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The Impact of Spatial Distribution of Vegetation on The Behavioral Ecology of Waterbuck Antelope (Kobus ellipsiprymnus defassa) in Bouba-njidda National Park, Northern Region, Cameroon

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Abstract
In most terrestrial ecosystems a diverse assemblage of herbivores, such as antelopes has been maintained over time. Resource partitioning is the mechanism that facilitates the coexistence of species in a habitat, where resources may be selected to meet their requirements. In Cameroon, natural landscapes are dominated by diverse land-use and land-cover that constitute heterogeneous habitats for flora and fauna communities. Hence, the acquisition of nutrition and avoidance of predators are the main factors that contribute to the survival of antelope species. The major aim of this survey was to investigate the waterbuck behavioral activity on vegetation type and landscape condition. The research data collection was done by visiting and monitoring waterbuck herds in different vegetation types within a period of four months. Observations were made on antelope aggregation size, behavioral activity, vegetation cover, and weather condition. The study revealed a significance between the waterbuck-aggregation size and vegetation cover, $X^2 = 6.89$, df = 10, $P<0.05$. The waterbuck population in Bouba-njidda national park congregates and dwells most in grassland areas (54%) than forest patches (3%) and shrubland respectively (9%). Different vegetation and weather condition revealed a significant correlation as well, $r = 0.235$, $P<0.05$. A flat landscape (71%) was most preferred for activity by the waterbuck compared to slopes (23%) and hills (3%) respectively. More so, aggregation/herd size and behavioral activity revealed a significance, $X^2 = 9.81$, df=20, $P<0.05$.The study showed a dominant antelope movement (45%), followed by rest (26%), and then feeding (20%) respectively. Different vegetation conditions also showed a significance on behavioral activity in the survey, $X^2 = 10.17$, df=8, $P<0.05$. Vegetation has been among the major factors determining wildlife activities in many ecological regions especially on herbivorous species such as the waterbuck antelopes that are predominantly grazers. Additionally, landscape type recorded a correlation on antelope activity $r = 0.418$, $P=0.048$. Waterbuck have been hunted in most of their ranges in Cameroon and are thought to be declining at a slow but significant rate, hence, there is need for a new management plan to enhance conservation.
Keywords: Waterbuck, Vegetation, Weather, Antelope activity, and Herbivorous species
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INTRODUCTION

The diversity and distribution of species has captured the attention of researchers for centuries. That species have evolved, and thrive, within a distinct range of environmental conditions continues to stimulate avenues for research. Species distribution models (SDMs) are empirical models that correlate environmental predictors with species observations in the field (Guisan & Thuiller, 2005), and are now commonly used in this field of research. The waterbuck (*Kobus ellipsiprymnus*) remains widespread across western, central, eastern and southern Africa, and occupies a range of habitats such as grassy savannah plains, and open woodland near permanent water bodies (Nowak 1991). Waterbuck are also an important game species (Cloete et al. 2007) but they are often poached. According to the IUCN Red List (IUCN 2020), the abundance of the species is suspected to be declining, but there is no evidence to confirm that the rate of decline meets the requirements for Near Threatened or Vulnerable status.

In most terrestrial ecosystems a diverse assemblage of herbivores has been maintained over time (du Toit & Cumming, 1999). Ecologists have investigated how these assemblages are maintained, considering the stable, coexistence of a large biomass of herbivores (Putman, 1996). The acquisition of nutrition and avoidance of predators are the main factors that contribute to the survival of animals (Orians, 2000). Habitat selection may be influenced by vegetation type, water availability or substrate on a macro-scale; where the presence, absence or abundance of potential forage species will affect herbivore habitat selection at the landscape level (Druce, 2005). In order to successfully manage habitats to support wildlife populations, an understanding of the species' ecological requirements needs to be established (Traill, 2004). Ecologists frequently conduct

studies to assess habitat use from which they may deduce a species habitat selection and preference (Garshelis, 2000; Kaunda et al., 2002). Previous studies have shown that, within a number of species, individuals will choose which habitat to occupy and that there is an increase in the range of habitats used with an increase in population density (Kaunda et al. 2002). This phenomenon is called density-dependent habitat selection (Kaunda et al., 2002) and could potentially have a strong effect on population dynamics and social organization, predominantly the distinctive distribution of males and females in space and time (Kaunda et al., 2002).

Resource partitioning is the mechanism that facilitates the coexistence of species in a habitat, where resources may be selected to meet their requirements (McNaughton & Georgiadis, 1986). Studies are also conducted to determine the carrying capacity of the area, which is the number of animals, taking into account their habitat requirements that an area can support without having a detrimental effect on the environment (Traill, 2003). By having a better understanding of the habitat requirements and behaviour of herbivores, wildlife managers may predict the distribution of herbivores (Dörgeloh, 2001) and their consequent effect on vegetation (van Aarde, Jackson & Ferreira, 2006). Globally, Waterbuck have been eliminated throughout much of their range from hunting, and are thought to be declining at a slow but significant rate (IUCN SSC Antelope Specialist Group 2016). There are local declines with drought impacts, which result in a change in habitat quality and forage availability and may be exacerbated by climate change in the future. Waterbuck are susceptible to poaching due to their sedentary nature and association with agricultural lands and several population declines, some of them severe, have been documented in other parts of its range (IUCN SSC Antelope Specialist Group 2016). Within the assessment region, bush-meat hunting, often with domestic dogs (*Canis familiaris*), along protected area boundaries may also cause local declines.

In Cameroon, natural landscapes are dominated by diverse land-use and land-cover that constitute heterogeneous habitats for flora and fauna communities. Landscapes on the country are experiencing alterations from extensive logging, agriculture and other human manipulations (Mertens et al. 2001, Mertens et al. 2000, MINEF and UNEP 1997) that has actually changed the physiognomy of once vast landscape and are responsible for declines and changes in species composition. In the northern part of Cameroon for instance, vast lands within and outside protected areas are often exposed to wild and sometimes controlled fires that have left the savanna landscape in this part of the country fragmented (Klop and van-Goethem 2008).

The term `habitat‟, refers to an ecological area or environment where plants, animals and other organisms live (Tagliapietra and Segovia 2010). Habitat as defined by Tews et al (2004) is a vegetation formation. Various vegetation formations occur around the globe and even within small areas resulting to heterogeneity in landscapes. The heterogeneity of a landscape is viewed as an environmental mosaic or the horizontal arrangement of diverse vegetation formations in space within a landscape (Forman and Godron 1986). Complex interactions among many factors including human activities and natural processes (e.g. climatic variation and variation in landscape topography) are responsible for heterogeneity of landscape at different scales (Colligne 2010). Human presence as indicated by their activities on natural landscape (managed and unmanaged) has been largely acknowledged as the major source of habitat alteration and spatial heterogeneity (Walker 2012). Among the multiple natural factors causing heterogeneity, habitat disturbance from natural factors such as floods, fire, wind storms and droughts are central, for the reason that they can cause devastation of flora and fauna and can leave legacies that may persist for a very long time depending on their intensities and spatial scale (Pickett 1985).

MATERIALS AND METHODS

Description of the Study Area

Bouba ndjidda national park is located in the northern region of Cameroon near the Chadian border, between latitude 8°37′ and 8°37′ N and longitude 14°39′ and 14°39′ E. It covers an area of 220,000 ha. (Klop et al, 2007), and its biophysical environment is described by its characteristic climate, relief, vegetation types and hydrology. Annual rainfall in the park ranged from 1500 mm to 1600 mm (COTCO 2011, GVC 2007). The park area features a typical equatorial and humid climate (Fotso et al. 2002) defined by the rainfall regime in this area. Seasonal pattern in the park area is characterized by distinct but unequal dry and wet season periods. Heavy wet season starts from August to November, a light wet season from April to June, a long dry season from December to March and a short dry season from July to mid-August. With a mean annual temperature of 23°C, annual minimum and maximum temperatures within the park area ranged from 15°C and 31°C (COTCO 2011, Fotso et al. 2002).

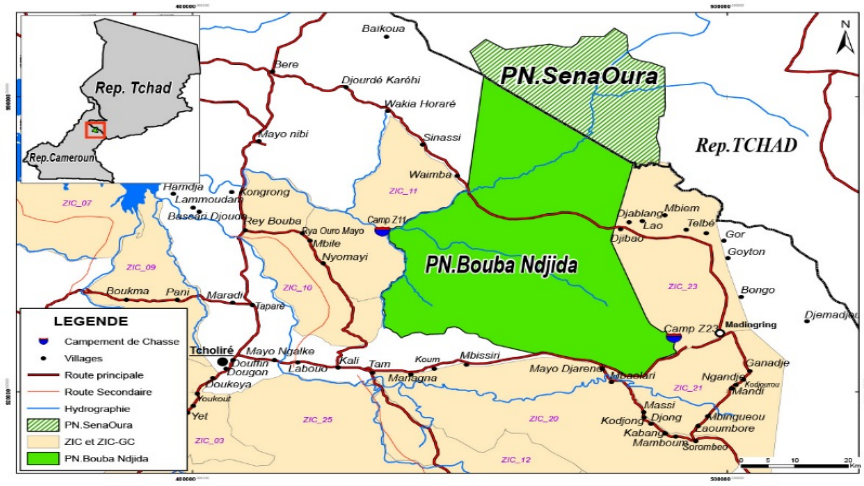

Figure 1: map of Bouba ndjidda National Park (Klop et al, 2007)

Data Collection Method

Data collection was during the monitoring of different waterbuck herds in the study area. Frequent random visits were programed such that a single animal herd was monitored for the day and behavioral activities observed were recorded alongside the vegetation type and weather. The aim of this was to understand the impact of landscape vegetation on the grouping activities of the antelopes. The feeding of herbivorous wildlife is strongly linked to vegetation types rich in food nutrient resources for animal survival. Most often herbivores spent more time dwelling in food-rich vegetation compared to others. Movement of the research team during data collection process was facilitated by the woodland ecological characteristic that is never dense in most areas. Visibility was also facilitated by the dry season, a period which the study was carried out.

Ad libitum sampling is probably the most widely used method of recording behavior in field studies. Observers typically record as much information as possible in the form of field notes, which could result in the observer making unconscious sampling decisions (Altman, 1974). Often this widely used technique is the one that is infrequently described in sampling methods. For *ad libitum* sampling, two assumptions are commonly made. These are: (i) that the probability of a behavior being observed and recorded does not depend on the class of behavior, so one behavior will not significantly attract more attention than another, relative to the frequency of occurrence of each behavior; (ii) behavior does not depend on the age or the gender of individuals, thus behavior may be juxtaposed across age and sex classes. *Ad libitum* sampling is often used in the primary quantification in field studies. It is uncommon and challenging to determine genuine differences between individuals, age-sex classes or behaviors when sampling *ad libitum*. Additionally, it is difficult to obtain all information on social behavior even when employing the focal-animal technique where observers concentrate on an individual and their interactions as well as non-social behavior (Altmann, 1974).

Data Analysis

Behavioral observations collected/recorded *ab libitum*, were sorted to determine the occurrence of various activities using the one-zero sampling principle (Olson, 1929; Altman, 1974) where the presence of a behavior is recorded as a one and absence as a zero. Additionally, landscape vegetation cover and weather condition were tested against each other, together with the antelope behavioral activity by using Ch-square(X^2) and correlation(r) statistical models. The degree of association/relationship of the variables were obtained through the inferential analysis.

RESULTS

This study revealed a significance between the waterbuck-aggregation size and vegetation cover, $X^2 = 6.89$, df = 10, $P<0.05$ (fig.1). Aggregation in wildlife, especially antelopes such as waterbuck (*Kobus ellipsiprymnus defassa*) is a common social characteristics which helps the animals to have adherence to each other. Location of healthy feeding sights, relocation to different areas, and defense against predators in the home range of wildlife is a group function. The highest aggregation observed was 1-5 animals (5%), while 26-0 animal recorded the least observation (3%) (fig.2). The waterbuck population in Bouba-njidda national park aggregates and dwells most in grassland areas (54%) than forest patches (3%) and shrubland (9%) respectively (fig.3). The national

park landscape is dominated by grassland vegetation, an ecological condition favorable to the feeding of antelopes especially waterbucks.

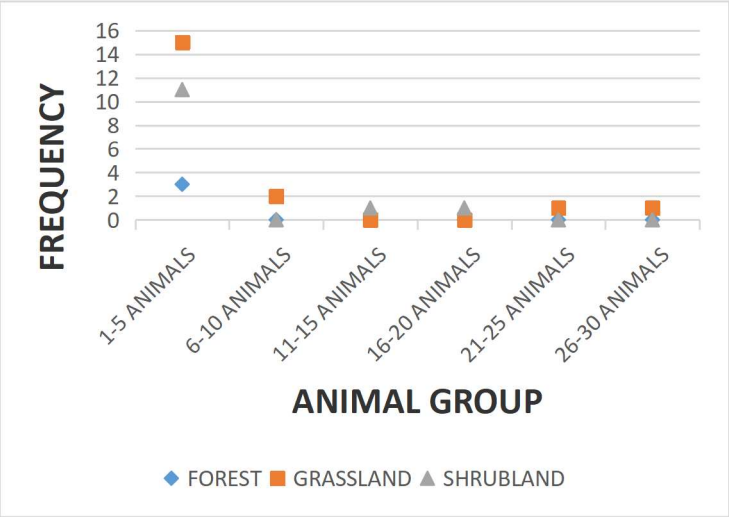

Fig.1: Waterbuck-aggregation size and landscape

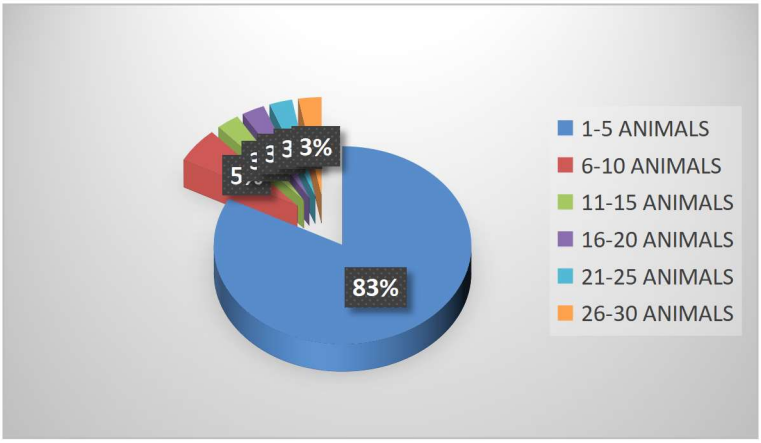

Fig.2: Aggregation size

The woodland savanna ecosystem of the national park comprises of three vegetation types, grassland, shrub-land and forest patches niching many species of bovid which depend mostly on the grasses for feeding. The high population of antelopes in this eco-zone might be due to this healthy grassland vegetation rich in nutrient resources.

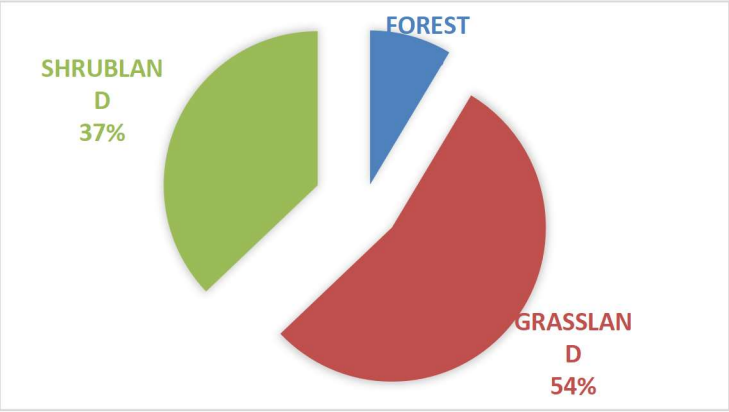

Fig.3: Vegetation condition

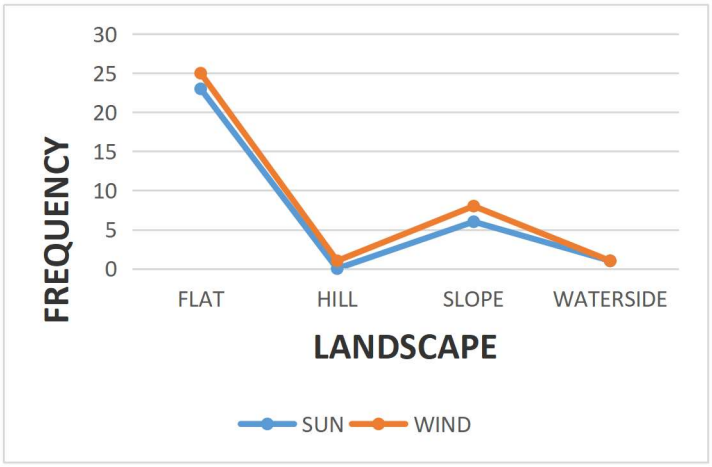

Fig.4. Landscape and weather

Landscape and weather condition have shown a significant correlation r = 0.235, P<0.05 (fig.4). The Sahel savanna ecosystem of sub Saharan African continent is dominantly characterized by a rocky flat landscape, poor in soil fertility but rich in grass species, establishing a vegetation cover that plays a key role in wildlife-feeding. A flat landscape (71%) preference by the waterbuck compared to sloppy (23%) and hilly (3%) respectively might enable the antelopes to sight predators at distances for their escape (fig.5). Secondly, a flat landscape facilitates the movement and feeding of antelopes in protected areas like national parks.

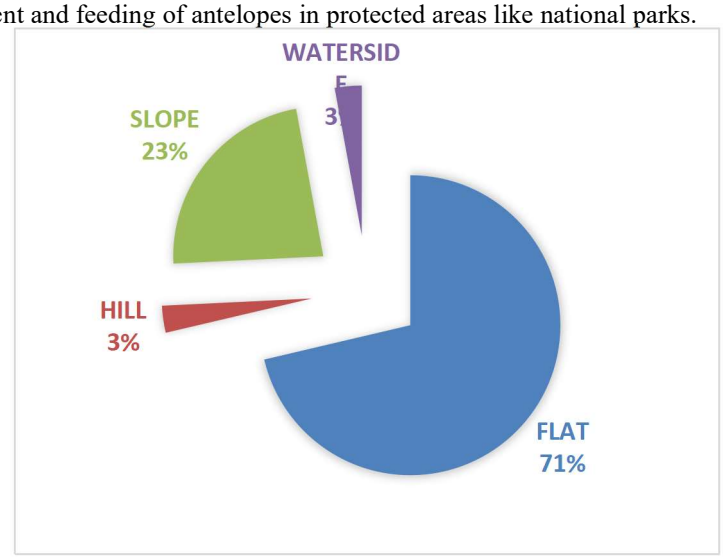

Fig.5: Landscape condition

Aggregation size and activity revealed a significance X^2 = 9.81, df=20, P<0.05 (fig.6). Wildlife activity, very much depend on healthy feeding sights, the reason they tend to cover long distances looking for healthy feeding areas. However, the absence of food resources in the home range of waterbuck can trigger fragmentation of larger aggregation or herds into smaller sizes that could be sustained by smaller vegetation patches available especially in the dry season. Since this study was carried out in the dry season, the animal movement behavior was dominant (45%) followed by rest (26%) and then feeding (20%) respectively (fig. 7). Play (3%) was the least observed activity in the animal aggregation, however, much time given to movement for food location during this season might be the key reason.

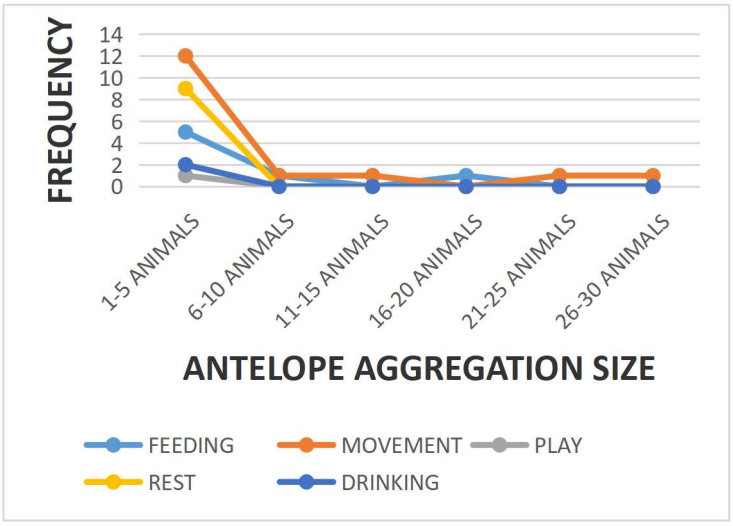

Fig.6: Antelope Behavioral activity and aggregation size

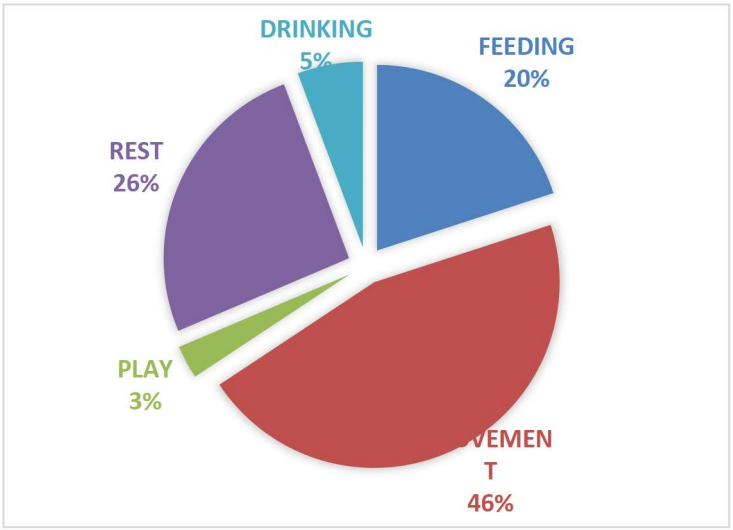

Fig.7: Animal behavioral activity

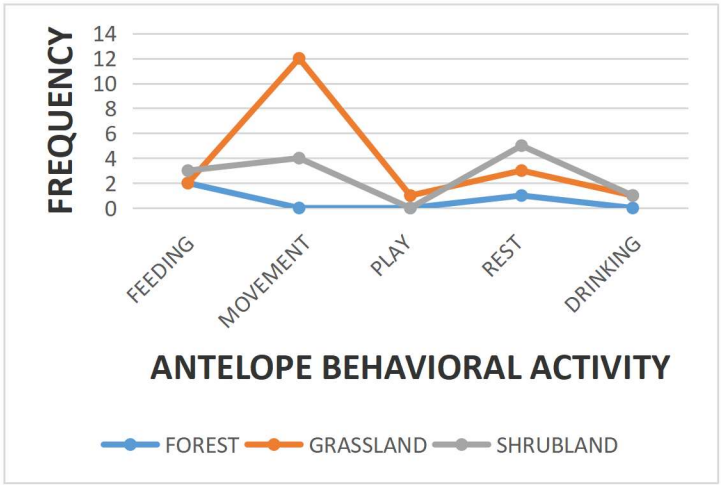

Fig. 8: Antelope behavioral activity and vegetation cover

Vegetation type also showed a significance on aggregation activity in this survey, $X^2 = 10.17$, df=8, $P<0.05$ (fig.8). Vegetation has been among the major factors determining wildlife behavioral activity in many ecological regions especially for herbivorous species such as the waterbuck antelopes that are predominantly grazers. Moreover, vegetation recorded a correlation on animal activity $r = 0.418$, $P=0.048$ (fig.9).

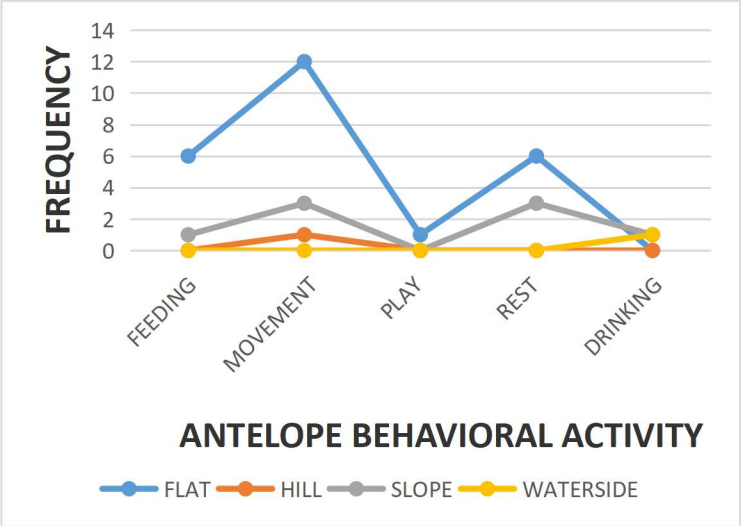

Fig.9: Landscape and antelope behavior

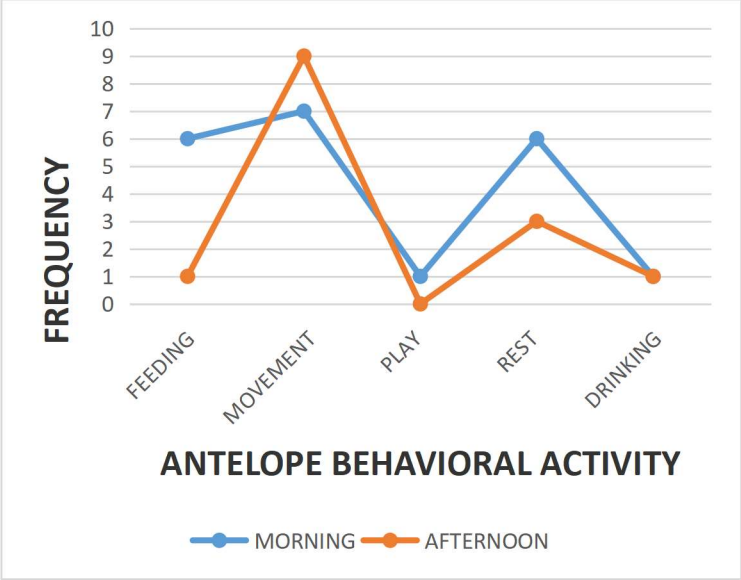

Fig. 10: Photo-period and antelope behavioral activity

The photo-period witnessed a weak significance on animal behavioral activity, $X^2 = 4.61$, df=4, $P<0.05$ (fig.10). The day-period is a major determinant to ecological and social activities of antelopes in the wild. This study observed the animals more active during the morning period of the day while the afternoon and evening periods witnessed a slowdown of activities probably due to a relative increase in environmental temperature.

DISCUSSION

The coexistence of woody plants and grasses is an important characteristic feature of savanna ecosystems. In moist savannas with a mean annual rainfall greater than 650mm the coexistence of grasses and woody cover is maintained by disturbances such as fire and herbivory (Sankaran et al. 2005). Savannas support a high diversity and biomass of ungulate herbivores (hoofed mammals), which may consume up to 65 % of the net foliage production. Ungulate herbivores are often classified into "grazers" that eat primarily grasses and sedges, and "browsers" that prefer forbs, leaves of woody plants and fruit. These herbivores have a large impact on the savanna vegetation by altering and maintaining ecosystem properties such as productivity, nutrient cycling and plant species composition (Anderson et al. 2006). There are a great variety of ungulate herbivores with diverse feeding strategies that may have different impacts on the savanna vegetation and other ecosystem properties. In order to assess this impact it is important to study the feeding behaviour of different herbivores in various savanna ecosystems. Such feeding studies are necessary, for instance, to enable estimates of the carrying capacities for these systems (Bodenstein et al. 2000). Knowledge on the feeding behaviour is limited for many herbivore species, and most information on plant-herbivore interactions in savanna ecosystems was obtained in semi-arid regions. These interactions may be different in moist savannas where rainfall and water availability are

not the only factors maintaining ecosystem characteristics (Sankaran et al. 2005).

The selection and use of habitat by individual animal species in a heterogeneous landscape is influenced by several interacting factors including the provision of adequate habitat requirement such as shelter, cover, nesting site, and foraging grounds (Kruasman 1999), and the special social systems, and dispersal patterns of animals . Altering landscapes and habitats therefore may influence the persistence of species in a given habitat and may affect the supply of basic requirements for species the lack of which may lead to species decline, isolation or extirpation. While some species show preference reflected by their presence, high abundances and continuous distribution patterns, others are restricted in their distribution and may rather decline or become locally extirpated or extinct. Large mammal species in particular, exhibit individualistic pattern of distribution, which can either be restricted in very small areas, continuous and randomly distributed over a large area

Waterbuck are large, robust ungulates with an unusually shaggy coat. The common waterbuck (*Kobus ellipsiprymnus*) has distribution ranges from the northern regions of South Africa, Botswana and Namibia, up towards Kenya and southern Somalia, in areas to the East of the Great Rift Valley (Skinner and Chimimba, 2005). Waterbuck are primarily grazers (Estes, 1991) that prefer open habitats with short to medium grasses and are in relatively close proximity to water (Traill, 2004; Gutbrodt, 2006). Waterbuck require an unusually high amount of water (Taylor et al., 1969b) with an estimated 9 litres of water needed per day (du Toit, 2010). The need for a greater water intake could be due to the consumption of mostly protein-rich grasses (Estes, 1991). Waterbuck are able to shift their diet to incorporate browse species in periods of environmental stress with a low abundance of preferred grasses (Tomlinson, 1980; Estes, 1991).

Waterbuck herds are not typical, distinct, cohesive units as individuals freely congregate and disband (Estes, 1991; Kingdon, 1997). Groups of six to 12 individuals form small herds and larger congregations of 30-70 individuals may be observed in areas where resources are plentiful (Skinner & Chimimba, 2005). Females are commonly seen alone or in pairs but casual groups of five to ten individuals may be observed (Estes, 1991). Weaned waterbuck calves and juveniles commonly form groups as they are driven out of their natal herd by adults (Estes, 1991). Waterbuck are slow to mature with males reaching their prime at five to six years old and females rarely conceive before three years of age (du Toit, 2010). Waterbuck are polyoestrus and do not have distinct breeding seasons, however calving peaks have been observed in October and again between February and March (Skinner and Chimimba, 2005). Females withdraw from the herd to give birth after a gestation period of 280 days (Skinner & Chimimba, 2005) and stop lactating about 180-210 days afterwards so that calves are generally weaned by 276 days (Spinage, 1982; Skinner & Chimimba, 2005). Waterbuck do not typically interact physically for example in greeting or in grooming, but mothers will communicate with their young with a serious of bleats and snorts (Estes, 1991). Foraging activity peaks in the early morning and late afternoons to early evening (Estes, 1991). Waterbuck are vigilant and regularly survey their environment for threats, running to cover when necessary and in some incidences, large bulls will engage in self-defence against predators.

Feeding patterns of ungulate herbivores differ between seasons. Nutrient levels vary between grass species, and they decrease with age. As the growing season progresses and plants get older, the available food quality decreases (Georgiadis & McNaughton 1990). However, in some species this happens more quickly than in others. This means that a comparatively nutrient poor grass species in the wet season may become relatively nutrient rich, and hence more attractive for herbivores, later in the dry season when other grasses age and die (Ben-Shahar & Coe 1992). This explains why grass species composition in the diet of ungulates was found to vary between seasons in a number of studies (Macandza et al, 2004, Omphile et al. 2004). Studies in semi-arid and moist savannas showed contrasting patterns of diet overlap among ungulate herbivores between wet and dry seasons. In semi-arid savanna ecosystems the dietary overlap of herbivores increased in the dry season, coinciding with decreasing quality of available forage (Omphile et al. 2004).

CONCLUSION

Antelopes have a broader geographical distribution in Sub Saharan Africa rich in woodland savanna ecosystem. Additionally, the woodland vegetation is very rich, supporting a huge population of antelopes. The northern region is Cameroon has a long standing history of wildlife conservation compared to other regions and has been the main area of tourists visitation. The huge population and welfare of waterbuck in Bouba-njidda national park is based on effective conservation approach. Secondly, the national park drainage system is comparatively richer, an ecological factor much needed by waterbuck population for survival. The riversides of the national park shelter the highest population of waterbuck especially in the dry seasons. These rivers and streams also provide enough atmospheric moisture in most areas keeping the vegetation ever healthy for the survival of antelopes and other wildlife species. Nevertheless, this study revealed that vegetation types significantly affected the group size and distribution of waterbuck population in the national park. Poaching has been the major setback to wildlife conservation in Cameroon. Bouba-njidda national park has been on the spot-light of hunting pressure from

neighboring countries like Central African Republic to finance war through elephant tusk. Cameroon government responded by building a military base in the national park to protect the wild games. Moreover, it is important to have a good understanding on the presence and distribution of wildlife within an area, to develop sound conservation strategies.

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