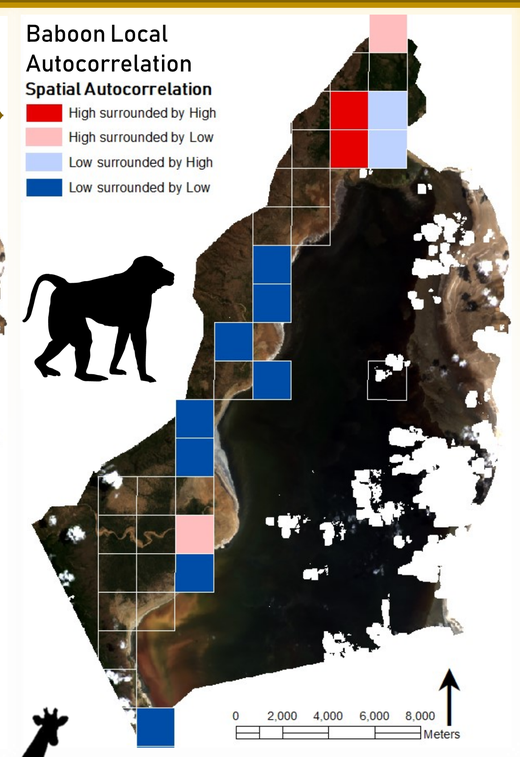
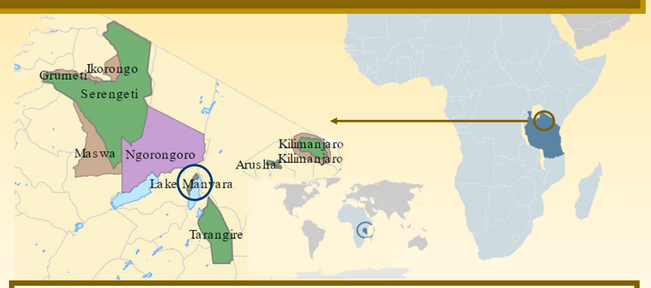
Clustering of mammals in Lake Manyara National Park, Tanzania

Introduction

Lake Manyara is a shallow alkali lake situated at the edge of the Eastern Great Rift Valley in Northern Tanzania. The National Park encompassing the northern and western edges of the lake is critical habitat for various species and is a popular destination for many tourists. The lake supports enormous populations of birds and dense populations of a various mammals.

The lake has seen significant changes over recent decades, however, due to expanded agriculture and pastoralism within its catchment basin in the local highlands and the nearby city of Mto wa Mbu. The effect of this on the species which reside in the park is unknown, although they themselves are experiencing increased poaching in the park and fragmented or degraded habitats neighboring the park. Understanding the distribution of species and where populations are centered may inform conservation and where to prioritize efforts in and around the park.





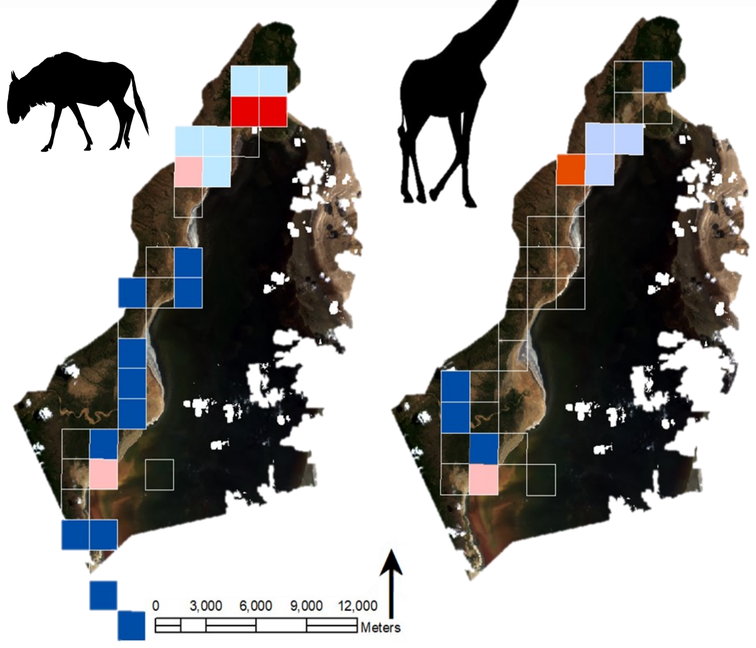
Lake Manyara

Lake Manyara is shallow with a pH of ~9.5. with about 470 sq. km of surface water during the wet season about 200 sq. km of the lake falls within Lake Manyara National Park itself. The park is a UNESCO Biosphere Reserve because of it's rich diversity and abundance of animal species.

Spatial Autocorrelation

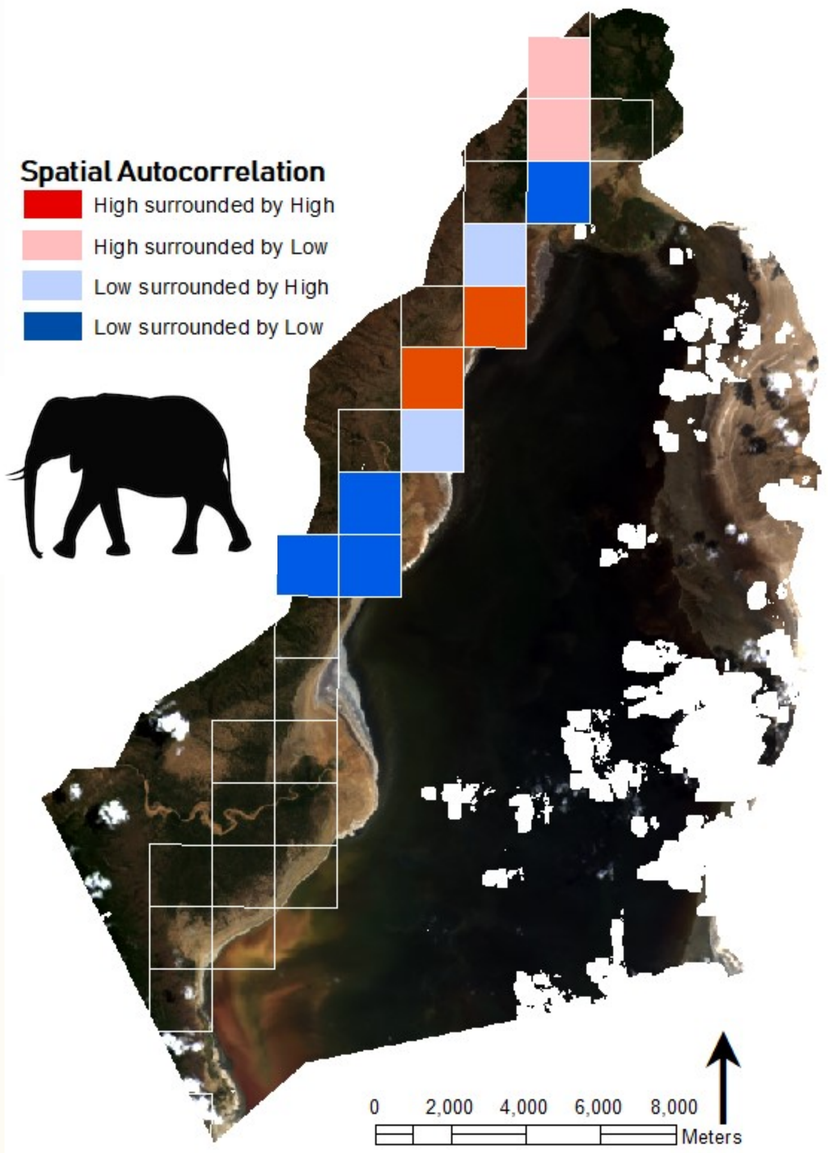
Species observations were made throughout the park from 2012 to 2017 and were analyzed to determine the location of clustering. Observations were collected into a grid and the local Moran's I of each species was calculated which gives a measure of local autocorrelation throughout the site. The resulting maps demonstrate where sightings of species were clustered; we see areas where species are seen higher relative to neighboring areas and vice versa. This was done for a variety of species (baboons, wildebeest, giraffe, impala, zebra, buffalo, hippo, warthog, elephant etc.) We can therefore see for any species areas with high density relative to surrounding areas etc. The nature of this clustering reveals areas that can be considered of high importance for species conservation.

Results for Baboons seem to suggest that groups in the northern part of the park have areas of high local clustering in certain parts of the groundwater forest with many lower observation areas in the west and south with one high area surrounded by lower areas. Similar patterns can be observed in both wildebeest and giraffes. This may be because these areas are particularly suitable for the animals in that they provide satisfactory food resources, cover from predators etc. Should these areas be refuge or population sources it would be necessary to prioritize protection or preservation in these areas of the park. It might also be useful information for travel companies in prioritizing where one might go to see certain animals if out on safari.



Elephants

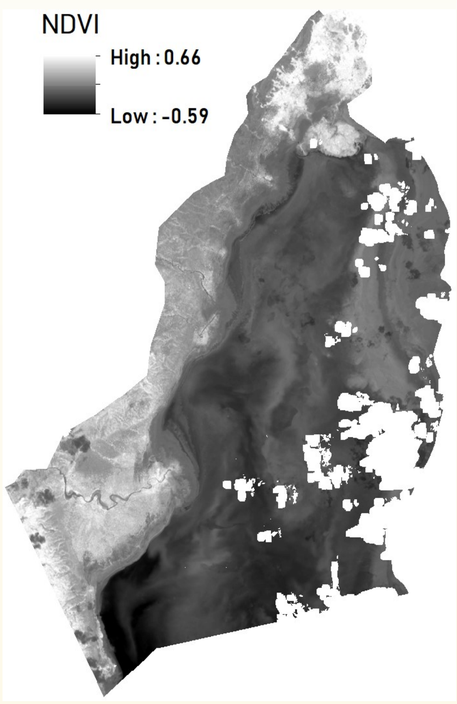
Only certain species show significant patterns of spatial autocorrelation. Sighting data makes it difficult to analyze the presence of rare or elusive species. For larger or more conspicuous species, however, it gives a generally good representation of that species' distribution. Elephants in Lake Manyara National Park have seen drastic declines in the past few decades. As a keystone species and iconic among tourists, elephants are integral to the well being of both the ecosystem and local economies. It appears that elephant clustering is marginally significant negative with respect to vegetative cover as measured by the NDVI ($p = 0.07$). Elephants here seem to cluster more heavily in areas of relatively lower vegetative cover. Though they are often seen in the forests here it seems they more commonly cluster in the open bushland and grassland along the western edge of the lake. It may be that these areas too are significant corridors for the elephants as they are known to frequently move between the high and low lands. The high surrounded by high areas and high surrounded by low areas may be most important in maintaining elephant populations and therefore may be a priority for ranger protection.



Remote Sensing

Satellite imagery was used to generate a Normalized Difference Vegetation Index (NDVI) for the park and northern part of the lake. A Landsat 8 imagery was used to create the NDVI of the park and lake in September of 2015 during the dry season. The NDVI uses red and near-infrared reflectance values to demonstrate for the entirety of the image where vegetation is most dense and reflective and areas that lack vegetation entirely. It does this on a scale from –1 to 1 (going from no vegetation to high vegetation respectively). More dense vegetation is found in the groundwater forest that covers the northern parts of the park while bushland and edaphic grassland cover the area west of the lake at the base of the Rift Valley escarpment. higher vegetative cover was observed in the wetlands at the northern drainage basin of the lake. The western boundary of the lake has been largely covered with grasses. The maximum extent of the lake is highly variable across years making the shoreline edaphic grassland

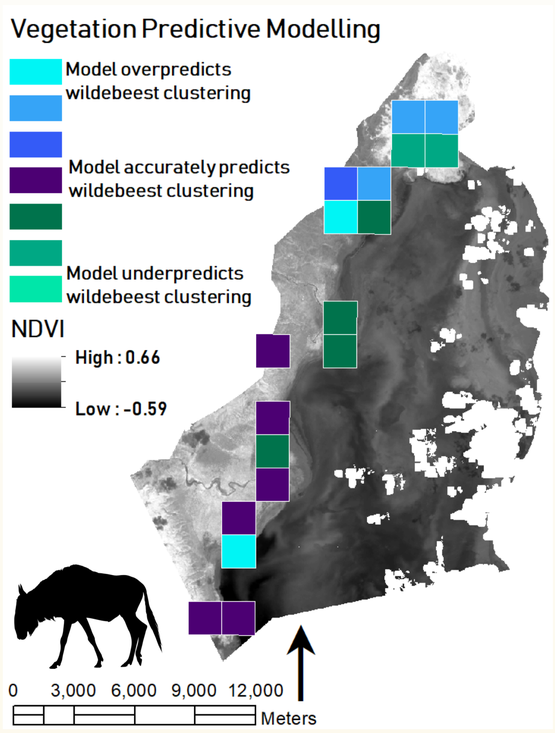
Quality assurance imagery associated with the Landsat image was used to account for cloud cover by using a mask.



Predicting Clustering with Vegetation

Vegetation may be able to predict the patterns of species abundance that are observed from calculating local autocorrelation. Ordinary least square regression uses average NDVI values for the each cell to predict its autocorrelation index which represents the magnitude and direction of autocorrelation. The result is a linear equation demonstrating how influential the effect of vegetation is on the pattern of clustering and if it's a significant predictor.

Vegetative reflectance is relatively accurate at predicting the clustering of wildebeest sightings in Lake Manyara ($p = 0.06$). In areas of the park with relatively higher vegetative groundcover wildebeest are more often seen. These results suggest that wildebeest sightings often occur and are clustered in areas of relatively high vegetative cover. The resulting map shows where the model accurately predicts the location of clusters based on standard deviations. The model we have assumes that wildebeest are more likely to be present in the heavily wooded ground-water forest in the north of the park whereas the model more accurately predicts the clustering of wildebeest in the southern plains.



Sources

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School for Field Studies, Center for Wildlife Management Studies
United States Geological Survey, Earth Explorer— Landsat 8
Esri—ArcMap 10.6.1 & Harris Geospatial Engineering—ENVI 5.5

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