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## STATUS AND DISTRIBUTION OF DUIKER SPECIES IN OKOMU NATIONAL PARK , NIGERIA

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### ABSTRACT

Hitherto, the populations of duikers in ONP were unknown. Therefore, this study assessed the abundance, density and distribution of duiker species in the area to ensure sound and sustainable management strategies. Twelve transects of 2-km-long were established at 10-20 km intervals within the four ranges (i.e. Arakhuan, Babui, Iguowan and Julius Creek). Each transect was walked three times, 'to-and-fro' for diurnal and nocturnal surveys. After 288 km-survey-efforts, only (47) *Philantomba monticola* and (39) *Philantomba maxwellii* were encountered. Data were analyzed using DISTANCE 7.0 to estimate density and encounter rates. Estimates of density and abundance were computed on species, developmental-stage and sex bases. Densities of *Philantomba monticola* and *Philantomba maxwellii* were 11.8 km<sup>-2</sup> and 9.8 km<sup>-2</sup> with encounter rates (ERs) of 0.16 km<sup>-1</sup> and 0.14 km<sup>-1</sup>, respectively. The encounter rates (ERs) for *P. monticola* were 0.28, 0.19, 0.07 and 0.11 km<sup>-1</sup> with densities of 5.0, 3.5, 1.3 and 2.0 km<sup>-2</sup> in Arakhuan, Babui, Iguowan and Julius Creek ranges, respectively. The values for *P. maxwellii* were 0.29, 0.13, 0.08 and 0.04 km<sup>-1</sup> with densities of 5.3, 4.5, 1.5 and 0.8 km<sup>-2</sup> in the four ranges. Sixty-two of the duikers sighted were adults with 24 juveniles, having ERs of 0.22 and 0.08 km<sup>-1</sup>, respectively. Of the adults encountered, 33 were *P. monticola* while 29 of them were *P. maxwellii*. There were 14 and 10 juveniles for both species, respectively. Fifty-six of the duikers were males, 34 of which were *P. monticola* with 22 *P. maxwellii*. There were 30 female duikers including 13 *P. monticola* and 17 *P. maxwellii*. Anthropogenic activities and bushmeat hunting significantly impacted duiker abundance negatively in the area.

**Keywords:** Duiker, population estimates, encounter rate, range, illegal hunting



## INTRODUCTION

Duikers belong to the subfamily *Cephalophinae* in the family *Bovidae*. The *Cephalophinae*, which are found throughout Sub-Saharan Africa, has three genera - *Sylvicapra* (one species) and *Cephalophus* with about 14 species and *Philantomba* with two species (Newing, 1994; Jimoh *et al.*, 2012). They are known to be among the most productive group of mammals, and some of them can tolerate high levels of habitat disturbance (Newing, 2001). Okomu National Park, as one of the key protected areas in Nigeria houses a number of duiker species, and until now the species, their distribution as well as abundance therein are yet unknown. This underscores the need to estimate the population size and density in order to implement appropriate conservation measures in favour of the species in the protected area.

Population estimation, either by direct or indirect surveys, has been described as very crucial to determine abundance, density and distribution of wildlife, and a number of methods are already in use, especially in dense forests and protected areas (e.g. Wilkie and Finn, 1990; Buckland *et al.*, 2001; Waltert *et al.*, 2006; Western *et al.*, 2009; Jimoh *et al.*, 2012). Out of the available methods, Distance sampling using line transects has been considered technically robust, as it allows accurate estimation of population size, flexible and it addresses detectability issues (Buckland *et al.*, 2001; Thomas *et al.*, 2010).

According to Eves and Stein (2002), duikers are intensively exploited as a source of bushmeat in most of the African forest zones. Consequently, many populations have been reported to be under serious threat due to unsustainable off-takes (Abernethy *et al.*, 2013). Nevertheless, these assertions have not been verified for duiker species in ONP. Although studies have revealed that duikers are the most heavily hunted species across forested West and Central Africa countries (Jimoh *et al.*, 2012; Bobo *et al.*, 2015), and they have been classified in Nigeria as nationally endangered due to their vulnerability to hunting pressure, and increasing habitat loss, according to Endanger Species Decree 11 of 1985, the exact scenarios of the impact of the over-hunting on the species in ONP have not been documented.

Wiafe and Amfo-out (2012) have observed that the need to better understand the population ecology of duikers is essential, if these communities are to be managed and conserved. So far 17 species are recognized, and it has been said that all of them are undergoing rapid population declines with only two being classified as common by the IUCN (Kingdon, 2001;



Baillie *et al.*, 2004). However, the exact species affected in ONP by the anthropogenic disturbances remained unknown. In ONP, duikers were rumoured to be among the species of mammals in the area. However, there is no information on the population status of the species inhabiting the ecosystem. Therefore, we assessed the abundance, density and distribution of duikers in ONP, Nigeria with a view to documenting the available duiker species in the area for sustainable management strategies.

## METHODOLOGY

### The Study Area

The study was carried out in Okomu National Park. It covers an area of 202 km<sup>2</sup>, which is about 19% of the 1,082 km<sup>2</sup> badly-degraded Okomu Forest Reserve. The area was originally gazetted as a wildlife sanctuary by the Old Bendel State Government in 1986 through legal notice number 198 of 1986, and was later upgraded to park status in 1999 at the onset of the fourth republic (the new democratic dispensation in Nigeria). It is situated within longitudes 5° and 5°30' E, latitudes 6° and 6°20' N in Ovia Southwest Local Government Area (LGA) of Edo State, Nigeria (Fig. 1). The area consists of semi-deciduous, humid, lowland rainforest. The area is rich in several mammalian and bird species, some of which are buffalos, duikers as well as various species of reptiles (Akinsorotan *et al.*, 2011).

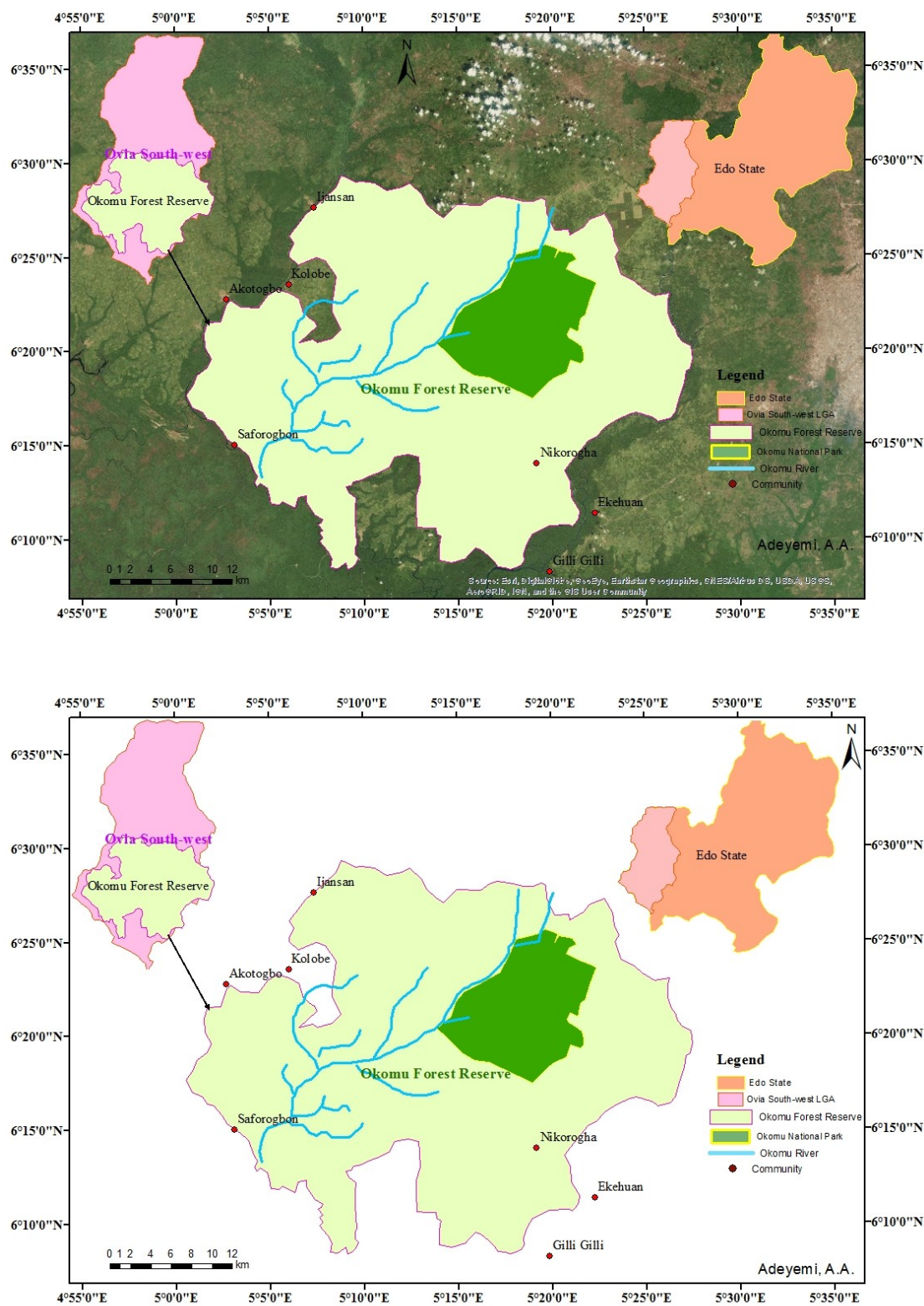


Fig. 1: Map of the study area





## Data Collection and Analysis

Systematic (line) transect sampling technique was adopted for the study. Three transects of 2 km long and 1 m wide was cut in each of the four ranges, Arakhuan (66.5 km<sup>2</sup>), Babui (56.2 km<sup>2</sup>), Julius Creek (41 km<sup>2</sup>) and Iguowan (38.3 km<sup>2</sup>) within Okomu National Park at 5 km intervals. To avoid edge effect, the first transect in each of the ranges was located 5 km away from the park boundary. A total of twelve (12) transects were used for the study. Transects were allowed to rest for two weeks before the commencement of census walks to ensure that the animals recover from disturbances associated with transect cutting (laying).

Each transect was walked three (3) times, 'to and fro' for diurnal and nocturnal surveys. The diurnal surveys was conducted between 6:00 and 9:00 hours while the nocturnal survey was carried out between 19:00 and 22:00 hours using flash light for proper identification. For both surveys, sighting and perpendicular distances were measured for all species' of duikers encountered. In addition, each of the duikers sighted was identified to species level. The time of sighting, numbers of the individuals seen along the transect lines were noted. The developmental stages of the animals sighted (adult or juvenile) and sex (male or female, Plates 1 and 2) were also recorded in the course of the transect walks. In total, all transects were walked 144 times (i.e. 3×2×2×12), which resulted in 288 km survey efforts (i.e. 144 × transect length, which is 2 km).



*Male blue duiker*



*Female blue duiker*

Plat 1: blue duiker (*Philantomba monticola*)



Male Maxwell's duiker

Female Maxwell's duiker

Plate 2: Maxwell's duiker (*Philantomba maxwellii*)

The data were analyzed using DISTANCE 7.0. In modelling detection probability globally (overall), stratum (range) was used as a covariate in order to compute density, encounter rate and abundance for each of the duiker species based on Akaike Information Criterion (AIC).

## RESULTS

After a survey effort of 288 km, only two duiker species ( blue - *Philantomba monticola* and Maxwell's - *P. maxwellii*) were sighted 47 and 39 times, respectively making a total of 86 sightings (Table 1). For the pooled data, for ONP, the mean encounter rates (MERs) were  $0.16 \text{ km}^{-1}$  and  $0.14 \text{ km}^{-1}$  for *P. monticola* and *P. maxwellii*, respectively. The estimated densities of the two species were  $11.8 \text{ km}^{-2}$  (CI: 8.3 - 15.3) and  $9.8 \text{ km}^{-2}$  (CI: 6.6 - 13.0), respectively for the entire park. On site basis, more duikers were sighted at Arakhuan range (i.e. 20 blue and 21 Maxwell's) than Babui (14 and 9); Iguowan (5 and 6) and Julius Creek (8 and 3) ranges. The MERs for the *P. monticola* were 0.28, 0.19, 0.07 and  $0.11 \text{ km}^{-1}$  with estimated densities of 5.0 (CI: 2.7 - 7.3), 3.5 (CI: 1.5 - 5.5), 1.3 (-0.3 - 2.9) and  $2.0 \text{ km}^{-2}$  for Arakhuan, Babui, Iguowan and Julius Creek ranges, respectively. The MERs for *P. maxwellii* ranges from 0.29 in Arakhuan, 0.13 in Babui, 0.08 in Iguowan to  $0.04 \text{ km}^{-1}$  in Julius Creek with densities of 5.3 (CI: 2.9 - 7.7), 4.5 (1.0 - 8.0), 1.5 (-0.1 - 3.1) and  $0.8 \text{ km}^{-2}$ , respectively (Table 1).

Table 2 presents estimates of duikers sighted according to developmental stage with 62 of the total species sighted being adults while 24 duikers were juveniles. The MERs were  $0.22 \text{ km}^{-1}$  and  $0.08 \text{ km}^{-1}$  with densities of 15.5 (CI: 11.5 - 19.5) and  $6.0 \text{ km}^{-2}$ , respectively. Of the total adults sighted, 33 were *P. monticola* while 29 were *P. maxwellii* with MERs of 0.11



and  $0.10 \text{ km}^{-1}$ . Estimated densities were  $8.25 \text{ (CI: 5.3 - 11.2)}$  and  $7.25 \text{ (CI: 4.3 - 9.7)} \text{ km}^{-2}$  for the adult duikers, respectively. There were 14 and 10 juveniles with MERs of 0.05 and  $0.03 \text{ km}^{-1}$  for *P. monticola* and *P. maxwellii*, respectively. The juvenile densities were  $3.5 \text{ (CI: 1.5 - 5.5)}$  and  $2.5 \text{ (CI: 0.9 - 4.6)} \text{ km}^{-2}$ , respectively.

**Table 1: Duiker densities and encounter rates in different ranges of ONP**

Species	Range	n	MER $\text{km}^{-1}$	D $\text{km}^{-2}$	CI
<i>P. monticola</i>	Pooled	47	0.16	11.8	8.3-15.3
<i>P. maxwellii</i>	Pooled	39	0.14	9.8	6.6-13.0
<i>P. monticola</i>	Arakhuan	20	0.28	5.0	2.7-7.3
	Babui	14	0.19	3.5	1.5-5.5
	Iguowan	5	0.07	1.3	-0.3-2.9
	Julius Creek	8	0.11	2.0	0.3-3.7
<i>P. maxwellii</i>	Arakhuan	21	0.29	5.3	2.9-7.7
	Babui	9	0.13	4.5	1.0-8.0
	Iguowan	6	0.08	1.5	-0.1-3.1
	Julius Creek	3	0.04	0.8	-1.2-2.8

*N.B.:* n - sightings; MER - mean encounter rate; D - density; CI - density confidence interval

**Table 2: Distribution of the two duiker species into developmental stages in ONP**

Species	Developmental stage	n	MER $\text{km}^{-1}$	D $\text{km}^{-2}$	CI
Pooled	Adult	62	0.22	15.5	11.5-19.5
	Juvenile	24	0.08	6.0	3.9-9.1
<i>P. monticola</i>	Adult	33	0.11	8.25	5.3-11.2
	Juvenile	14	0.05	3.5	1.5-5.5
<i>P. maxwellii</i>	Adult	29	0.10	7.25	4.3-9.7
	Juvenile	10	0.03	2.5	0.9-4.6

*n* - sightings; MER - mean encounter rate; D - density; CI - density confidence interval

Fifty-six (56) of the duikers encountered were males of the two species, 34 of which were *P. monticola* with 22 *P. maxwellii*. There were 30 female duikers, which include 13 *P. monticola* and 17 *P. maxwellii*. The MERs for the male and female duikers were 0.19 and



0.10 km<sup>-1</sup> with densities of 14.0 (CI: 10.7 - 18.3) and 7.5 (CI: 4.7 - 10.3) Km<sup>-2</sup>, respectively. On species basis, *P. monticola* had MERs of 0.11 and 0.05 km<sup>-1</sup> for males and females with densities of 8.5 (CI: 5.5 - 11.5) and 3.25 (CI: 1.3 - 5.2) km<sup>-2</sup>, respectively. For *P. maxwellii*, the MERs were 0.08 and 0.06 km<sup>-1</sup> for males and females with densities of 5.5 (CI: 3.1 - 7.9) and 4.25 (CI: 2.1-6.4) km<sup>-2</sup>, respectively (Table 3).

**Table 3: Sex distribution of the two duiker species in ONP**

Species	Sex	n	MER km <sup>-1</sup>	D km <sup>-2</sup>	CI
Pooled	Male	56	0.19	14.0	10.7-18.3
	Female	30	0.10	7.5	4.7-10.3
<i>P. monticola</i>	Male	34	0.11	8.5	5.5-11.5
	Female	13	0.05	3.25	1.3-5.2
<i>P. maxwellii</i>	Male	22	0.08	5.5	3.1-7.9
	Female	17	0.06	4.25	2.1-6.4

*n* - sightings; *MER* - mean encounter rate; *D* - density; *CI* - density confidence interval

## DISCUSSION

Across the four ranges of the park, *P. monticola* were sighted more than *P. maxwellii*, which implied higher encounter rate and density per km<sup>2</sup>. This is similar to the finding of Jimoh *et al.* (2012), who reported high density and mean encounter rate for blue duiker (*P. monticola*) than Ogilby's duiker (*C. ogilby*) in Cross River National Park of Nigeria. This is also in line with the report by Wilson (2005), who noted the wider distribution of blue duikers compared to other species of duikers in Africa. It is possible that blue duiker breeds more than the Maxwell's duiker in the area, just as noted by Lunt and Mhlanga (2011), who observed higher breeding rate in blue duiker compared to other duiker species. It has also been observed by Estes (1997) that these two species usually occur in close association, suggesting that anywhere blue duikers were present, there were chances of Maxwell's being present in such an ecosystem, hence their occurrence in the park.

The occurrence of the two duiker species in the four ranges of the park, though at different rates, may not be unconnected to food availability and quality as oil palm fruits, *Trichilia sp* and *Macaranga bateri* fruits were prevalent in the area. These floral species constitute the





major foods for duiker species. As noted by Rogers (1987), Bowland (1990), food quality and disturbance are two of the major limiting factors for duiker survival, indicating that the two factors were inversely correlated in enhancing the survival of duiker populations. Although more duikers were sighted at the Arakhuan range, which happens to be closest to the park administrative headquarters, due to the reduced hunting pressure by its geographic location, it is still less-justifiable as the two larger duikers (i.e. Red-flanked and Yellow-backed) previously recorded in 2008 and 2009 as reported by Akinsorotan *et al.* (2011) were not sighted during the survey. Nevertheless, least signs of human hunting were noticed around most of the transects, where duikers were found, and there were relatively far more sightings in Arakhuan range compared to others. According to Bowland and Perrin (1995), duikers generally flourish in habitats, where there is balance between food resources and shelter with minimal or no threat. This is also in line with the work of Nyabasa (2010), who noted that the major threats facing most duikers are bush-meat hunting and habitat loss.

The species sighted in this range were more relaxed compared to those seen in the other three ranges, in which most of the duikers sighted took off almost immediately the observers were noticed. Specifically, it appeared that the farther the ranges, the more depleted the populations of duikers due to more hunting pressures. This is supported by the work of Bowen-Jones (1998), who opined that the continued growth in human population has deleterious effects on the populations of duikers.

In the past (though not documented, but confirmed by a local hunter), there were rumoured presence of Red-flanked (*C. rufilatus*) and Yellow-backed (*C. sylvicultor*) Duikers at the Babui range, however, no single individual of these species was sighted. These two species are larger and more sluggish compared to *P. monticola* and *P. maxwellii*, hence, they were prone to more risk of being easily-hunted through poaching. The faster the preys, the lesser the chances for the predators, same could be true of poachers.

Previous studies by Wilkie and Carpenter (1999), Newing (2001) decried that the type and level of hunting of duikers are far from their sustainability, especially in areas surrounded by human settlement. This is particularly true for the two larger duiker species, which have become very scarce, or completely exterminated in Okomu National Park. This is similar to the report of Jimoh *et al.* (2012), who noted apparent absence, indicating local depletion of



two larger duiker species due to unsustainable off-take and overexploitation. According to Stoner *et al.* (2007), reduction or lack of hunting has a positive effect on the regeneration and development of duikers. This is also in consonance with the report by Hart (2000), who associated the reduced abundance of duiker species to the high off-take.

The fact that there were more adult than the juvenile, as there were almost twice males as female duikers raises some concern, and this may not be unconnected to vulnerability of the latter than the former due to inactiveness of female and juvenile duikers. Hence, most of them may have been lost to human extractions. As observed by Nasi *et al.* (2008), poor management of hunting results in local species extinction of younger or weaker duiker species. For instance, most of the duiker carcasses seen around the park were identified to be pregnant females, which must have resulted from their inability to escape as fast as their male counterparts. Blue duiker was sighted more at night (51.5% of the sightings) than in the day (48.5%). On the contrary, more Maxwell's duikers were sighted during the day with about 62% of the individuals sighted. This corroborates the report by Newing (1994), who noted more activities of blue and Maxwell's duikers at night and in the day, respectively.

## CONCLUSION

The study has shown that only two of the four duikers species originally rumoured to be present in the park were sighted in the course of the field survey. The other two larger duiker species (i.e. Red-flanked (*C. rufilatus*) and Yellow-backed (*C. sylvicultor*) were not sighted in the area, indicating possibility of local depletion. Overall, duiker populations in the park can be said to be dwindling due to the absence of Yellow-backed duiker and Red-flanked duiker. These species may be approaching local extinction or threatened in the area. The study further showed that the distribution of available duikers according to range (habitat), sex or age may be influenced by food availability, degree of perturbation and extent of illegal anthropogenic activities, such as hunting, as a range with more protection and least illegal activities tends to harbour more duiker species than others. Therefore, the protection measure at the Arakhuan range should be sustained and extended to other ranges (locations). Although the availability of the two duiker species with such number of sightings indicates hope, and that the conservation efforts are yielding some results, the disappearance of the larger duiker species requires urgency in stemming the tides of illegalities. Specifically, the estimates of



densities in all categories of the results presented was based on 288 km survey efforts, perhaps, additional efforts could yield more sightings. Therefore, more transect walks are recommended in order to capture possibilities of wider habitat variation in subsequent studies.

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