Journal of Applied Biosciences (2008), Vol. 10(2): 507 - 510.
ISSN 1997 – 5902: www.biosciences.elewa.org

Factors influencing impala distribution patterns in Nairobi National Park, Kenya

[Short Paper]

[redacted]

ABSTRACT
Objective: To study the factors influencing the distribution of impala in Nairobi National Park, Kenya using remote sensing.
Methodology and results: Using impala as an indicator species, the following parameters were determined: (1) food availability estimated by the Normalized Difference Vegetation Index (NDVI); (2) presence of water and (3) disturbance represented by density of roads. Landsat 7-ETM+ satellite imagery for February, 2002; *IDRISI*^{â} *32 version 2* software and *SPSS 11.0* statistical software were used for analysis. A positive statistical relationship between impala population density and NDVI was observed, indicating that fewer animals occur where there is less vegetation and vice versa. The correlation between impala population density and water distance was negative, indicating that fewer impalas would be expected as the distance from water sources increase. A positive correlation was determined between impala population and road density.
Conclusion and application of findings: The findings show that more impala preferred habitats next to the roads and closer to water sources, while fewer animals would be expected far from water sources where feed resources are also likely to be less. The information can be useful for sustainable management practices such as redistributing animals within the park.

Key words: habitat, impala, Kenya, management, patterns, remote sensing

Citation: [redacted]

INTRODUCTION

Sustainable habitat management requires thorough understanding of the factors that influence species distribution patterns. In Kenya, the factors responsible for spatial variability of wildlife populations are still not fully understood, despite numerous attempts to identify them. Reliance on data that is predominantly from sparse 'in situ' point samples has been one key constraint. Wildlife managers would prefer to have continuous information over time on the number of animals in a park (abundance), the spatial distribution of these animals and the availability of pasture (Ottichilo *et al.,* 2001). Identification of potential wildlife habitat sites is a prerequisite for successful protection. Remote sensing technology could fill the need for accurate, up-to-date information that is essential for wildlife management. However, the full capabilities of this technology are yet to be exploited (Serneels *et al*., 2001).

The basic resource that fuels life on earth is solar energy, which is captured by plants and converted to carbon compounds, otherwise referred to as primary productivity (Huston, 1994). Since herbivores feed on the carbon compounds in plants, higher animal populations would be expected where vegetation is abundant. Furthermore, the numbers of consumer individuals are determined by the productivity of the vegetation, which in turn is influenced by climatic variability (Lovett *et al.,* 2005). Consequently, in order to better understand the factors determining distribution of animal species, it is important to investigate the relationship between vegetation and animals (Chapman *et al.,* 2006). Other factors that could influence species abundance include predators, the presence of water, and the effect of disturbance (Dale & Beyeler, 2001).

The objective of this study was to establish the relationship between impala (*Aepyceros melampus* Lichtenstein) population density and specific environmental parameters with a view to providing information that can improve the capacity for policy formulation.

MATERIALS AND METHODS

Nairobi National Park is located in Kenya between latitudes 1° 20' - 1° 25'S and longitudes 36°45' - 36° 55' E. The impala was chosen as an *indicator species*, since (1) there is similarity in feeding habits among herbivores (Hacker & Ternouth, 1987), and (2) a high impala population variability has been noted in the park over the years. In view of the complex nature of the environment, only the following parameters were selected: (1) food availability estimated by the Normalized Difference Vegetation Index (NDVI); (2) presence of water and (3) disturbance represented by density of roads.

To collect animal census data in Kenya, the Directorate of Resource Surveys and Remote Sensing (DRSRS) uses low flying aircraft, with grids and counters on both windows (Ottichilo *et al.,* 2001). Although this method is appropriate for larger animals, e.g. zebra, wildebeast, etc, it is not suitable for small animals, e.g. impala. For example, in the Nairobi National Park the grass can be as high as a metre towards the end of the rainy season, thus making it difficult to see the impala at this time. An alternative to aerial census is ground census whereby teams of rangers are sent to the field to count the animals observed in specific blocks. The fifteen different block sizes in Nairobi National Park varied between 1000 to 3000 hectares. This study relied on the actual ground census data from the KWS records.

A model of the *impala population density,* which was assumed to be referenced from the center of the respective counting blocks and distance to water sources, was created. The *road density* was computed using Equation 1:

$$\text{Road density} = TL / AR \quad (1)$$

Whereby "TL" is the total length of road in metres and "AR" is the area of corresponding block in square metres. NDVI which provides an effective measure of photosynthetically active biomass of plant canopies (Tucker & Sellers, 1986), was computed using Equation 2. NDVI combines the reflectance in the red and near infra-red parts (NIR) of the electromagnetic spectrum into one index; whereby high positive values correspond to dense vegetative cover, whereas negative values are associated with bare soil, snow, or clouds. Landsat 7-ETM+ satellite imagery for February, 2002; *IDRISI^{â} 32 version 2* software and *SPSS 11.0* statistical software were used for analysis.

$$NDVI = (NIR - Red) / (NIR + Red) \quad (2)$$

RESULTS AND DISCUSSION

The positive statistical relationship between impala population density and NDVI (Figure 1 and Table 1) supports the findings of Rosenzweig and Abramsky (1993) and Bourgarel *et al*., (2002), indicating that fewer animals occur where there is less vegetation and vice versa. Under conditions of low primary productivity in natural ecosystems, the landscape would mostly be non-vegetated while as productivity rises, a more diverse community of plants that can support a larger number of herbivore species are expected (Rosenzweig & Abramsky, 1993). The correlation between impala population density and water distance (Table 1 and Figure 2) was negative, indicating that fewer impalas would be expected as the distance from water sources increase. In addition, less vegetative cover would be expected as the distances from the water-sources increase, as evidenced by the negative correlation between NDVI and water sources (Table 1). Thus, further from water sources, impala populations would be less due to water scarcity and also due to the reduced feed resources.

Table 1: Statistical relationship between impala density, vegetation, distance to water source and road density within Nairobi National park, Kenya.

	Pearson Correlation**	Significance
Impala density vs. water distance in metres	-0.443	0.099
Impala density vs. NDVI	0.644	0.01
Water distance vs. NDVI	-0.329	0.232
Impala density per hectare vs. road density	0.323	0.240

**Correlation is significant at the 0.01 level (2-tailed) and N = 15. NDVI = Normalized Difference Vegetation Index.

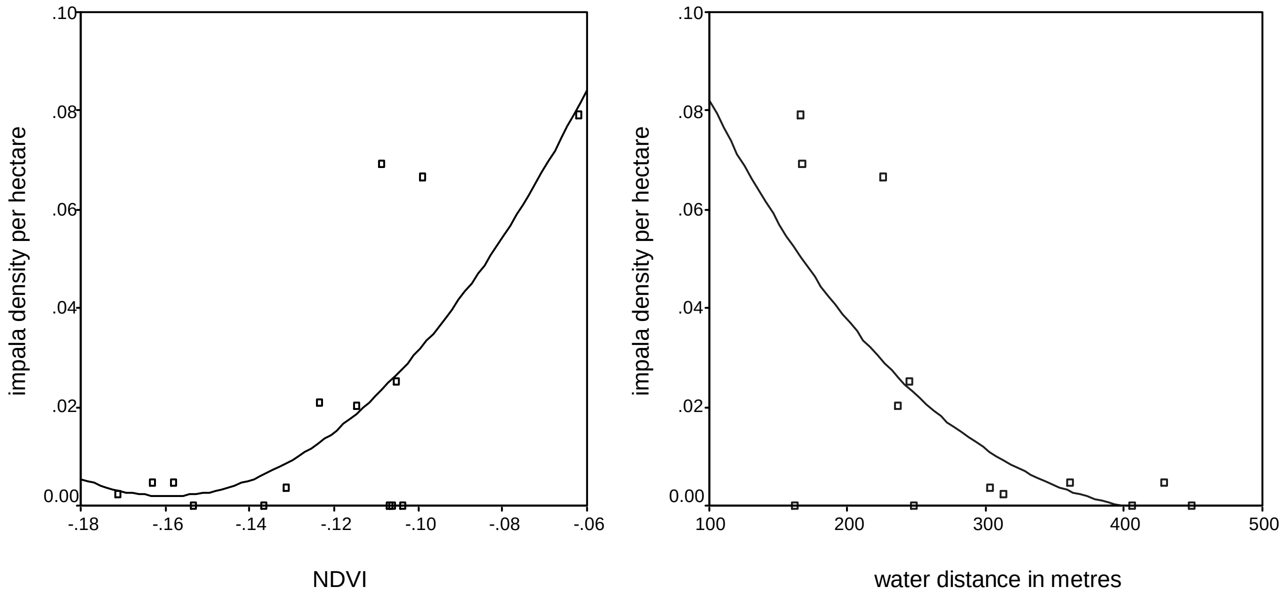

Figure 1: Impala density per hectare versus NDVI (left) and water distance (right). NDVI = Normalized Difference Vegetation Index.

There was a positive correlation between impala population and road density (Table 1), which is contrary to the findings of Little *et al.* (2002 that wild animals are disturbed by human activities, e.g. roads. The positive correlation between impalas and road density could be attributed to: (i) the utilization of roads as the platform for the animal counting procedure and (ii) the proximity of the park to the city, which could have made the animals more accustomed to vehicular presence.

A potential source of error includes averaged NDVI values for each block, which was correlated to the total number of animals in that block. Given the large size of the blocks, it is possible that there is some level of spatial heterogeneity in the NDVI values within blocks and at certain times, the animals can graze in areas that do not reflect vegetation represented by the "average" NDVI values used in the model. Furthermore, Impala tend to avoid tall grasses due to the threat presented by predators, e.g. lions. Another limitation was that the variability of animal distribution patterns with scale which can provide information useful for predicting spatial patterns of herbivores in other locations was not examined (Sullivan & Unwin, 2003).

Future research should incorporate techniques that locate the impala more precisely, so as to verify the correlations on point data (or a small window around the points) rather than using only aggregated data. Finally, the weak statistical relations could imply that remote sensing alone may not adequately give precise predictions of herbivores distribution patterns, due to the complexity of the environment.

ACKNOWLEDGEMENTS: Authors are grateful to Dr. Richard Bagine and Mr. Shadrack Ngene of the Kenya Wildlife Service for granting permission to conduct field visits and providing ancillary data. Ghent University, Belgium provided funding for the study.

REFERENCES

Bourgarel M, Fritz H, Gaillard J, De Garine-Wichatitsky M, Maudet F, 2002. Effects of annual rainfall and habitat types on the body mass of impala (*Aepyceros melampus*) in the Zambezi Valley, Zimbabwe. African Journal of Ecology 40 (2): 186-193.

Chapman CA, Lawes MJ, Harriet AC, 2006. What hope for African primate diversity? African Journal of Ecology 44 (2): 116–133. doi:10.1111/j.1365-2028.2006.00636.x

Dale VH. and Beyeler SC, 2001. Challenges in the development and use of ecological indicators, *Ecological Indicators j.* 1, 3-10.

Hacker JB. and Ternouth JH, 1987. *The nutrition of herbivorous*, Academic press, Sydney.

Huston MA, 1994. Biologic Diversity. The coexistence of species on changing landscapes, Cambridge University Press, Cambridge.

Little SI, Harcourt RG, Clevenger PA, 2002. Do Wildlife passages act as prey traps? Biological Conservation 107: 135-145.

Lovett JC, Midgley GF, Barnard P, 2005. Climate change and ecology in Africa. African Journal of Ecology 43 (3): 167–169. doi:10.1111/j.1365-2028.2005.00598.x

Ottichilo WK, Leeuw J, Prins HHT, 2001. Population trends of resident wildebeests (*connochaetes taurinus hecki* (Neumann)) and factors influencing them in the Maasai mara ecosystem, Kenya. Biological conservation 97: 271-282.

Rosenweig ML. and Abramsky Z, 1993. How are diversity and productivity related? In, *Species Diversity in Ecological communities. Historical and Geographical perspectives*, R.E. Ricklefs and D. Schluter (Eds.), University of Chicago Press, Chicago, USA. pp. 52-65.

Serneels S, Said MY, Lambin EF, 2001. Land-cover changes around a major East African wildlife reserve: the Mara Ecosystem, Kenya.

Sullivan DO. and Unwin D, 2003. Geographic Information Analysis, John Wiley and Sons.

Tucker CJ. and Sellers PJ, 1986. Satellite remote sensing of primary production. International Journal of Remote Sensing, 7: 1395-1416.