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Critical and Demographic Effective Population Size of African Buffalo (*Syncerus caffer*) in Borgu Sector of Kainji Lake National Park, Nigeria

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Abstract: Effective population size of African Buffalo (*Syncerus caffer*) was estimated using Franklin and Frankham model. Buffalo relative abundance was calculated using a 4×4 km transect constructed in each of the identified six vegetation communities in the Park, which were traversed once a month for a period of 24 months. The results revealed that the relative abundance of Buffalo in the Park was 0.372±0.03 groups km^{-2} consisting of 51±5.827 groups representing 242±16.309 individuals which consist of 30 adult males and 70 adult females representing 12.40 and 28.93%, respectively of the total Buffalo population in the Park which was considered to be the effective breeding population size. The composition of the population structure was significantly different ($p<0.05$). The effective population size of Buffalo in the Park was estimated to be 581.34±4.91 which was above the recommended value of 100 which shows that the Buffalo population in the Park was not threatened by demographic stochasticity factors but rather by illegal human activities in the Park. Measures to improve conservation and management of the existing Buffalo population in the Park are also discussed.

Key words: Breeding, population, buffalo, stochasticity, relative abundance

INTRODUCTION

A common rule of thumb in conservation biology is that population of more than 100 individuals are not threatened by demographic stochasticity on population survival which may be strengthened if the population has a non-homogenous demography. No population ever has zero risk of extinction. Since births and deaths are inherently probabilistic events, some fluctuations in population numbers always prevail even if the system is striped of any environmental variation (Burgman *et al*., 1993). Demographic stochasticity may have more profound reflects on a population with a complex structure, differences in age, social status or spatial distribution may account for increased vulnerability (Bowers, 1994).

The effective population size required for a population to remain its evolutionary potential sets a lower limit to viable population size for wildlife. The conservation of quantitative genetic variation is an important factor in managing endangered species (Culotta, 1995). Franklin (1996) suggested that there were two primary considerations, an immediate danger in small populations due to inbreeding and in the longer term, a loss of quantitative genetic variation that would limit future evolutionary change.

The population of *Syncerus caffer* in the Park is presently under threat from poaching, habitats loss and degradation (Aremu, 2005). The objectives of the study are to estimate effective, critical population size and effect of stochasticity on the population of *Syncerus caffer* in the Park so as to ascertain the level of threatening and survival of its population. The study also intends to suggest measures for adequate conservation and management of the remaining *Syncerus caffer* population in the Park.

MATERIALS AND METHODS

Kainji Lake National Park (9°40^{1}-10°30^{1} N, 3° 30^{1}-5° 50^{1}E) has a total land area of 5,340.83 km^{-2} with Borgu sector comprising 3,970.83 km^{-2} (74.3%) and the Zugurma sector covering an area of 1,370 km^{-2} (25.7%). The vegetation of the Borgu sector has been described as northern savanna (Keay, 1989) and according to (Afolayan, 1978 Milligan, 1978) the six main vegetation communities in Kainji Lake National Park are (i) *Burkea africana/Detariam microcarpum* woodl and savanna (ii) *Diospyros mespliformis* dry forest (iii) Riparian forest and woodland (iv) *Teminalia macroptera* tree savanna (v) *Isoberlina tomentosa* woodland (vi) *Isoberlina doka* savanna woodland.

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The Oli river flows from the Republic of Benin through Borgu sector of the Park into the Niger river. In the dry season, the river breaks into pools, which hold water throughout the year and serve as the only source of water for the wild animals. Long-term average annual rainfall is between 900 and 1,100 mm. The Park is blessed with diverse fauna resources including *Syncerus caffer*, *Hippotragus equinus*, *Alcelaphus buselaphus*, *Kobus kob*, *Papio anubis*, *Panthera leo*, *Hippopotamus amphibious* and *Crocuta crocuta* among others. Flora resources in the Park include Burkea africana, *Terminalia aricennoides*, *Diospyros mespliformis*, *Entanda africanan*, *Vitex domiana* and *Anogeissus leiocarpus* among others.

Methods: Six, 4×4 km transects were laid within the six main vegetation communities in the Park as recognized by (Afolayan, 1978; Milligan, 1978) with a total effective study area of 96 km^{-2}. The transects were modified as recommended by Hall *et al.* (1998) and were traversed once a month for a period of 24 months (January 2003 and December 2004) between 7.00 to 13.00 h and 16.00 to 19.00 h with an average walking speed of 2.5 km h^{-1}. Periods of walking were interspersed with period of silent and watch to increase the possibility of detecting animals that might hide of flee upon the approach or movement of the observers (Buckland *et al.*, 1993). Only including individual seen made the counts of individuals per group conservatively. Zeiss Dialyt (10×40) Binoculars were used to observe and detect presence of *Syncerus caffer*. Animals sighted were identified as described by Jean and Pierre (1990).

The following assumptions were made, animals on the transects were detected with certainty, no animals falling on or over the transacts are missed, animals were detected at their initial location and measurements were exact (Walsh and White, 1999). The following information was recorded on any group of *Syncerus caffer* sighted, species, date, time sighted, sighting angle, sighting distance, perpendicular distance and population structure such as adult males, adult females, subadult males, subadult females and juveniles.

Syncerus caffer relative abundance was calculated as recommended by Barnes *et al.*, (1995) as follows:

$$P = AZ/ZXY \text{ km}^{-2}$$

Where: P-population, A-total area, Z-number of group sighted, X-mean sighting distance, Y-area of transect

Effective population size of *Syncerus caffer* was calculated as recommended by Franklin and Frankham (1998) as follows:

$$Ne = 4 (Nm) (Nf)/Nm + Nf \quad (1)$$

Where: Ne-effective population size, Nm-number of adult males, Nf-number of adult females.

All data collected were subjected to Analysis of variance (ANOVA) and Duncan's multiple range test contracts at ($p<0.05$) as recommended by Snedecor and Cochran, (1989).

RESULTS AND DISCUSSION

Relative abundance and population structure: A total of 51±5.827 groups of *Syncerus caffer* were directly sighted in all the six habitats. Highest relative abundance of *Syncerus caffer* was recorded in the riparian forest and woodland habitat (13±1.374) groups representing 0.089 groups km^{-2}. Followed by *Terminalia macroptera* tree savanna habitat and *Isoberlinia tomentosa* woodland habitats with relative abundance of 0.071 and 0.64 groups km^{-2}, respectively. The least relative abundance of *Syncerus caffer* was recorded in *Diospyros mespliformis* dry forest habitat 0.033 groups km^{-2}. A total of 242±15.362 individuals Buffalo were recorded in all the six habitats (Table 1). The highest population of *Syncerus caffer* recorded in the riparian forest and woodland habitat (13±1.3740 group may not be unconnected to the fact that the habitat provide forages and water to the wildlife population of the Park in both wet and dry seasons when resources of other habitats in the Park must have been limited (Aremu, 2005; Afolayan, 1978; Milligan, 1978). Adult females constituted highest proportion (28.93%) of the population of *Syncerus caffer* in the sector, followed by juveniles and subadult females with 26.45 and 21.90% of the population, respectively. Adult males and subadult males had 12.40 and 9.92% respectively (Table 2).

Effective population size: Estimate of viable population is generally summarized by effective population size (Ne) in which there is random mating and equal contribution to the gene pool. A total of 242 Buffalo directly sighted consist of 30 adult males and 70 adult females, which were considered to be the effective breeding population, while 24 and 53, were subadult males and subadult females,

Table 1: Relative abundance of *Syncerus cafer* In borgu sector of kainji lake national park

Habitat	Group sighted	Group (km^{-2})	Ind. Sighted
Badmw	8.0±0.959	0.062	40.00±2.921
Dmdf	4.0±0.627	0.033	15.00±1.732
Rfw	13.0±1.374	0.089	74.00±4.859
Tmts	10.0±1.013	0.071	47.00±2.962
Itw	9.0±1.011	0.064	37.00±2.224
Idsw	7.0±0.843	0.053	29.00±2.131
Total	51.0±5.827	0.372±0.03	242.00±16.329
Mean	8.5±0.971	0.062±0.005	40.33±2.722

Badmw-Burkea africanal/Detarium microarpum woodland savanna, Dmdf -Diospyros mespliformis dry forest, Rfw-riparian forest and woodland, tmts Terminalia macroptera tree savanna, Itw-Isoberlinia tomentosa woodland, Idsw-Isoberlinia doka savanna woodland, Ind-individuals

Table 2: Population structure of *Syncerus caffer* in Borgu Sector of Kainji Lake National Park

Habitat	Am	Af	Sam	Saf	Juv	Total
Badmw	5	11	5	7	12	40.000±2.395
Dmdf	2	4	1	4	6	17.000±1.938
Rfw	11	22	7	16	9	75.000±4.246
Tmts	5	15	5	10	11	46.000±2.634
Itw	4	10	3	9	9	35.000±2.148
Idsw	3	8	3	7	7	29.000±2.001
Total	30	70	24	53	64	242.000±15.362
Mean	5.0	11.666	4.0	8.833	10.666	40.333±2.560
Percentage (%)	12.40	28.93	9.92	21.90	26.45	

Badmw-*Burkea africana/Detarium microcarpum* woodland savanna, Dmdf-*Diospyros mespliformis* dry forest, Rfw-riparian forest and woodland, Tmts - *Terminalia macroptera* tree savanna, Itw-*Isoberlinia tomentosa* woodland, Idsw-*Isoberlinia doka* savanna woodland Am-Adult males, Af-Adult females, Sam-Subadult males, Saf-Subadult females, Juv-Juveniles

respectively which were expected to be recruited into the effective breeding population in the subsequent breeding seasons (Tutin and Fernadex, 1984).

Using Eq. (1) the Ne was calculated to be 84, a value that is 84% of the total effective breeding population of 100 (adult males and adult females). When extrapolated to the entire land area of the Borgu sector of the Park, which is 3,970.85 km^2 with a total relative abundance of 0.372±0.003, it translated to a total population of 1,410.2±11.91 Buffalo in the sector. Out of which 41.23% of the population was effective breeding population (Ne = 581.34±4.91).

Since Ne is grater than 100, which indicated that, the population was not threatened by demographic stochasticity (Burgman *et al*., 1993). There was a significant difference ($p<0.05$) in the components of the population structure.

CONCLUSIONS

Since the population of Buffalo in the sector was large enough it may not be necessarily affected by demographic stochasticity that is not to say that the population may not be affected by environmental factors and illegal human activities such as poaching, habitat destruction, habitat loss, draught, flooding and indis criminate burning of the vegetation among others. It could be recommended that using effective population size may be certain and more relevant than a straight forward population census, as it is designed to visualized the risk associated with a give population size and structure.

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