Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 2, No. 8, p. 50-57, 2012
http://www.innspub.net

RESEARCH PAPER OPEN ACCESS

Effect of protected area category on mammal abundance in Western Ghana

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Received: 11 July 2012
Revised: 07 August 2012
Accepted: 08 August 2012

Key words: Ghana, mammal, species, carnivores, transect, protection, hunting.

Abstract

A comparative study of the species composition and encounter rates of mammals (>400g) in two different protected area categories was conducted in the Bia-Goaso Forest Block in western Ghana from April 2008 to February 2009. One hundred and eighty-seven line transects were systematically distributed in an extensive network of 2 wildlife reserves and 9 forest reserves. Mammal signs (droppings and tracks) belonging to twenty-three species (2 rodents; 5 primates; 6 carnivores and 10 ungulates), representing 4 Families and 17 Genera were recorded for the survey period. The most abundant species recorded were brush-tailed porcupine (*Antherurus africanus* 14.0%), mammal signs, marsh cane rat (*Thryonomys swinderianus*; 13.4%), Maxwell's duiker (*Cephalophus maxwelli*; 11.3%) and bushbuck (*Tragelaphus scriptus*; 10.2%). Large mammals, including elephant (*Loxodonta africana cyclotis*), buffalo (*Sycerus caffer nanus*), chimpanzee (*Pan troglodytes verus*) and leopard (*Panthera pardus*) had relative abundance of less than 1.0%. Mammal density was significantly greater (Mann-Whitney U test: U=3057.0, P<0.01) in wildlife reserves (31 signs per km; 66%) than forest reserves (16 signs per km; 34%). Species richness in wildlife reserves (13 species; 57%) was however not very different (U=2262.5, P>0.05) from forest reserves (10 species; 43%).The forest reserves seem to be achieving only partial success in protecting wildlife, whereas wildlife reserves seem to be considerably more effective, although not entirely successful. The results calls for renewed efforts to include more wildlife protection in the management priorities of Ghana's forest reserves.

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Introduction

The abundance of species differs among hunted and un-hunted or less heavily hunted places (Lopes and Ferrari 2000; Carrillo *et al*., 2000). Therefore, to avoid the negative effects of human activities, including hunting, and to conserve natural and cultural features of the land, many protected areas have been established throughout the world. These areas play important roles in the maintenance of wildlife populations, and in many cases serve as a source of food that are consumed by the human communities living in or adjacent to protected areas (Carrillo *et al*., 2000).

According to Protected Area Development Project (2000, 2001), in which limited areas of the country were extensively surveyed for mammals, thirty-four medium-sized and large mammalian species have been recorded in western Ghana alone (PADP, 2001; Danquah *et al* 2009b). Also, poor information is known from areas outside the catchment area of the PADP and that the possibility of these other landscapes harbouring different fauna composition needs to be determined. Therefore, there is a need for further survey as more and more areas are affected as a result of human activities. It is also necessary to assess whether the management of protected areas is achieving the objectives set for them (Carrillo *et al*., 2000). In particular, changes and trends in wildlife populations should be documented.

As a result, a comparison of encounter rates and species richness of mammals in 11 reserves belonging to two protected area management categories (2 wildlife reserves and 9 forest reserves), with similar environmental characteristics but different hunting restrictions and levels of protection was done. The hypothesis was that the encounter rates and species richness of mammals in forest reserves would be less than in wildlife reserves, where hunting is prohibited and there is better natural-resource protection through law enforcement. The study also formalized a method based on the use of mammal track records and arboreal mammal sightings that requires little effort and can be used to monitor population trends in a given area and to compare populations in sites with different levels of exploitation or other types of habitat disturbance. The findings presented provide information on the effectiveness of protected areas in Ghana.

Materials and methods

Information on the encounter rates and species richness of medium-sized and large mammal species (>400 g) was recorded in western Ghana during the wet and dry season months of April–July and November–February respectively from 2008 to 2009.

A grid of 10km was laid over a map of the study area, resulting in 100 cells. Of these cells, 43% was systematically selected. Two kilometer line transects were then distributed systematically over a numbered grid at intervals of 2 km in each of the selected cells. The intersections of the grids formed the starting point for each transect. This gave 187 transects (22 transects in wildlife reserves and 165 transects in forest reserves), that conformed to the systematic segmented line transect design required by MIKE (Fig. 1). Transect orientation was perpendicular to the main drainage lines of the region (Norton-Griffiths, 1978).

Line transects were walked looking for mammals and their signs (droppings and tracks). Each time a mammal or its sign was encountered, the species and place the sign was found was recorded. The tracks of an animal crossing the trail was counted as one sighting. Likewise, when animal footprints were following the trail, they were considered as one observation. In the case of gregarious species, such as mongoose, one group of tracks was counted as one sighting. For primates, monkey troops were located along or near the trail and number of individuals estimated.

An encounter rate index per km for each species was estimated by dividing the number of mammal

encounters (direct sightings and signs) by the total length of a given transect. A Mann-Whitney U test was used to compare the encounter rates and species richness of mammals between wildlife and forest reserves. All analyses were conducted using the Statview software (SAS, 1999).

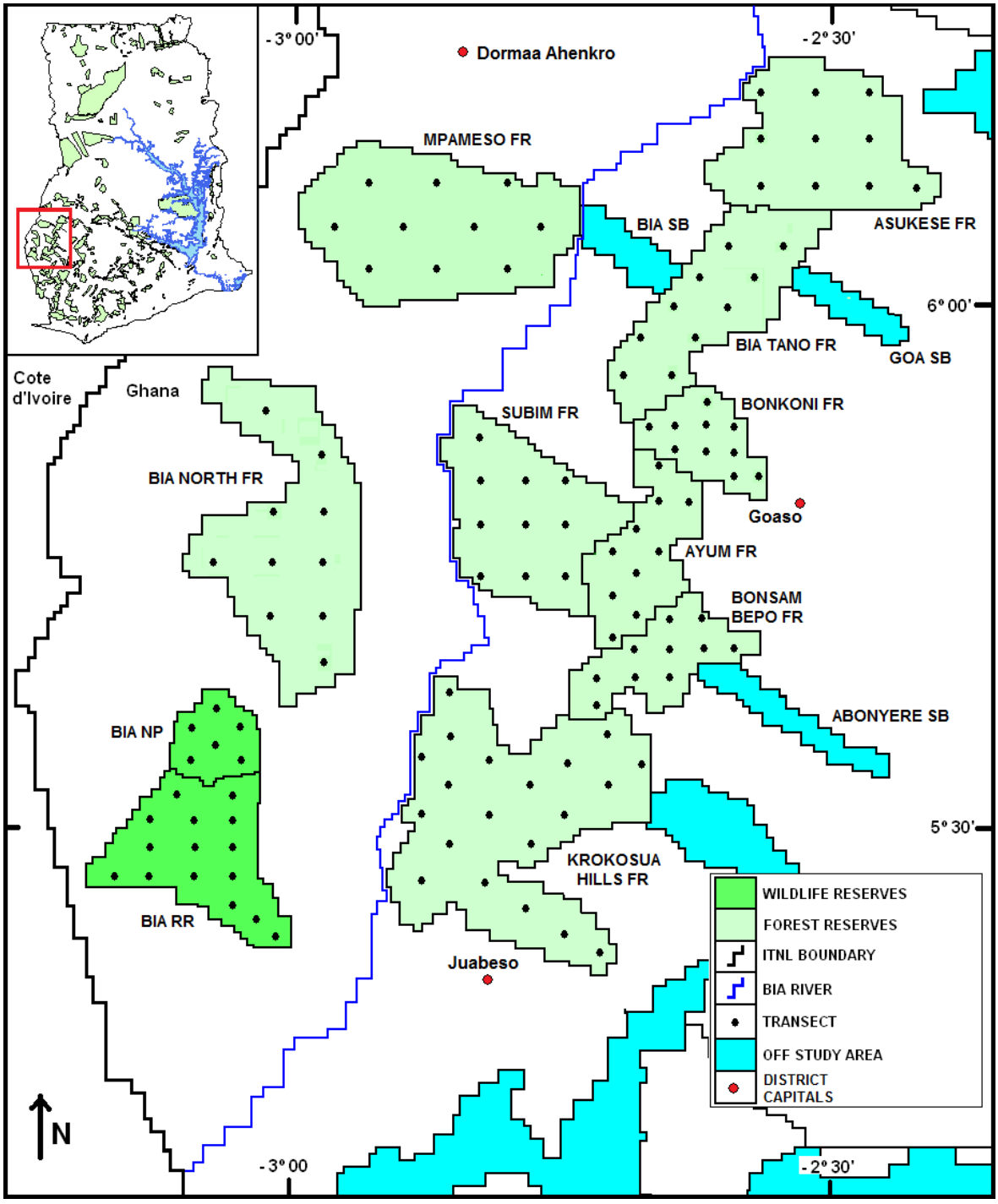

Fig. 1. Study area showing distribution of transects in the wildlife and forest reserves. The inset map shows the location of the study area in southwestern Ghana.

Table 1. Summary of medium-size and large mammal species characteristics.

Common Names	Scientific Names	Total Signs	Relative Abundance	Conservation Status (IUCN 3.1)
Primates	***Primates***	**700**		
† Western Chimpanzee	*Pan troglodytes verus*	21	0.3	Endangered
† Lowe's (Mona) Monkey	*Cercopithecus (mona)*	302	4.6	Least Concern
† Lesser Spot-nosed Monkey	*lowei*	157	2.4	Least Concern
† Black and white colobus	*C. petaurista petaurista*	116	1.8	Least Concern
† Olive colobus	*Colobus vellerosus*	104	1.6	Near Threatened
	Procolobus verus			
Rodents		**1810**		
‡ Brush-tailed Porcupine	***Rodentia***	924	14.0	Least Concern
√ Marsh Cane Rat	*Antherurus africanus*	886	13.5	Least Concern
	Thryonomys swinderianus			
Carnivores		**1477**		
‡ Slender Mongoose	***Carnivora***	358	5.4	Least Concern
‡ Cusimanse Mongoose	*Herpestes sanguinea*	190	2.9	Least Concern
‡ Marsh Mongoose	*Crossarchus obscurus*	289	4.4	Least Concern
‡ Blotched Genet	*Atilax paludinosis*	354	5.2	Least Concern
‡ African Civet	*Genetta tigrina pardina*	259	3.9	Least Concern
† Leopard	*Civettictis civetta*	27	0.4	Uncertain
	Panthera pardus			
Ungulates		**2599**		
† African Forest Elephant	***Ungulata***	34	0.5	Endangered
† Red River Hog	*Loxodonta africana*	118	1.8	Least Concern
† African Forest Buffalo	*cyclotis*	32	0.5	Least Concern
‡ Bushbuck	*Potamochoerus porcus*	680	10.3	Least Concern
† Bongo	*Sycerus caffer nanus*	103	1.6	Near Threatened
‡ Maxwell's Duiker	*Tragelaphus scriptus*	743	11.3	Least Concern
† Black Duiker	*Tragelaphus euryceros*	266	4.0	Near Threatened
† Yellow-backed Duiker	*Cephalophus maxwelli*	148	2.2	Least Concern
† Bay Duiker	*Cephalophus niger*	270	4.1	Least Concern
† Royal Antelope	*Cephalophus silvicultor*	205	3.1	Least Concern
	Cephalophus dorsalis			
	Neotragus pygmaeus			

NB: † are forest specialists, ‡ are forest generalists and √ is restricted to degraded lands

Results

Mammal taxonomic groups

Twenty-three taxonomic groups, representing 4 Families, 18 Genera, and 23 Species (Table 1) were confirmed on transects during the survey period.

The most commonly registered signs were those of the brush-tailed porcupine (*Antherurus africanus*), which represented 14.0% of all mammal signs, the marsh cane rat (*Thryonomys swinderianus*; 13.4%), the Maxwell's duiker (*Cephalophus maxwelli*; 11.3%) and the bushbuck (*Tragelaphus scriptus*; 10.2%). Larger mammals, including elephant (*Loxodonta africana cyclotis*), buffalo (*Sycerus caffer nanus*), chimpanzee (*Pan troglodytes verus*), leopard (*Panthera pardus*) had relative abundance of less than 1.0%.

Forests specialists were classified as endangered, near threatened or of least concern and these species accounted for 60.9% of the mammal signs registered. Species found in only degraded areas were of least concern and accounted for 4.3% of the mammal signs registered. Forest generalists found in both forest and degraded areas were also of least concern conservation concern and accounted for 34.8% of the mammal signs registered.

Mammal functional types

Among functional types, herbivores dominated (52 percent of mammals) in the study area (Table 2). Carnivores and omnivores formed 26 percent and 22 percent respectively of the remaining mammals recorded. Large mammals constituted only 30 percent whilst medium-sized mammals formed the major (70 percent) group.

Overall, medium-sized herbivores recorded the most species (31 percent), followed by large herbivores (22), medium-sized carnivores (22 percent) and then large omnivores (17 percent). Comparatively, very few mammal species were recorded in the large carnivore (4 percent) and large omnivore (4 percent) categories whilst no record of large or medium-sized insectivores was made (Table 2).

Table 2. Overview of mammal functional types and species.

Functional Type	Body Mass (kg)	English Name	Scientific Name
Large Herbivore	900 – 3000	African Forest Elephant	*Loxodonta africana cyclotis*
	270 - 870	African Forest Buffalo	*Syncerus caffer nanus*
	210 - 405	Bongo	*Tragelaphus euryceros*
	45 - 80	Yellow-backed Duiker	*Cephalophus silvicultor*
	54 - 81	Red River Hog	*Potamochoerus porcus*
Medium Herbivore	29 - 71	Bushbuck	*Tragelaphus scriptus*
	18 - 24	Bay Duiker	*Cephalophus dorsalis*
	15 - 20	Black Duiker	*Cephalophus niger*
	10 - 24	Brush-tailed Porcupine	*Antherurus africanus*
	8 - 9	Maxwell's Duiker	*Cephalophus maxwelli*
	5 - 9	Grasscutter	*Thryonomys swinderianus*
	2 – 3	Royal Antelope	*Neotragus pygmaeus*
Large Carnivore	20 - 90	Leopard	*Panthera pardus*
Medium Carnivore	11 – 18	African Civet	*Civettictis civetta*
	3 – 6	Marsh Mongoose	*Atilax paludinosus*
	1.5 – 2.6	Blotched Genet	*Genetta tigrina pardina*
	0.4 – 1	Cusimanse	*Crossarchus obscurus*
	0.4 – 0.8	Slender Mongoose	*Herpestes sanguinea*
Large Omnivore	34 – 70	Western Chimpanzee	*Pan troglodytes verus*
Medium Omnivore	10 – 23	Black & white colobus	*Colobus vellerosus*
	4 – 8	Spot-nosed Monkey	*C. petaurista petaurista*
	3 – 6	Lowe's (Mona) Monkey	*Cercopithecus lowei*
	3 – 6	Olive colobus	*Procolobus verus*

Functional traits (feeding type, body mass, activity pattern) from Skinner &Chimimba (2005)

Mammal encounter rates and species richness

There was not enough data to conduct realistic comparison of encounter rates and species richness estimates between reserves for some mammal species, especially chimpanzee, leopard, elephant and buffalo. Hence, the data was pooled for the specific functional types, i.e. medium and large mammal groups.

There were significant differences in the mean encounter rates of signs (Mann-Whitney U test: U = 573.0, $p < 0.05$) registered across the two categories of protected areas. The mean number of mammal signs per km was significantly greater in wildlife reserve (62%) than in forest reserves.

Mammal species composition also varied across the protected areas but was not significant (Mann-Whitney U test: U = 1367.5, $p > 0.05$). None of the species were unique to any of the protected area categories, but the generally higher species richness in wildlife reserves in comparison to forest reserves may result from the disproportionately higher numbers of uncommon large mammals like elephants, buffaloes, leopards and chimpanzees.

Discussion

Mammal abundance indices

Although it is difficult to count animals accurately in forest habitats, the results of this survey indicate that censusing these species by their signs is feasible. Available evidence for elephants indicates that dung counts give good estimates with reasonable confidence limits (Plumptre and Harris, 1995; Barnes, 2001, 2002; Eggert *et al.*, 2003). Furthermore, the line transects method (Buckland *et al.*, 1993) is very well suited to mammal dropping surveys. Tracks can also be used to document the presence and abundance of many species, even of those that tend to flee or hide when sensing human presence. In addition, observations can be made independent of the main time of activity of a species because tracks remain in sight for longer periods than the animals and are less likely to go undetected (Carrillo *et al.*, 2000). A further advantage of our approach is the low cost and the fairly rapid way in which data can be obtained.

All species recorded by tracks, were observed directly but most species were seen only rarely, and mainly in wildlife reserves. Direct observations of 4 species (*Cercopithecus (mona) lowei, C. petaurista petaurista, Colobus vellerosus* and *Procolobus verus*) were also made for which there was no record of tracks. These species are predominantly arboreal. Conversely, the tracks of the leopard (*Panthera pardus*) were recorded only once and never seen directly. Some species known to occur in the area, such as the golden cat (*Felis aurata*), were not recorded directly or by their tracks.

Effects of category of a protected area on mammals

Despite similar vegetation types in wildlife and forest reserves, mammal encounter rates in the wildlife reserves were significantly higher than forest reserves. This is in line with the hypotheses that encounter rates and species richness of mammals in forest reserves would be less than in wildlife reserves, where hunting is prohibited and there is better natural-resource protection through law enforcement. This is particularly the case for large mammal species such as elephants, leopards and chimpanzees. The only remaining large mammal species, which did not differ significantly in abundance between both protected areas, is the red river hog, an adaptable species with a relatively high reproductive rate. The elephant, which was significantly less abundant outside wildlife reserves, is often hunted because of its ivory. The apparent absence of the leopard in forest reserves is presumably unrelated to exploitation, because the species is not usually eaten.

Some species (e.g. black and white colobus, forest buffalo, yellow-backed duiker and bay duiker) considered internationally as least concern had populations in wildlife reserves comparable to those species that were considered threatened. This could be because park managers have been unsuccessful in safeguarding these species. Alternatively, it is possible that the populations of some of these species are in fact threatened locally but not as the IUCN red listings assumes, and their status could be re-assessed.

There was no significant difference in species richness in the area between wildlife and forest reserves, but there was substantial variability. The abundance of mammal species has been shown to vary considerably between the reserves (Danquah *et al.*, 2009a, 2009b), and the data show a similar pattern. Again, there was a decline in the abundance among all large mammal between wildlife and forest reserves. This trend confirms recent increases in reduction of hunting activities in the Bia

Conservation Area since 1992 when the Protected Areas Development Programme was implemented.

The study documents a case in which the category of a protected area clearly has had an effect on the populations of some mammal species (Carrillo *et al*., 2000). The type of activities allowed in the protected areas and the level of law enforcement are directly affecting the abundance of mammals. Although all species were influenced, the ones that were more severely affected were larger mammals. Evidence from Danquah *et al*. (2009a, 2009b) suggest that the main factor differentiating the abundance of mammals in the two protected areas categories considered could be the level of hunting. Forest reserves seem to be achieving only partial success in protecting wildlife, whereas wildlife reserves seem to be considerably more effective, although not entirely successful.

Enforcement of hunting restrictions in the forest reserves of Ghana is difficult, perhaps unrealistic, and perhaps even socially undesirable, as long as the current socioeconomic conditions persist. Yet overexploitation must be avoided so that many large animals do not become ecologically (or economically) extinct in the region; hunting should be sustainable. This goal can be reached, however, only if we have basic information about the populations of wildlife in the area so that changes in their abundance and the effects of disturbance and management can be assessed. Standardization of methods to undertake these assessments in tropical forests is of foremost importance. It is also necessary to work with the communities that live in and around protected areas: if their standards of living improve, then pressure on wildlife populations will be minimized (Carrillo *et al*., 2000).

Acknowledgments

We wish to acknowledge the Ghana Forestry Commission for provision of field staff, logistics and granting permission to work within the reserves. Special thanks go to the management of the Wildlife Division and Forestry Division.

The study would not have been possible without the contributions of the field team.

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