SPATIAL PARTITIONING OF WILDLIFE SPECIES IN THE KRUGER NATIONAL PARK SAVANNA LANDSCAPE AS A FUNCTION OF SPATIAL HETEROGENEITY OF VEGETATION COVER

Amon Murwira, Andrew K. Skidmore, Bert Toxopeus, Rina Grant, Izak Smit

South African NATIONAL PARKS

ITC

Introduction

- Spatial heterogeneity, i.e., patchiness of resources such as vegetation cover in the landscape is a critical determinant of the spatial distribution of wildlife species in the landscape. **In other words, distribution of wildlife responds to patchiness in landscape suitability that reflect varying levels of resource availability.**
- Remote sensing has provided opportunities to the understanding of wildlife distribution as a function of spatial heterogeneity in landscape resources.
- **BUT,** ambiguity surround the approaches to quantify spatial heterogeneity from remote sensing imagery.

Introduction

- This makes the objective characterization of spatial heterogeneity a critical preamble to understanding spatial distribution of wildlife species.
- **Patch mosaic approach**: cartographic crisp boundary determination. Approach assumes within patch homogeneity
- **Direct image approach:** using the variance measures such as the coefficient of variation calculated at the original pixel size of the image. Approach ignores spatial structure in the image

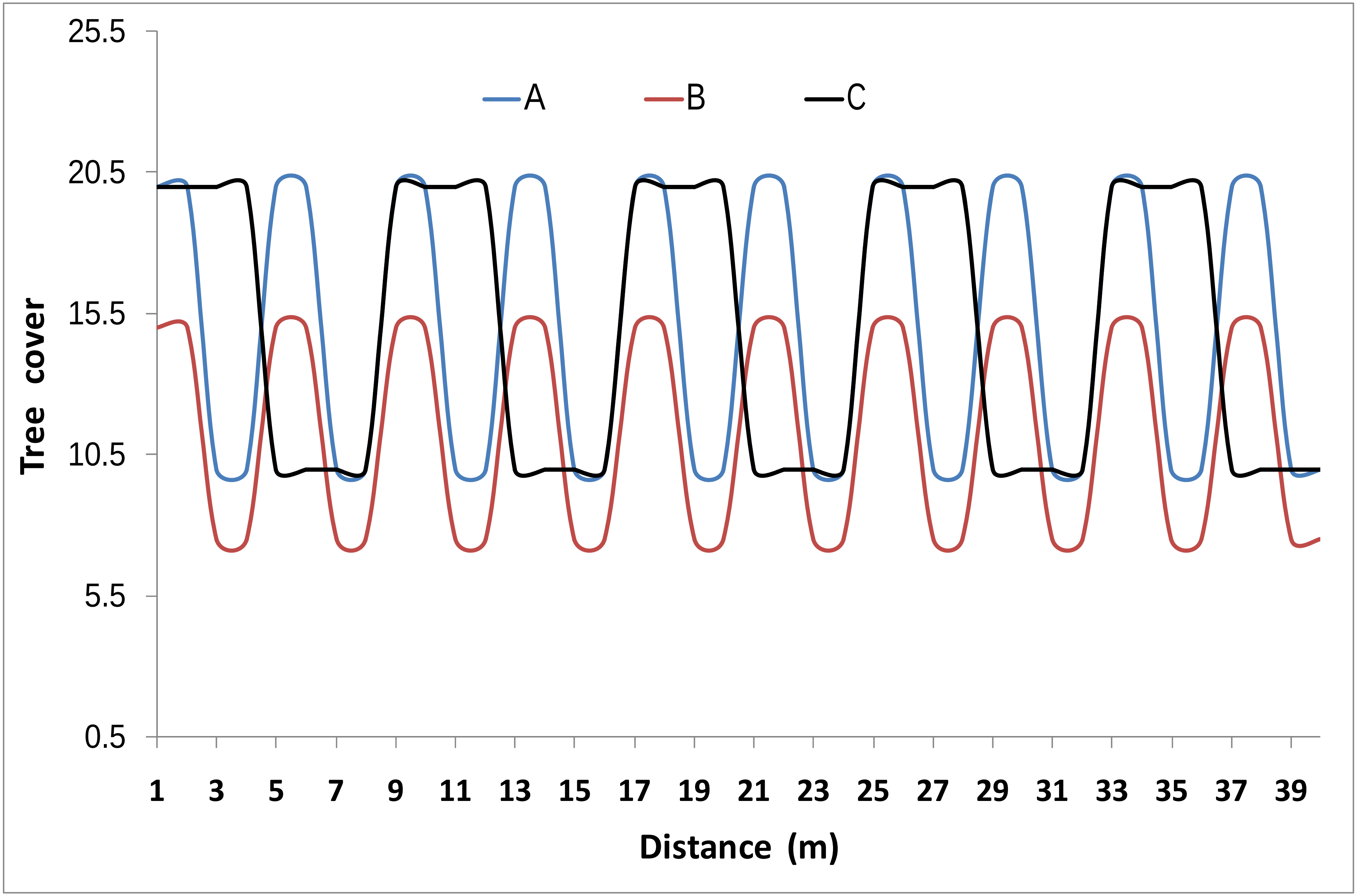
South African NATIONAL PARKS

ITC

Introduction

- We use a novel approach to quantify spatial heterogeneity based on the dominant scale (i.e., the window size at which maximum variance (intensity) is displayed)
- This approach hybrids the advantages of both the patch mosaic and direct image approaches

Intensity- Dominant scale approach

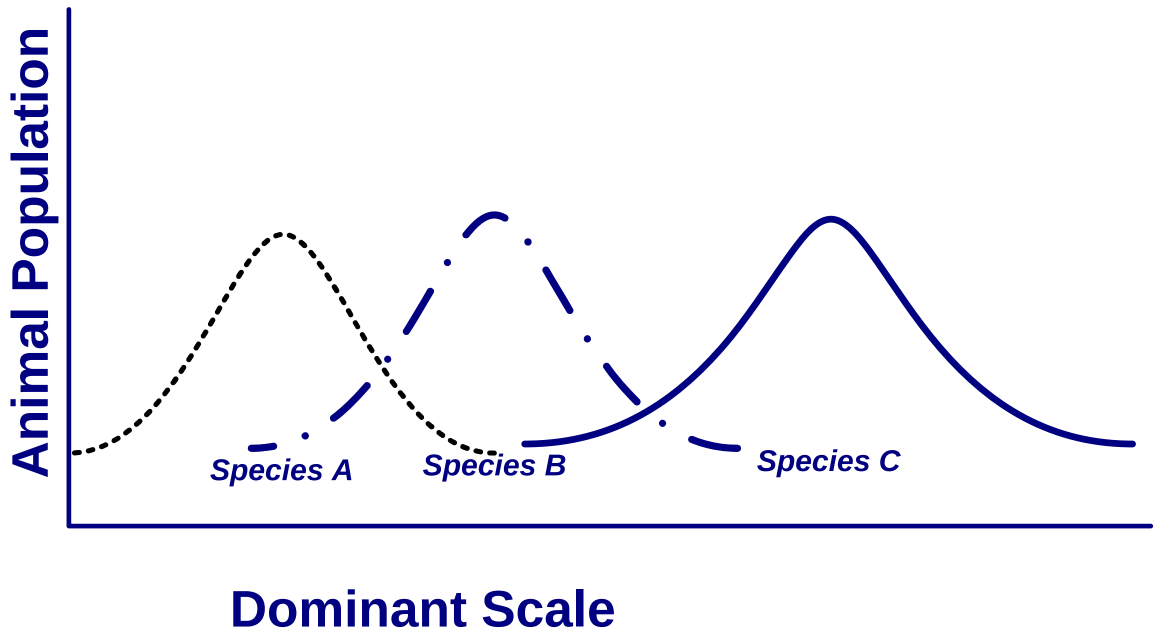


Introduction

- Murwira and Skidmore (2005) successfully used the intensity-dominant scale of spatial heterogeneity in vegetation cover to explain elephant distribution in in the Zambezi valley, Zimbabwe.
- In this KNP study, we further test the intensity-dominant scale approach in understanding wildlife distribution
- Specifically, we test whether the spatial distribution of impala, giraffe, kudu and sable population is a significant function of dominant scale of spatial heterogeneity of vegetation cover in KNP

Introduction

We also test whether the spatial distribution of impala, giraffe, kudu and sable population show different preferred dominant scales of spatial heterogeneity of vegetation cover in KNP



Introduction

- Finally, we test whether we can map habitat for each of the 4 species based on the dominant scale of spatial heterogeneity

MATERIALS AND METHODS

Amon Murwira, Andrew K. Skidmore, Bert Toxopeus, Rina Grant, Izak Smit

Remote sensing data

- Four Landsat TM images of April/May 1990 covering KNP were obtained and calibrated to reflectance
- The Near Infrared and Red bands were then used to calculate a normalized difference vegetation index to characterize vegetation cover for KNP:
  NDVI = NIR-R/NIR+R

South African NATIONAL PARKS

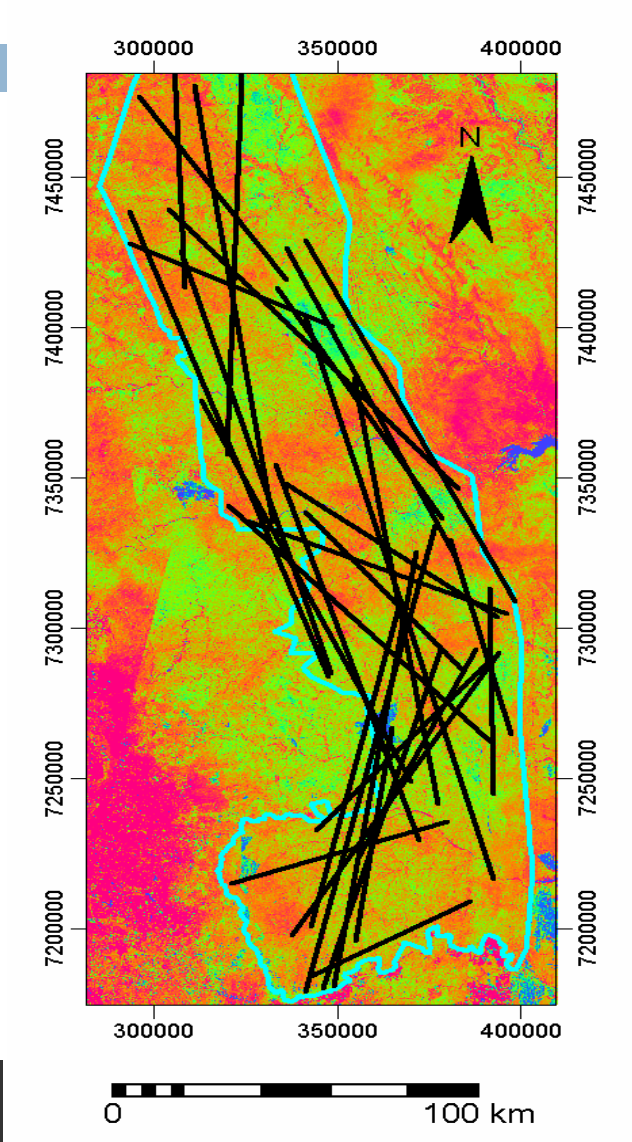
ITC

Wildlife data

- Wildlife georeferenced observation data for 1989-1993 were obtained from the KNP
- The spatial resolution of the data is 800 m

Transect generation

- 99 transects were randomly generated in a GIS
- Minimum transect length of 50 km



Wavelet analysis for transects

- Wavelet transform for the 99 transects up to 3840 m, j=7

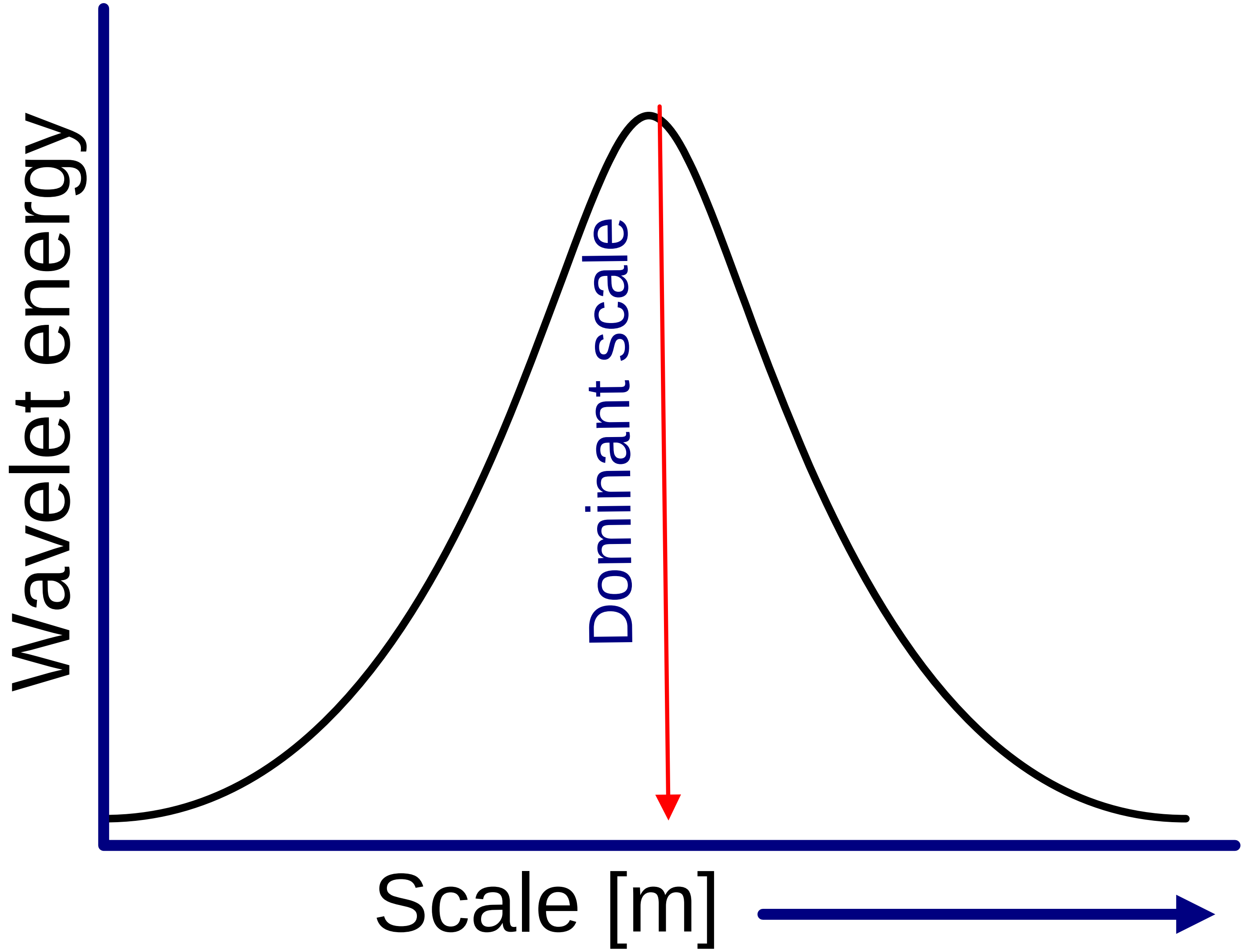
$$\hat{f}(x) = S_J(x) + \sum_{j=1}^{J} \sum_{dir} D_j(x)$$

Wavelet analysis for transects

- Wavelet Energy was calculated for the 99 transects up to 3840 m, j=7

$$E_j^d = \frac{1}{E} \sum_{k=1}^{n/2^j} d^2 j(x),\ j = 1,2,3\ldots J$$

Determining dominant scale from wavelet energy



Nonlinear regression

- Dominant scales were determined for each transect.
- The variance of each of the four animal species observed numbers was calculated for each dominant scale, 60 m to 3840 m based on the 99 transects
- Variance was used because dominant scale is also based on the variance of vegetation cover
- Non-linear regression was used to test the relationship between the variance of each wildlife species and dominant scale of spatial heterogeneity in vegetation cover (NDVI).

Wavelet analysis for NDVI image

- Wavelet transform for the NDVI image was performed up to 3840 m , j =7

$$\hat{f}(x,y) = S_J(x,y) + \sum_{j=1}^{J} \sum_{dir} D_j^{dir}(x,y)$$

Wavelet analysis for NDVI image

- Wavelet Energy was calculated for the NDVI image up to 3840 m, j=7

$$E_j^d = \frac{1}{E} \sum_{k=1}^{n/2^j} d^2 j(x, y), \; j = 1,2,3 \ldots J$$

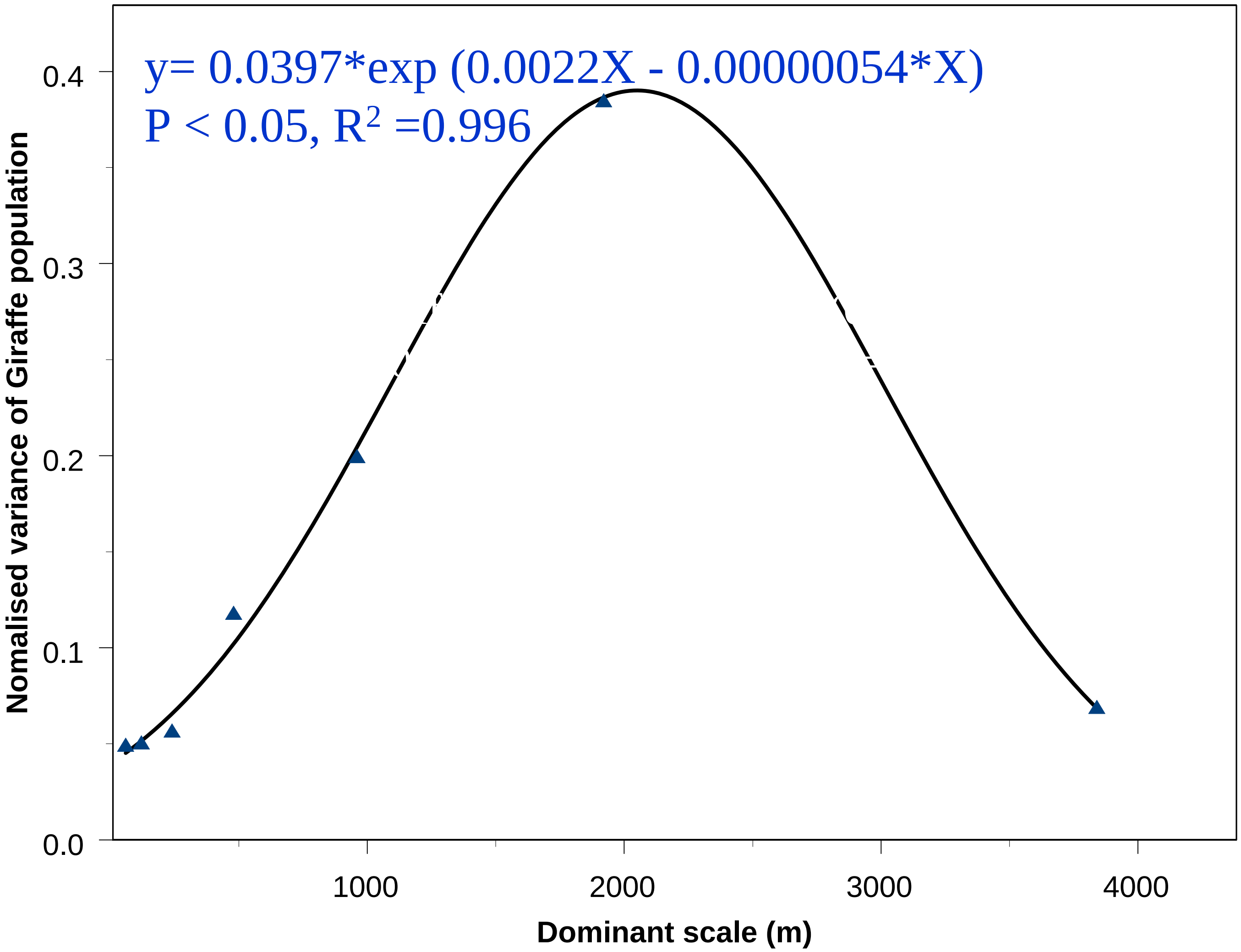
Mapping habitat based on dominant scale

- Data for each of the 4 wildlife species along the transects was converted to binary format: 1for where an animal was present and 0 otherwise
- We related the presence/ absence for each of the 4 wildlife species to location specific wavelet energy for each of the 7 scale levels, 60 m to 3840 m through logistic regression
- Significant logistic regression functions obtained were applied to image based wavelet energy at appropriate scales to map habitat for each species

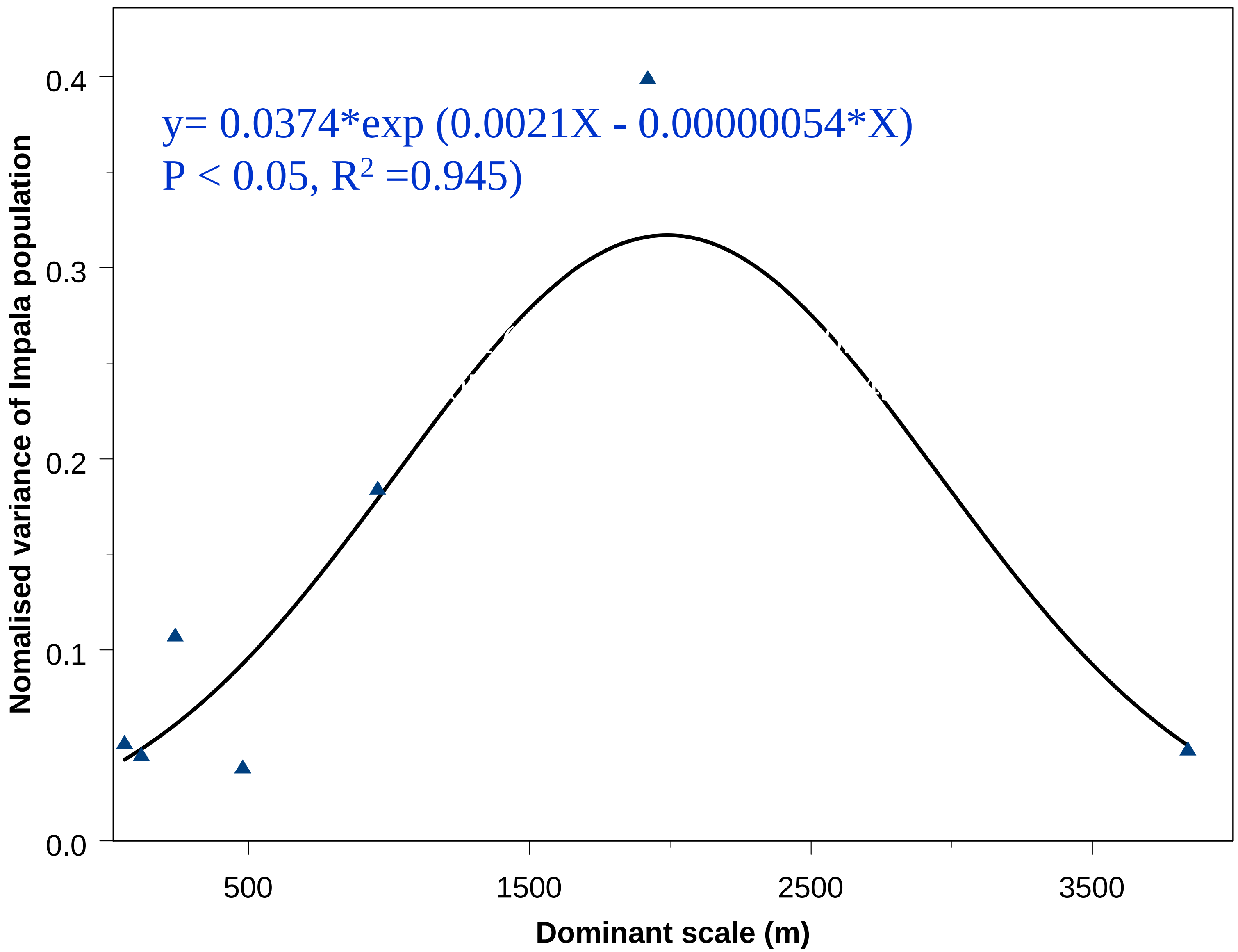
RESULTS

Amon Murwira, Andrew K. Skidmore, Bert Toxopeus, Rina Grant, Izak Smit

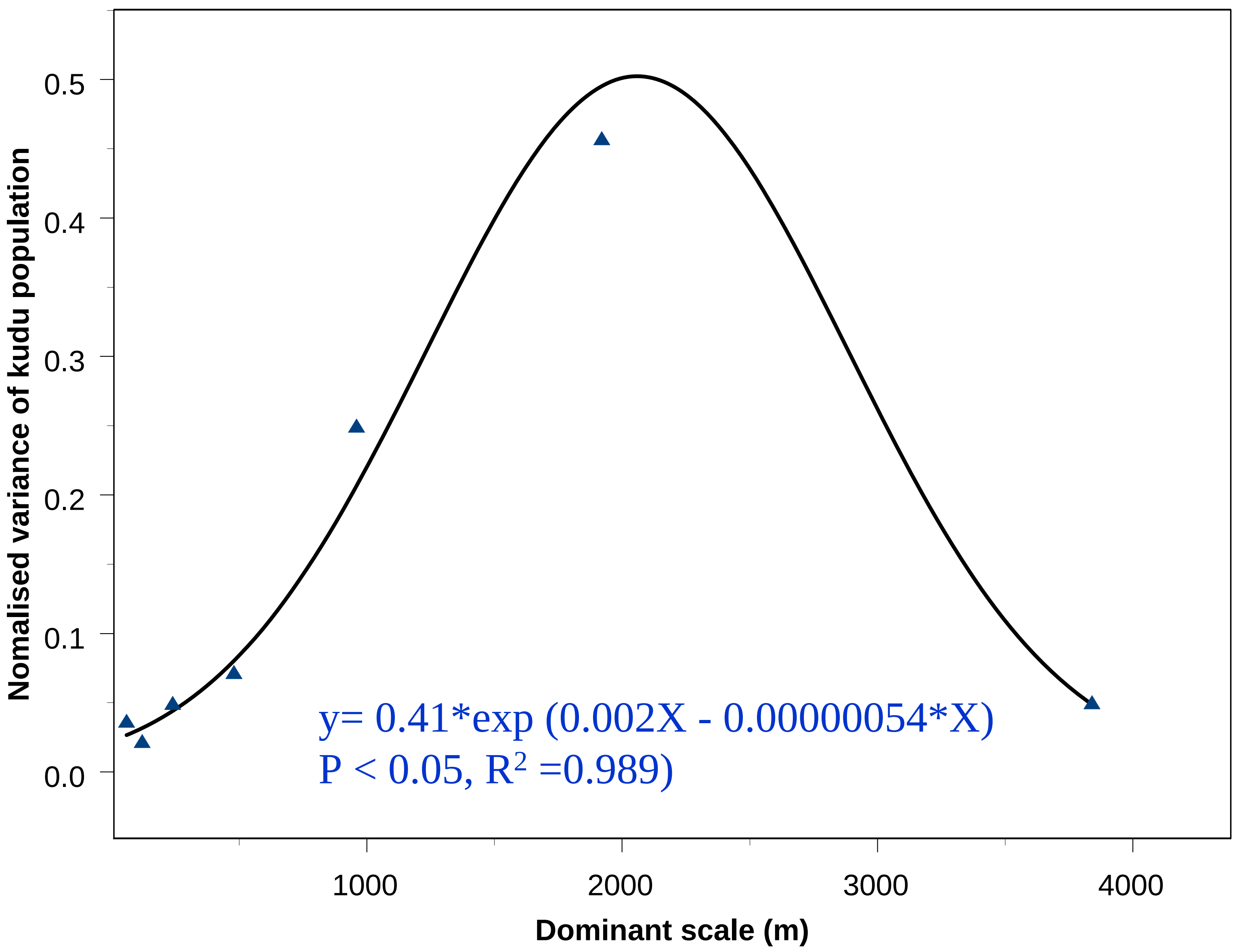
Giraffe & dominant scale of spatial heterogeneity of NDVI



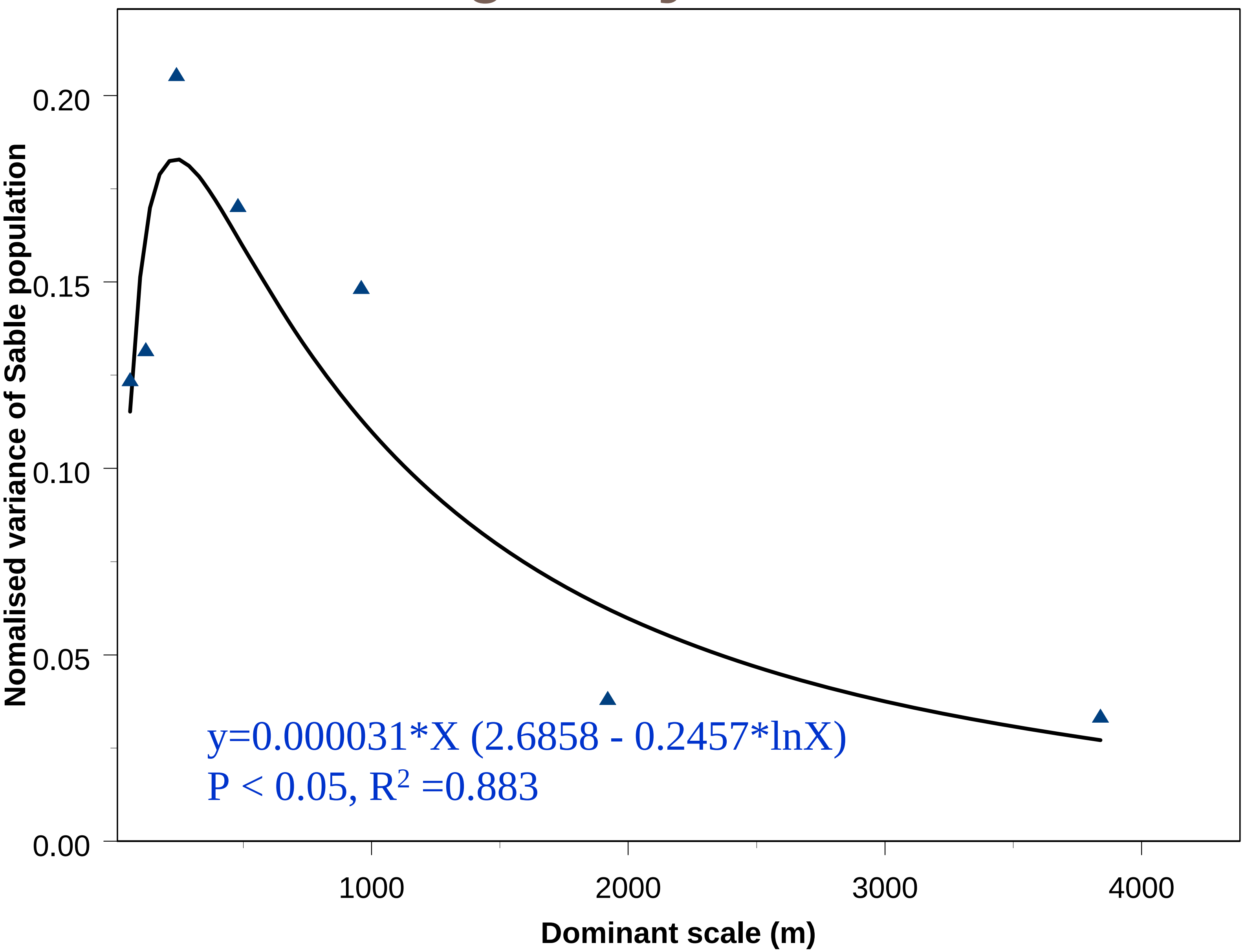
Impala & dominant scale of spatial heterogeneity of NDVI



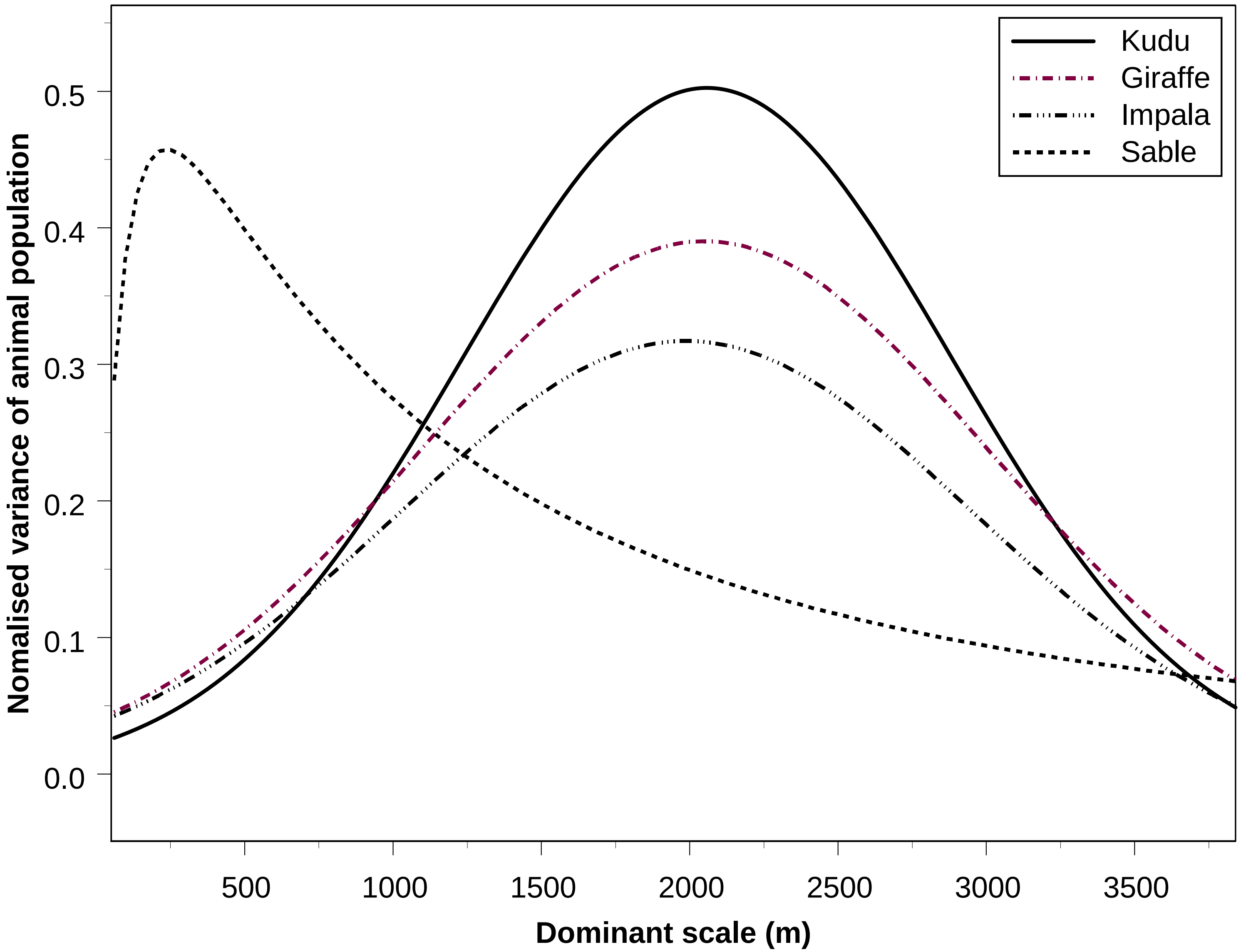
Kudu & dominant scale of spatial heterogeneity of NDVI



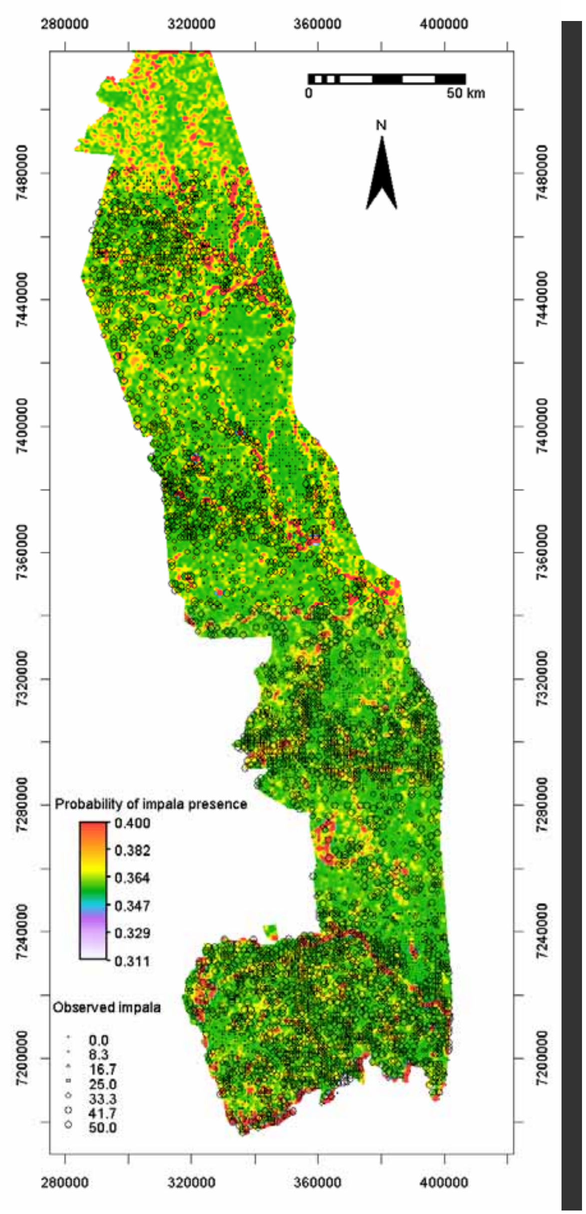
Sable & dominant scale of spatial heterogeneity of NDVI

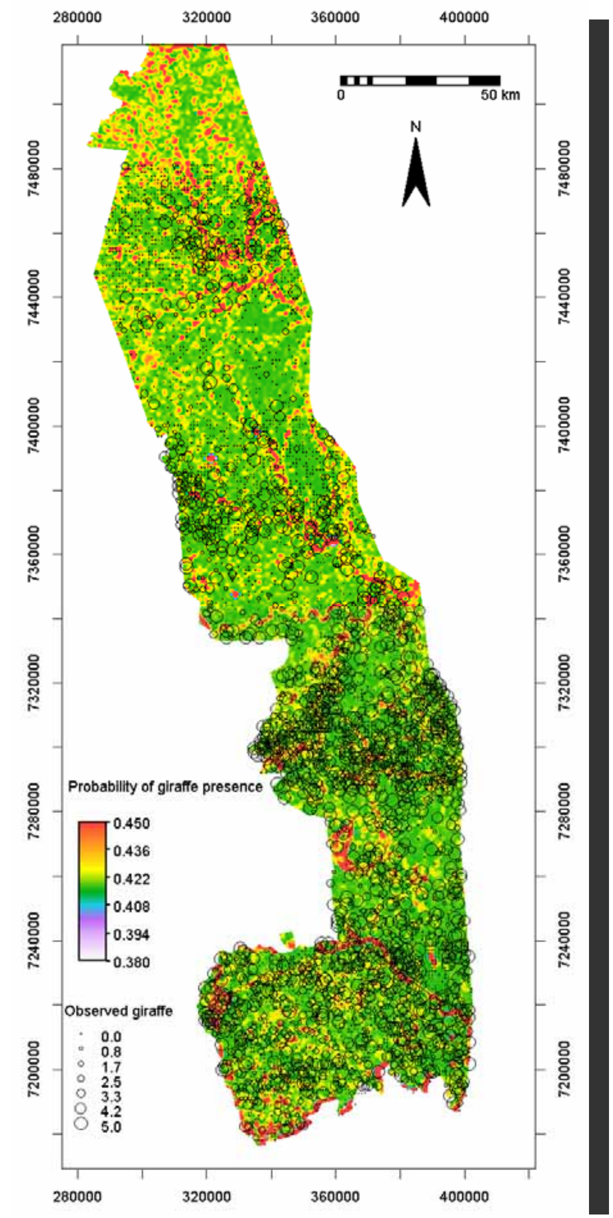


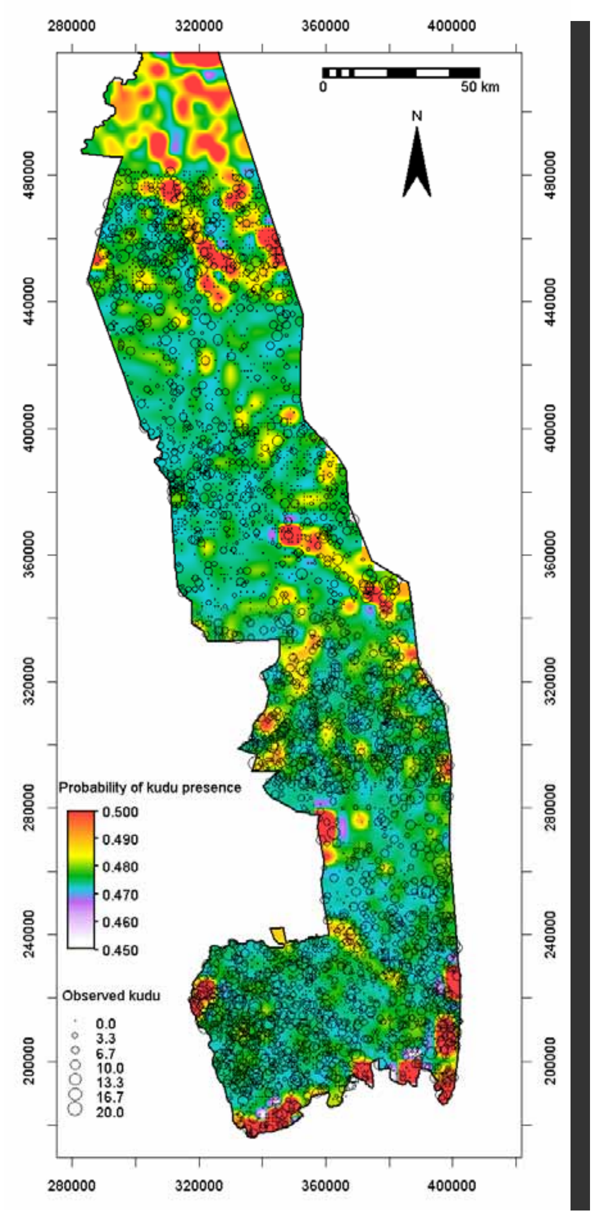
All 4 wildlife species Vs. spatial heterogeneity of NDVI



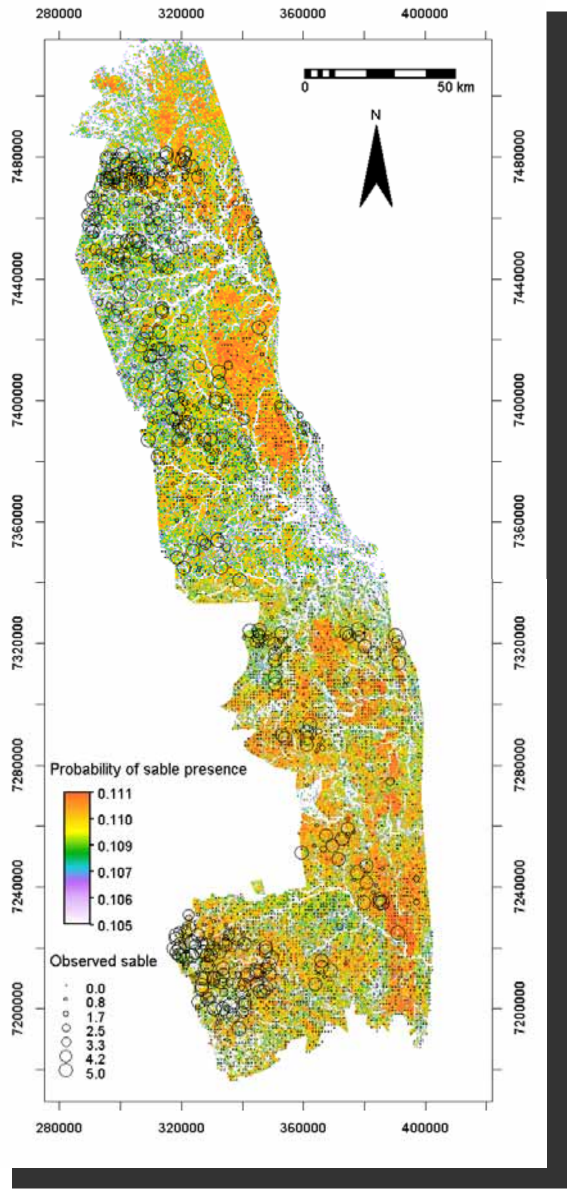
Impala, Giraffe & Kudu habitat at 1920 m dominant scale







Sable habitat at 240 m dominant scale



Conclusions

- Results indicate that impala, giraffe and kudu respond to larger dominant scales of spatial heterogeneity vegetation cover (i.e., 2000 m) compared with sable which responds to smaller dominant scales of spatial heterogeneity in vegetation cover (i.e., 240 m).
- Sable preference for smaller dominant scales show that densification of woody cover may result in less favourable conditions for its survival while the other 3 animals may well thrive under conditions of large scale vegetation variations

South African NATIONAL PARKS

ITC

Conclusions

- Remotely sensed data analyzed within the Intensity-dominant scale framework for characterizing spatial heterogeneity improves understanding of wildlife distribution
- We also conclude that wildlife species in the landscape are significantly spatially partitioned by dominant scale of spatial heterogeneity of vegetation cover.
- The results important to the management of spatial heterogeneity in savanna landscapes as a way to influence landscape occupancy by different wildlife species.

South African
NATIONAL PARKS

ITC

THANK YOU FOR YOUR ATTENTION

Amon Murwira, Andrew K. Skidmore, Bert Toxopeus, Rina Grant, Izak Smit

South African NATIONAL PARKS

ITC