted systematically above

0 than the empirical distribution function (edf). These suggest that proper care should be taken whenever distance data is being collected. Animals should be sighted and recorded quickly before they start running away and to ensure that distances are measured without errors. All this will help to arrive at a good fit (Buckland *et al.* 2001).

The findings in figure 2 shows the perpendicular distance in meters, as shown, the histogram bars represent number of detections divided by distance from the point; this transformation allows the fit of the detection function to the data to be assessed visually (Buckland *et al.*, 2001). The result shows that the frequency of observations is higher close to the transect, and increases with increase in distance and highest at distance between 24 and 40m, while it recorded fewer and fewer observations as the distance gets farther, up to 120m. Between 110m and 120m, there was no sighting.

The Number of buffalos counted in each transect shows that Mora Tasude Track and Zaure Track have the highest number of buffalo having 216 and 176 respectively. While Shehu Shagari Track and Gilbert Child tracks has the least with 48 and 96 buffalo respectively. There is a high significant difference *** ($P < 0.001$) between the habitat types in both buffalo composition and distribution. The finding therefore suggests that Mora Tasude Track and Zaure Track might have been adequately protected and having both dense vegetation, with abundant annual and perennial grasses that provide food for the species. This agrees with Bhola *et al.* (2012) report that buffalo generally avoid heavily grazed regions of short grassland, preferring woodlands dominated by tufted and leafy perennial grasses. The habitats Mora Tasude Track being associated with mixed *Azelia africana* woodland, while Zaure Track associated with *Terminalia macroptera* woodland. These woodlands are very close to river Oli and it pools that serve as source of water for buffalo and all other wildlife in the park. It would also suggest that buffalo populations are greater in the denser vegetation, quiet and peaceful areas of the park. Buffalo preferentially select for areas near water, but they may range farther in the dry season for higher-quality food (Sianga, *et al.* 2017). They demonstrate overall preference for habitat in close proximity to water; as well as preference for certain habitat types; and select greener areas of the park (Macandza, *et al.* 2012). This also agrees with (Sianga, *et al.* 2017) assertion that African buffalo are formed in savannah and woodland mosaics, preferring areas with access to grass, water and dense cover, such as thickets, reed, or forest. On the other hand, Shehu Shagari Track and Gilbert Child tracks being riparian woodland recorded fewer numbers of

buffalos in them. The reasons is because the woodlands are close to more accessible areas of the Park, closer to human settlements, cattle grazing as well as noise from humans and vehicles are eminent. Hence the habitat may not be conducive area for the buffalo to inhabit.

In the dendrogram above, buffalos' clusters are joined based on the average distance between all individuals in the habitats. The findings indicates that Shehu Shagari Track and Gilbert Child Track are similar with low number of Buffaloes with average distance distance of 17m between all individuals, while Mora Tasude Track and Zaure Track are similar with high Buffaloes composition with average distance of about 25m between all individuals. Mamudu Lapai Track associated with mixed *Azelia africana* woodland has a high Buffaloes composition different from all other habitats with average distance of about 22km. This is in line with Ryan, *et al.* (2006) report that buffaloes were found to prefer *Acacia* shrub and *Combretum*-dominated woodlands in South Africa.

4.2. Population Structure of Buffalo

Buffalo herds are composed of adult (adult males, adult females), and Young, (juveniles, calves). Adults were consistently larger than young. Small groups containing 4 and 16 individuals were most common throughout the study period. During dry season buffaloes congregated in large groups near the pools and river Oli, they split in smaller number of groups and distributed in a wider area during the wet season. Megaze, *et al.* (2012) confirms that buffaloes exhibit a herd size, and they often rely on more productive riverine vegetation during the dry season (Sianga, *et al.* 2017; Fynn, *et al.* 2014; Macandza, *et al.* 2012). The low standard deviation indicates that the buffaloes in Kainji Lake National Park are clustered closely around the mean and analysis of variance showed that there are no significant differences in the population structure across the different months ($P > 0.05$).

4.3. Threat to Buffalo Population (*Syncerus caffer*)

The threat to Buffalo population in Borgu Sector, Kainji Lake National Park includes; poaching, cattle grazing, disease, predations, tree logging, bush burning and illegal mining at the periphery of the park. All this causes disturbance to wild animal presence generally.

Poaching is being carried out by hunters domiciled in the adjoining communities of the park, neighboring states like Kebbi, Zamfara and other countries especially Benin Republic. More worrisome is their preference for the big game trophies and meat. This combination of poachers' undoubtedly causes the extirpation of the remaining

games in the park; hence there is decrease in the number and distribution of games like buffalo in the area. The use of snares and other traps to capture wild animals is a common phenomenon in the park. Poachers set traps all the time with hope to capture small and big games, although, the rangers often discover and quickly remove the traps. Most game usually escape with various injuries which may lead to early death thereby reducing the population number of the species. Maisels *et al.*, (2001) confirmed that in KilumIjim, Cameroon, most large mammals, including elephants, buffalo, and lions, have been lost as a result of hunting by humans. Opinion gathered from the surrounding communities indicates that buffalo population once thrives in large number in the park but after some years of persistent illegal hunting and trade in the trophy, the population reduces. On the part of the government insufficient ammunitions and other field facilities hinders effective protection operations in the park.

Wild fire, grazing, loggings and illegal mining are one of the most important anthropogenic disturbances in savanna-woodlands affecting vegetation patterns. Selective tree cutting tended to decrease the density of single-stemmed individuals (Kennedy & Potgieter, 2003) and this in the long run when extensive clearing is made habitat fragmentations will result and large mammals as buffalo, that require thick vegetation for survival will be exposed to danger of being poached and preyed upon hence the population number will reduce. Also, when extensive clearings were made, the number of most mammals like deer and elk reduces (Zida1, *et al.* 2008)

The other factors responsible for the dwindling population of the buffalo in the park are the presence of predators like lion in the park. Lions do kill and eat buffalo regularly in KLNP, other predators include the leopard and spotted hyena. However, the predators are threats mainly to the Youngs and the Calves, although spotted hyena have been reported to have kill grown bulls in some occasions. This confirms Valeix *et al.*, (2009) assertion that lion do kill and eat buffalo regularly, and that lions are known to drive the daily activity patterns of ungulates, including such large prey species as African buffalo (*Syncerus caffer*), at waterholes.

Disease is also a threat to the population growth of buffalo in the park. For instance, tsetse fly is present in the park especially during the rainy seasons. Cattle grazing which is common in the park also can be a means of transferring zoonotic diseases to buffaloes and this could be another way diseases can be transferred to buffalo in the area. In studies carried out in other African National parks, Tuberculosis, caused by *Mycobacterium bovis*, was first diagnosed in African buffalo in South

Africa's Kruger National Park in 1990, while 10 other small and large mammalian species, including large predators, are spillover hosts (Michel *et al.*, 2006). *Brucella abortus*, the pathogenic bacteria responsible for bovine brucellosis, has been isolated from many ungulate species, including African buffalo (Gorsich *et al.* 2015). It is therefore important that the park authority should create cattle corridors for livestock to use while passing through the park as this will prevent diseases passing from livestock to wildlife

5. CONCLUSION AND RECOMMENDATIONS

1. The total population of buffaloes censused in Kainji Lake National Park is high.
2. These observations have indicated that the population of buffalo at Borgu sector was very stable and viable.
3. In terms of the buffalo species composition in Kainji Lake National Park, the Mora Tasude Track and Zaure Track will always attract many ecotourist who are interested in seeing more buffaloes in their high number, than will the other three habitat types were the buffalo's population is low. These sites are therefore a very important habitat for buffalo conservation.
4. Also buffalo being among the "Big Five" species is usually a tourist delight and the park will be a tourist destination. This means that tourist can tour and within a kilometer square will sight clusters of buffaloes, especially during the dry season giving that visibility is good.

5.1. RECOMMENDATIONS

From the study the following recommendations are made;

1. **Use of DISTANCE model;** To allow simple and accurate abundance determination in wildlife studies I strongly recommend the use of DISTANCE model in analyzing results so that the probability of observing an object within the circle or strip can be estimated.
2. **Adequate Monitoring of the Whole Park;** Trans-boundary anti-poaching programs should be enhanced so as to reduce foreign poachers from neighbouring countries entering the Park. The park should extend its monitoring programme to all sectors of the Park. This will go a long way to check illegal activities such as grazing and poaching.
3. **Conservation Education;** Adequate and extensive conservation education should be carried out in the support zones communities of the park

4. There is need for more training of Park Management staff on community-based-participatory management approaches to conservation and sustainable use of natural resources.

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