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Full Length Research Paper

Forest duiker (*Cephalophus spp.*) abundance and hunting activities in the Kakum conservation area, Ghana

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The abundance of forest duikers (*Cephalophus* spp.) was compared to the incidence of hunting activities in the Kakum conservation area, Ghana. Transect surveys indicated that four duiker species were present: Maxwell's duiker (*Cephalophus maxwellii*), Bay duiker (*Cephalophus dorsalis*), Black duiker (*Cephalophus niger*), and Yellow-backed duiker (*Cephalophus silvicultor*). The indicators of hunting activities included the presence of empty cartridges, snares, gunshots, carbide powder, poacher's camps and arrest of poachers. Season's fluctuations and hunting activities appear to have effect on duiker abundance; the study could have strong evidence to establish it. A long term duiker population monitoring program is required in the area in order to come out with strong factors affecting duiker populations and their implications on conservation of wildlife resources.

Key words: Forest duikers, hunting activities, abundance, conservation, Kakum conservation area.

INTRODUCTION

Forest duikers (*Cephalophus* spp) are bovids of the sub family Cephalophinae, found only in Africa and primarily inhabiting forested areas (Grubb and Groves, 2001). The genus *Cephalophus* comprises of seventeen species, making it the most species-rich group of forest ungulates (Kingdon, 1997). Fruits and seeds constitute the bulk of the diet of duikers and they are thus potentially important seed dispersers (Eves et al., 2002). Many of the forest ungulates, including duikers, are intensively exploited as a source of game meat over most of the African forest zone (Gautier-Hion et al., 1980; Eves et al., 2002). Infield (1988) estimated that in the Korup National Park (Cameroon), duikers constituted 63.3% by weight of the total off-take by hunting, and that the number of animals killed by 15 households in six villages was estimated at 15,566 duikers from four species. Though conservation status of the duikers globally is least concern, apart from Ader's and Zebra duikers (*Cephalophus adersi* and *zebra*), the populations keep decreasing (SSC-IUCN, 2009). In Ghana, wildlife populations are under constant threat from human activity, even in protected areas, and illegal activities have affected the populations of most wildlife species (Jachmann, 2008). The need for a better understanding of the population ecology of duikers is essential if these communities are to be managed and conserved. The objectives of this study were to provide baseline information on the abundance of different forest duiker species relative to human hunting activities and seasonal variations, in the Kakum conservation area in Ghana.

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MATERIALS AND METHODS

The Kakum conservation area (KCA) is situated in the central region of Ghana. The KCA, established in 1992, is composed of the Kakum National Park, established in 1932, and the Assin-Attandanso resource Reserve, where selective logging took place from 1936 until 1989, when it was converted into a conservation area (Figure 1). The KCA covers an area of 360 km^2 of moist, semi-deciduous forest located between latitudes 05° 20'N and 05°40'N and longitude 001° 30'E and 001° 51'E. The rainfall pattern is bimodal, the major season occurring between April and July and

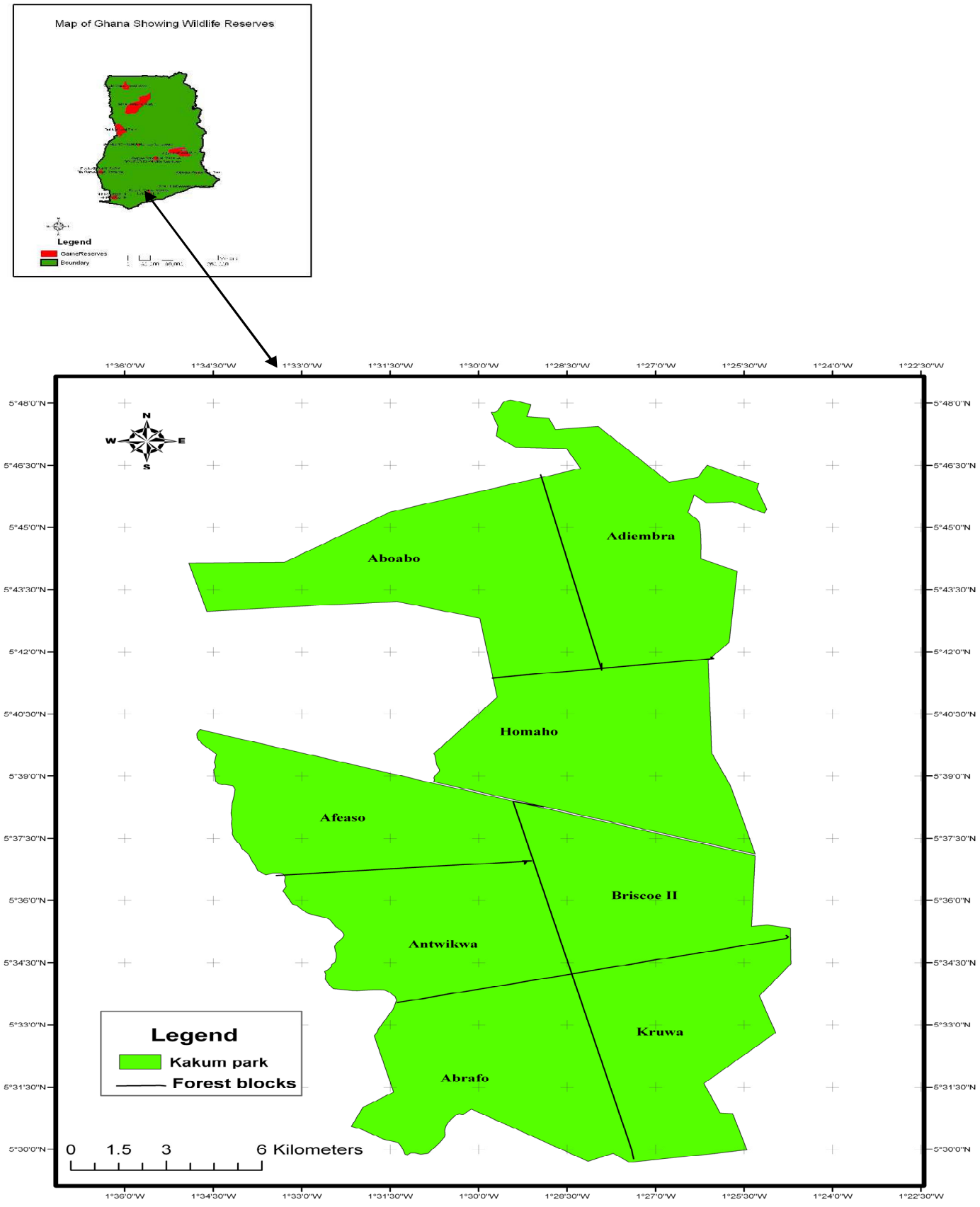

Figure 1. Map of Kakum conservation area showing the divisions into forest blocks. Inset: Map of Ghana indicating the position of Kakum conservation area and other protected areas in Ghana.

Table 1. Kilometric indices of abundance of the duiker species encountered in the wet season and dry season at the various forest blocks in the Kakum conservation area, Ghana. Numbers in parentheses indicate standard deviations.

Forest block	Bay duiker	Maxwell duiker	Black duiker	Yellow- backed duiker
		Wet season		
Antwikwa	0.63	1.25	1.13	0.00
Abrafo	0.63	1.38	0.50	0.00
Afeaso	0.00	2.88	0.13	0.38
Kruwa	1.50	1.75	0.50	0.00
BriscoeII	0.75	1.13	0.88	0.00
Aboabo	0.75	1.75	0.50	0.13
Homaho	1.00	1.75	0.25	0.00
Adiembra	0.88	2.25	1.38	0.13
Mean	0.80 (0.39)	1.80 (0.54)	0.70 (0.40)	0.10 (0.12)
		Dry season		
Antwikwa	0.63	1.00	0.75	0.00
Abrafo	0.38	0.88	0.00	0.00
Afeaso	0.00	1.25	0.00	0.25
Kruwa	1.13	3.38	0.75	0.00
BriscoeII	0.50	2.13	0.00	0.00
Aboabo	0.75	1.50	0.38	0.00
Homaho	0.38	1.25	0.00	0.13
Adiembra	1.00	2.75	1.50	0.00
Mean	0.60 (0.36)	1.80 (0.90)	0.40 (0.55)	0.05 (0.09)

the minor season between September and November (Ghana Wildlife Department, 1996). To equalize the sampling intensity, the KCA was divided into eight blocks of approximately equal sizes (Figure 1). In each of the blocks, four 2 km transects were randomly distributed perpendicular to the main drainage lines of the area. Transects followed compass lines, measured with a Geographical Positioning System (GPS) and censuses were conducted on foot by a team of up to three people from 6:00 to 16:00 GMT.

The team walked slowly (1 km/h), recording the presence of forest duiker species (by animal sighting) and signs of illegal hunting activities. A total of 64 km was surveyed during the dry season (December 2009 to January 2010) and the wet season (June to July 2010). Each transect was surveyed once per season. The software package DISTANCE (Thomas et al., 2005) is commonly used to analyze data from line transects (Gatti, 2010). However, the survey failed to meet the assumptions of the analysis (Buckland et al., 2001). The data was thus analyzed by calculating the Kilometric Indices of Abundance (KIA). This method consists in recording the number of animals and indicators of hunting observed per kilometre of transect (Groupe, 1991; Gatti, 2010). Mann-Whitney U-test was used to compare the abundance of duiker species in the dry and wet seasons. A Kruskal-Wallis test was used to evaluate the difference in medians of indices of hunting activities. The indices for duiker abundance and of all categories of hunting were summed up into a single index. Spearman's rank correlation was conducted to evaluate the relationship between these indices.

RESULTS AND DISCUSSION

Four species of duikers belonging to the genus *Cephalophus* were encountered during the survey and were categorized into small, medium and large duikers in accordance with Estes (1991) and Hart (2001). They were Maxwell's duiker (*Cephalophus maxwellii*), Bay duiker (*Cephalophus dorsalis*), Black duiker (*Cephalophus niger*), and Yellow-backed duiker (*Cephalophus silvicultor*) (Table 1). Total abundance across all species and forest blocks did not differ between the two seasons ($U = 435$, $p>0.05$), rejecting the hypothesis that seasonal differences influence duiker abundance. This may be due to the fact that as the duikers do not migrate to or from the protected area, they may have evolved to adjust to the local conditions which are the fluctuations between the dry and wet seasons. Another explanation may be that the seasonal conditions were not extreme enough to bring about significant changes in the species abundance. The mean KIAs for the following illegal hunting activities enumerated in the wet season and dry seasons included the presence of empty cartridges, snares, gunshots heard, carbide powder location of poachers' camps and arrest of poachers (Table 2).

The incidence of hunting activities did not differ ($H = 7.93$, $p>0.05$) between categories during the wet season, however, there was a significant difference ($H = 15.99$, $p<0.05$) between the categories of hunting activities in the dry season (Table 2). A weak negative relationship ($r_s = -0.25$, $p>0.05$) was found between the duiker indices and the incidence of hunting activities in the conservation

Table 2. Kilometric indices of abundance of indicators of hunting activities encountered in the wet season and dry season in the forest blocks in the Kakum conservation area. Numbers in parentheses indicate standard deviations.

Forest block	Empty cartridges	Gunshot heard	Snares found	Carbide powder	Poacher's camps	Poacher's arrested
			Wet season			
Antwikwa	1.50	0.63	1.25	0.00	0.00	0.13
Abrafo	0.13	0.25	0.00	0.00	0.00	0.00
Afeaso	0.25	0.50	0.00	0.50	0.13	0.00
Kruwa	2.50	1.25	6.13	0.25	0.13	0.00
BriscoeII	4.13	0.88	5.25	0.00	0.25	0.38
Aboabo	0.63	0.13	0.00	0.13	0.13	0.13
Homaho	1.88	0.63	0.63	0.13	0.00	0.00
Adiembra	0.75	0.88	0.50	0.13	0.00	0.38
Mean	1.47(1.35)	0.64(0.36)	1.72(2.5)	0.14(0.17)	0.10(0.09)	0.13(0.16)
			Dry season			
Antwikwa	1.13	0.25	0.00	0.00	0.13	0.13
Abrafo	0.63	0.25	0.38	0.00	0.00	0.00
Afeaso	0.00	1.13	0.00	0.38	0.38	0.00
Kruwa	1.88	0.75	0.88	0.38	0.00	0.00
BriscoeII	2.88	1.25	1.00	0.00	1.25	0.00
Aboabo	0.00	0.00	0.00	0.00	0.00	0.13
Homaho	0.75	0.50	4.25	0.38	0.13	0.00
Adiembra	2.00	1.25	0.50	0.38	0.00	0.00
Mean	1.16(1.02)	0.67(0.50)	0.88(1.42)	0.19 (0.20)	0.23(0.43)	0.03(0.06)

area in the wet season (Table 2). However, during the dry season, this relationship was positive (r_s = 0.45, p>0.05) (Table 2). During the wet season, the negative relationship suggested a higher density of duikers in areas with low incidence of hunting activities. However, during the dry season, duiker abundance was higher when the incidence of hunting activities was greater. The relationships were found to be very weak and this might suggest that hunting alone does not influence the abundance of duikers in forest environment. This study could not establish any strong relationship between hunting activities and duiker population, probably due to the short period of the study, however, this is strongly suspected to affect the duiker population at one time or another. A long term study for monitoring duiker population and hunting activities is therefore, recommended. Further research investigating the role of other limiting factors, such as the availability of fruiting trees and water, are recommended.

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