EFFECTS OF HABITAT QUALITY ON ABUNDANCE AND DISTRIBUTION OF OLIVE BABOON Papio anubis IN YANKARI GAME RESERVE

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ABSTRACT

This study determined the abundance, density and distribution of Olive Baboon (*Papio anubis*) in relation to habitat quality in the Yankari Game Reserve. The integration of remote sensing, GIS, and statistical analysis provides a good tool for Olive Baboon distribution mapping and determination of habitat quality using Normalized Difference Vegetation Index (NDVI) and micro climatic variables. Habitat quality of Olive Baboon was described via Normalized Difference Vegetation Index (NDVI) as a measure of vegetation primary productivity, distance from water source, temperature, relative humidity and habitat types. Olive Baboons were more abundant in the gallery forest (1211) than in the savannah (414). The distribution map generated from the sightings of Olive Baboons during this study also agrees with the abundance result, revealing higher concentration of Olive Baboons in the gallery forest than in the savannah. The most widely used index of habitat quality is the population density that a habitat can support at carrying capacity; a quality habitat can support high population density. Result from this study showed that gallery forest had a higher density of Olive Baboons (0.261 Olive Baboons/ha) than the savannah with a population density of 0.042 Olive Baboons/ha. Olive Baboons in the Yankari Game Reserve tend to select better quality habitat, characterized by water source, high relative humidity, suitable NDVI values (0.38) and suitable temperature.

Keywords: Habitat quality; NDVI; Abundance; Distribution; olive baboon.

1.0. INTRODUCTION

Habitat for an organism can be defined as an area with the combination of resources and environmental conditions that favour a particular species' individual survival and reproduction (Morrison *et al*., 1992).

Habitat quality refers to the ability of an environment to provide appropriate conditions for individuals and population persistence. Habitat quality is a continuous variable, ranging from low rate which is based on the resources available for survival, median rate based on resources available for reproduction, and to high rate based on resources available for species persistence (Hall *et al.*, 1997). The quality of a habitat is a degree to which that habitat can supply resources required by species such as Olive Baboon for survival and reproduction within that habitat (Begon *et al.*, 1996; Krebs, 2001). Essential resources obtained by species from a quality habitat will be useful in maximizing their fitness and survive environmental conditions (Stiling, 1996). Habitat quality is considered based on the habitat's effect on survival and reproductive performance of individuals occupying a particular habitat. High quality habitat could increase the rate of survival and reproduction of an individual (Franklin *et al., 2000*).

Habitat alteration reduces habitat quality (Hoffman, 2011) and can have a dramatic effect on the availability and distribution of primate resources (such as shelter, food, water source and breeding ground) and this will in turn affect the primate spatial patterns and distribution. Habitat quality is the major factor that determines the distribution and

abundance of non-human primates (Olive Baboons) - high quality habitat has a great effect on their abundance and distribution (Zinner *et al*., 2001).

The IUCN red list of threatened species states that about 38% of primate species are considered threatened with extinction (IUCN, 2007). Habitat loss and degradation, agriculture, urban development, fuel wood collection and other anthropogenic activities such as pollution has caused threats to primates of the world. In addition there have been massive reductions in primate numbers because of live harvesting by commercial bush meat hunters (Mittermeier *et al*., 2007).

The most important index widely used for habitat quality is the density of a population that a habitat can support at carrying capacity; high quality habitat supports high population density and low quality habitat supports low population densities (Begon *et al.*, 1996; Krebs, 2001). Availability of food resources is the major factor that determines primate's population density (Chapman, 1999). Therefore, Olive Baboons are mostly found concentrated where the habitat provides quality food resources (Zinner & Torkler, 2002).

Therefore, in this study the effect of habitat quality on the abundance and distribution of Olive baboon was investigated. Abundance and distribution of Olive baboon was determined in relation to habitat quality (in terms of habitat type, vegetation primary productivity (Normalized Differential Vegetation Index (NDVI)), proximity to water source and microclimatic conditions; relative humidity and temperature). The study was able to look at the Olive baboon population density between the gallery and savannah habitat types in the study area.

2.0. MATERIALS AND METHODS

2.1. STUDY SITE

Yankari Game Reserve is located on the central co-ordinates 9° 45' 00''N and 10° 30' 00"E, and lies in the south-central area of Bauchi state in North-eastern Nigeria, in the southern portion of Sudan savanna zone (Green & Amance, 1987). Some 72Km north off the Bauchi-Gombe road at Dindima (Ezealor 2002). The Reserve covers an area of about 2,244Km^2 with a rolling hilly topography sloping towards centre and south (Green & Amance, 1987) with an altitude that ranges from 150-750m above sea level. The Gaji River as the major river in the Reserve (Ezealor, 2002). It experiences a mean annual rainfall of 900-1000mm during the wet season (May-September) with heaviest rainfall in August. Temperature ranges from 12-36˚C in dry season and 18-36˚C in the raining season (Crick & Marshall 1981).

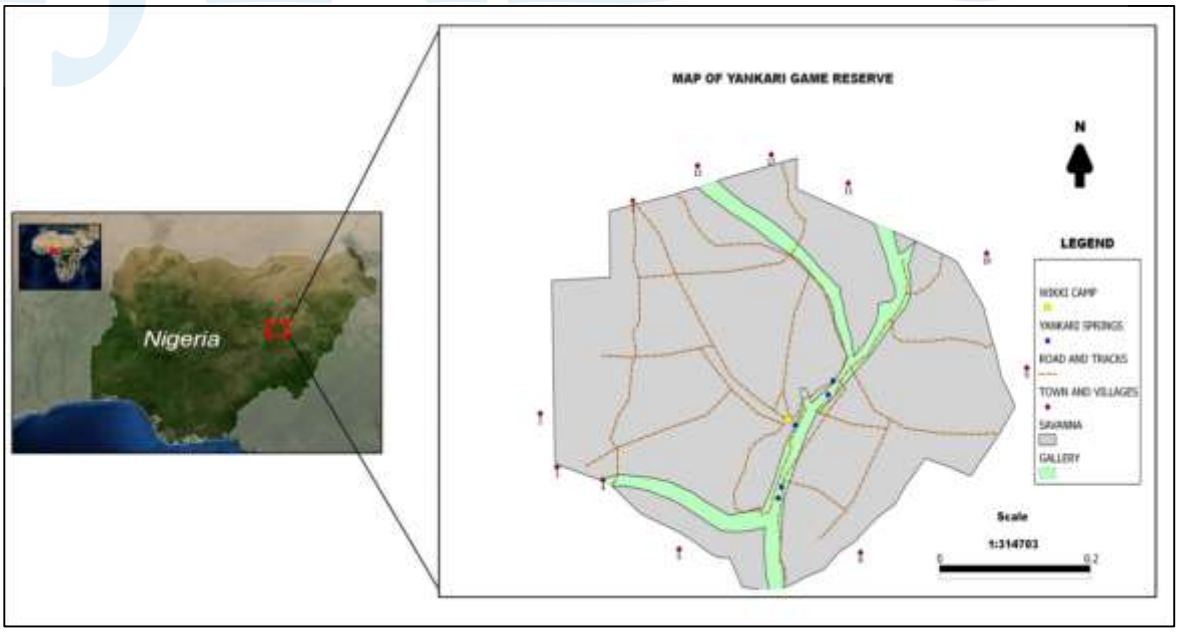

Figure 1: **Map of Yankari Game Reserve**

2.2. TRANSECT DESIGN

The line transect method was used to estimate Olive Baboon population and troop composition (Burnham *et al*., 1980 and Ajibade, 2011). A total of 50 transects, each measuring 5km in length with a minimum of 1 Km apart were selected along pre-existing tracks (Burnham *et al*., 1980). Each transect was visited 3 times at 2 different sessions of the day. A total distance of 1535 Km was covered during the transect survey. Thirty transects were placed in the savanna woodland and 20 in the gallery forest. The start and end of each transect was marked on a Global Positioning System (GPS) unit eTrex H.

2.3. BABOON COUNTS

Daily observations were carried out in two sessions. Morning session, between the hours of 06h30 and 11h00, and evening sessions, between the hours of 15h00 and 18h00. The survey was carried out from a vehicle moving at an average speed of 20km/h. Where the Olive Baboons are sighted during each visit, the following parameters were recorded: number of individuals in the troop, micro-climatic condition, habitat type, sex, age, adult and juvenile. A Global Positioning System (GPS) unit eTrex H was used to mark the geographical location of Olive Baboon and a laser range finder was used to measure the perpendicular distance from the transect to point where Olive Baboon is sighted.

2.4. MEASUREMENT OF HABITAT QUALITY

In this study Olive Baboon habitat quality was measured in terms of vegetation primary productivity by calculating the Normalized Differential Vegetation Index (NDVI) from landsat ETM+ satellite image, habitat type, temperature, relative humidity and proximity

to water source. Temperature of points where Olive Baboons are found was measured using a thermometer. The dry and wet humidity was recorded using a whirling hygrometer and the values obtained were used to calculate the relative humidity of any point where Olive Baboon was sighted.

2.5. SATELLITE DATA ACQUISITION AND PROCESSING

Satellite imagery of Yankari Game Reserve was ordered on-line via lansat.org/ Tropical Rain Forest Information Center (TRFIC). A single scene path 187 and row 053 of land sat imagery with 30 x 30m resolution after rectification was captured by a sensor called Enhance Thematic Mapper (ETM+). The image bands were layer stacked and sub-mapped to get the imagery of the reserve using GIS software (ERDAS). Normalized Difference Vegetation Index (NDVI) was generated from a geo-corrected scene of land-sat Enhance Thematic Mapper (ETM+) using ILWIS 3.2. It is a simple formula using two satellite channels :(NDVI = (NIR-VIS)/ (NIR+VIS)). Where NIR is near infrared and VIS visible spectrum. For this study two spectral bands (3 and 4) were used to calculate NDVI values of Yankari Game Reserve (Santin-Janin *et al.,* 2009). The NDVI values were extrapolated by overlaying baboon points on the NDVI layer; values for each pixel were recorded. Data generated from NDVI was used as a means of quantifying above ground primary productivity of the habitat (Tucker 1979).

2.6. DISTANCE FROM WATER SOURCE

The co-ordinate locations of Olive Baboon from the GPS were used to generate Olive Baboon point layer. The Olive Baboon point layer was superimposed on the map of Yankari Game Reserve which shows Gaji River as the major water source. Distance to

water source was measured by recording the distance between the water source and points of Olive Baboon sighting using QGIS distance tool. For this study all Olive Baboon points found between 0 and 1000m were considered near to the water source while those found greater than 1000m were considered far from the water source.

2.7. DATA ANALYSIS

Data obtained from this study was compiled using Microsoft Excel and all statistical analyses were performed using R-statistical package version. A generalized linear model (GLM) was used to determine the effect of temperature, relative humidity and Normalized Difference Vegetation Index (NDVI) on the abundance of Olive Baboons.

Student's t- test was used to compare the effect of habitat types on the mean abundance of Olive Baboons between gallery and Savanna habitats.

Chi-square test was used to test the effect of distance from water source (Gaji River) on the number of Olive Baboons. Distance software version 4.0 was used to estimate the Olive Baboon population density (individuals per ha). And the Student's t- test was used to compare the density of Olive Baboons between habitats. All the statistical analysis was considered significant at the 0.05 level.

Spatial distribution of Olive Baboons was analyzed using QGIS software version 1.7.2 and Global Positioning System (GPS) unit Garmin eTrex H. The GPS co-ordinates of Olive Baboon sightings were imported into QGIS environment, the points were used to generate a distribution layer.

3.0. RESULTS

A total of 1625 Olive Baboon were recorded during this survey. Of this number, (414) 25.5 % of the total number observed was found in savanna and (1211) 74.5 % were found in the gallery forest habitat. Of the total number of individuals recorded, 1228 were sexed; and (469) 38.2% were males and (759) 61.8% females.

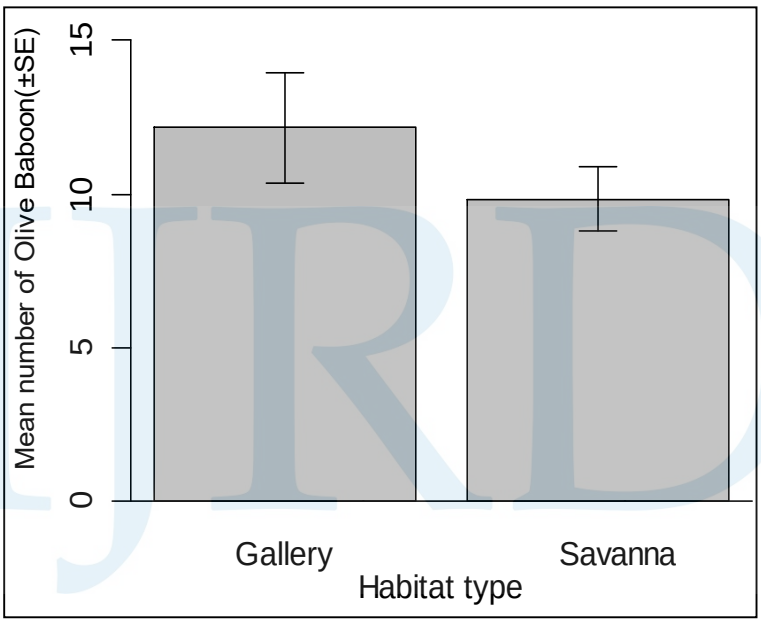

Figure 2: Mean number of Olive Baboon in gallery and savanna habitats in the Yankari Game Reserve

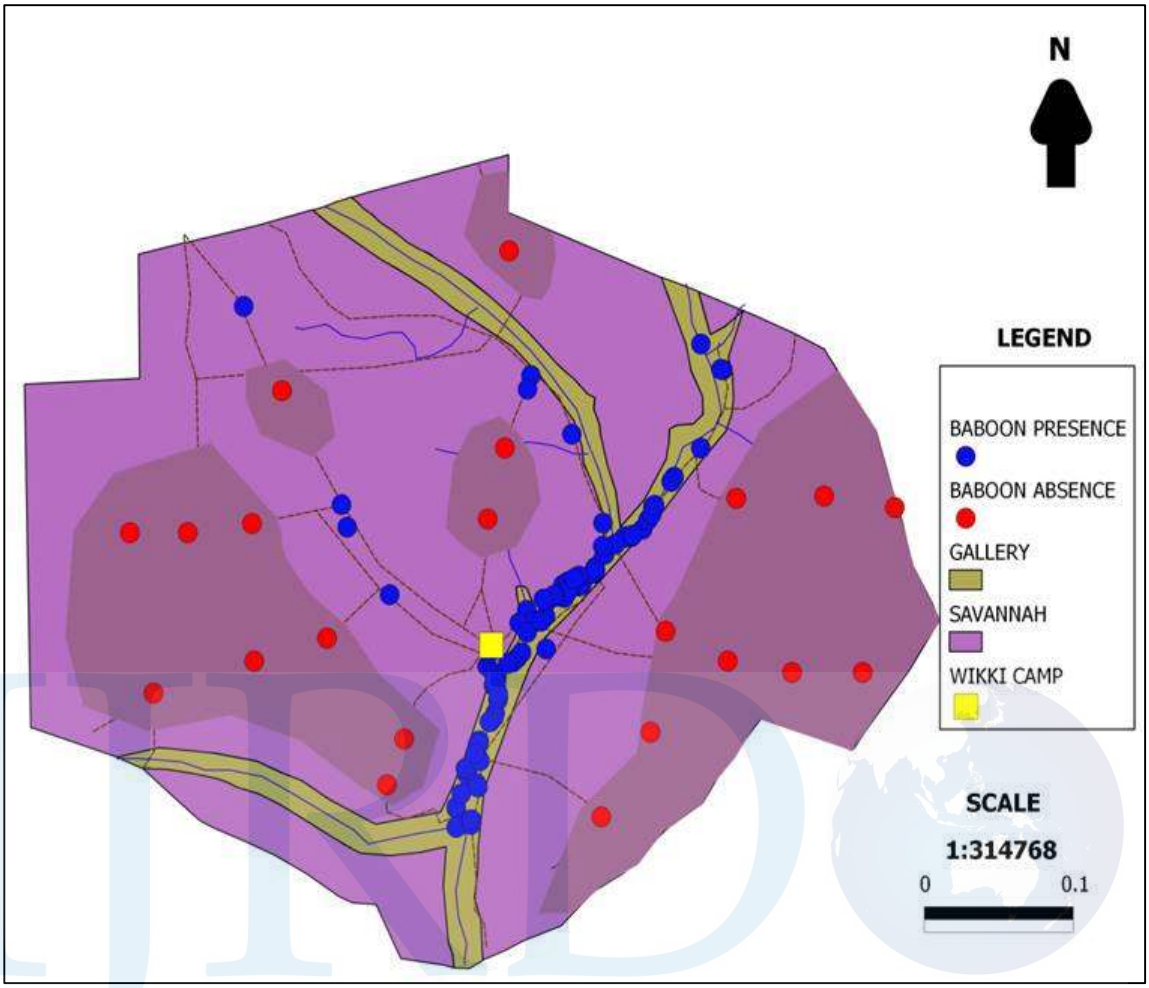

Figure 3: Distribution map of Olive Baboon in Yankari Game Reserve.

The distribution maps generated from the sightings of Olive Baboons during this study also show a higher concentration of baboons in the gallery forest and a much lower concentration in the savanna (Figure 3).

Olive Baboons were more abundant in the gallery forest (1,211 individuals) than in the savanna (414 individuals; figure 2). However, there was no significant difference in the mean abundance of baboons between habitats (t=1.7, df=92, P=0.09).

3.1. EFFECT OF HABITAT QUALITY ON ABUNDANCE OF OLIVE BABOON

Table 1: Relationship between abundance of Olive Baboon and Temperature, Relative humidity, Habitat type and NDVI Model <- (Olive Baboon abundance= temperature + habitat type +relative humidity. + NDVI * habitat type) Dependent variable=Olive Baboon abundance

Variables	DOF	Deviance	Resid DOF	Resid. Dev	Estimate	SE	z value	P value
(Intercept)			109	558.52	3.731	0.505	7.39	**<0.001**
Temperature	1	26.9638	108	531.56	-0.038	0.011	-3.32	**<0.001**
Habitat savanna	1	24.8823	107	506.68	-0.967	0.297	-3.26	**0.001**
Relative humidity	1	4.4168	106	502.26	0.006	0.003	2.38	**0.02**
NDVI	1	2.8455	105	499.42	-1.505	0.570	-2.64	**0.008**
Habitat (savanna)* NDVI	1	4.6332	104	494.78	2.219	1.044	2.13	**0.03**

Null deviance: 558.52 on 109 degrees of freedom
Residual deviance: 494.78 on 104 degrees of freedom
AIC=948.38.

3.2. EFFECT OF TEMPERATURE

The temperature where Olive Baboon was observed ranged from 22°c to 39°c. The number of Olive Baboon significantly decreased with increase in temperature (table 1, figure 4).

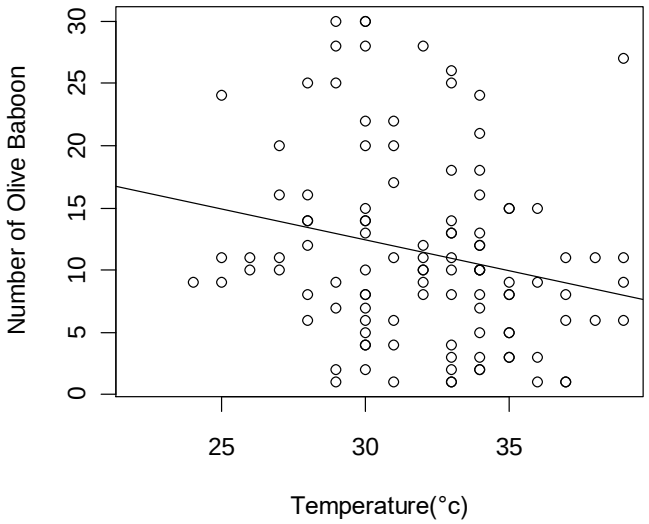

Figure 4: Effect of temperature on the number of Olive Baboon in Yankari Game Reserve.

3.3. EFFECT OF RELATIVE HUMIDITY

The number of Olive Baboon increased with increasing relative humidity (table 1, figure 5)

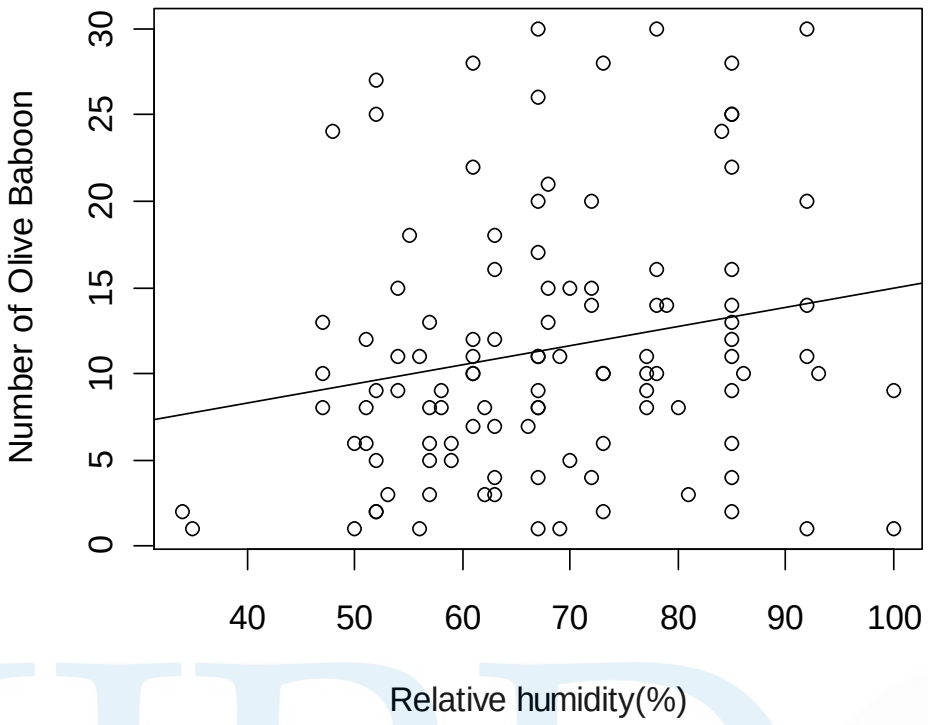

Figure 5: Relationship between relative humidity and the number of Olive Baboon in Yankari Game Reserve.

3.4. DISTANCE TO WATER SOURCE

Olive Baboons occurred more in areas that were near to water source classified as (0-1Km) than areas that were far from water source classified as (> 1Km). Chi-sq test showed a significant difference in the number of Olive Baboon found between near and far from water source (chi-sq=252.8, P< 0.0001)

3.5. RELATIONSHIP BETWEEN NDVI VALUES AND OLIVE BABOON ABUNDANCE

Table 2: Relationship between Olive Baboon abundance and NDVI values in the savanna habitat

Model (Olive Baboon abundance= Temperature + Relative humidity + NDVI)

Variables	DOF	Deviance	Resid. DOF	Resid. Dev	Estimate	SE	z value	P value
Intercept			34	123.16	2.92	0.96	3.04	**<0.001**
Temperature	1	3.7508	33	119.41	-0.03	0.02	-1.39	0.16
Relative humidity	1	0	32	119.41	0.00	0.01	<0.001	1.00
NDVI	1	0.7438	31	118.67	0.74	0.87	0.85	0.39

Null deviance: 123.16 on 34 degrees of freedom

Residual deviance: 118.67 on 31 degrees of freedom

AIC= 263.61

Table 3: Relationship between Olive Baboon abundance and NDVI values in the gallery habitat

Model (Olive Baboon abundance= Temperature + Relative humidity + NDVI)

Variables	DOF	Deviance	Resid. DOF	Resid. Dev	Estimate	SE	z value	P value
Intercept			74	423.82	4.00	0.60	6.69	**<0.001**
Temperature	1	43.068	73	380.75	-0.05	0.01	-3.50	**<0.001**
Relative humidity	1	5.001	72	375.75	0.01	<0.001	2.56	**0.01**
NDVI	1	6.404	71	369.34	-1.47	0.57	-2.56	**0.01**

Null deviance: 423.82 on 74 degrees of freedom

Residual deviance: 369.34 on 71 degrees of freedom

AIC= 682

The relationship between abundance of Olive Baboon and NDVI values varied significantly between habitat types (table 1; p=0.03). In the savanna Olive Baboon abundance increased with increase in NDVI values (p=0.39; table 2, figure 6) , while in the gallery forest Olive Baboon abundance decreased significantly with increase NDVI values (p=0.01; table 3; figure 6).

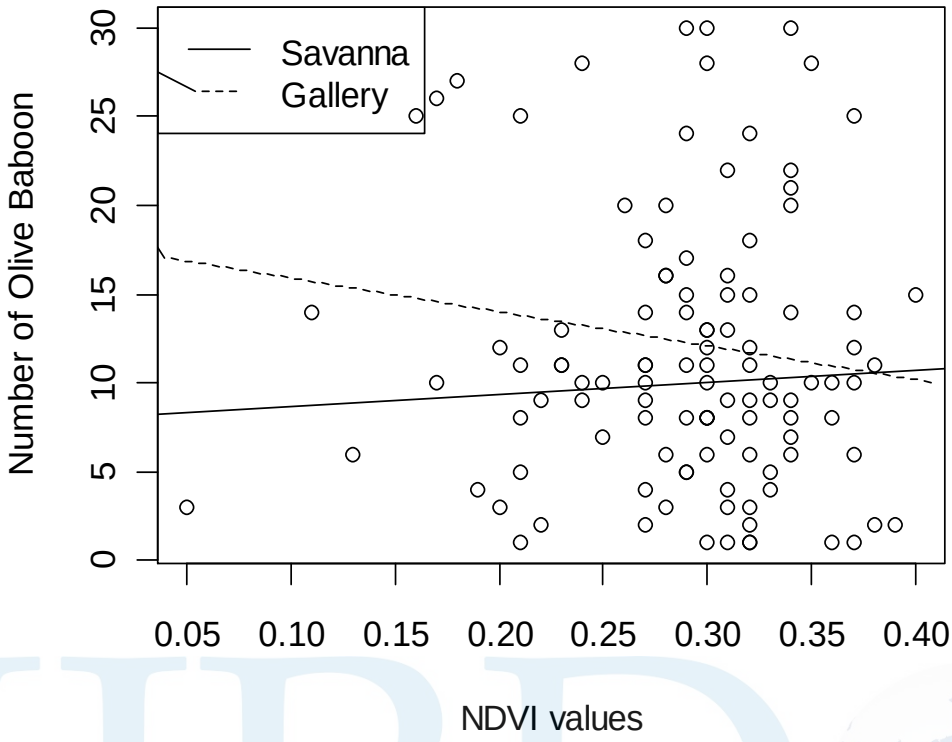

Figure 6: Relationship between NDVI values and number of Olive Baboon in Yankari Game Reserve

3.6. POPULATION DENSITY OF OLIVE BABOON

The population density of Olive Baboons in Yankari Game Reserve was estimated to be 0.003 baboons/ha (95% CI=0.002-0.004). There was higher density in the gallery forest (0.261 ± 0.01 baboons/ha) than in the savanna (0.042 ± 0.003 baboons/ha). Although, t-test showed no significant difference (t=1.38, df =1, p=0.39).

4.0. DISCUSSION

4.1. ABUNDANCE AND DISTRIBUTION

Habitat quality is the major factor that determines the distribution and abundance of Olive baboon in the study this finding agrees with study by Zinner *et al*., (2001). In his findings, non-human primates were attracted by habitat quality characterized by food resources availability.

Okecha & Newton-Fisher, (2006) reported that Olive Baboon feeds predominantly on the plant matters such as fruits, leaves, stems, and roots. In Yankari, it was observed that olive baboon spent more time feeding on plant materials. One of the favourite fruits for the Olive Baboon is *Borassus aethiopium*, one of the dominant fruiting trees in the gallery forest, during the period of this study. This make the gallery forest a higher quality habitat to occupy, therefore explaining the reason for the higher abundance, higher density and higher occurrence of Olive Baboon in the gallery forest than in the savannah. During this study baboons were observed foraging more in the gallery forest than in the savannah.

4.2. EFFECT OF HABITAT QUALITY ON OLIVE BABOON ABUNDANCE

In this study habitat quality for Olive Baboon was determined using microclimatic conditions; temperature and relative humidity, vegetation primary productivity using NDVI, habitat types, and distance to water source. The GLM showed that all these parameters were significant in determining the abundance of Olive Baboon in the Yankari Game Reserve (table 1).

4.3. EFFECT OF TEMPERATURE AND RELATIVE HUMIDITY

The result of this study showed that Olive Baboon was recorded in higher abundance in place with lower temperature and in lower abundance in places with higher temperature. The act of seeking shade and cooler environment may also account for the higher occurrence of the Olive Baboon in the gallery forest, (which has big trees with thick canopies and provide a cooler environment), than in the savannah. Studies by Hill, (2006) reveals that Maximum temperature affects the foraging activity of Olive Baboon, high temperature may lead them to seek for shade and cool environment. May also account for the higher occurrence of the Olive Baboon in the gallery forest, (which has big trees with thick canopies and provide a cooler environment), than in the savannah. There was a positive relationship between the number of Olive Baboons and relative humidity (figure 5) the relative humidity was very high in the gallery forest due to presence of tick vegetation cover which reduces the rate of evaporation. Study by Blondel (1991) suggests that effects of extreme climatic conditions may be overcome by a high quality habitat.

4.4. EFFECT OF DISTANCE FROM WATER SOURCE

The number of Olive Baboon was significantly different with distance to water source. More Olive Baboons were found close to water source, which means water is an important resource for the Olive Baboons; therefore water is an important factor that influences the abundance of Olive Baboon in Yankari Game Reserve. This is in line with the study by Zinner *et al.*, (2001).

4.5. EFFECT OF NDVI ON OLIVE BABOON ABUNDANCE

The NDVI values of Yankari ranged from 0.02 to 0.4 this shows that the vegetation of Yankari Game Reserve is healthy. Healthy vegetation with higher NDVI normally has a higher primary productivity in plants matters (fruits, leaves, stems and roots) this is in line with the studies reported by Kidwell, (1990). The result of the analysis shows a negative relationship between NDVI values in the gallery forest and Olive Baboon abundance while in the savannah is showing a positive relationship. This is an indication that there is a threshold of NDVI values that the Olive Baboon can tolerate in Yankari Game Reserve and once that value is exceeded, Olive baboon may not utilize such habitat. This threshold value is the point at which the slopes for the gallery forest and the savannah intercept on the graph (approx 0.38; Figure 6). Although high NDVI value means a higher productivity and as a result, more food for the Olive Baboon, at the same time, it seem when the vegetation becomes too think, it is unfavourable for the Olive Baboon, probably because it implies less visibility, therefore more prone to danger from predators. This does not reduce the value of the gallery forest in the sight of the Olive Baboon, rather they simply avoid areas with NDVI value higher than 0.38.

4.6. POPULATION DENSITY

Begon *et al.*, (1996) and Krebs, (2001) report that the most widely used index of habitat quality is the population density that a habitat can support at carrying capacity; high quality habitats support high population density.

From the result of this study, the density estimate of Olive Baboon showed that gallery forest was more densely populated than the savannah. This therefore means that for the

Olive Baboons in Yankari Game Reserve, the gallery forest is of higher quality than the savannah.

4.7. CONCLUSION

From this study, habitat quality had an overall effect on the abundance and distribution of olive in Yankari Game Reserve. Olive Baboons were found more in gallery forest than in the savannah; this is because gallery forest provides higher primary productivity (NDVI values of to 0.4), good source of drinking water, good microclimatic conditions, and availability of vegetation matters which serve as food for Olive baboon. This study has shown that habitat with low temperature, high relative humidity, higher primary productivity (NDVI values of to 0.4) and habitat types are important in explaining the preferred habitat of Olive Baboon in the Yankari Game Reserve.

4.8. RECOMMENDATIONS

With these findings, it is observed that vegetation cover forms a major resource utilized by Olive baboon for food and shelter. I therefore recommend, to the Government of Bauchi State to develop a proper management and conservation plan of vegetation cover from illegal cutting down trees and other human activities that will affect the reserve, this will enhance the conservation of olive baboon and other biodiversity in Yankari Game Reserve. And the Olive Baboon population estimate from this study can be used to monitor Olive Baboon population changes in Yankari Game Reserve. And more research work should be carried out in Yankari Game Reserve to also look at the effect of food availability and seasonal variation on the abundance and distribution of Olive Baboon in the Yankari Game Reserve.

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