FORAGE SPECIES OF IMPALA SANCTUARY, KISUMU; KENYA

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ABSTRACT

The study evaluated the forage species of Impala sanctuary-Kisumu over a six month period that corresponded to two seasons (wet and dry). The study identified the grasses in the sanctuary with the help of a hand book on Primer on grass identification and uses in Kenya. Further identification was done with assistance of grass manuals and family taxonomic keys of Poaceae (graminae) which provide food for the impalas of the sanctuary. The sanctuary was divided into three ecosystems that is grassland, marshes and shrubland. Quadrats of 1m x 1m were used to sample grassland and marshes while those of 5m x 5m used to sample shrubland in a completely randomized design. The plant species diversity in the three ecosystems was calculated using the Shannon wiener diversity index. The results revealed that grassland had the highest species richness of 37 grass species. Shrubland had 13 grass species while 9 grass species were recorded in marshes. In terms of diversity, grassland had a diversity index of 1.6; shrubland had 1.03 while marshes had 0.92. In conclusion, impala sanctuary has different species of grasses distributed within it, which provide forage for the grazers. This study is significant as it will provide the managers with information about forage species present in the sanctuary for better management practises with reference to the forage. It can also be replicated in other similar sanctuaries.

Keywords: Grazing, Forage, Grasses, Herbivores, Sanctuary, Ecosystem.

INTRODUCTION

Savanna ecosystems are progressive grasslands with scattered shrubs and isolated trees. They cover approximately an eighth of the global land surface area coming second to tropical forests in their contribution to terrestrial productivity (Smith, 1999). Savannah vegetation consists predominantly of grasses and forbs. Different savannas support different grasses that are a function of rainfall and local soil conditions, herbivory and fires that act as modifiers of their distribution and accessibility (Sankara *et al*., 2004). For instance in the savannas of the Maasai Mara plains of Kenya, the dominant grasses on well drained soil are rhodes grass (*Chloris gayana* Kunth) and red- oat grass (*Themedatriandra .L*) (Chidumayo, 2001). African

Savanna ecosystems have many species of large mammalian herbivores than any other known ecosystem. This is due to a combination of precipitation, soil fertility and habitat heterogeneity which promote establishment of a variety of forage resources for the herbivores (Smith, 1999; Otieno *et al*., 2005). Impala is an intermediate feeder that prefers to graze, but its diet includes grasses, forbs, seeds and fruit (Jarman 1974; McNaughton and Georgiadis 1986; Skinner and Chimimba 2005). Impala switches between forage types, and plant parts, in response to fluctuating environmental factors such as change in rainfall (Du Toit 1988; Van Rooyen 1992; Skinner and Chimimba 2005).Studies have also shown that grasses constitute upto 90% of impala diet during the rainy season, but only 33% during the dry season (Meissner *et al*., 1996). The aim of this study was to identify the various grass species that act as forage to the impala in the three ecosystems of the sanctuary. Specifically (i) To identify the grass forage species within the sanctuary available to be grazed on by the impalas (ii) To establish the diversity and distribution of the grasses in three ecosystems of the sanctuary.

MATERIALS AND METHODS

Study Site

The study was conducted in Impala Sanctuary-Kisumu, (00^0 37^0s and 34^0 12' E) in Kisumu county- Kenya. It is located at an altitude of 1,149mabove sea level and situated about 2km west of Kisumu city center. The sanctuary which measures about 0.34 km^2 (less than1.0 km^2) is predominantly grassland and shrub land, making it one of Kenya's smallest wildlife sanctuaries. It is home to a herd of impala as well as many reptiles and birds (Kenya Wildlife Service, 2012). Currently the sanctuary has two sections called impala sanctuary A with the other animals and impala sanctuary B with a swamp that only has the sitatunga. There are also several caged baboons and leopards that enhance the tourism potential of the sanctuary. The area experiences warm- hot humid type of climate with an annual precipitation of 300-900mm per annum and an annual mean diurnal temperature of 27^0C with extreme fluctuations. The soils are predominantly black cotton clays (Kenya Wildlife Service, 2012).

Identification of the Grass Forage Species

The sanctuary was divided into 3 study ecosystems; grassland, shrubland and marshes. Quadrats of 1m x 1m plot for grassland and marshes, 5m x 5m for shrub land were set completely randomized for the grassland and marshes and at an interval of 5 meters for shrubland. All the grass species in each quadrat in each ecosystem were identified and coded with the help of a hand book on Primer on grass identification and uses in Kenya, (Muyekho *et al*., 2004). Further identification of the grass species in the field was also done using Family taxonomic key of Poaceae (family graminae) Barkworth *et al.*, (2007).Additional information on the forage species grazed on was obtained from secondary information especially records by the Kenya Wildlife Service, (checklist of animals of impala sanctuary and feeds available for the animals 2012-unpublished data).

Data Analysis

The plant species diversity in the three ecosystems was calculated using the Shannon wiener diversity index (Magurran, 1988).

$$H' = -\sum_{i=1}^{n} pilnpi$$

Where H'= Shannon's diversity index

Pi=proportion of individuals or the abundance of the i^{th} species expressed as a proportion of total cover
Ln =log $base_n$
Species evenness in the three ecosystems was calculated using the Shannon Evenness Index (Magurran, 1988)

E=H'/ H max where;
H max=Ln S
H' =Shannon diversity Index
Ln S=the natural logarithm of the number of species
S=No. of species in a community
Data obtained from the samples were used to describe the species composition of the sanctuary and also of the three ecosystems.

RESULTS

Identification of Various Grass Species within the Three Ecosystems

A total of 37 grass species were identified in Kisumu sanctuary. All of these species (37) were present grassland ecosystem while 13 species and 9 species were identified in shrubland and marshes respectively. *Digitaris scalarum, Cynodon dactylon and Torulinium odoratum* were some of the species present in all the three ecosystems (Table 1).

Table 1: Grass species of the three Ecosystems

GRASSLAND	SHRUBLAND	MARSHES
Bothriochloainsculpta (A. Rich.) A. Camus	*Brachiariahumidicola*(Rendle) Schweick	BrachiarisviridulaStapf
Bothriochloainsculpta (A. Rich.) A. Camus	*Brachiarisannulatum (*Forsk.) Stapf	*Cynodondactylon* (L.) Pers
Brachiariaannulatum (Forsk.) Stapf	*Chlorisroxybarghiana*Schult	*Cynodonplectostachyus*auct. Non (K. Schum.) Pilg.
Brachiariabovonei (Chiov.) Robyns	*Cynodondactylon (L.)* Pers	*Digitarisscalarum*(Schweinf.)
Brachiariabrizantha (A. Rich.) Staff	*Digitarisscalarum L*	*Melinisminuteflora* P. Beauv
Brachiariahumidicola (Rendle) Schweick	*Eragrostiscurvula (Schrad.) Nees*	*Pennisetumpurpureum*Schumach
Brachiariaradicans	*Panicumcoloratum*L	*Pennisetumsetaceum*(Forsk) Chiov
Brachiariaromosa (L.) Stapf	*Panicum maximum* Jacq.	*Phragmiteskarka* (Retz.) Steud.
*Brachiariaruziziensis*Germain&Evrard	*Panicumvirgatum*L	*Toruliniumodoratum* L
*Brachiariaviridula*Napper	*Sorghum arundinaceum* (Desv.) Stapf	
Cenchrus spinex L	*Sorghum versicolor*Andersson	
*Cenchrusspinifex*Cav	*Sporoboluspyramidalis* P. Beauv.	
Cenchurusciliaris L	*Toruliniumodoratum*L	
*Chlorisgayana*Kunth		

Chlorisroxybarghiana
Cynodondactylon (L.) Pers
Cynodonplectostachyusauct. Non (K. Schum.) Pil
Dactylocteniumaegyptium
Digitarisscalarum (Schweinf.)
Eleusineindica (L.) Gaertn
Eragrostiscurvula (Schrad.) Nees
Hyparrheniafilipendula (Hochst.) Stapf
Hyparrheniarufa(Nees) Stapf
Loudetiakagerensis (K. Schum.) Hutch.
Melinisminuteflora P. Beauv
Panicumcoloratum L
*Panicum maximum*Jacq.
Panicumvirgatum L
*Pennisetumpurpureum*Schu mach
Pennisetumrubrum
*Pennisetumsetaceum(*Forsk) Chiov
Phragmiteskarka (Retz.) Steud.
Rottboelliacochinchinensis(Lour.) W.D. Clayton
Sorghum arundinaceum (Desv.) Stapf
Sorghum versicolor
Sporoboluspyramidalis P. Beauv.
Toruliniumodoratum L

Diversity and distribution of the grasses in three ecosystems

Grassland ecosystem was more diverse with highest species diversity index of 1.60; followed by shrublandecosystem with 1.03 and then marshes ecosystem with 0.92. The species evenness in the three ecosystems was grassland 0.89, Marshes 0.45 and shrubland 0.84 as shown in Table 2

Table 2: Species richness, diversity and evenness indices in the three ecosystems

Ecosystems	Grassland	Marshes	Shrubland
Species Richness	37	09	13
Species diversity index	1.60	0.92	1.03
Evenness	0.89	0.45	0.84

DISCUSSION

From the study, the Impala sanctuary has at least thirty seven major grass species distributed all over the sanctuary in the various ecosystems with some grass species such as *C. dactylon*, *D. scalarum* and *T.odoratum* found in the three ecosystems. Grassland had the highest species diversity and richness, followed by shrubland and then marshes. This results could be attributed to the fact that grassland is open and there is high primary productivity (Sankara *et al*., 2004) thus can support more species. The shrubland ecosystem is usually well shaded with the shrubs canopy; therefore fewer grass species can grow under the canopy created by the shrubs. The findings were in agreement with those of (Belsky, 1994; Manuel and Molles, 2003).The marshes ecosystem is water logged more so during the wet seasons and thus does not favor the growth of most of the grass species which are not adapted to such an ecosystem. This is supported by the fact that only those species which are adapted to the water lodged soils are dominant in these areas, for instance *Phragmiteskarka*, *Pennisetumpurpureum*and *Pennisetumsetaceum*(Muyekho*et al*., 2004).

The Impala sanctuary soils are predominantly black cotton clays and therefore the soil factors are uniform for all the species hence may not be a major contributing factor to the distribution of the grass species within the three ecosystems as established in a study by Kenya Wildlife Service, (2012).For instance *Cynodondactylon*, *Eragrostiscurvula*, *Eleusineindica*and *Hyparrheniafilipendula* were found more predominantly in the grassland although were also in the other two ecosystems with the exception of *H.filipendula* which was only found in the grassland ecosystem. *Cynodon dactylon*, *D. scalarum* and *T.odoratum* were found in all the three ecosystems although were predominant in the grassland and marshes ecosystem. This is due to their ability to survive in the environmental conditions of the three ecosystems; *P.setaceum* was found only in the grassland and marshes but was more predominant in the marshes where there are favorable conditions for its growth since it does well in water logged areas (Muyekho *et al*., 2004).The shaded nature of the shrubland also allows for growth of some tolerant forage species which can photosynthesize under low light intensity under the shrubs therefore available to be grazed on by the animals during the dry season. Studies have shown that underneath the canopies of the shrubs very few species of grasses can survive due to inadequate amount of light for photosynthesis. Some shrubs have allelopathic influence which hinders the establishment of other species around them (Sankara *et al*., 2004).

CONCLUSIONS

The sanctuary has a rich diversity of grass species which provide forage for provide forage for the impala population although grasses are not evenly distributed in the three ecosystems.

RECOMMENDATIONS

In order to increase forage availability in various ecosystem, the management should consider re-seeding the sanctuary with appropriate species which can survive in those habitats.

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REFERENCES

Augustine, J. D. and McNaughton, J. S. (2006). Internetive effect of ungulate herbivores, soil fertility, and variable rainfall on ecosystem processes in a semi-Arid savannah. *Ecosystem*, 9:1242–1256.

Barkworth, M. E., Capels, K. M. S., Long, L. K., (2007). Flora of North America Poaceae, part1 volume 24. Anderton and M.B. Piep, editors. *Oxford University Press*, New York, 911.

Belsky, A. J. (1994). Influence of trees on savanna productivity; tests of shade, nutrients and tree-grass competition. *Journals of Ecology*, 75 (4): 922 – 932.

Chidumayo, E. N. (2001). Land use, deforestation, and reforestation in the Zambian copper belt. Journal of LandDegradation and Rehabilitation, 1**:** 209-216.

Du Toit, J. T (1988). Patterns of resource use within the browsing guild in the central Kruger National Park. PhD dissertation, University of the Witwatersrand, Johannesburg.

Gordon, I .J, Illius, A. W (1994). The functional significance of the browser-grazer dichotomy in African ruminants. Oecologia 98:167-175.

Jarman, P. J (1974). The social organization of antelope in relation to their ecology. Behavior 215- 267.

Kenya Wildlife Service, (2012). Checklist of animals of impala sanctuary and feeds available for the animals- unpublished.

Manuel, C, and Molles, J. R. (2003). Ecology concept and Applications. *Journal of Ecology* (3) 372-373.

Magurran, A. E. (1988). Ecological diversity and its measurement. Princeton university press.374-12

McNaughton, S. J, Georgiadis, N. J (1986). Ecology of African grazing and browsing mammals. *Annu Rev EcolSyst* 17:39-66.

Muyekho, F. N, Barrison, A. T Khan, Z. R, (2004). A Primer on Grass Identification and their uses in Kenya. Published by Development communication Ltd, Nairobi pg84.

Otieno, D. O., Schmidta, M. W. T, Kinyamario, J. J, Tenhunen, J. (2005). Responses of Acacia fortilis and Acacia Xanthophloea to seasonal changes in soil water availability in the savanna region of Kenya. *Journal of Arid environment* (62), 377-400.

Sankara, M., Jayashree, R., Niall, P. H. (2004). Tree-grass coexistence in savanna revisited insights from an examination of assumption and mechanisms invoked in existing models. *Ecology letter* 7(6):480-490.

Skinner, J. D, Chimimba, C. T (2005). The mammals of the southern African sub region. *Cambridge University Press*, Cape Town

Smith, R. L. (1999). Elements of Ecology. 3rd Edition. Island Press Washington D.C 551 – 465.

Van Rooyen, A. F (1992). Diets of impala and nyala in two game reserves in Natal, South *Africa. S Afr J Wildl Res* 22:98-101.