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DEPARTMENT OF WILDLIFE AND RANGE MANAGEMENT

**A SURVEY OF MEDIUM-SIZED MAMMAL IN ASUBIMA FOREST
RESERVE
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1. ABSTRACT

Medium-sized mammals (5kg-45kg) in Asubima Forest Reserve were censused to determine species presence and their abundance within the month of February 2011. The census was conducted using fixed-width/strip/belt (King's method) and line transects (Hayne's method) methods by employing direct count of signs (feeding signs, pellet's and footprints). Ten species of medium-sized mammals from six orders were recorded from the Forest Reserve. Species recorded included Bush buck (*Tragelaphus scriptus*), Maxwell's duiker (*Cephalophus maxwelli*), African civet (*Civettictis civetta*), Marsh mongoose (*Atilax paludinosus*), African palm civet (*Nandinia binotata*), African Brush-tailed porcupine (*Atherurus africanus*), Grass cutter (*Thryonomys swinderianus*), Togo hare (*Lepus capensis*), Tree pangolin (*Manis tricuspis*), and Mona monkey (*Cercopithecus mona*). These species are all listed in 2010 IUCN Red List of Threatened species as Least Concern. The results provide evidence of estimated population densities of medium-sized mammals in Asubima Forest Reserve. The highest estimated population density was recorded for Grass cutter (250.73 km²) and the lowest for African brush-tailed porcupine (16.67 km²). The main ecological factors influencing medium-sized mammals' distribution in Asubima Forest Reserve were found to be riverine forest, farm land, and altitude. There were significant difference ($p < 0.05$) between habitat types and number of medium-sized mammals encountered. These results can be used for further monitoring of medium-sized mammals in Asubima Forest Reserve.

2. INTRODUCTION

2.1 Background to the Study

Not much is known about the species composition, population size and densities of wildlife species in Asubima Forest Reserve in the Ashanti region of Ghana (Abeney *et al.*, 2008). Asubima Forest Reserve is among the Forest Reserves which were established by the Forestry Commission as an instrument to secure a sustainable forest estate throughout Ghana. The Forest Reserve has been classified as a degraded forest reserve by the Forestry Commission (FC), due to severe logging, extensive wildfires and illegal farming practices (Sool and Wanders, 2009).

The mammalian fauna contributes in the maintenance and regeneration of tropical forest, since they have essential functions and can be considered key-species in structuring biological communities, through predation, seed dispersion, grazing, and frugivory (Cuaron, 2000). This study provides a checklist of medium-sized mammals, estimated densities and distribution of medium-sized mammals in Asubima Forest Reserve. In this study medium-sized mammal was defined as “any mammal whose known average weight is 5kg to 45kg” (Estes, 1991; Stuart and Stuart, 2006)

According to Abeney *et al.* (2008), wildlife species in Asubima forest reserve have been severely impacted by wildfires and over-exploitation by humans. FORM Ghana Ltd. is a forest plantation management company based in Central Ghana (Kumasi) and a joint private venture between FORM International (FORM) and Wienco Ghana Ltd. From 1997, FORM Ghana started reforesting parts of the highly degraded Asubima Forest Reserve near Akumadan in Ashanti Region of Ghana. As a requirement for the implementation of the project in Ghana and in pursuance of Forest Stewardship Council™ (FSC™) certification the company conducted a Social and Environmental Impact Assessment (Abeney *et al.*, 2008). In this assessment significant work was carried out considering both social and ecological values. Amongst other conclusions the inventory shows that no intact natural forests were present at the time. FORM Ghana concluded it was necessary to manage its plantations in such a way that the restoration of the remaining natural vegetation is stimulated. In 2009, FORM Ghana received FSC™ certification intended to enhance wildlife population where and when this is possible (Sool and Wanders, 2009).

This survey provides scientific information to FORM Ghana as a prerequisite for a management plan for the protection of the mammals, conservation programmes and tourism development activities. Resource reserves like the Asubima Forest Reserve, Wildlife sanctuaries, National Parks and other types of protected areas are at the forefront of efforts to conserve biological diversity, however many protected areas are in crisis (Well *et al.*, 1992).

2.2 Objectives

The specific objectives for the study were:

- To provide a checklist of medium-sized mammals in Asubima Forest Reserve.
- To estimate population densities of medium-sized mammals in Asubima Forest Reserve.
- To determine factors which influence the distribution and abundance of medium-sized mammals in Asubima Forest Reserve.

3. MATERIALS AND METHODOLOGY

3.1 Study area

3.1.1 Location

The Asubima Forest Reserve lies within a grid reference of 7°24.812 N, 1°53.244 W near Akumadan, Ghana and with an area of 73 km² (Hawthorne and Abu-Juam 1995). It was reserved in 1945 and last logging was recorded in 1989.

The Forest Reserve is located within Offinso Forest District in the Ashanti Region. The Reserve covers a total area of 7,870 ha out of which approximately 1729.9 ha constitute the area allocated to FORM Ghana Limited for commercial plantation development. The entire Reserve is located within the dry semi-deciduous forest zone (Hall and Swaine 1981).

3.1.2 Climate

The Asubima Forest Reserve lies at the northern fringes of the semi-deciduous forest ecological zone of Ghana. The zone has a tropical monsoon climate with alternating wet and dry seasons. The long wet season starts around mid-March and ends in mid-July. It is followed by a short dry season until the end of August. From September till the end of October there is a short rainy season, followed by a long dry season from November till mid-March. Temperatures are generally high and uniform throughout the year. Mean annual temperature is about 26° C. February and March are the warmest months.

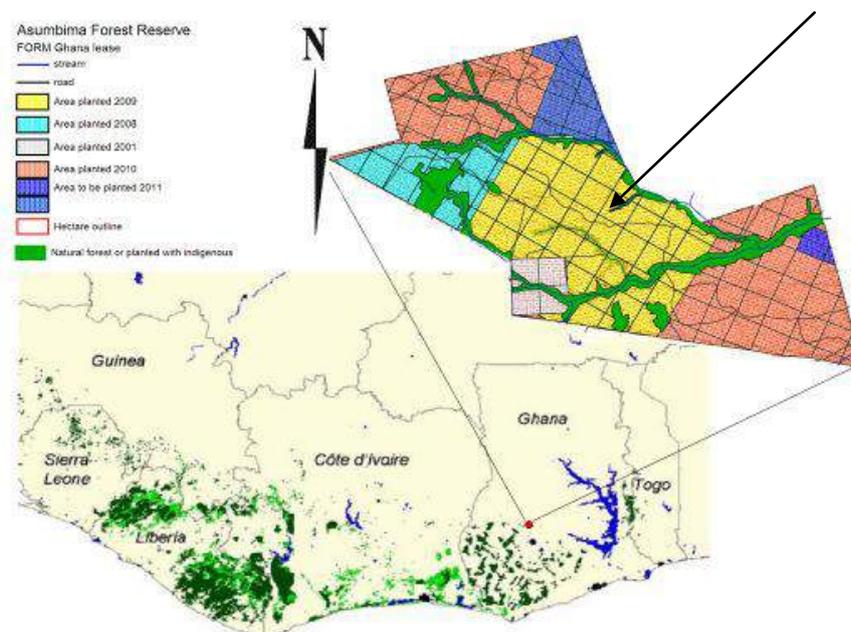


Figure 1: Asubima Forest Reserve (arrowed) is situated at the north edge of the upper Guinea forest in West Africa (Adapted from Hillers and Form International, 2008).

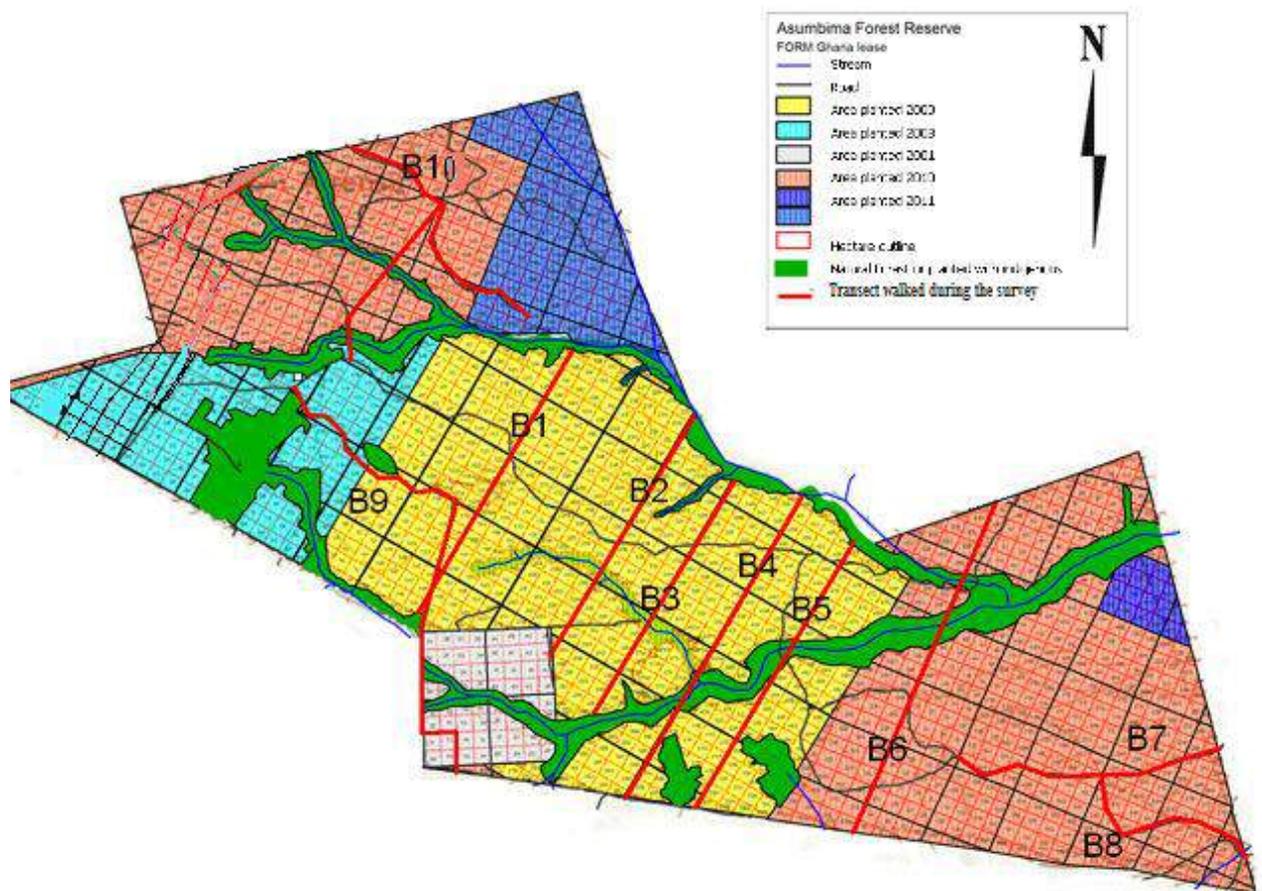


Figure 2: Map of Asubima Forest Reserve with Transects B1 – 10 walked during the survey period.

3.2 Flora and Fauna

The Asubima Forest Reserve formally was endowed with diverse plants species such as timber species, grass species and medicinal plant species. The vegetation of the reserve is mostly of the dry semi-deciduous forest type which contained valuable timber trees such as Wawa, Odum, Sapele and Kokrodua (Amponsa-kwatiah, 1993). Derived savannah conditions are observed in large areas of the reserve which have resulted from destruction by man. The savannah has virtually taken over the reserve. Due to intensive farming activities and reported annual fires very little of the original forest remains and what is left is secondary forest and with many areas of grass land. Where there is secondary vegetation especially in sparsely population climbers, shrubs and soft woody plants are mainly observed.

Birds, mammals, reptiles and some invertebrates are found in the Forest Reserve (Abeney *et al.*, 2008), but illegal logging of trees and bushfires have resulted in the decline of wildlife species in the Asubima Forest Reserve.

3.3 Socio-economic information

The population of the study area is multi-ethnic. Most of the people living within or around Asubima Forest Reserve temporarily but had their families in the town of

Akumadan and other villages are known to be farmers (Abeney *et al.*, 2008). According to Abeney *et al.*, (2008) over 50% of the village communities have migrant farmers predominantly cultivating yam and maize.

Vegetable production particularly tomatoes is very important as a source of short term cash. Also many people living in or around the study area however have other livelihood skills apart from farming skills these include; machine operation and repair, driving, carving and weaving, building construction and carpentry as well as trading and wine tapping (Abeney *et al.*, 2008).

4. METHOD

4.1 Data Collection

A reconnaissance (recce) survey was first of all conducted in the study area to have a general view of the area. Ten transects of 1km were randomly and systematically laid to cover a large proportion of Asubima Forest Reserve and traverse the five main vegetation types in the Reserve (Figure 3). Existing tracks, quadrant lines and dirt roads were used in some inaccessible areas and as much as possible when necessary, vegetations were cut through to generate a path. Direct count of signs (footprints, pellet's and feeding signs) were employed using fixed-width/strip/belt transect method (King, 1949) and the line transect method (Hayne, 1949).

During February 2011 all transects were walked (average speed 1km/h) by two trained scouts, and it was repeated for three days within the same month. Counting started at 6:30 am and was completed before 12:00 noon; same start time every day. When an animal sign was sighted movement stopped and species and geographic location were recorded. For every sighting, the location was read using a hand-held Global Positioning System (GPS). The perpendicular distance from the transect line to the sign of the animal was recorded for determining estimated densities of medium-sized mammals. Transects orientation were perpendicular to the main drainage lines of the area. Since the main river flows from west to east, transects run from south to north. Along transect lines ecological variables such as vegetation types, water bodies, and altitudes were recorded in the determination of mammal distribution. Straight line transects were maintained throughout the survey to ensure consistency in data collected. For logistical reasons, no transect counts were undertaken at night during the study.

4.2 Data Analysis

1. Literature was reviewed to gather relevant information about the species of conservation interest and their threat category.
2. Density of medium-sized mammals was calculated.
3. Software package Distance 5.0 (Thomas *et al.*, 2002) was used for the analysis of the data.
4. Regression analysis was used to determine relationship between medium-sized mammal signs and some key ecological variables recorded on transect to determine which factor influences medium-sized mammal distribution in Asubima FR.
5. In this case Stat View 5.0.1 was used.
6. Descriptive analysis was done using Microsoft Excel 2007.
7. Kruskal wallies test was used to test for significant difference between habitat types and number of individuals encountered.

5. RESULTS

5.1 Medium-sized Mammals Recorded

Ten mammal species were recorded in Asubima Forest Reserve during the study period. All species were recorded using direct count of signs and within the five habitat types in the Forest Reserve, only one kind of species Grass cutter (*Thryonomys swinderianus*) was recorded in the recent fire damaged vegetation. All the species recorded are listed as least concern (species with no current identifiable risks) in the IUCN's Red data list of threatened species (2010) in view of their distributions, presumed large population, and occurrence in a number of protected areas and tolerance of habitat modification.

Table 1: list of medium-sized mammals in Asubima Forest Reserve, including their conservation status (LC-Least Concern), and Documentation methods (FP-Footprint, FS- Feeding signs and P-Pellet)

English name	Scientific name	Local name	Threat category	Mode of observation
Order Artiodactyla				
Bush buck	<i>Tragelaphus scriptus</i>	Owansane	LC	FP
Maxwell's duiker	<i>Cephalophus maxwelli</i>	Otwe	LC	FP
Order Carnivora				
African civet	<i>Civettictis civetta</i>	Kankane	LC	FP
Marsh mongoose	<i>Atilax paludinosus</i>	Dompo	LC	FS,P
African palm civet	<i>Nandinia binotata</i>	Aberebee	LC	FP
Order Rodentia				
African Brush-tailed porcupine	<i>Atherurus africanus</i>	Apese	LC	FS
Grass cutter	<i>Thryonomys swinderianus</i>	Akrantee	LC	FP,FS
Order Lagomorpha				
Togo hare	<i>Lepus capensis</i>	Adanko	LC	FP
Order Pholidota				
Tree pangolin	<i>Manis tricuspis</i>	Aprawa	LC	FS
Order Primate				
Mona monkey	<i>Cercopithecus mona</i>	Okwakuo	LC	FS

5.2 Species Abundance

The number of signs varied among species with the highest recorded for Grass cutter (26) and lowest African Brush-tailed porcupine (1) (Table 3). Grass cutter was also the most medium-sized mammal (2.6 km⁻¹) encountered in the Forest Reserve and African Brush-tailed porcupine (0.1 km⁻¹) was the least encountered among all the medium-sized mammals. There were significant differences (p<0.05) between medium-sized mammals which were encountered (Table 3).

Medium-sized mammal varied in density between individual species with the highest estimated density (250.73 km²) recorded for Grass cutter (*Thryonomys swinderianus*), followed by Togo hare (*Iepus capensis*) (159.26 km²) and lowest African Brush-tailed porcupine (*Atherurus africanus*) (16.67 km²) (Table 4.2). 95% Confidence Interval (CI) indicates that the actual population density lies within the lower and upper CI limits and also shows the reliability of the medium-sized mammal population estimates. Coefficient of variation indicates how precise the estimated densities of the medium-sized mammals to their population densities.

Table 2: Summary of estimates number of sign, encountered rates, and densities of various medium-sized mammal species in Asubima FR. Sample size is 10 transects.

Medium-sized mammal	Number of signs	Encounter rate (km ⁻¹)	Density estimates(km ²)	95% Confidence Interval (CI)	CV (%)
African Brush-tailed porcupine	1	0.1	16.67	(3.04-91.49)	1.00
Mona monkey	2	0.2	22.22	(4.048-121.98)	1.00
Marsh mongoose	3	0.3	25.00	(6.52-95.87)	0.74
African palm civet	4	0.4	33.33	(10.82-102.69)	0.60
Bush buck	4	0.4	44.44	(14.43-136.92)	0.60
Tree pangolin	5	0.5	41.67	(9.64-180.09)	0.82
Maxwell's duiker	6	0.6	50.01	(15.19-164.60)	0.64
Africa civet	11	1.1	78.70	(15.86-390.60)	0.92
Togo hare	19	1.9	159.26	(48.38-524.21)	0.64
Grass cutter	26	2.6	250.73	(116.17-541.13)	0.40

Means with the same letters in a column are not significantly different (p<0.05)

5.3 Distribution According to Habitat Types

Medium-sized mammal signs varied in sign numbers among the various habitat types. The highest number of signs observed was recorded for fallow land. But almost all medium-sized mammal signs observed were recorded in and around the riverine forest during the study (Figure 3). Only one medium-sized mammal (Grass cutter) was recorded around fire damaged vegetation. There were significant

differences ($p < 0.05$) between the various habitats type, meaning medium-sized mammal varied significantly in various habitat (Figure 4).

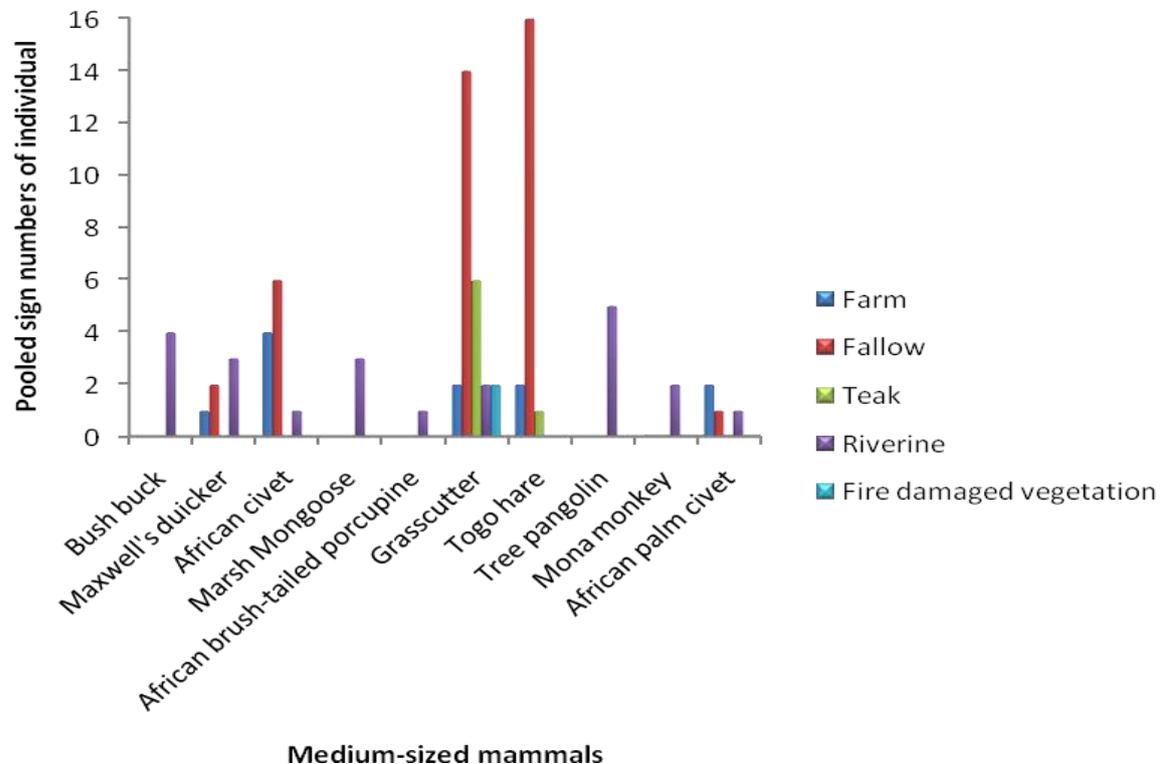


Figure 3: Medium-sized mammal and the number of pooled sign observed within each habitat types.

5.4 Ecological Factors Influencing Distribution of Medium-sized Mammals

Riverine forest, farmland, altitude, teak plantation, fallow land, recent fire damaged vegetation and the number of water bodies (Table 4.3) are the ecological variables recorded during the study period which influence medium-sized mammals distribution in Asubima Forest Reserve.

The ecological variable that greatly influenced medium-sized mammal distribution was riverine forest with a correlation coefficient of ($r^2 = 0.992$) when expressed as polynomial (Figure 4a). Farmland emerged as the second most important key ecological variable that influenced medium-sized distribution in the reserve with a correlation coefficient of ($r^2 = 0.999$), again in polynomial (Figure 4b). The third most important key ecological variable was altitude with correlation coefficient of ($r^2 = -0.686$), which influenced the distribution of medium-sized mammal negatively. Once again the relationship was polynomial (Figure 4c). As one moves from the edge to the center in the riverine forest and farm land more medium-sized mammal signs are encountered, during the survey period (Figure 4a-b). Also as altitude increased less medium-sized mammal signs are encountered (Figure 4c)

Table 3: Correlation coefficients (r) between mammalian sign per km and key ecological variables recorded on transect. Number of transect lines =10.

Ecological Variables	Bush buck	Maxwell, duiker	Africa n civet	Marsh mongoose	A. brush-tailed porcupine	Grass cutter	Togo hare	Tree pangolin	Mona monkey	African palm civet
Farmland	0.602	0.365	0.846	0.602	-0.191	0.155	0.052	-0.191	-0.191	0.860
Fallow land	-0.271	-0.021	-0.136	-0.271	0.293	0.038	0.262	0.293	0.293	-0.177
Teak plantation	-0.404	-0.424	-0.239	-0.404	-0.216	0.145	-0.029	-0.216	-0.216	-0.216
Riverine forest	0.891	0.848	0.515	0.891	0.100	0.047	-0.117	0.100	0.100	0.522
Recent fire damaged vegetation	-0.156	-0.218	-0.123	-0.156	-0.111	-0.306	-0.194	-0.111	-0.111	-0.111
Altitude	-0.427	-0.728	0.291	-0.427	-0.544	0.357	-0.307	-0.544	-0.544	0.305
Number of water seen on the transects	0.000	0.000	0.000	0.000	0.000	-0.091	0.000	0.000	0.000	0.000

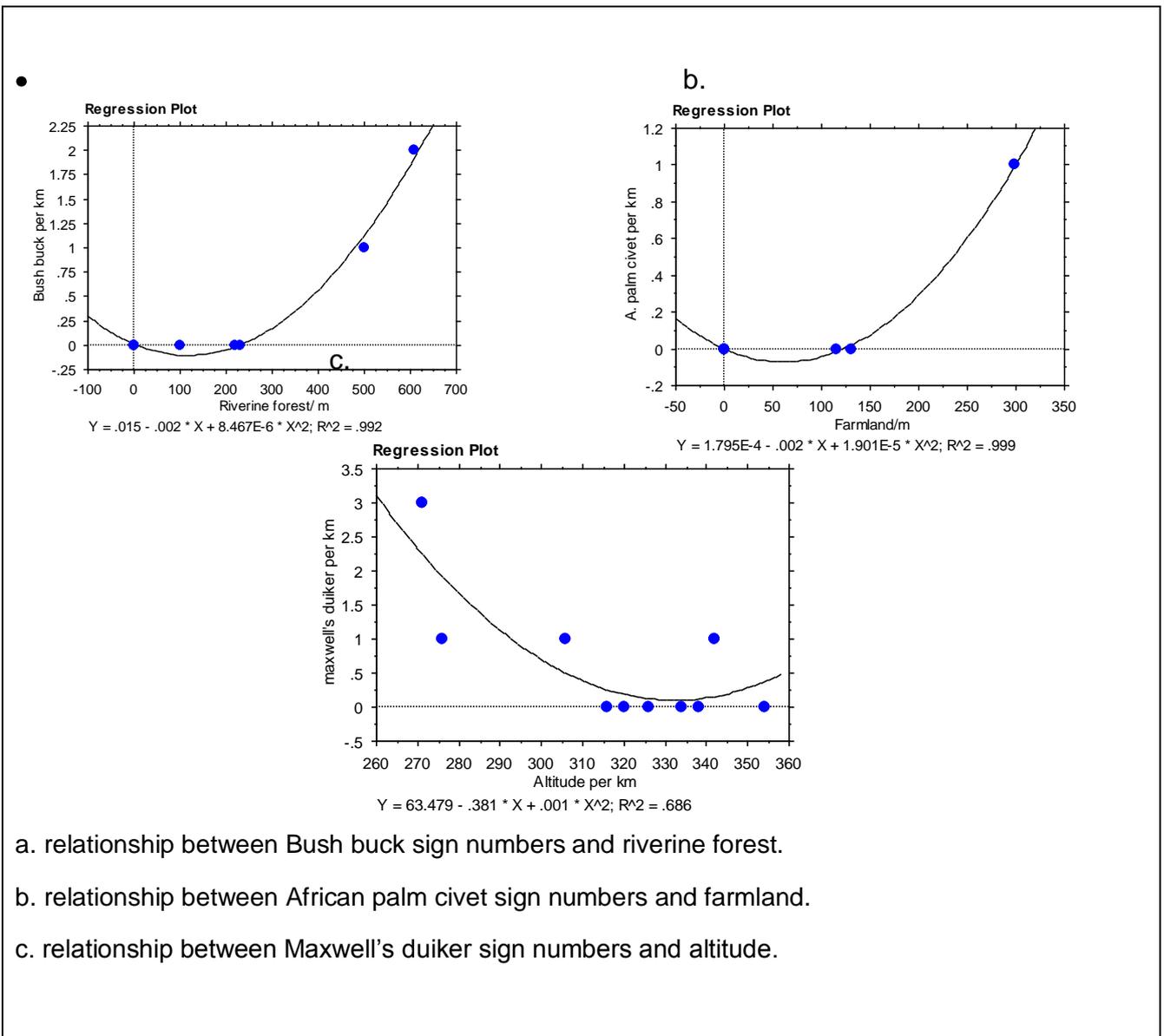


Figure 4: Relationship between some medium-sized mammals and some key ecological variables.

6. DISCUSSION

6.1 Checklist of Species

The study provided a list of medium-sized mammals in Asubima Forest Reserve. From the result, two ungulate species (Bush buck and Maxwell's duiker), three carnivorous species (Marsh mongoose, African civet and African palm civet), two rodentia species (Grass cutter and African brush-tailed porcupine), one lagomorph species (Togo hare), one pholidota species (Tree pangolin) and one species of primate (Mona monkey) (Table 4.1) were all observed during the study period in Asubima Forest Reserve. In all a total of 10 species of medium-sized mammals were observed in the Forest Reserve and all species were without any current identifiable risks (Least Concern) (IUCN, 2010).

6.2 Abundance of Medium-sized Mammals

The study provides evidence on medium-sized mammal estimated population in Asubima Forest Reserve. The results indicated that some of the medium-sized mammals have low numbers (Table 3), due to illegal logging and bushfires (Abeney *et al.*, 2008) which went on in the reserve for some time. Despite the low medium-sized mammal densities in the reserve, densities of Grass cutter (250.73 km²) and Togo hare (159.26 km²) were high in the Forest Reserve. Also densities of Mona monkey (22.22 km²), African Brush-tail porcupine (16.67 km²) and Marsh mongoose (25.00 km²) were low in the study area as compared to the other medium-sized mammals. The low densities of medium-sized mammals in Asubima Forest Reserve was attributed to several factors that are known to limit mammal densities such as destruction of habitat, rainfall amounts and patterns (Coe *et al.*, 1975; Abeney *et al.*, 2008). No evidence of poaching or any illegal activities were recorded in the Forest Reserve during the survey period.

6.3 Distribution of Medium-sized Mammal

During the survey period, five habitat types of medium-sized mammal community were described in Asubima Forest Reserve. Medium-sized mammals were observed in all habitat types (Figure 3.1) during the study. Riverine forest, farmland, and altitude (ecological variable recorded along transects) had significant influence on medium-sized mammal distributions in the Forest Reserve (Figure 3). Fallow land, teak plantation, recent fire damage vegetation and number of water bodies have shown to have limited significant influence on medium-sized mammal distribution (Table 3).

The results also indicated that medium-sized mammal shows high preference for riverine forest and farm land than the rest of the habitat types. This high preference is attributed to the security, shelter and shade that mammal derived from riverine forest and also food source on farmland (Evans, 1974). Grass cutter and Togo hare were the medium-sized mammal that were most observed in fallow land. Grass cutter was the only medium-sized mammal that was observed in all habitat types (Figure 3) during the study period. The frequencies of species presence in various habitat type or selection of habitat by species are a reflection of many variables including, food sources, cover, social interaction, and seasonal variation in ranging patterns (Mduma and Sinclair, 1994; Lahm *et al.*, 2002).

Also altitude has negatively affected medium-sized mammal distribution in Asubima forest reserve (Figure 4). The altitudinal variations within a particular area produce a range of climate, which affect every aspect of life in that area; plant and animal distribution (Yalden and Largen, 1992). During the study, at high altitude less medium-sized mammals were recorded and at low altitude more medium-sized mammals were recorded, due to the undulating nature of the Forest Reserve topography (Figure 4c).

7. CONCLUSION AND RECOMMENDATION

7.1 Conclusions

The results of the study indicated Grass cutter (*Thryonomys swinderianus*) and Togo hare (*Lepus capensis*) are most abundant and widespread medium-sized mammals in Asubima Forest Reserve. This survey provides a checklist and estimated population densities of medium-sized mammals in Asubima Forest Reserve. Factors affecting medium-sized mammal distribution in the Forest Reserve were also determined.

7.2 Recommendations

Future surveys on medium-sized mammal in Asubima Forest Reserve, should extend survey period and number of transect lines to cover wider areas in the Forest Reserve. Indigenous plant species such as Odum, Wawa and Sapele recommended by Amposa-Kwatiah (1993) should be planted to help restore the Forest Reserve, which has been seriously degraded by illegal logging activities and bush fires (Abeney *et al.*, 2008). Also preventive measures and enforcement of law and regulations on illegal logging and wildfire in Asubima Forest Reserve should be implemented, to help maintain the Forest Reserve. Hunting must be prevented for a while to improve the population size of medium—sized mammals in Asubima Forest Reserve.

8. REFERENCES

Abeney, E.A., Oduro, W., Nutakor, E., G. Owusu Boateng, (2008). Social and Environmental Impact Assessment of the FORM Agroforestry Project in Asubima Forest Reserve, Ghana.

Amponsah-Kwatiah, (1993): The Effects Of Changes In Rural Land Use Pattern On Agricultural Development I Rural Ghana. A Case Study of Offinso District: Student Dissertation, KNUST Faculty of Social Sciences, Department of Land Economy and Estate Management.

Boerner J. E. R., (1983): Nutrient Dynamics of Vegetation and Detritus following Two Intensities of fire in the New Jersey. *Oecologia* 59(1): 129-134.

Chiarello, A.G. (1999). Effects of fragmentation of the Atlantic forest on mammals communities in the south-eastern brazil. *biol. conserv.* 89:71-82.

Chiarello A. C., (2000). Density and population size of mammals in Remnants of Brazilian Atlantic forest, *Journal of conservation Biology.* Vol. 14, 6: 1644-1657.

Coe, M.J., D.H. Cumming & J. Phillipson,. (1975). Biomass and production of large African herbivores in relation to rainfall and primary production. *Oecologia* 22: 341–254.

Corbet, G.B. & Hill, J.E. (1991). A World List of Mammalian Species, Third edition. Natural History Museum Publications & Oxford University Press, London and Oxford.: v-viii, 1-243.

Cuaron, A.D, (2000). A global perspective on habitat disturbance and tropical rain forest mammals. *Conservation Biology.* 14 (6): 1574-1579.

Estes, D. R., (1991). The behavior Guide to African Mammals: Including hoofed mammals, carnivores and primates. London, England, University of California press, Ltd.

Evans, H. C. (1974) Natural control of arthropods with special reference to ants (Formicidae) by fungi in the tropical high forest of Ghana, *J. Appl. Ecol.* 11:37-49.

Flematti, Gavin R.; Ghisalberti, Emilio L.; Dixon, Kingsley W.; Trengove, R. D. (2004). A Compound from Smoke That Promotes Seed Germination

Gehring, T.M. & Swihart, R.K,. (2003). Body size, niche breadth, and ecologically scaled responses to habitat fragmentation: mammalian predators in an agricultural landscape. *Biol. Conserv.* 109:283-295.

Hall J.B. & Swaine, M.D. (1981) Geobotany: Distribution and ecology of vascular plants in a tropical forest of Ghana. Dr W Junk publishers, The Hague

Hawthorne, W.D. and Abu-Juam, M., (1995). Forest Protection in Ghana. A paper prepared under an assignment from the Ghana Government, the IUCN and the ODA (now DFID).

Hayne, D.W. (1949). An examination of the strip census method for estimating animal abundance. Journal of Wildlife. Management. 13:145-157.

Hillers, A., B. Zimkus and M.-O. Rödel (2008): A new species of Phrynobatrachus (Amphibia: Anura Phrynobatrachidae) from northwestern Guinea, West Africa. Zootaxa 1815:43-50.

International Forest Fire News (1996). Ghana: Bushfires in Ghana 15: 24-29.

Lahm, A. S. and Tezi, J. P., (2002). Assessment of the communities of medium-sized and large Arboreal and Terrestrial Mammals in the Rabi-Toucan Region of the Ngove-Ndogo Hunting Domain and Southwestern Loango National Park. Bulletin of the Biological Society of Washington, 12: 383-416.

Laurance, W.F. (1994). Rainforest fragmentation and the structure of small mammal communities in tropical Queensland. Biol. Conserv. 69:23-32.

Lobert, J. M.; Warnatz, J. (1993). Crutzen, P. J.; Goldammer, J. G.. eds. Emissions from the combustion process in vegetation. Wiley.

Madu A.(2007), The environmental impacts of regional disparity in population and wealth distribution in Nigeria: Journal of Environment Development and Sustainability (EDS).

Mduma, S.A.R. & Sinclair, A.R.E., (1994). The function of habitat selection by oribi in Serengeti, Tanzania. African Journal of Ecology, 32, 16-29.

Oehler, J.D & Litvaitis, J.A. (1996). The role of spatial scale in understanding responses of medium-sized carnivores to forest fragmentation. Can. J. Zool. 74:2070-2079.

Sool R. and Wanders T, (2009). Management plan Asubima Forest Reserve Public version, FORM Ghana

Stuart, C.T and M.D Stuart, (2006). Field Guide to the large Mammals of Africa. Struik publishers, Cape Town.

Sutherland, W. J. (1996) Ecological Census Techniques: A Handbook, Cambridge University Press.

Thomas L, Laake L. J, Strindberg S, Marques C. F. F and Bishop B. R. J. C., (2002). Distance 5.0 Beta 4. Research Unit for Wildlife Population Assessment University of St Andrews.

Turner, D.C (1975). The vampire Bat. Tohwtopkins press, Baltiauore, Maryland.

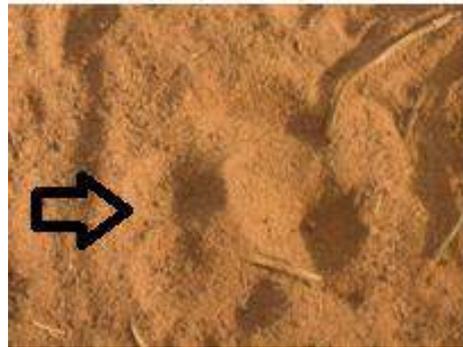
Well M., Brandon K., and Leett., (1992). People and parks linking protected Area management with local people. The World Bank. The world Wildlife Fund U.S Agency for International Development Washington, DC.

Yalden, D.W., Largen, M.J. and Kock, D. (1976b). Catalogue of the mammals of Ethiopia. Primate. Monit. Zool. It. (NS) Suppl. 9:1-52.

9. APPENDIX A: LIST OF PLATES



1. Arrow showing Footprint of Maxwell's duiker



2. Arrow showing African Civet footprint



3. Arrow showing Togo hare's footprint



4. Arrow showing Marsh Mongoose's pellet



5. Arrow showing Grass cutter's footprints



6. Riverine Forest



7. Teak plantation



8. Fallow land

10. APPENDIX B: LIST OF MEDIUM-SIZED MAMMAL AND THE NUMBER OF SIGNS OBSERVED WITHIN EACH HABITAT TYPE.

MEDIUM-SIZED MAMMAL	HABITAT TYPES AND NUMBER OF SPECIES FOUND IN EACH				
	Farm	Fallow	Teak	Riverine	Recent fire damage
1. Bush buck	0	0	0	4	0
2. Maxwell's duiker	1	2	0	3	0
3. Africa civet	4	6	0	1	0
4. Marsh mongoose	0	0	0	3	0
5. African Brush-tailed porcupine	0	0	0	1	0
6. Grass cutter	2	14	6	2	2
7. Togo hare	2	16	1	0	0
8. Tree pangolin	0	0	0	5	0
9. Mona monkey	0	0	0	2	0
10. Africa palm civet	2	1	0	1	0

11. APPENDIX C: TRANSECTS AND NUMBER OF SIGNS RECORDED ALONG EACH.

Transects	Number of medium-sized mammal signs observed.
1	22
2	10
3	10
4	3
5	4
6	2
7	7
8	18
9	3
10	2

