NIGERIAN JOURNAL OF WILDLIFE MANAGEMENT 2020 VOLUME 4, ISSUE 1

Wildlife for Sustainable Development

NIGERIAN JOURNAL OF WILDLIFE MANAGEMENT

Published by
WILDLIFE SOCIETY OF NIGERIA
2020 Volume 4, Issue 2

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Wildlife for Sustainable Development

Nigerian Journal of Wildlife Management

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https://wildlifesocietyng.org/ojs/index.php/wildlifesocietyng-journal/index ISSN 2735-9298 (PRINT) ISSN 2735-928x (ONLINE)

Resource selection modelling of Bushbuck (*Tragelaphus scriptus)* in Iwofin Forest, Ogun State, Nigeria.

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ABSTRACT
Resource selection modelling has become a useful ecological concept for quantifying wildlife-habitat relationships. Bushbuck (*Tragelaphus scriptus*) is well-known wildlife species in West African sub-region with a few documented evidence of their present population status. The study conducted a logistic regression modelling of bushbuck presence-absence data collected with a handheld Global Positioning System (GPS) from Iwofin Forest in Ogun State, Nigeria to predict their resource selection use for survival. The resource selection model showed that there was high probability (0.45 - 0.72) of resource selection by bushbucks in Iwofin Forest at areas that are closer to the watershed and of lower elevations covering about 45% of the entire 65.81 hectares. The study concluded that the resource selection model would assist in identifying bushbuck habitats towards developing suitable conservation plans for their management in Iwofin Forest.

Keywords: *Tragelaphus scriptus*, Resource Selection Function (RSF), Logistic Regression, GIS

INTRODUCTION
Wildlife habitats are places of safety that provide resources such as food, cover, water for the survival and procreation of wildlife species (Van Beest, Mysterud, Loe, & Milner, 2010). Vegetation composition and resource distribution of most wildlife habitats are reflections of the physical structures of the environment, and therefore, the survival of wildlife species is greatly influenced by the physical and vegetation structures within their habitats (Rovero, Martin, Rosa, Ahumada, & Spitale, 2014). The availability, selection and utilization of resources by wildlife species are some of the key ecological concepts now being studied to understand how to effectively predict wildlife species interactions with their environment for conservation and management purposes (Loe, Bonenfant, Meisingset, & Mysterud, 2012). Understanding the abundance and patterns of distribution of resources in wildlife habitats have assisted tremendously in monitoring, tracking the movement of wildlife species and how they use space and resources (McLoughlin, Morris, Fortin, Vander Wal, & Constasti, 2010).

Resource selection describes the quantity of habitat materials utilized by wildlife populations among several other alternatives available within the habitat (Alldredge & Griswold, 2006). Resource selection modelling has become one of the most popular procedures deployed by scholars in recent times to explore interactions between wildlife species and their environment (Loe, Bonenfant, Meisingset, & Mysterud, 2012). Home

range modelling (Moorcroft & Barnett, 2008); habitat suitability modelling; and resource probability selection function (Loe, Bonenfant, Meisingset, & Mysterud, 2012) are various methods that have been used extensively to explore relationships between wildlife species and their environment. (McLoughlin, Morris, Fortin, Vander Wal, & Constasti, 2010). Generally, resource selection modelling involves the fitting of generalized linear regression with a logit link containing dichotomous variables of "use-available" dependent variables and a host of categorical and/or continuous predictor variables to obtain a resource selection probability function that best describes the habitat suitability scenario for a particular wildlife species (Boyce, et al., 2003). In ecological modelling with Geographic Information System (GIS), resource selection concepts have been increasingly applied to wildlife habitat study for the development of conservation strategies for mitigating wildlife species extinction and habitat loss (Hirzel & Le Lay, 2008).

Tragelaphus scriptus is considered one of the most abundant antelopes in the Sub-Saharan African continent occurring from Senegal through the Gambia in West Africa to the Cape Province in South Africa (Wronski, Apio, Wanker, & Plath, 2006). Considering the significance of *Tragelaphus scriptus* as a relatively cheap source of proteins and revenue for local hunters in most parts of Africa, this important wildlife species is prone to be endangered in the nearest future (Sillero-Zubiri, 2007). It, therefore, becomes essentially necessary to understand their habitat preferences to develop effective conservation strategy (Yosef, Addisu, & Girma, 2015). Predominant populations of *Tragelaphus scriptus* were mostly observed in the savannas and plains of West African countries such as Senegal, Gambia, Guinea, Ghana and Nigeria (Wronski & Moodley, 2009). Previous ecological studies have mainly emphasized the feeding habit, nutrition, habitat selection (Boyce, et al., 2003) of the Eastern and Southern African subspecies of bushbuck with just a few documented information on the West African bushbuck (Smits, 1986).

Tragelaphus scriptus is small to medium-sized antelopes widely spread across West and Central Africa, belonging to the family Bovidae, and are generally referred to as Bushbuck (Wronski & Moodley, 2009). The small/medium-size body of *Tragelaphus scriptus* makes it different from other closely related tragelaphine antelopes such as *Trageloaphus angasi* –'Nyala' (Wronski & Moodley, 2009). 'Nyala' and Bushbuck show remarkable similarity in physical appearance, and they co-exist in the same area for food and habitat (Wronski, Apio, Wanker, & Plath, 2006). In parts of West Africa, bushbuck is widely recognized as more important and economically relevant than the 'Nyala' (Smits, 1986). Previous studies have identified bushbuck as solitary bush dwellers, selective browsers feeding on the highly nutritive vegetative plant in open savannas and around watersheds (Smits, 1986). Due to the economic importance of bushbuck to local hunters as a relatively easy and cheap source of revenue, their exploitation has continued to increase leading to a steady decline in their populations (Sillero-Zubiri, 2007; Evangelista, 2006). Habitat fragmentation and habitat loss, which impact directly on the availability of resources to the wildlife (Evangelista, 2006), are becoming increasingly apparent following evidence of anthropogenic activities (Kumar & Ram, 2005) in land clearing for arable farming, overgrazing through cattle herding, illegal logging, un-managed fuelwood collection and infrastructural development (Nigatu & Tadesse, 1989). The study aimed to develop a resource selection model for *Tragelaphus scriptus* in Iwofin Forest, Ogun State using logistic regression and Geographic Information System (GIS) in predicting their resource preferences and promoting their habitat protection and conservation.

METHODOLOGY

Study Area

Iwofin Forest is located in Ogun State, Southwest Nigeria from latitude 7°12'0" N to 7°24'0" N, and longitude 3°07'0" E to 3°18'0" E. (Figure 1). The forest enclave covers an area of approximately 65.81 hectares. It appears to be highly degraded and is gradually becoming a derived savanna type of ecosystem due to increased anthropogenic activities such as fuelwood gathering, land clearing for arable farming and cattle herding (Adesegun, Adesegun, Odulana, Ojelade, & Ogunbanwo, 2017). It is characterized by woody

species that include *Anogeissus leiocarpus*, *Pterocarpus erinaceus* and grasses (e.g. *Andropogon gayanus*, *Hypharrhenia* sp, *Anchomanes dalzielii*) widely spread across the ecosystem.

Annual rainfall of between 100mm and 200mm Hg occurs from April to November with bi-modal peaks in June and October (Oduntan, Soaga, Akinyemi, & Ojo, 2013). Relative humidity ranges between 60% and 80% in the dry season, and above 80% with a mean maximum daily temperature ranging from 28° C to 32° C (Oduntan *et al.*, 2013). The topography is undulating at an elevation of between 30 m and 200 m above sea level with a distinct watershed traversing the Northwest – Southeast direction (Figure 1).

Iwofin, established in the 18th century, is one of the most important towns within Yewa Division of Ogun State. Apa, Ajero and Gbopaehin are some of the notable settlements in the town (Figure 1). Other major neighbouring towns include Ilaro, Ayetoro, Olorunda, Olubo, Imeko, Ipokia, and Igbogila. The inhabitants are primarily vegetable farmers and hunters who predominantly hunt for antelopes. They also produce food and cash crops such as cassava, maize, melon, cashew, citrus and kola and some of the inhabitants are into artisanal textile processing (Oduntan *et al.*, 2013).

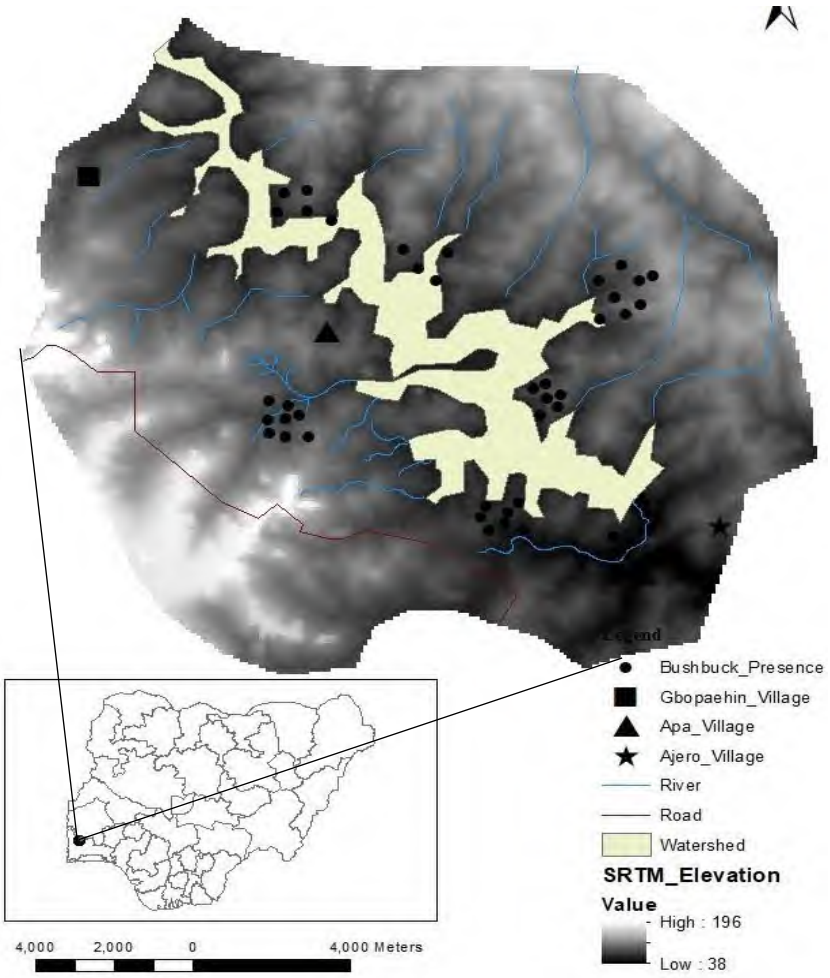

Figure 1 – Map of Iwofin forest. Inset-Map of Nigeria showing Iwofin Forest.
Source: Researcher, 2019.

Data collection

Collection of data was done along strip transect (300 m x 8 km) established by compass bearings within the study area (White & Edwards, 2000). Three observers and a local hunter walked a total of 8 km by 300 m strip random transects across the entire study area. The hunter guided the lead-member of the crew by walking a transect supported at 150 m strip on each side from the central line, walked by the remaining two (2) members of the crew. The crew was careful to observe indicators of bushbuck sightings, vocalizations and cues such as footprints, tracks, carcasses, scat piles and food remains. Two pairs of binoculars and a hand-held GPS (Garmin e-Trex 20) were carried to observe and record geographic coordinates (locations) of bushbuck sightings. Digital camera (Canon Powershot ELPH 360) was also used to take snapshots of bushbuck locations and their cues such as scat piles, footprints and food materials (Figure 2). The relief features observed during the field survey were also recorded.

Figure 2 – (L-R) Dead Bushbuck, Footprints, Scat piles, Anchomanes dalzielii

Source: Field Survey, 2019.

Data processing and preparation

Studies have shown that vegetation cover are affected by topography - elevation, relief – such that sun-facing slopes and hill shades are reflected differently by plant canopy which consequently affect the available plant resources for wildlife consumption (Bian & Walsh, 1993; Li & Wong, 2010). Digital Elevation Model (DEM) data were obtained from the National Aeronautics and Space Administration's (NASA's) Shuttle Radar Topographic Mission (SRTM) available on the website of the United State Geological Survey (USGS). 3-arc second SRTM's digital elevation data (vertical accuracy of 16 m) were downloaded in GeoTiff format and used for the data modelling in GIS (Farr & Kobrick, 2000).

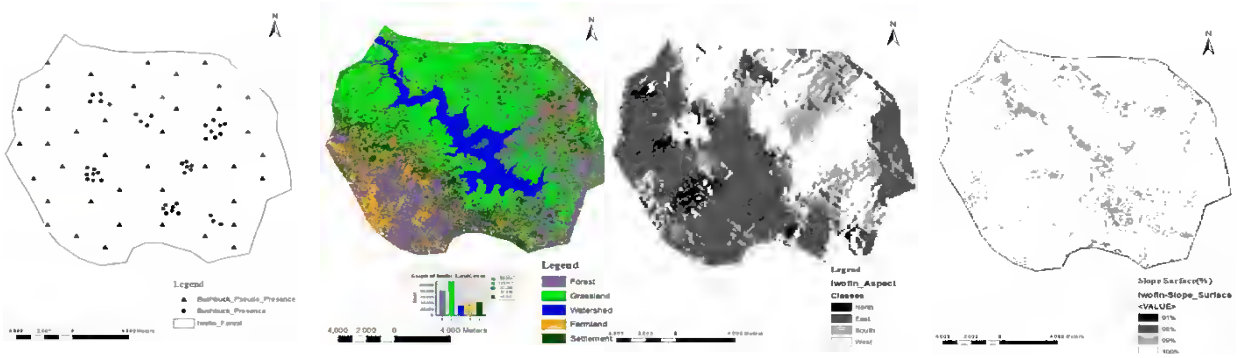

Figure 3 – (L-R): Bushbuck locations, Landcover types, Aspects and Slopes of Iwofin Forest

Relief features that include watersheds, rivers, lakes and other physical features such as roads, campgrounds and settlements observed during the data collection were obtained from the topographic map of Ogun State and digitized as map layers in GIS environment. Forty-one (41) presence points of bushbuck sightings were recorded and uploaded as a single (GIS) shape file (Figure 3). Randomly generated absence points of bushbuck were also created as another GIS layer (Figure 3). These two sets of points were merged to create a single dichotomous dependent variable of presence and absence points used in the binary logistic regression modelling (Warton & Geert, 2013). Satellite imagery from the United States Earth Explorer Landsat 8 image scene taken on board Operational Land Image (OPI) and the Thermal Infrared Sensors (TIRS) at 30-m spatial resolution (USGS, 2019) was also downloaded in GeoTiff format in January 2019 for the study area. The DEM data and the image data (Landsat) were projected to Nigeria's geographic coordinate system (Universal Transverse Mercator - UTM WGS84 Zone 31N) and clipped to the study area. Surface slopes and aspects (Figure 3) were derived from the SRTM's DEM using ArcGIS 10.3 Spatial Analyst tool (ESRI, 2015). Based on prior knowledge of the observed vegetation features during the field survey and the features evident in the topographic maps of the local area, land-cover in the Landsat image scene for the study area was categorized using the supervised classification algorithm (maximum likelihood function) in ArcGIS into the forest, grassland, watershed, farmland and settlement (Figure 3). The response variables for this study were represented in vector format in ArcGIS as point shape file. However, all the explanatory variables used in the model were processed in raster format including the road, river and watershed features for which their Euclidean distances were derived and used directly in the model. Pixel values of the rasterized explanatory variables were extracted to the bushbuck points using the multi-extraction tool in ArcGIS (ESRI, 2015).

Data analysis and model assessment

Generalized linear model with a binomial logit link function was used to perform the statistical analysis on the generated data. The general logistic model is described by the equation presented in equation (1). The full model was run in R statistical package 3.5.2 (R Core Team, 2013) and a stepwise backward selection model procedure with Akaike Information Criterion (AIC) was used to select the parsimonious model containing significant variables that best explained the presence or otherwise of bushbuck in the study area. Non-significant variables (i.e. variables with high p-values) were iteratively removed from the model and the outputs assessed in turn using their AIC values. Model with the lowest AIC value was adjudged to be most parsimonious (Harrel, 2001). Estimates of the parsimonious model were extracted and then used to create the resource selection model of bushbuck using the Raster Calculator tool in ArcGIS 10.3 (Pearce & Ferrier, 2000).

$$Log\left(\frac{P}{1-P}\right) = \beta + \beta 1X1 + \beta 2X2 + \cdots + \beta nXn \ldots \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Where: P – Probability of presence

β – Intercept of the model

$\beta_{(1-n)}$ – i th coefficient of the model

$X_{(1-n)}$ – X^{th} explanatory or independent variable

n – number of explanatory or independent variables

RESULTS

The candidate models and their corresponding AIC values are as presented in Table 1. The full model that included all the explanatory variables had the highest AIC value of 97.002 while the selected model with the lowest AIC value (82.651) consisted of distance to watershed and elevation. The estimates of the selected model were -327.65 and -0.058 for distance to watershed and elevation respectively as presented in Table 2. Figure 4 also shows inverse relationships between the log odds of presence-absence of bushbuck in the study area with respect to distance to watershed and elevation. Table 3 represents bushbuck resource selection function and their relative spatial coverages (hectares) in Iwofin Forest, further shown as a map in Figure 5 and described in Table 3 as low (0.00 - 0.17), moderate (0.17 – 0.45) and

high (0.45 – 0.72) probabilities of resource selection over spatial coverages of 4.84, 12.82 and 48.14 hectares respectively.

Table 1-Candidate models and their corresponding AIC values

#	MODEL	AIC
1	Pres_Abs = Aspect + Dist_River + Dist_Road + Dist_Watershed + Elevation + LandCover + Slope	97.002
2	Pres_Abs = Aspect + Dist_River + Dist_Road + Dist_Watershed + Elevation + Slope	92.350
3	Pres_Abs = Aspect + Dist_River + Dist_Road + Dist_Watershed + Elevation	90.570
4	Pres_Abs = Aspect + Dist_River + Dist_Watershed + Elevation	89.612
5	Pres_Abs = Dist_Road + Dist_Watershed + Elevation	83.821
6	Pres_Abs = Dist_Watershed + Elevation	82.651

Source: Field Survey, 2019.
Pres_Abs – Log odds of presence of bushbuck; Aspect – ASPECT; Dist_River – DISTANCE TO RIVER; Dist_Road – DISTANCE TO ROAD; Dist_Watershed – DISTANCE TO WATERSHED; Elevation – ELEVATION; LandCover – LANDCOVER TYPE

Table 2-Estimates of selected model

VARIABLES	Estimates	Standard Error	z-value	p-value
CONSTANT	5.564	1.535	3.625	0.0003***
DISTANCE TO WATERSHED	-327.647	126.884	-2.582	0.009**
ELEVATION	-0.058	1.535	-3.373	0.0007***

Source: Field Survey, 2019. *Significant at 10% level. ** Significant at 5% level. ***Significant at 1% level

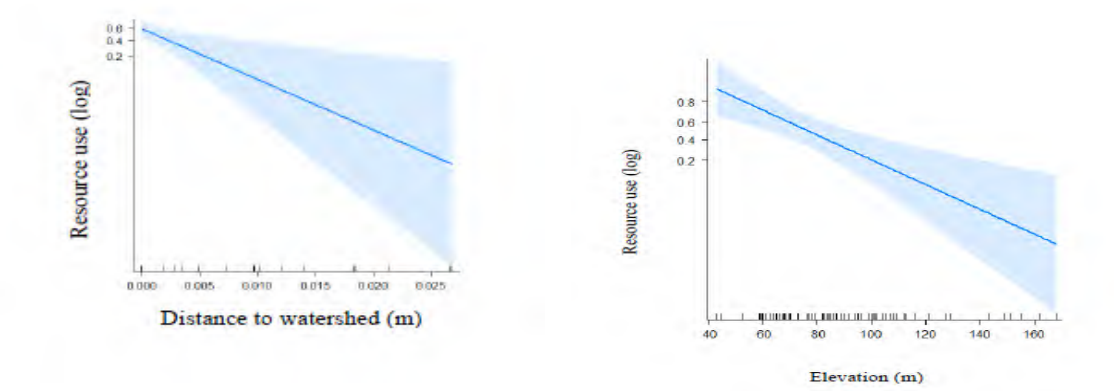

Figure 4 (L-R): Relationship between resource use (log) and distance to watershed and elevation

RSF = exp("DISTANCE TO WATERSHED" *-327.647 + "ELEVATION" * -0.058)…….(2)
RSF_{STD} = (RSF – lowest_value)/(highest_value – lowest_value) ……(3)
Where: RSF – Resource Selection Function
RSF_{STD} – Standardized Resource Selection Function (0 – 1)

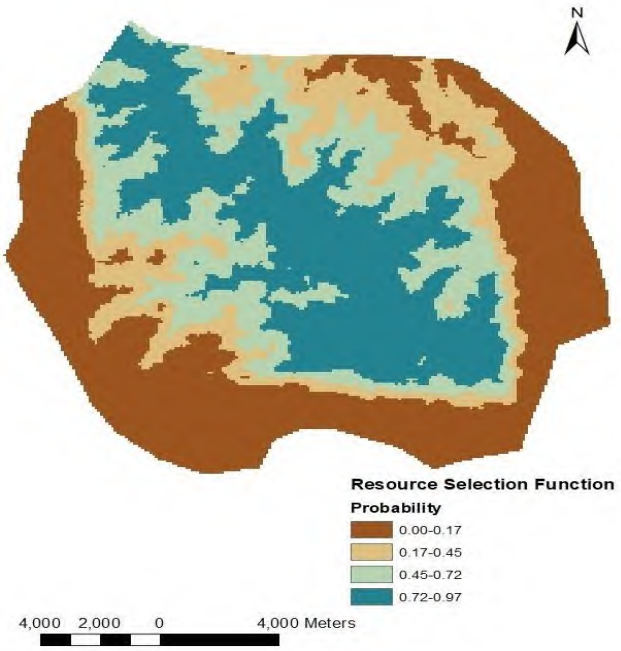

Figure 5: Resource selection model for bushbuck in Iwofin Forest

Table 3: Probabilities of Resorce Selection Functions and spatial coverage in Iwofin Forest

	Probability	Spatial Coverage (ha)
Low	0.00 – 0.17	4.84
Moderate	0.17 – 0.45	12.82
High	0.45 – 0.97	48.15

Source: Field Survey, 2019.

DISCUSSION

Past research studies have alluded survival of wildlife species to the presence of relief features and essential habitat characteristics that include topography, vegetation, and climate (Warton & Geert, 2013). The grassland was observed to be the dominant landcover type in Iwofin Forest. With this observation, it was expected that bushbuck would likely be found in the grassland landcover type where there were abundant food resources but the final model showed contrary as landcover type was not an influential variable in this study. It appeared that bushbuck avoided the grassland and sporadically utilized this essential food resource, i.e. *Anchomanes dalzielii* (Smits, 1986). This was similar to the findings of (Brnesh, Tsegaye, Tadese, & Gelaye, 2015) who reported that bushbuck do not favour open vegetation but prefer to browse woody plants and forbs in more covered vegetation. In the research work done by Duchesne, Fortin, & Courbin, 2010, it was observed that logistic regression could successfully model the relationship between dichotomous dependent variables and independent environmental variables. Therefore, the observed inverse relationship of bushbuck presence with respect to distance to watershed and elevation were valid. The statistical analysis showed that distance to watershed and elevation were the significant variables that contributed to the observed presence of bushbuck in the study area. This result showed that the log odds of bushbuck

being present in the areas where they were sighted actually decreased with increasing elevation when the distance to the watershed was held constant. Also, the log-odds of bushbuck presence decreased with increasing distance to the watershed, holding elevation constant. In other words, bushbucks were mostly sighted at areas of lower elevations that were closer to the watersheds. This conforms with (Yelden, Largen, & Kock, 1984) who reported that bushbuck ecologically occupy lower altitudes near watercourses where there are high species richness in food materials and vegetation cover to hide from predation and harsh weather conditions. The Resource Selection Function (RSF) for bushbuck was standardized (RSF_{STD}) to probability value between 0 and 1. The prediction map derived from the back-transformed logistic model and the model validation check confirmed that bushbucks were present within the high probability area of the resource selection function. Therefore, there was a high probability (0.45 to 0.72) of bushbuck selecting food and water resources located close to the watershed at lower elevations covering 48.15 hectares within Iwofin forest. This finding was similar to (McDonald, Alldredge, Boyce, & Erickson, 2006) who reported that wildlife tends to select food and water resources in their habitat according to the prevalence of the environmental features that maximise the availability of such resources. This study revealed that locations of high resource selection probabilities were preferred habitats and appeared suitable for bushbuck in Iwofin forest, a position that was also supported by (Hirzel & Le Lay, 2008). However, moderate (0.17 – 0.45) and low (0.00 – 0.17) probabilities for resource selection by bushbuck were predicted for areas of higher elevations, i.e. covering 4.84 hectares and 12.82 hectares respectively of the forest, and away from the watershed where bushbuck were less prevalent.

CONCLUSION

This study provided further information on *Tragelaphus scriptus* in Ogun State Nigeria by exploring the use of resource selection modelling concept to predict the relationship between bushbuck presence and the distribution of resources in Iwofin Forest, Ogun State, Southwest Nigeria. It was discovered that the bushbuck selected material resources at lower elevations near the watershed. This information would aid subsequent research surveys and assist in developing effective conservation strategies through the identification of resource selection pattern of *Tragelaphus scriptus* in Iwofin Forest.

ACKNOWLEDGEMENT

I would like to acknowledge the assistance of the local hunter Mr. M. Jimoh who agreed to lead the research team through Iwofin Forest to identify the bushbuck locations for this study. Immense gratitude also goes to Mr. Stephen Oladapo Alakija for his assistance with the data collection.

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Nigerian Journal of Wildlife Management

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Nig. J. of Wildl. Mgt., 2020, 4(2): 11 - 19
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https://wildlifesocietyng.org/ojs/index.php/wildlifesocietyng-journal/index ISSN 2735-9298 (PRINT) ISSN 2735-928x (ONLINE)

Assessment of Level of Awareness of Rabies in Obubra Local Government Area, Cross River State, Nigeria

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ABSTRACT
The study assessed the awareness of rabies in Obubra Local Government Area of Cross River State. Structured questionnaire (N=123) were administered to respondents in three council wards viz Obubra Urban (n=48), Ochon (n=45) and Ovonum (n=30). Descriptive statistics was used to examine the frequencies and temporal patterns of rabies occurrence while the chi-squared test was used to evaluate the association between seasons and rabies incidence in the area. Dog ownership is high in Urban (42%) than Ochon (36%) and Ovonum (22%). Most (80%) dogs are kept as pets and for security purposes. Incidence of rabies is high (68.3%) and was not associated with seasons *(P-value = 0.31>0.05)*. Vaccinations were higher in Ochon (45%) than Urban (34%) and Ovonum (21%). About four (78%) cases of rabies were recorded in hospitals and private clinics. High vaccination cost and lack of awareness and income are the reasons why most dogs are not vaccinated.

Keywords: Rabies, dog, incidence, infection, vaccination.

INTRODUCTION
Rabies is zoonotic and fatal viral disease of all warm-blooded mammals. It is responsible for the death of humans and wildlife for many years, and is still a public health hazard in many parts of the world, particularly Nigeria. It is one of the most recognizable zoonosis and has been well known for more than 4,300 years (Takayama, 2005). It is caused by the rabies virus (RABV) which belongs to the family *Rhabdoviridae* in the genus Lyssa virus. While rabies has been controlled throughout most of the developed world, it remains a significant burden in developing countries, causing a large number of animal and human deaths (Ekanem, Eyong, Philip-Ephraim, Eyong & Adams, 2013). Animals especially dogs are the most common sources of human rabies infection. Skunks, raccoons, bats, cats, coyotes, foxes, and other mammals can also transmit the disease. The RABV is known to cause fatal encephalomyelitis in all warm-blooded animals including mammals and usually results in death if unattended. It is transmitted from infected animals to other animals and humans through bite or scratch wounds, licking of broken skin and mucous membranes (MacLachlan & Dubovi, 2011). The distribution of Rabies virus is worldwide, although no case has been reported in Japan and New Zealand. Many are now considered to be free of the disease after eradication campaigns (MacLachlan & Dubovi, 2011). Rabies continues to claim the lives of humans yearly especially in developing countries of Africa including Nigeria despite the

availability of effective human and animal anti-rabies vaccines (Knobel *et al*., 2005).

According to the World Health Organization (2013), the annual number of human rabid deaths globally is about 61,000, with the vast majority of deaths occurring in rural areas. More than 10 million people undergo post-exposure prophylaxis every year, and rabies ranked 12th on the World Health Organization list of major killer diseases (Meslin & Stohr, 1997). An International Office of epizoonotics (OIE) lists the disease as a threat to human populations and animals in many parts of the world. They further reported that most of the disease occurs in developing countries particularly in Asian countries. Rabies represents an economic burden for both developed and developing countries due to the costs of human post exposure treatment, diagnosis, surveillance, and immunization of domestic animals and wildlife. However, the most serious losses are the number of humans suffering and killed by rabies disease. In Nigeria, dogs are the main reservoirs accounting for more than 96% of rabid animals (Otolorin, Umoh & Dzikwi, 2014).

In most developed countries, human rabies has dramatically declined over the past years due to direct consequence of routine vaccination of pet animals, whereas most developing countries are still battling with the disease. It is therefore important to investigate the level of awareness, incidences as well as the prevention of the disease.

Materials and Methods

The study was carried out in Obubra Local Government Area of Cross River State. It is situated in the Central Senatorial District of the State, and lies between latitude 5^{o} 45^{I} N and 6^{o}15^{I}N of the Equator and longitude 8^{o}12^{I} E of the Greenwich Meridian and has a total land area of about 1115km^{2} with a projected population of 182,546 for 2019 (NBS, 2017).

Sampling Technique and Sample Size

Three (3) out of the eleven (11) wards in the study area were purposively selected due to accessibility, each one representing the three political blocks of Obubra, Osopong, Adun and Okum. The sampled wards included Obubra Urban, Ochon and Ovonum. One hundred and twenty three (123) questionnaires were administered to respondents based on the population size in each council ward in the study area; forty-eight (48) in Obubra Urban, forty-five (45) in Ochon, and thirty (30) in Ovonum council wards. The questionnaire which were in three sections were administered to households, workers in health facilities and dog owners. The study population was subjected to Taro Yamane (Otabo & Obahiagbon, 2016) sample formula in order to get the sample size for the research.

$$n = \frac{N}{1 + N(e)^2}$$

Where; n = Sample size, N = Sample population, e = Significant level of 0.05.

Data analysis

The data generated from the study was analyzed using descriptive statistics to examine the frequencies and temporal pattern of rabies occurrences in the study area. The time series plots were created to visualize possible trends and seasonality. The expected numbers of cases was calculated under a null hypothesis that rabies incidence is independent of seasons in the study area. The chi-squared test was used to evaluate the association between season and rabies incidence in the study area.

Results

Demographic Characteristics of Respondents

The study reveals that 88% of the respondents own dogs, while 80% keep dogs as pets and for security purposes respectively. The study also revealed ownership of dogs for more than one year, with the dogs kept under chain mostly during the night (Figure 1). No human population in the study area had ever been vaccinated against rabies.

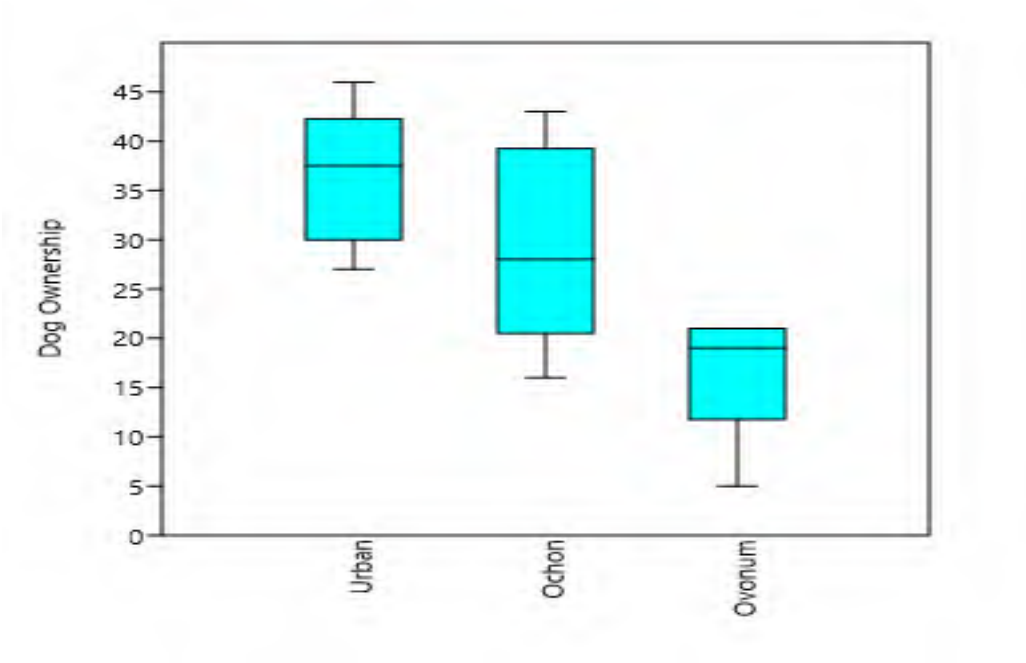

Figure 1: Box plot showing ownership of Dogs in the study area.

Rabies incidence and seasonal variability in the study area

There were incidences of rabies in communities in the study area, and the disease was prevalent in both the rainy and dry seasons (Table 1). Human related deaths have also been recorded within the communities in the study area, with cases treated in the hospitals, clinics and health centers.

Table 1: Seasonal variation and rabies incidence among respondents in the study area

S/N	QUESTION	SA	A	U	D	SD	Mean	Remark
1	Have you had of any rabies incidence in your community?	40(200)	44(176)	17(51)	13(26)	9(9)	3.8	Agree
2	Is rabies common during the rainy season?	10(50)	32(128)	46(138)	18(36)	17(17)	3.0	Agree
3	Is rabies common during the dry season?	8(40)	36(144)	45(135)	23(46)	11(11)	3.1	Agree
4	Has anyone died of rabies in your community?	17(85)	39(156)	27(81)	29(58)	11(11)	3.2()	Agree
5	Is the number of rabies death between 1 - 2?	8(40)	20(80)	45(135)	42(84)	8(8)	2.8	Disagree
6	Are the number of rabies death more than 2?	15(75)	18(72)	43(129)	37(74)	10(10)	2.9	Disagree
7	Do you treat rabies cases in the hospital/clinic/health center	23(115)	32(128)	31(93)	11(22)	26(26)	3.1	Agree
8	Do you treat rabies cases with herbs?	8(40)	16(64)	31(93)	23(46)	48(48)	2.4	Disagree

SA= STRONGLY AGREE (5), **A**= AGREE (4), **U**= UNDECIDED (3), **D**= DISAGREE (2), **SD**=STRONGLY DISAGREE (1) Agree, if mean ≥ 3.0, Disagree if mean < 3.0

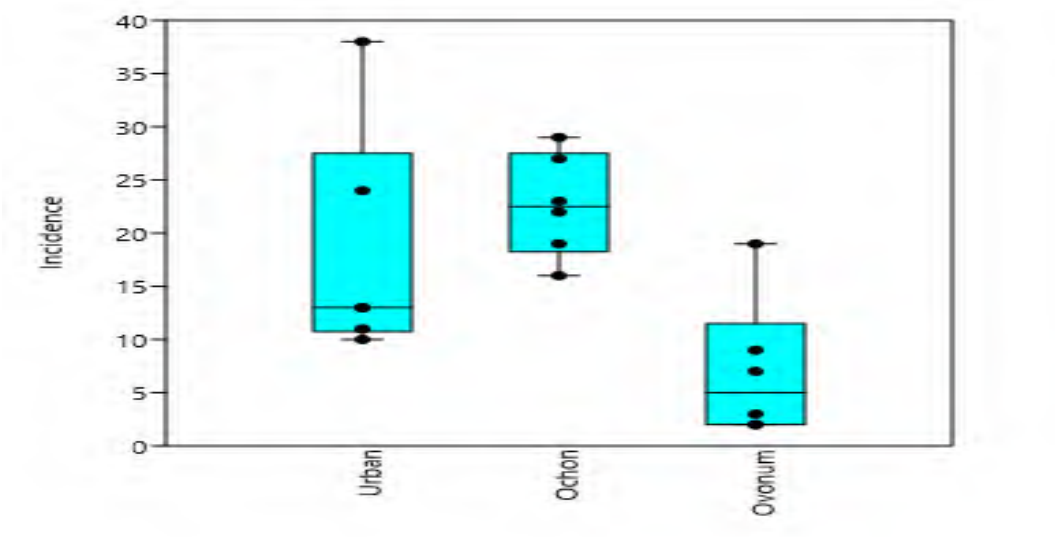

Figure 2: Box and Jitter plot showing incidence of rabies in the study area. Incidence is highest in Ochon than Obubra Urban and Ovonum.

Management of Rabies in the study area

The respondents agreed that their dogs were vaccinated against rabies every one to two years, with cost of vaccination rising a little over five thousand (Table 2). The study also reveals the factors responsible for the reduction in rabies cases in the study area to include awareness creation, routine vaccination, availability of drugs and vaccines, as well as provision of health facilities.

Table 2: Reduction and management approaches of rabies among respondents in the study area

S/N	QUESTION	SA	A	U	D	SD	Mean	Remark
1	Do you vaccinate your dog(s) against rabies?	40(200)	41(164)	14(42)	24(48)	4(4)	3.7	Agree
2	Do you vaccinate your dog(s) every year?	27(135)	39(156)	24(72)	22(44)	11(11)	3.4	Agree
3	Do you vaccinate your dog(s) after every 2 years?	21(105)	21(84)	35(105)	39(78)	7(7)	4.9	Agree
4	Is the cost of vaccinating your dog(s) less than N 3000	11(55)	35(140)	33(99)	37(74)	7(7)	3.0	Agree
5	Is the cost of vaccinating your dog(s) more than N 5000	12(60)	29(116)	36(108)	31(62)	15(15)	2.9	Agree
6	Do you think awareness creation can reduce rabies cases?	26(130)	39(156)	18(54)	26(52)	14(14)	3.3	Agree
7	Can free and routine vaccination reduce cases of rabies?	32(160)	36(144)	17(51)	19(38)	19(19)	3.3	Agree
8	Can availability of drugs and vaccines reduce rabies cases?	30(150)	38(152)	21(63)	22(44)	12(12)	3.4	Agree
9	Provision of health facilities can reduce rabies cases?	29(145)	32(128)	20(60)	20(40)	22(22)	3.2	Agree

SA= Strongly Agree (5), A= Agree (4), U= Undecided (3), D= Disagree (2), SD= Strongly Disagree (1)

Agree, if mean ≥ 3.0, Disagree if mean < 3.0

Rabies case management and treatment by health facilities in the study area

All health facilities agreed to have received between 1 and 5 (78%) rabies cases in their facilities, with no deaths recorded in any of the facilities in the study area (Table 3). The study also reveals that vaccines and drugs for the treatment of rabies were not available all the time in the health facilities. The study also reveal that incidences of rabies in the study area are not associated with seasons (*P-value = 0.31 > 0.05*).

Table 3: Reported cases and Human treatment of rabies by health facilities in the study area

S/N	QUESTION	SA	A	U	D	SD	Mean	Remark
1	Have you had any rabies case in your facility?	7(35)	1(4)	0(0)	1(2)	0(0)	4.6	Agree
2	Have you had between 1 to 2 rabies cases in your facility?	7(35)	0(0)	0(0)	2(4)	0(0)	4.3	Agree
3	Have you had more than 5 rabies cases in your facility?	5(25)	1(4)	0(0)	2(4)	1(1)	3.8	Agree
4	Have you recorded any death?	0(0)	2(8)	0(0)	6(12)	1(1)	2.3	Disagree
5	Was the death between 1 to 2?	0(0)	0(0)	0(0)	6(12)	3(3)	1.7	Disagree
6	Was the death more than 5?	0(0)	0(0)	0(0)	6(12)	3(3)	1.7	Disagree
7	Do you have vaccines or drugs for rabies cases all times?	1(5)	1(4)	0(0)	5(10)	2(2)	2.3	Disagree
8	Do the vaccines or drugs cost less than ₦ 3000?	1(5)	2(8)	1(3)	3(6)	2(2)	2.7	Disagree
9	Do the vaccines or drugs cost more than ₦ 5000?	2(10)	0(0)	1(3)	5(10)	1(1)	2.7	Disagree

SA= Strongly Agree (5), A= Agree (4), U= Undecided (3), D= Disagree (2), SD= Strongly Disagree (1). Agree, if mean ≥ 3.0, Disagree if mean < 3.0

Challenges of vaccination and treatment of dogs by hunters in the study area

The hunters interviewed agreed that they use their dogs for hunting, and that their dogs were vaccinated against rabies with anti-rabies vaccines (Table 4). The cost of vaccinating the dogs was less than five thousand naira. Lack of awareness and money was the reasons sometimes their dogs were not vaccinated.

Table 4: Factors affecting dog vaccination and treatment by hunters

S/N	QUESTION	SA	A	U	D	SD	Mean	Remark
1	Do you keep dog(s) for sale as meat?	7(35)	2(8)	0(0)	0(0)	0(0)	4.8	Agree
2	Do you use dog(s) for hunting?	9(45)	0(0)	0(0)	0(0)	0(0)	5.0	Agree
3	Do you vaccinate your dog(s) with anti-rabies vaccines?	2(10)	2(8)	5(15)	0(0)	0(0)	3.7	Agree
4	Do you vaccinate your dogs in the hospital/clinic/health center?	2(10)	2(8)	5(15)	0(0)	0(0)	3.7	Agree
5	Do you vaccinate your dogs with local herbs	0(0)	0(0)	0(0)	7(14)	2(2)	1.8	Disagree
6	Is less than ₦ 3000 the cost of treatment?	0(0)	1(4)	0(0)	6(12)	2(2)	2.0	Disagree
7	Is above ₦ 5000 the cost of treatment	0(0)	0(0)	1(3)	7(14)	2(2)	2.1	Disagree
8	Is lack of awareness the reason you don't vaccinate your dogs?	1(5)	2(8)	2(6)	4(8)	0(0)	3.0	Agree

9	Is lack of money the reason you don't vaccinate your dogs?	2(10)	3(12)	2(6)	2(4)	0(0)	3.6	Agree
10	Is lack of drugs the reason you don't vaccinate your dogs?	0(0)	1(4)	2(6)	5(10)	1(1)	2.3	Disagree

SA= Strongly Agree (5), A= Agree (4), U= Undecided (3), D= Disagree (2), SD= Strongly Disagree (1). Agree, if mean ≥ 3.0, Disagree if mean < 3.0

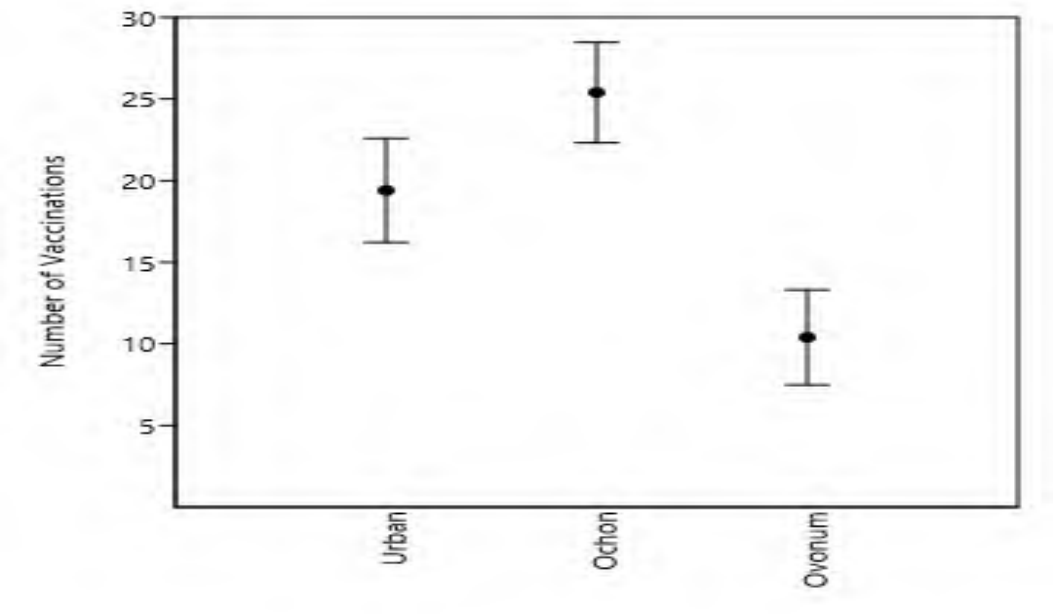

Figure 3: Mean and Whisker plot showing number of rabies vaccination in the study area. Number of vaccinations are higher in Ochon than Obubra Urban and Ovonum.

Discussion

Wild animal diseases are becoming a global issue and a source of concern in developing countries. People living in rural communities with little or no knowledge of these diseases are the worst hit. Rabies is one of the diseases prevalent in rural areas with majority of the people keeping dogs either as pets, security, for meat and even using dogs for hunting wild animals. Thousands of people die yearly due to rabies as most people and dogs are sometimes not treated nor given any form of medication or vaccinated against the disease (Otolorin, Umoh & Dzikwil, 2014). The rabies vaccine is supposed to be given to those with high risk of coming in contact with the disease, or given after a bite from animal suspected to be carrying the disease (Karshima, Kujul, Ogbu, Abdullateef & Dung, 2013). In this study no one had ever received vaccination against rabies in the study area, thereby increasing the chances of vulnerability after a bite. Persons vaccinated may have been absent during the survey. Eighty percent of the people in the study area own dogs, with the dogs put under chain during the day, implying that dog bites occur at night. However, it is common knowledge that over ninety percent of houses in rural areas do not have perimeter fences, with stray dogs seen roaming the streets all day (Garba, Oboegbulem, Junaidu, Magaji & Umoh, 2010).

Rabies cases are common, and people have died of the disease according to the study but the people are ignorant of the actual number of deaths in the study area. This could be so as people hardly keep records in rural areas. The study though reveals that rabies cases are usually treated in clinics, hospitals and health centers, in reality there is only one government hospital in the entire area, the others are private clinics and petty medical

dealers who might not really be able to handle such cases especially if they become more severe. Again, the proximity of these rural communities to the health facilities is such that sometimes the victims die before arrival (Kehinde, Adebowale, Olaogun & Olukunle, 2009).

Dogs in the area are usually vaccinated against the disease annually and/or biannually, with the cost of treatment reaching as high as five thousand naira. Especially that most dogs in rural areas are never vaccinated either due to lack of awareness, or people may be aware but may not have the money to pay for the vaccination of the dogs. The claim that dogs are vaccinated against rabies in the study area may not be unconnected with suspicion on the part of the owners for fear they may be arrested for not vaccinating their dogs. No death was recorded in the available health facilities, even though more than five cases each were reported in the facilities. But all suspected cases not recorded and reported by victims in hospitals in different cities across the country were confirmed dead according to Otolorin *et al*., 2015. Drugs are not all the time available in the facilities to effectively handle cases.

Hunters keep dogs for meat, as well as using them for hunting wild animals in the study area. They also agreed that their dogs are usually vaccinated in the clinics, health centers and hospitals. But it also common knowledge that hunters in the rural areas are ignorant of the fact that dogs require vaccination and other forms of treatment. Dogs that are not vaccinated if infected, can transmit rabies to hunters kill, and to other animals that may escape bites. This can result to consumers and wounded animals contracting the virus (Adeyemi, Adetunji, James & Alonge, 2005).

However, lack of awareness and money were the reasons why their dogs were not vaccinated, and offenders usually are scared of being arrested and prosecuted, especially if authorities discovered they hunt animals with dogs that are not vaccinated which can be harmful to the rural populace. Studies have shown that people die of rabies in urban areas where medical facilities are more accessible by the people (Knobel *et al*., 2005). This can get worse in rural areas where most people are ignorant, lack money to cater for their everyday living, and are not vaccinated against the disease. Vaccines are not always available in the few health facilities available, and if available are usually expensive. This can prevent people from vaccinating their dogs or giving them any other treatment. More so that people keep dogs as pets and for security in their homes (Dzikwi, Garkida & Umoh, 2011).

Though owners of dogs were highest in Obubra Urban, rabies incidence was higher in Ochon. This may well be due to the fact that, they are more fenced houses in Obubra Urban than Ochon. Number of vaccinations was highest in Ochon, but this did not translate to the increasing cases. They are indications that most respondents in the study are economical with the truth with regards to whether or not their dogs were vaccinated.

Conclusion

This study reveal that the rabies virus exist in rural areas, with other studies showing its existence in urban areas. The number of confirmed cases and deaths recorded over the years justifies the fact that the people are in danger if nothing is done to salvage the situation. With the failing security situation in the country and with those living in the rural areas being the most vulnerable, people in the rural areas resort to dogs for security. The virus is zoonotic and economically important with high degree of virulence, high mortality and morbidity rates. This brings to question the effort to check its spread and control. Lack of awareness, finance, drugs and health facilities are challenges militating against effectively checking infestation, spread and possibly control.

It is important that priority be given to this disease by providing all that is needed to put its spread under control, so as to ensure that people living in rural areas and wild animals are not badly affected. When measures are put in place to check the epidemiology of the

disease, the number of incidences can be reduced to the barest minimum.

To reduce incidences of rabies in rural areas, mortality and economic losses caused by the disease the following measures are therefore suggested; effective sensitization and mass mobilization of the people by government. Government and other organizations should carry out free vaccination for humans and dogs against the disease, especially in rural areas to curtail or reduce infestations. Mobile health facilities and drugs should be provided by government and NGOs especially in rural areas to reduce cases to its barest minimum if not eradicated. Health facilities should also be provided by government and NGOs to diagnose and attend to cases on time. There should be an improved regulatory framework on acquisition and keeping of dogs by ensuring that dogs upon purchase are registered. Government should discourage hunting wild animals with dogs especially in rural areas. Offenders of any agreed laws should be prosecuted to serve as deterrent to others.

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Nigerian Journal of Wildlife Management

Wildlife for Sustainable Development

Nig. J. of Wildl. Mgt., 2020, 4(2): 20 - 33
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https://wildlifesocietyng.org/ojs/index.php/wildlifesocietyng-journal/index ISSN 2735-9298 (PRINT) ISSN 2735-928x (ONLINE)

Studies on *Thonningia sanguinea* Vahl.: Reproductive Phenology, Sex Ratio and Insect Visitors in Okomu National Park, Nigeria

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ABSTRACT
The present study investigated the phenology, sex-ratio, and potential pollinators of *Thonningia sanguinea* in Okomu National Park, southern Nigeria. Data were collected through regular visits to sites habouring the plant. Results show that *T. sanguinea* flowers all-year-round, with varying frequencies across different months of the year. A significant correlation (r=0.917; p=0.000) was observed between the frequency of flowering and rainfall. Overall, the incidence of female plants surpassed male plants by approximately a 2:1 ratio. Also, 71 % of the sites had only a single-sex type, i.e either male or female inflorescence, while 29 % of the sites had both male and female inflorescences. The ant *Technomyrmex* species were the most common floral visitors, accounting for a 55.54 % frequency of occurrence. Consequently, the lengthy reproductive phenology period and persistent interactions with a diverse faunal species indicate *T. sanguinea* as a keystone species in forested habitats and it is recommended that such habitats should be treated as an area of importance for biodiversity conservation

Keywords: cryptic, parasitic plant, phenology, pollination, sex ratio, *Thonningia sanguinea*.

INTRODUCTION
Phenology is the study of cyclic and seasonal events of an organism, in relation to other environmental and climatic factors (Durant et al. 2005). One of such events, particularly in plants is flowering. The reproductive success of a plant's population is largely dependent on the schedule of flowering and pollinator availability (Fenner, 1998; Stucky et al. 2018). According to Cascaes, Citadini-Zanette, & Harter-Marques. (2013), flowering and fruiting periods are of critical importance in the survival of the plant species and faunal visitors who rely on it for food and subsequent pollination activity. In some plant species, like members of Balanophoraceae, growth habit is totally subterranean and only visible during the flowering period.

Thonningia sanguinea is one of the few representative members of Balanophoraceae in Nigeria. Members of this family are parasitic and are notable for their bizarre inflorescence development, obscure host affinity, and are mostly noticed by their inflorescence that grows above ground. Despite these interesting attributes, the reproductive biology of these

unusual species is yet to be fully understood. Although there exist reports on the potential pollinators of some members, for instance, *Lophophytum mirabile* (Borchsenius & Olesen, 1990, *Dactylanthus* (Ecroyd, 1996), *Balanophora tobiracola* (Kawakita & Kato 2002), *T. sanguinea* Goto,Yamakoshi, & Matsuzawa, (2012). *B. fungosa* (Suetsugu & Aoyama, 2014), and *Langsdorffia hypogaea* (Freitas *et al.*, 2017), more research is required to fully understand their biology. For *T. sanguinea*, the likelihood of pollen transfer from a male to a female inflorescence was not established due to the limited availability of female inflorescence (Goto, Yamakoshi, & Matsuzawa, 2002).

T. sanguinea is a cryptic, obligate holoparasitic plant endemic to forested areas of tropical Africa. Beyond the visual parasitism of *T. sanguinea* on the roots of forest trees, not much is known about its reproductive biology and mechanism of pollination. The dearth of information on *T. sanguinea* is probably due to its prevalence in only tropical Africa, where limited resources are committed to research. Its status as either dioecious, monoecious, or both is still contentious among different researchers. More so, inconsistent records about the sex ratio and the fact that seeds are unknown indicate that pollination and seed production are extremely rare. However, a preliminary investigation report suggests a slightly balanced sex ratio between male and female individuals, which further attests to the limited research attention *T. sanguinea* has received so far. For a proper understanding of the reproductive biology of *T. sanguinea*, it is imperative to ensure ample availability of both sexes, which was a major limitation in earlier studies, particularly that of Goto, Yamakoshi, & Matsuzawa, (2002). Hence, the present study was conducted to investigate the reproductive phenology, sex ratio, and identify insect visitors of *T. sanguinea* in Okomu National Park, Southern Nigeria.

MATERIALS AND METHODS

Study Area

The mapped area of the Okomu National Park (ONP) is presented in Figure 1. It is situated in Ovia South-West, Edo State, Nigeria; with a coordinate of longitude 5º16'0" E and latitude 6 º20'0" N. The park, comprising of a forest area of about 200 km^2, is now regarded as refugia of the former Nigerian lowland forests that was once a continuous forest belt that stretches across the Niger River, west of the Dahomey Gap in Benin republic (Williams, 2008). The climatic condition of the park is tropical; with a mean annual rainfall of 2100 mm, which peaks around March through October. The relative humidity and mean monthly temperature are mostly around an average of 65 percent and 30.2ºC respectively. The soils are made up of sandy loams derived from deep loose deltaic and coastal sediments that date back from the Eocene period and it is markedly acidic with an average pH of 5.0 (Greengrass, 2009). The much diverse ecosystem of ONP comprising areas of swamp-forest, high forest, secondary forest, and open scrub, undoubtedly qualifies it as one of the best examples of a mature secondary forest in Southern Nigeria (WWF, 2017). *Thonningia sanguinea* populations were located in the following compartments (Comp.) of the Park: Comp. 33 (N 06º24.113" E 005º 19.44"), Comp .53 (N 06 º24.113" E 005º 19.44, Comp. 55 (N 06º 21, 656" E 005º 21.587"), and Comp. 61 (N 0 º 20.764" E 005 º 20.697").

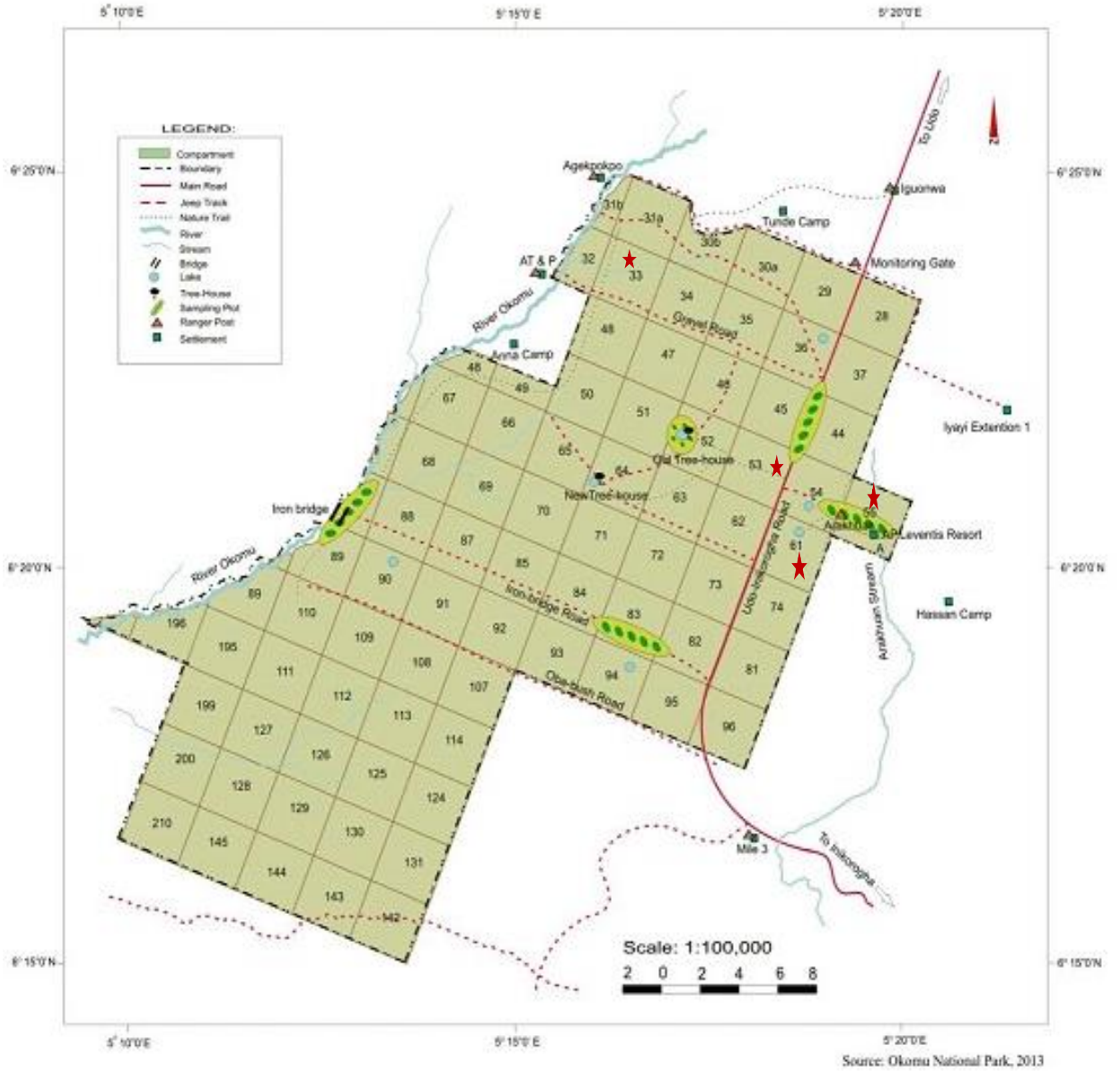

Figure 1. Map of study area showing quadrat sites (33, 53, 55 and 61) in Okomu National Park

Population Sampling

Thonningia sanguinea population were accessed using meander searches and personal communications. Stratified sampling method was used to evaluate *T. sanguinea* populations in line with the objectives of the study. Where *T. sanguinea* population was spotted, a (10 x 10) m quadrat size was mapped to accommodate the number of host trees present.

Reproductive phenology

Bi-monthly visits to sites harbouring *Thonningia sanguinea* in Okomu National Park was carried out from January-December, 2016, to observe and record the flowering period and frequency of flowering. Data were collected on the frequency of male and female inflorescence and fruiting heads. Following the method of Cascaes, Citadini-Zanette, & Harter-Marques. (2013), the period of occurrence of different stages of the

reproductive phenophases (under-ground bud development, above ground bud development, anthesis, fruit development, and dry out) were assessed from direct observations. Ten (10) *T. sanguinea* plants were tagged at each site and observed on a daily basis to record developing flowering shoots. Upon bud initiation, data were taken through the period of inflorescence development to fruiting stage. To assume synchronicity in constructing the phenogram, the period of a phenophase was based on the period (days) taken for 50 % of tagged buds to change from one reproductive phenophase to another. To determine whether there was a correlation between phenology (flowering and fruiting) and rainfall, Spearman correlation analysis (α=0.005) was employed. Rainfall data of the Park were accessed from the Nigerian Meteorological Agency (NIMET), Benin City.

Sex Ratio

Data on the distribution of inflorescence, grouped by single or co-occurrence of sex-type, was collected and analyzed in percentage. In order to arrive at a more comprehensive sex ratio for *T. sangunea*, the numbers of male and female capitulum were recorded at different sites and subjected to the Chi test (Goodness of fit).

Fauna Visitors (potential pollinators)

A total of 54 visits were made to monitor insect visitors of *T. sanguinea* during day-time periods (from 7.00 am to 2.00 pm). Insects found on *T. sanguinea* inflorescence bud were collected, identified, and recorded. Photographic shoots, video photography, and complemented visual observations were used to monitor inflorescence-insect interactions. The following data were collected during the survey: foraging time (time spent on flowers (male and female) from arrival to departure), foraging sequences (the number of inter and intra plant movement), insect species number, percentage visit by insect species using the formula below

$$\%\ of\ visits = \frac{Number\ of\ visits\ per\ species \times 100}{The\ grand\ total\ of\ all\ insect\ visits}$$

Following the method outlined by Southwood & Henderson (2000), the Berger -Parker index was used to identify the most dominant species of insect visitors. Insect specimens encountered during the survey were identified using standard insect identification keys.

Statistical Analysis

Using Microsoft Office Excel package, 2010, a combined chart was used to show the pattern of relationship between phenology and rainfall. Chi-square Test (goodness of fit) was used to assess the sex ratio pattern in *T. sanguinea*

RESULTS

The reproductive phenology (flowering and fruiting) of *Thonningia sanguinea* at different compartments of the Okomu National Park is presented in Figure 2 (a-d). Flowers were recorded all-year-around, however, the frequency of inflorescence varied across different months of the year. The rainfall pattern was uniform for all compartments. The frequency of rainfall rose steadily from January, and experienced a fairly constant rate around May to August, before reaching its peak around September and October. For compartment 33 (Figure 2a), the frequency of male inflorescences was observed to increase steadily from January to June. Beyond this period, there was a temporary drop in June and August, before reaching a peak in September. The highest and lowest frequencies of male inflorescence were recorded in September and January respectively. The number of female inflorescences increased steadily from January, and slightly dropped around March and increase steadily to reach its peak in August. The highest and lowest frequency of female inflorescence value were recorded in

August and March respectively. For the number of fruiting heads, the highest and lowest frequencies were recorded in December and June respectively. For compartment 53 (Figure 2b), the frequency of male inflorescences was observed to increase in from January to March and July to September. However, no record of male inflorescence was observed in May and June. However, for female inflorescence, the highest and lowest frequency of female inflorescence values were recorded in August and November respectively. The highest frequency of fruiting heads was recorded in January and none was observed for June.

For compartment 55 (Figure 2c), the frequency of male inflorescences was observed to increase steadily from March to June. The highest frequency of male inflorescence was recorded in June while none was observed for December, January, and February. The numbers of female inflorescence increased steadily from March to June and dropped gradually through November to total absence around December, January, and February. For the number of fruiting heads, the highest and lowest frequencies were recorded in December and June respectively. For compartment 61 (Figure 2d), the frequency of male inflorescences was observed to increase steadily from April to June and temporarily dropped in august and again increased in September before reaching its peak value in October. No record of the male inflorescence was observed in December and January. The numbers of female inflorescence increased steadily from February through July and temporarily dropped in August and again increased in September before reaching its lowest value in December. No record of the male inflorescence was observed in January. For the number of fruiting heads, the highest and lowest frequencies were recorded in December and June respectively.

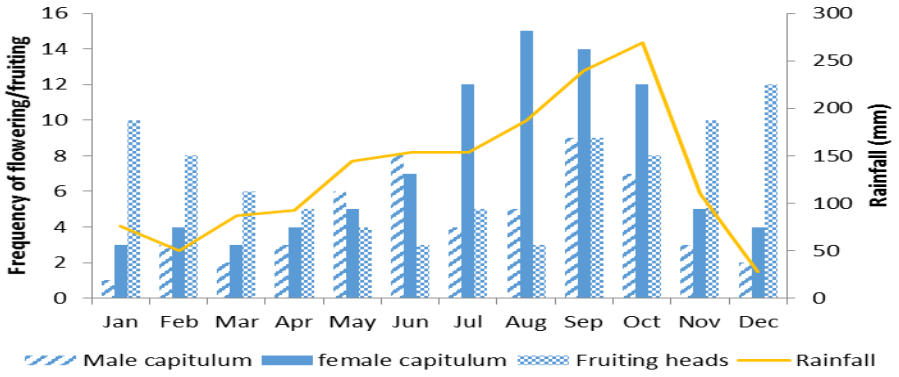

Figure 2a: Reproductive phenology of *Thonningia sanguinea* at compartment 33 of the Okomu National Park

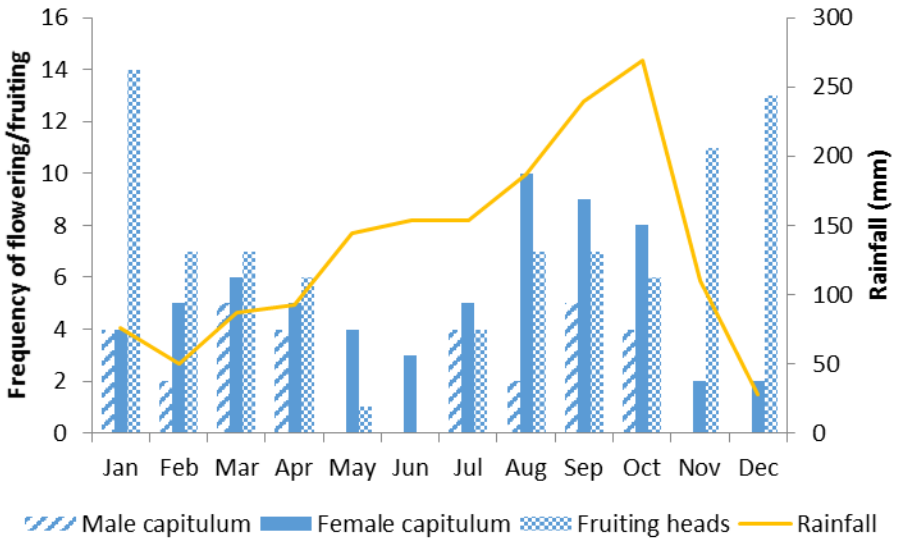

Figure 2b: Reproductive phenology of *Thonningia sanguinea* at compartment 53 of the Okomu National Park

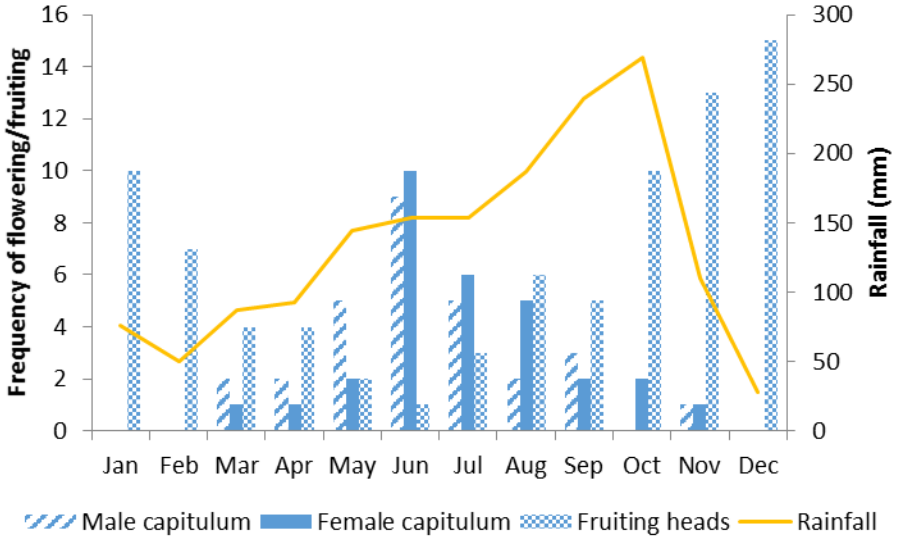

Figure 2c: Reproductive phenology of *Thonningia sanguinea* at compartment 55 of the Okomu National Park

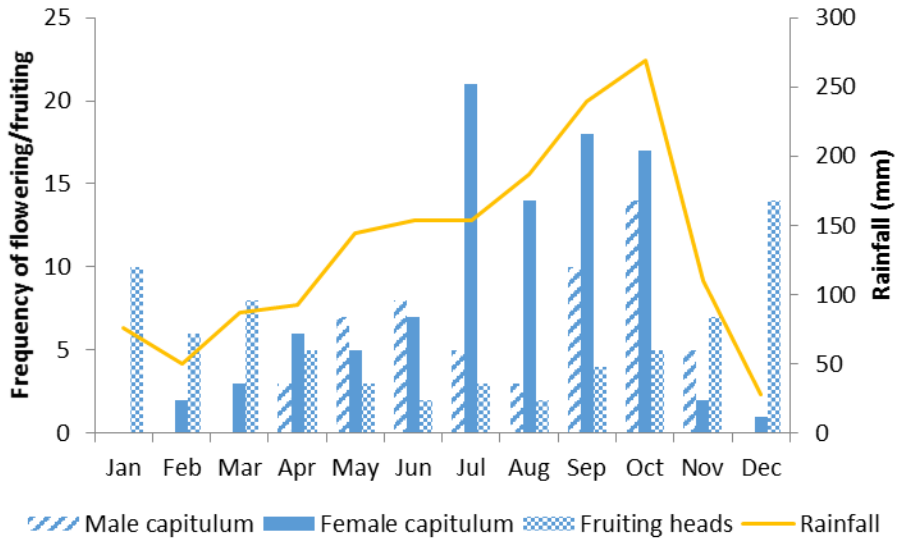

Figure 2d: Reproductive phenology of *Thonningia sanguinea* at compartment 61 of the Okomu National Park

The reproductive phenophases for both male and female *Thonningia sanguinea* inflorescence is presented in figure 3. The flowering cycle (from bud establishment to flower maturity) for male and female plants, take an average of 31 and 40 days respectively. Underground bud development to its visibility above-ground takes an average of 14-day period; however, this is subject to the depth level of the underground rhizome. Anthesis takes an average of 6 days for both male and female inflorescence, while flower development in female plant takes 15 days.

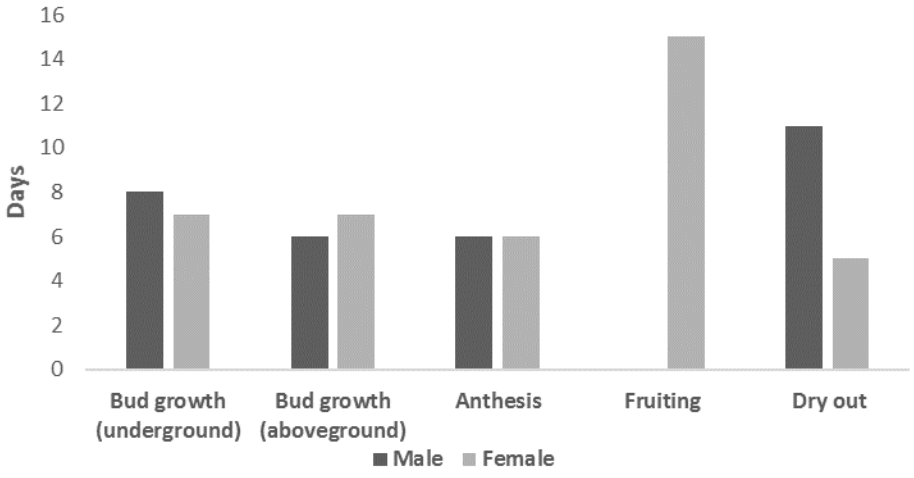

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Figure 3: Phenological chart for male and female *Thonningia sanguinea* inflorescence

The relationships between the frequency of flowering and fruiting of *Thonningia sanguinea* and the rainfall pattern in Okomu National Park is presented in Figure 4a and b respectively. A statistically significant correlation was observed between the

frequency of flowering and rainfall patterns at 0.005 level of significance (R=0.917; P=0.000). The correlation between the frequency of fruiting and rainfall was not statistically significant. However, a negative correlation coefficient was recorded (R= -0.28; P=0.370).

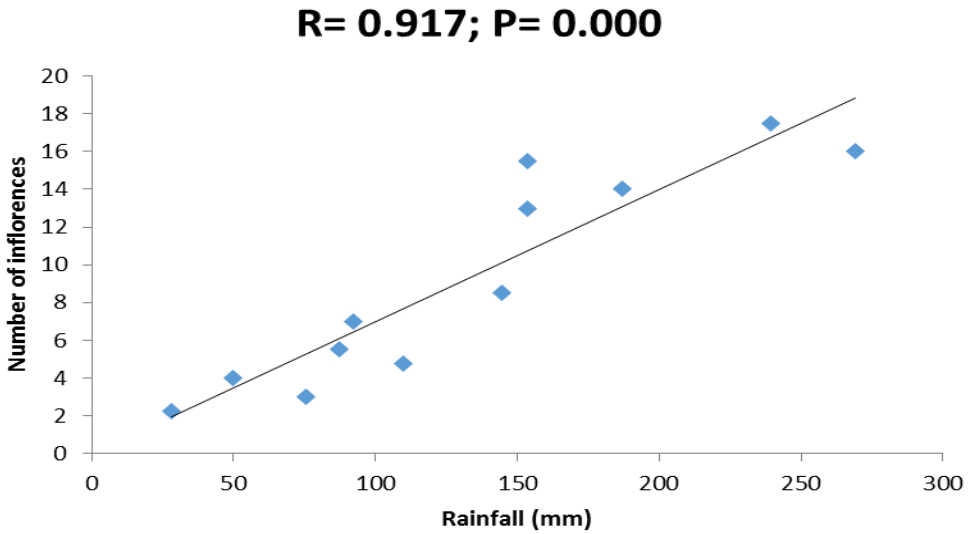

Figure 4a: The relationship between the frequencies of flowering vs. Rainfall pattern of *Thonningia sanguinea* in Okomu National Park.

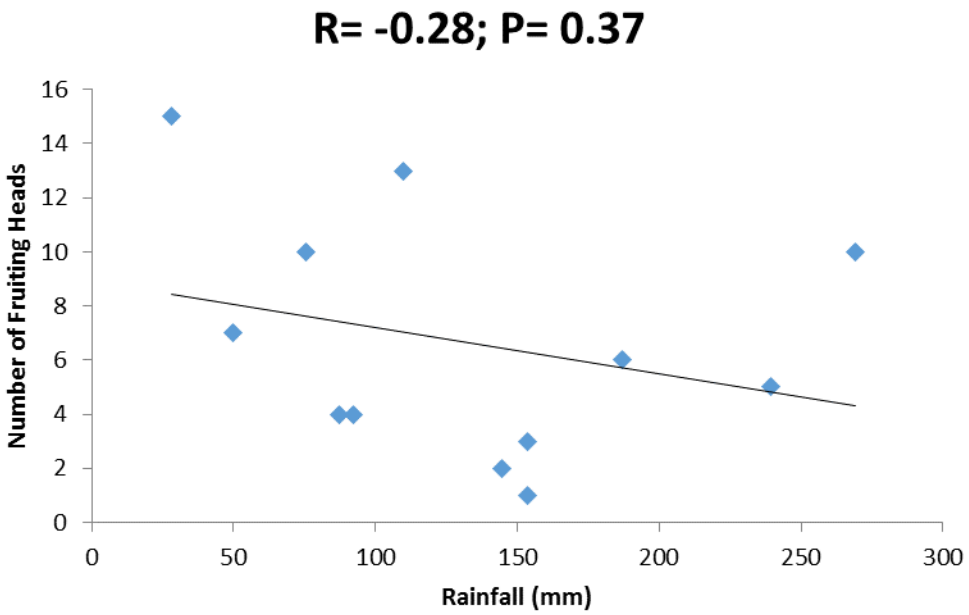

Figure 4b: The relationship between the frequencies of fruiting vs. Rainfall pattern of *Thonningia sanguinea* in Okomu National Park.

The percentage distribution of *Thonningia sanguinea* based on single or co-occurrence of sex-type among the different sites is presented in Figure 5. The result revealed that 71 % of the sites were found to harbour a single-sex type, i.e male and female inflorescences while, 29 % of the sites were found to harbour both.

A close co-occurrence of both sex was recorded in one of the sites (compartment 54), with a spatial distance of approximately 6 cm, regrettably, due to the breakable nature of the rhizome, it was impossible to link both flower heads as a single plant in order to ascertain if it was monoecious.

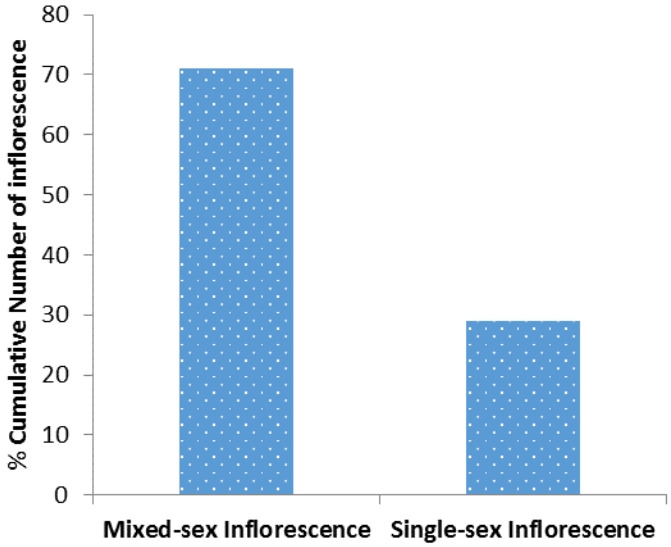

Figure 5: Percentage distribution of inflorescence grouped by single or co-occurrence of sex-type

Table 1 shows the chi-square result of *Thonningia sanguinea* inflorescence sex ratio. The total number of inflorescence head recorded was 371. The number of male inflorescence head was 153 while the female inflorescence head was 218. The sex ratio was statistically significant with a P-value of 0.001. This demonstrates that the sex ratio in *T. sanguinea* is skewed towards the male plant with an approximate sex ratio of 2:1.

Table 1: Goodness of fit test of *Thonningia sanguinea* Sex Ratio

Factors	**N_{total}**	**Male**	**Female**	**Sex ratio (M/F)**	**P-value**
Value	371	153	218	0.70	0.001

N_{total}- total number of inflorescence recorded; χ^2- Chi square

Table 2 shows the relative frequency of insect visitors of *Thonningia sanguinea* in Okomu National Park**.** The following insect species were observed: *Technomyrmex* sp., *Monomorium* sp. *Tetramorium* sp. (all in the order Hymenopteran), *Chrysomya* sp. *Morellia* sp, (Diptera), and some unidentified species such as species 1 (Lepodotera), species 2 (Orthoptera) and species 3 (Orthoptera). The relative frequencies of insect interaction with *T. sanguinea* inflorescences show that *Technomyrmex* sp (Hymenopteran) had the highest percentage frequency of floral visits with a percentage value of 33.3 %, followed

by the *Chrysomya* sp. (Diptera) with 18.51 %, species 3 (Orthoptera) however, had the lowest percentage frequency of insect floral visit with 3.7 %. *Technomyrmex* sp (Hymenopteran) had the highest number of insect species per capitulum at a particular time with an average value of 13.4, followed by *Monomorium* sp (Hymenopteran) with 3.67, species 3 (Orthoptera) however, had the lowest insect species number per capitulum head with just one at a time. *Technomyrmex* sp also had the highest Berger -Parker index with a value of 0.52, followed by the *Chrysomya* sp. (Calliphoridae) with 0.14 and species 3 (Orthoptera) had the lowest Berger -Parker Index value of 0.04. In terms of the behavioral characteristics expressed by the visiting insects, *Technomyrmex* sp (Hymenopteran) and *Chrysomya* sp. (Diptera), were observed to forage both in the male and the female inflorescence head, while *Morellia* sp, (Diptera), species 2 (grasshopper) and Orthoptera (cricket) were found foraging only on the female inflorescence head. Breeding sites of *Technomyrmex*, *Chrysomya* sp. (Diptera), and an unidentified species of Lepidotera order was observed on the male as well as female *T. sanguinea* inflorescence. In addition to insect species visitation, shreds of evidence from footprints on sites harbouring emasculated *T. sanguinea* inflorescence heads indicate herbivory by some suspected forest ruminant (*Galarella sanguinea* and *Cephalophus* sp.) in Okomu National Park

Table 2: Relative frequency of insect visitation on flowers of *Thonningia sanguinea* estimated from a data collected on a 54 visit account

Insect visiting species	**Order**	**Frequency of visits**	**Percentage frequency of visits (%)**	**Average number of Insect**	**Berger - Parker Index**
Technomyrmex sp.	Hymenopterans	18	33.00	13.4	0.52
Monomorium sp	Hymenopterans	7	12.96	3.67	0.14
Tetramorium sp.	Hymenopterans	5	9.25	2	0.07
Chrysomya sp.	Diptera	10	18.51	1.67	0.06
Morellia sp.	Diptera	5	9.25	2	0.07
Morellia sp.	Lepodotera	2	3.70	1	0.04
Species 1 (butterfly)	Orthoptera	5	9.25	1	0.04
Species 2 (grasshopper)	Orthoptera	2	3.70	1	0.04
Total		**54**	**100**	**25.74**	**1.00**

Figure 7. Insect visitors of *Thonningia sanguinea* in Okomu National Park, Nigeria (A, B, D & K-*Technomyrmex* sp), (E & F-Ant sp.), (H- *Monomorium*), (G- *Morellia*), (I- *Chrysomya*), (J- Orthoptera), (L-Lepidotera- Caterpillar)

DISCUSSION

Reproductive Phenology

The study presents the first report on the phenology of *Thonningia sanguinea* in a rainforest habitat in Nigeria. *T. sanguinea* was observed to have an all-year-round flowering period but with varying frequencies across different months of the year. Flowers were recorded for up to 11 months. A similar flowering pattern had previously been reported by Ecroyd (1996) for *Dactylanthus taylori*, another member of Balanophoraceae in New Zealand, where it was observed to have a long flowering period with the peak of flowering usually in March or April. In terms of the relationship between climatic factors and flowering patterns in *T. sanguinea*, a statistically significant correlation was observed between the frequency of flowering and rainfall patterns. Similarly, according to Ecroyd (1996), *Dactylanthus* seems to flower slightly at lowland sites with a warm-weather condition than at higher altitude sites with a cold-weather condition. Based on the flowering patterns of both species, it is reasonable to assume that weather condition appears to play a key factor in the pattern of flowering in both species. It is not yet clear how *T. sanguinea* utilizes the correlated pattern of flowering and rainfall to its ecological advantage, but one observable explanation is that the period of rainfall creates a moist-soil condition that allows the easy proliferation of the inflorescence, allowing visibility of the inflorescence head above ground. Another unique feature of the flowering pattern in *T. sanguinea* is the occurrence of flower synchrony in male and female plants. The frequency of flowering in male and female plants was relatively synchronized with both having peak values from June through November and low values from December to March. Such synchronized events can be advantageous especially in species that undergo sexual reproduction. Also, as stressed by Bawa (1980), the synchronization of flowering events in dioecious plants (i.e. with separate sexes) is an obligatory requirement to achieve sexual reproduction success. The fruiting periods

were markedly noticed around October to March, which corresponds with the dry period. With such a long reproductive phenology period, the perennial nature of *T. sanguinea* is significant for ants, caterpillars, and mammals that prey and browse on the fruiting heads of *T. sanguinea*, allowing for an all-year-round supply of food resources even in a season of scarcity.

Sex ratio

The sex ratio for *T. sanguinea* was significantly female-biased, with a skewed figure of approximately 2:1. The sex ratio of most dioecious plant species commonly deviates from the equilibrium expectation of 1:1, presenting an excess either male or female plant (Field, Pickup, & Barrett, 2013). According to Godfray and Werren (1996), the allocation of resources to male and female progeny is a major component of the reproductive strategies of all sexually reproducing dioecious plants. Ecroyd (1996), recorded a sex ratio of 5:1 male to female inflorescences in *Dactylanthus taylorii* (Balanophoraceae) in New Zealand. Therefore, with a fairly skewed ratio in *T. sanguinea*, there will be likely exclusion of reduced reproductive fitness, low seed production, and pollen limitation. Furthermore, there has been a controversy in the literature as to whether *T. sanguinea* is dioecious or monoecious. Bullock (1948) reported observing some dioecious specimens. Heide-Jørgensen (2008) reported that *T. sanguinea* is dioecious but monoecious specimens have been found. In the present study, based on the percentage distribution of inflorescence grouped by single or co-occurrence of sex-type/quadrat, 71 % of the total quadrat had *T. sanguinea* populations of a single sex-type (male or female) while the remaining 29 % were mixed sex-type (both sexes). The closest spatial proximity between both sexes was observed in compartment 54 of the Okomu National Park; with a measured distance of 7 cm. however, the breakable nature of the rhizome made it difficult to link both inflorescences as a single plant. Our data, therefore, suggest that *T. sanguinea* is usually, but not strictly dioecious. However, molecular techniques may be useful in authenticating the sex of the plant to ensure accurate inference of the ratio of male to female plants.

Insect visitors

A number of insect visitors that includes *Technomyrmex* sp (Hymenopterans), *Monomorium* sp (Hymenopterans), *Tetramorium* sp. (Hymenopterans), *Chrysomya* sp. (Diptera), *Morellia* sp (Diptera), an unidentified species of grasshopper (Orthoptera), and an unidentified species of cricket (Orthoptera) were observed to interact with the inflorescence of *Thonningia sanguinea*. According to Herrera (1989), a species can increase seed set by having a high individual efficiency as a pollen vector and a high frequency of flower visitation. Ants were the most abundant pollinators, accounting for 55.54 % of insect floral visits, The Hymenoptera order; particularly *Technomyrmex* sp. (ant) was the most frequent in both male and female inflorescence, hence had a Berger-parker index value of 0.52. However, after visiting, subsequent movement of the ant species was in a zigzag pattern and consequently, no foraging sequences involving male to female inflorescence head or verse versa was observed.

Apart from ant species, *Chrysomya* sp (Diptera) was observed to forage between a male and female inflorescence head; indicating a possible agent of pollen transfer. However, the visitation made by flying insects were low compared to ant species. De Vega, Arista, Ortiz, Herrera, & Talavera, (2009) reported that the presence of high ant visitation of a species could discourage flying pollinators from visiting its flowers. In addition, *T. sanguinea* may have had a high frequency of ant visitation because of its position on the ground, in combination with

floral scents, nectar, and a large amount of pollen produced by the inflorescence. Based on our observation, we suggest a high chance of myrmecophily pollination in *T. sanguinea*, but the possibility of a myophily occurrence is possible. Hymenoptera, Diptera, and Lepidotera were observed to utilize *T. sanguinea* inflorescence (male and female inflorescences) as a food resource and an oviposition site. This study further confirms the earlier report on the brood -site pollination mutualism between *Morellia* sp. and *T. sanguinea* by Goto, Yamakoshi, & Matsuzawa, (2012). But in addition, the presence of the larvae of *Chrysomya* sp (Diptera) and a member of the Lepodotera was observed on the female inflorescence.

CONCLUSION

The study has established the phenological pattern of *T. sanguinea* to be on an all-year-round basis. However, the frequency of flowering varies across different months of the year, and it is most prevalent during the rainy periods. The lengthy reproductive phenology qualifies *T. sanguinea* as a keystone species in the forest community and consequently, ants, caterpillars, and forest ruminants have an all-year-round food resource supply, even in a season of scarcity. Therefore it is recommended that *T. sanguinea* habitats should be treated as an area of importance for biodiversity conservation.

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Nigerian Journal of Wildlife Management

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Nig. J. of Wildl. Mgt., 2020, 4(2): 34 - 37 **©2020 Copyright Wildlife Society of Nigeria**
https://wildlifesocietyng.org/ojs/index.php/wildlifesocietyng-journal/index ISSN 2735-9298 (PRINT) ISSN 2735-928x (ONLINE)

A Survey of Natural Attractions Important for Tourism Development in Dekina Local Government Area of Kogi State, Nigeria

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ABSTRACT

This study focused on surveys of natural attractions that are important for tourism development in Dekina Local Government Area of Kogi State, Nigeria. Selection of respondents was through purposive sampling technique. The Staff of Kogi Tourism Board, Local Government Tourism Committee, Council of Chiefs and the Dekina Monarch formed the major respondents for this study. On-site observation, questionnaire and interview schedule were the instruments used to obtain data. Forty-seven (47) respondents were the sample for questionnaire administration in this study. The data collected were subjected to descriptive analysis. Results identified Ofo-obaji, Ebi (cold and warm spring), Itemie, Dekina uphill, Ofejiji, Ogo Iyale, Agbenemi cave, Odu-ogane, Uwo Ogboniha, Aji Idehi, Uwo Imodu, Okuta Ijoji, Abu-uja, Obara, and Unugbabi hill as the natural attractions important for tourism development in Dekina Local Government Areas. The study recommended the development of the identified attractions for tourism.

Keywords: Survey, natural attractions, tourism development, Dekina, Nigeria.

INTRODUCTION

Nature gave the environment numerous endowments. The interaction of man with nature has greatly influenced the natural composition and contribution of these endowments with development. Natural area is an area of historic, geologic, or ecological values and of sufficient size and characters so as to allow its maintenance in natural condition by the operation of physical and biological process, usually without direct human intervention (Amadi, 2015). Natural attractions are attractions created by nature. They are different types of physical natural features that pull or entice a person to it. Such resources include landscape, seascape, parks, mountains, flora, fauna, coasts, and islands (Goeldner *et al.*, 1999).

.Nature has endowed Kogi State with numerous natural attractions and potentials that are yet to be tapped. It is disheartening to observe that despite the availability of abundant natural attractions in Kogi State, these attractions are left in their natural form to diminish. Probably covertly, the efforts of government to survey, develop and maximize the gains of these potentials (natural attractions) have not been seriously noticed. Dekina Local

Government is endowed with wide varieties of natural attractions ranging from water base to rock formations. There are previous studies on natural attractions in different parts of Nigeria, however it is important to note that limited work has been on the tourist attractions in Dekina Local Government Area of Kogi State. Faniyi (2001) states that Kogi State is still at the infant stage on tourism development and needed to do more especially on the most important ones. Ogundayo (2001) observed that there is no tourism awareness in Kogi State. The study carried out inventory of natural attractions that are important for tourism development in Dekina Local Government Area of Kogi State. According to Ayodele (2002) inventory of potentials in natural tourism resources should be kept up to date for necessary information and promotion.

METHODOLOGY

Study Area

The study was conducted in Dekina Local Government Area of Kogi State located in the North Central part of Nigeria. Dekina Local Government Area lies between Latitude 7° 41' 24.59"N and Longitude 7° 01' 12.00" E. It shares boundaries with Anambra State to the South, Benue State to the East, Ekiti State to the West, and Niger to the North. The Local Government is predominantly made up of Igalas with other ethnic group which are sparsely populated. These tribes include Igbo, Yoruba, Bassa nge, Fulani, Tiv, Hausa, Ebira among others. The region lies within the warm humid climatic zone of Nigeria with distinctive wet-dry seasons. The climate of the area is thus affected by two main air masses: the tropical maritime, (TM) and the tropical continental (TC) all year round with high temperatures with an annual range of 24.1^0-31.2^0. Associated with the Tropical continental air mass is the North-East wind (Harmattan), which is prevalent at the beginning of (November-January) of the dry season. The South West monsoon wind is associated with the Tropical maritime air mass during the rainy season (Essien et al., 2013). Rainfall is heavy within the rainy months with an average of about 1500-2000mm annually.

Data Collection and Analysis

Quantitative and Qualitative methods were adopted for this study: questionnaire, interview schedule involving the key informants, and on-site observation. The selected areas were purposively selected based on preliminary information on the availability of natural attractions. A total of twenty-two (22) staff of Kogi State Tourism Board, sixteen (16) staff at the Local Government Tourism Committee, ten (10) members of the Traditional Chiefs Council were selected based on their knowledge of various natural attractions in Dekina Local Government. Dekina Monarchs were sampled for interview schedule while on-site observation was done to identify sites of tourism importance. Data obtained were presented descriptively.

RESULTS

Natural Attractions of Tourism Importance in Dekina Local Government

Table 1 presents the natural attractions that are important for tourism development in Dekina Local Government Area and their respective locations. The attractions identified are Ofo-obaji, Ebi (cold and warm spring), Itemie, Dekina uphill, Ofejiji, Ogo Iyale, Agbenemi cave, Odu-ogane, Uwo Ogboniha, Aji Idehi, Uwo Imodu, Okuta Ijoji, Abu-uja, Obara, and Unugbabi hill.

Table 1: Natural attractions in Dekina Local Government Area

S/N	Natural Attractions	Locations
1	Ofo-obaji	Dekina town
2	Ebi (cold and warm spring)	Dekina
3	Itemie	Dekina town
4	Dekina uphill	Dekina
5	Ofejiji fall	Ochaja
6	Ogo Iyale	Iyale
7	Agbenemi cave	Agbeji Ojimele
8	Odu-Ogane	Egume
9	Akpa	Anyigba
10	Uwo-Ogboniha	Dekina
11	Aji Idehi	Dekina
12	Uwo-Imodu	Odu-ate
13	Okuta Ijoji	Egume
14	Abu-uja	Ojo-ofo
15	Aji Obara (cold spring)	Dekina

State of Development of the Natural Attractions

Table 2 shows that one (1) out of the natural attractions in Dekina Local Government Area was developed, fourteen (14) were undeveloped, while three (3) were maintained and twelve (12) were not maintained.

Table 2: State of development of the identified natural attractions in Dekina Local Government Area

S/N	Natural Attractions	Developed	Underdeveloped	Maintained	Not maintained
1	Ofo-obaji		+		+
2	Ebi (cold and warm spring)		+		+
3	Itemie		+		+
4	Dekina uphill	+		+	
5	Ofejiji fall		+	+	
6	Ogo Iyale		+		+
7	Agbenemi cave		+		+
8	Odu-Ogane		+		+
9	Akpa		+		+
10	Uwo-Ogboniha		+		+
11	Aji Idehi		+		+
12	Uwo-Imodu		+		+
13	Okuta Ijoji		+	+	
14	Abu-uja		+		+
15	Aji Obara (cold spring)		+		+

DISCUSSION

The result revealed that Ofo-obaji, Ebi(warm and cold spring), Itemie, Dekina Uphill, Ofejiji, Ogo Iyale, Akpa, Abu-uja, and Unugbabi hill are the prominent natural attractions important for tourism development in Dekina Local Government of Kogi State that were known by the inhabitants of the Local Government while others were not well known due to of lack of awareness. This explains one of the reasons why there has been low patronage to potential tourism sites in Kogi State. Contrary to the findings of Ajake and Amalu (2012) that tourists who visited tourism attractions in Cross River State had increased from 53,634 to 63,972 due to awareness created by mass media and internet. The results indicated that out of the seventeen (15) attractions identified, only one (1) is developed, while 14 are underdeveloped, three (3) are maintained and fourteen (12) are not maintained. This is an indication of the untapped status of natural attractions that could be explored for tourism in the Local Government.

CONCLUSION

With Kogi state as a tourists' haven, with much tourist potentials that are capable of attracting local and foreign tourists to Nigeria and the state in particular, it requires gingering and sustaining private entrepreneurship in tourism at its infancy for her tourism industry to develop in Dekina Local Government Area. As a matter of urgency, there is need for Dekina Local Government to ensure the preservation, development, and maintenance of the identified natural attractions in the Local Government.

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Nigerian Journal of Wildlife Management

Wildlife for Sustainable Development

Nig. J. of Wildl. Mgt., 2020, 4(2): 38 - 54
https://wildlifesocietyng.org/ojs/index.php/wildlifesocietyng-journal/index
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ISSN 2735-9298 (PRINT) ISSN 2735-928x (ONLINE)

Potentials for Sustainable Tourism Development in Andoni and Opobo/ Nkoro Local Government Areas of Rivers State, Nigeria

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ABSTRACT
The study examined the potentials for sustainable tourism development in Andoni and Opobo/ Nkoro local government areas in River state. Data were collected through questionnaire, observation and in-depth interview. A set of questionnaire was administered to household respondents in Ikuru (40), Ilotumbi (19), Oyorokotor (64), Epellema (20), Opobo town (263) and Queens's town (40) in proportion to population size. Total of 446 respondents were sampled. Data collected were subjected to descriptive analysis. Festivals (89.47%), Islands (82.05%); fishing (81.03%) and wild animals (80.22%) were the major tourist attractions in the study area. In Opobo, ancient land marks and relics of ancient instrument of warfare for defense of ancient kingdoms and chiefdoms, such as King Jaja's monument (100%), and canon (100%) amongst others are still preserved. Tourist attractions in the area are underutilized and can be harnessed for sustainable tourism development. The government should establish tourist centers in Opobo to preserve the cultural heritage in the area.

Keywords: Sustainable tourism, environmental resources, economic empowerment, rural development, culture

INTRODUCTION
Tourism is a very unique sector that influences other social and economic activities that contribute positively to man's development. With tourism many aspects of man's occupation and environment (accommodation and business, catering, transportation, education, religion and telecommunication etc.) can be vibrant and marketable. Many countries have discovered the importance of tourism in sustaining economic growth and development and proceeded to adopt tourism as not just a means for revenue generation (Ijeomah, 2007) but as a sector that can foster sustained growth and development. According to World Tourism Organization (WTO), one out of ten jobs worldwide depends on tourism, and international tourism arrivals reached 1.5 billion in 2019 (UNWTO, 2019). Tourism has grown to become the major component of economic strategies for development (Williams and Show, 1991) being a valuable strategy for creating jobs and sustaining economic growth and development in many

countries. Most countries in Africa have been consistent in tourism development and investment by identifying and developing tourist destinations with good tourist attractions and infrastructural facilities. Tourist attractions, whether natural or man-made bring about visitation, thus offer services that can enhance tourist experiences and satisfactions in a destination. Effective management of these attractions can improve the condition of eco-destinations to provide benefits such as economic empowerment, employment opportunities, wildlife conservation, preservation of local cultures, value addition to local products, and foreign exchange earnings, thus bringing about sustainable tourism development. Sustainable tourism development attempts to make low impact on the environment and local culture while enhancing the conservation of wildlife resources and generate income and employment opportunities for the local people (UNWTO, 2021).

Misinterpretation on the value and use of tourist attractions in an eco-destination can affect its maintenance and sustainable utilization. In the absence of proper management of tourist attractions and infrastructural facilities, eco-destinations can be dilapidated; which limits the development of sustainable tourism in the area. Absence of tourist attractions in an eco-destination can affect tourist satisfaction; reduce tourists' period of stay, level of visitation and spending. Poor infrastructural facilities constitute a serious barrier to sustainable tourism development in tourist destinations in Nigeria (Ashikodi, 2011). Poorly maintained roads, seaports, airport facilities, railways; lack of portable water; poor electricity supply etc. hinder tourist impetus to visit tourist destinations in Nigeria in spite the marketing efforts put in place.

The deplorable states of tourist attractions, infrastructural facilities etc. are strategic competitive disadvantages because they discourage tourists from visiting eco-destinations in Nigeria. Put in another way, the conditions make tourists to seek for experiences in other countries thereby reducing the patronage of eco-destinations in Nigeria. Research has also shown that prevalence of armed smuggling, kidnappings and bomb blast in recent times also makes it difficult for tourists to patronize tourist destinations. However, the prospects and challenges of sustainable tourism development in some ancient kingdoms of the Niger delta are yet to be documented. Knowledge of the attractions and their respective awareness level and popularity among both host community members and potential tourists is sacrosanct in predicting the visitation share an eco-destination gets from the competitive tourism market. It therefore becomes imperative to study the sustainable tourism development potentials of Andoni and Opobo/Nkoro, being coastal areas that are culturally inclined, with histories of ancient kingdoms and chiefdoms of global attention as regards to colonization and the slave trade in Nigeria. The objectives of the study are to 1) identify and assess the awareness of potential tourist attractions in the study area, 2) determine the prospects of sustainable tourism development in the study area, 3) identify the challenges of sustainable tourism development in the study area, and 4) recommend ways of improving sustainable tourism in the study area

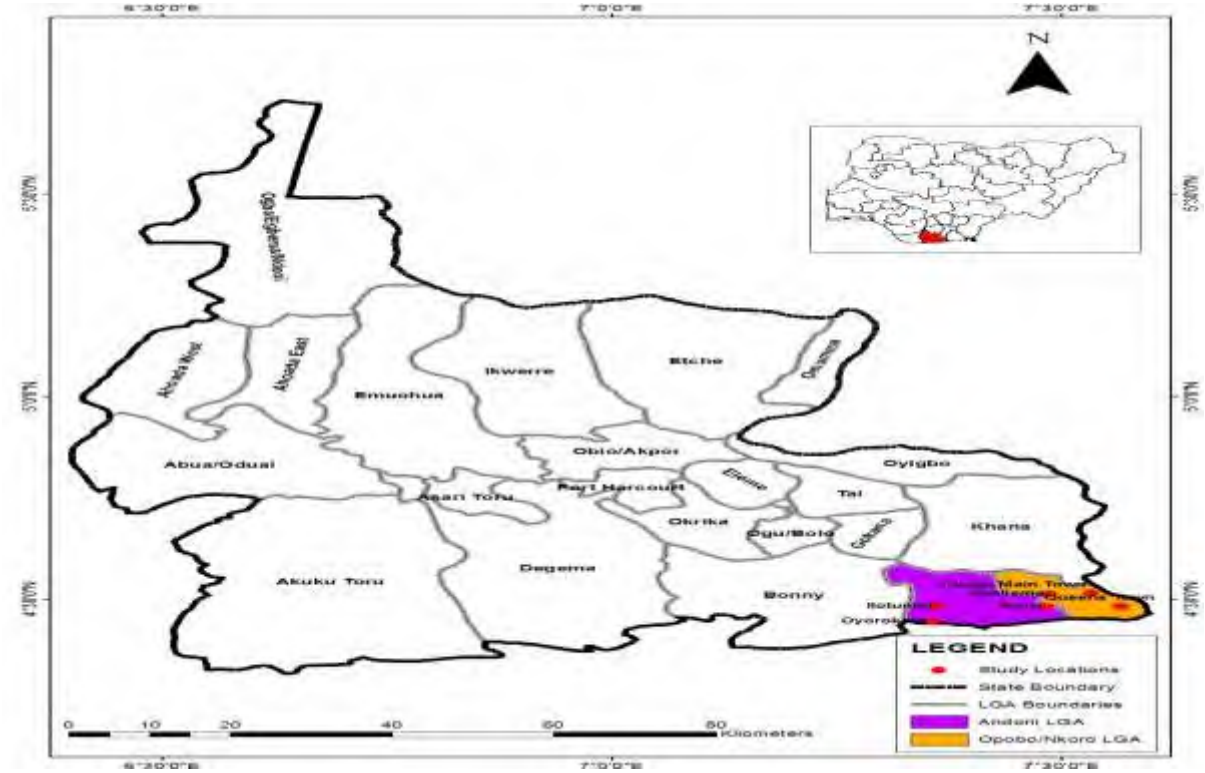
METHODOLOGY

The Study Area

The study area is Andoni and Opobo/Nkoro Local Government Areas in River State (Figure 1). Andoni local government area lies between Latitude 4˚26' 40" N and 04˚ 35' 00" N and longitude 7˚ 16' 30" N and 7˚ 33' 00" N (Richard and Chima, 2016). It covers an area of 233Km^2 and has a population of over 217,924 (at the 2006 census) (NPC, 2006). It's headquarter is located at Ngo town. Towns and villages in Andoni are situated on four

islands. Ikuru town, Ilotumbi and Oyorokotor are situated on island 1.These communities are rich in biodiversity. Being that it is a coastal area majority of the indigenes of these communities' harness fishing as their major source of livelihood with few involve in subsistence farming and business.

Opobo Nkoro LGA is made of several communities situated on islands. The communities include Opobo main town, Queens town and Epellema etc. It is located on 4˚3041'N and 7˚3224'E. It covers a land area of 130km^2 and has a population of over 152,833 (at the 2006 census) (NPC, 2006). Its council headquarters situated at Opobo main town. Communities in Opobo especially Queen's town has boundaries with Andoni communities. People from these communities are culturally inclined and have fishing as their major occupation.



Sampling Techniques

A purposive sampling technique was used to select six communities in the study area. The communities were selected based on noticeable presence of big games and unique tourist potentials. The selected three communities from Andoni Local Government are Ikuru town, Ilotumbi and Oyorokotor, while in Opobo/Nkoro Local Government area, Opobo main town, Epellema and Queens town. From 2018 projected population of the study area (using the growth rate 2.8). Number of households (based on the average family size 10) in Opobo (5,259), Oyorokotor (1,281), Ikuru (874), Queens town (804), Epellema (403) and Ilotumbi (371) were estimated. Five percent of the estimated number of households in Opobo (263), Oyorokotor (64), Ikuru town (40), Queens town (40), Epellema (20) and Ilotumbi (19) were sampled. Thus a total of Four hundred and forty six households were sampled in the six communities (Figure 1). Household was used as a unit of data collection because it is a basic economic unit.

Data Collection and Analysis

Data used for this study were collected through administration of questionnaire (to household representatives in the selected communities).This was complemented with observation of areas with potential tourist attraction, and in-depth interview of four members of each community who have spent at least ten years in the study area and are therefore very aware of the environment as regards to tourism. Data collected were analyzed using descriptive statistics (Percentage, frequency counts, tables and chats).

RESULTS

Results on tourist attractions in order of popularity are presented from Table 1 to 4. Table 1 shows that most respondents in Oyorokotor indicated fishing (81.03%) and monument (79.00%) as popular tourist attractions. Island (82.05%), wild animals (77.05%) and festivals (77.05%) were indicated as the major tourist attractions in Ikuru town, while festival (89.47%) top the list of attractions in Ilotumbi. In the case of Opobo/Nkoro local government area (Table 2), wild animal (80.22%), Island (79.84%), King Jaja's monuments (79.84%) and festivals (78.32%) were listed by most respondents as the top tourist attractions in Opobo main town while festivals (100%), Island (100%), creek/beach (97.05%), wildlife species (70.00%) and fishing (67.05%) take the lead of tourist attractions in both Queens town and Epellema (Table 2). This shows that Opobo, Queen's town and Epellema are rich in natural and cultural tourist attractions. As presented in Table 3, Nwamtam (100%) is a popular and commonly practiced cultural festival in Andoni followed by Ekekpe (85.09%), Egwu-eni (78.94%) and Ekparu (65.00%). This shows that Nwamtam cultural festival is a common cultural festival played in all communities in Andoni in addition to the different cultural festivals indigenous to each community. Nwamtam (95.00%), Boat regatta (85.93%) and fongu (69.96%) topped the list of cultural festivals indicated by respondents in Opobo LGA (Table 4). This shows that communities in Opobo have a common history and origin.

Table 1: Awareness of tourist attractions in Andoni Local Government Area

S/N	Community	Tourist attraction	Frequency	Percentage
1	Oyorokotor	Fishing	52	81.03
		Monuments	51	79.00
		Forest vegetation	48	75.00
		Marriage occasion	48	75.00
		Wild animals	46	71.09
		Fishing port	45	70.03
		Masquerade	44	68.08
		Festivals	43	67.02
		Island	40	62.05
		Creek/Beach	33	51.06
		Cawries	24	37.05
		Mangrove swamp	22	34.04
		Ancient buildings	22	34.00
		Ancient currency	16	25.00
		War drum	9	14.01
		Coronation	7	10.09

2	Ikuru	Island	33	82.05
		Wild animal	31	77.05
		Festival	31	77.05
		Trade	22	55.00
		Marriage occasion	22	55.00
		Forest vegetation	21	52.05
		Ikuru palace	21	52.05
		Ancient gongs	19	47.05
		Masquerade	19	47.05
		1st Anglican church in Andoni	17	42.05
		Monuments	16	40.00
		Fishing	16	40.00
		War drum	14	35.00
		Creek/beach	14	35.00
		Mangrove swamp	12	30.00
		Fishing port	6	15.00
		Ancient building	5	12.05
3	Ilotumbi	Festivals	17	89.47
		Marriage occasions	16	84,21
		Island	15	78.94
		War drum	14	73.68
		Fishing port	14	73.68
		Ancient building	14	73.68
		Mangrove swamp	13	68.42
		Wild animals	12	63.15
		Masquerade	12	63.15
		Trade	9	47.36
		Creek/beach	7	36.84
		Monuments	7	36.84
		Fishing	5	26.31
		Forest vegetation	5	26.31
		Ancient currency	2	10.52
		Ancient gongs	2	10.52
		Cawries	1	5.26

Source: Field survey, 2018

Table 2: Awareness of tourist attractions in Opobo/Nkoro Local Government Area

S/N	Community	Tourist attraction	Frequency	Percentage
1	Opobo main town	Wild animals	211	80.22
		Island	210	79.84
		King jaja monuments	210	79.84
		Festival	206	78.32
		Marriage occasions	180	68.00
		Trade	167	63.49
		War canoe	146	55.51
		King jaja grave	141	53.61
		Manilla tree	131	49.08
		Mangrove swamp	123	46.76
		Ancient bell	121	46.00
		Creek and beach	113	42.96
		Fishing	82	31.17
		Ancient building	79	30.03
		Monuments of past heroes	69	26.23
		Gigi	67	25.47
		Canon	66	25.09

		Remains of old king jaja palace	64	24.33
		War drum	41	13.68
		Nipa palm	27	10.26
		Ancient pot	25	9.05
		King jaja new palace	24	9.12
		Ancient gong	22	8.36
		Ancient tank	21	7.98
		Mgbede(tieing of wrapper)	16	6.08
		Cawries	8	3.04
		City gate	6	2.28
		Fishing port	5	1.09
2	Queens town	Festival	40	100
		Island	40	100
		Creek/beach	39	97.05
		Wildlife species	28	70.00
		Fishing	27	67.05
		Ancient building	26	65.00
		War drum	26	65.00
		Marriage occasions	23	57.05
		Trade	22	55.00
		Monuments of past heroes	22	55.00
		Forest	20	50.00
		Ancient bell	19	47.05
		Fishing port	15	37.05
		War canoe	8	20.00
		Mangrove	7	17.05
		Canon	3	7.05
		Cawries	3	7.05
3	Epellema	Festival	40	100
		Island	40	100
		Creek/beach	39	97.05
		Wildlife species	28	70.00
		Fishing	27	67.05
		Ancient building	26	65.00
		War drum	26	65.00
		Marriage occasions	23	57.05
		Trade	22	55.00
		Monuments of past heroes	22	55.00
		Forest	20	50.00
		Ancient bell	19	47.05
		Fishing port	15	37.05
		War canoe	8	20.00
		Mangrove	7	17.05
		Canon	3	7.05
		Cawries	3	7.05

Source: Field survey, 2018

Table 3: Cultural festivals in Andoni Local Government Area in order of awareness

S/N	Community	Cultural festival	Frequency	Percentage
1	Oyorokotor	Nwantam	59	92.02
		Ukekpe	55	85.09
		Efit-ukpoo	33	51.06
		Afala	3	4.07
		Agaba	2	3.01
		Ukah	2	3.01
		Akamiete	2	3.01
2	Ikuru	Nwantam	39	97.05
		Ekparu	26	65.00
		Egbelegbe	25	62.05
		Ukekpe	13	32.05
		Age grade	6	15.00
		Efit-ukpoo	6	15.00
		Afala	3	7.05
		Boat regatta	2	5.00
		Egwu-eni	2	5.00
3	Ilotumbi	Nwantam	19	100
		Egwu-eni	15	78.94
		Awaji-Ilotumbi	10	52.63
		Owu	2	10.52
		Ukekpe	2	10.52

Source: Field survey, 2018.

Table 4: Cultural festivals in Opobo/Nkoro local government area in order of awareness

S/N	Community	Cultural festivals	Frequency	Percentage
1	Opobo main town	Nwantam	250	95.00
		Boat regatta	226	85.93
		Fongu	184	69.96
		Jeki-alali	174	66.15
		Owu-ogbo cultural festival	119	45.25
		Masquerade display	103	39.16
		Iria marriage	94	35.74
		Mgbede(tieing of wrapper)	6	2.28
2	Queens town	Nwantam	39	97.05
		Boat regatta	21	52.05
		Fongu	17	42.05
		Owu-ogbo	13	32.05
		Age grade	7	17.05
		Asenti	1	2.05
3	Epellema	Nwantam	20	100
		Boat regatta	20	100
		Ogolo-nwantam	9	45.00
		Owu-ogbo	8	40.00
		Okonko and osukpe	7	35.00
		Masquerade	2	10.00

Source: Field survey, 2018

Results on challenges of tourism development in the study area were identified as difficulty in accessing the area in Queens town (87.05%), Epellema (82.60%), Opobo main town (70.52%) and Ilotumbi (58.62%). Community crisis was indicated in Oyorokotor (57.08%) and Ikuru town (25.49%). This shows that insecurity is a major challenge in Andoni unlike in Opobo LGA (Table 5).

Table 5: Challenges of tourism development in the study area

S/N	Community	challenges to tourism development	Frequency	Percentage
1	Opobo main town	Accessibility issue	189	70.52
		None	38	14.17
		Weather condition	26	9.70
		Kidnapping	8	2.98
		Pirate	6	2.24
		Restiveness	1	0.37
	Total			100
2	Oyorokotor	Community crisis	37	57.08
		Restiveness	31	48.04
		Kidnapping	25	39.01
		Pirate	25	39.01
		Accessibility issue	18	28.01
		Cultism	8	12.05
		Weather condition	5	7.08
	Total			100
3	Ikuru	Restiveness	25	49.02
		Community crisis	13	25.49
		Kidnapping	7	13.72
		Accessibility issue	6	11.76
	Total			100
4	Queens	Accessibility	35	87.05
		Kidnapping	3	7.05
		None	2	5.00
	Total			100
5	Epellema	Accessibility	19	82..60
		Kidnapping	2	8.69
		Restiveness	2	8.69
	Total			100
6	Ilotumbi	Accessibility issue	17	58.62
		Community crisis	7	24.13
		Restiveness	2	6.89
		Pirate	1	3.44
		Weather condition	1	3.44
		Cultism	1	3.44
	Total			100

Source: Field survey, 2018

Results on the indicated ways of improving tourism in the study area were establishment of tourist center in Ilotumbi (57.89%), Ikuru (40.47%) and Opobo (36.70%), while in Epellema (57.14%), Queen's town (43.07%) and Oyorokotor (29.54%), construction of road was mostly indicated as the way of improving tourism (Table 6).

Table 6: Ways of improving sustainable tourism in the study area

S/N	Community	ways of improving sustainable tourism	Frequency	Percentage
1	Opobo main town	Establish tourist center	127	36.70
		Completion of road under construction	56	16.18
		Establishment of industries and financial	46	13.29
		institution	37	10.69
		Construct good roads	31	8.95
		Improve existing tourist attraction	25	7.22
		Build museum	9	2.60
		Government intervention	7	2.02
		Development of existing Atlantic beach	6	1.73
		Reduce cost of living	2	0.57
	Total	Create employment		100
2	Oyorokotor	Construct good roads	26	29.54
		Establish tourist center	18	20.45
		Government intervention	18	20.45
		Develop the community	17	19.31
		Political stability	4	4.54
		Tackle security challenge	4	4.54
		Create employment	1	1.13
	Total			100
3	Ikuru town	Establish tourist center	17	40.47
		Tackle security issue	8	19.04
		Develop the existing beach	8	19.04
		Construct good roads	5	11.90
		Government intervention	3	7.14
		Employment	1	2.38
	Total			100
4	Queens town	Construct good roads	28	43.07
		Establishment of tourist center	22	33.84
		Establishment of industries and financial	11	16.92
		institution	4	6.15
	Total	Government intervention		100
5	Epellema	Construct good road	20	57.14
		Establish tourist centers	9	25.71
		Establish protected areas	3	8.57
		Electricity	3	8.57
	Total			100
6	Ilotumbi	Establish tourist centers	11	57.89
		Construct good roads	8	42.1
	Total			100

Source: Field survey, 2018.

DISCUSSION

The major tourist attraction in Opobo Local Government Area (LGA) is wild animals. Wild animals like Crocodile (*Crocodylus sp*), Hippopotamus (*Hippopotamus amphibius*) and Elephant (*Loxodonta africana*) are seen once in a while in the natural environment. Viewing of these animals interests tourists. Dung of Elephant (*Loxodonta africana*) could easily be sited in some communities and that brings some level of satisfaction to tourists but most tourists desire to view elephant. The presence of the species is most times dictated by flies and its foot prints. These wild animals were seen on regular basis many years ago especially the large aquatic organisms like Crocodile (*Crocodylus sp*) and Hippopotamus (*Hippopotamus amphibious*). Hippopotamus

could be seen by indigenes and tourists feeding on crops in farms close to the river side. Many tourists who visit Opobo main town during this period enjoyed viewing these animals in the natural environment while enjoying the cool breeze from the island. Presently, the wild animal seen regularly is the monkey. The high value placed on observing big games by tourists is evidenced and agrees with the report of Ijeomah and Duke (2016) that numerous tourists visit Finima Nature Park purposely to view the remains of Whale brought out by water waves from the Atlantic Ocean. This also corroborates the findings of Eltringham (1984) that wildlife is the major attraction in many eco destinations in Africa. Tourists enjoy watching big games (in their natural environment) including primate species because of their noise, agility and acrobatic displays as observed by Ijeomah (2012) in Jos Wildlife Park. In Queen's town and Epellema festivals are the main attractions- elephant (*Loxodonta africana*) is hardly observed in this community. Opobo /Nkoro LGA is rich in cultural festivals that attract tourists from within and outside Nigeria. Festivals in Opobo/Nkoro LGA are unique, interesting and educating to tourists and the local inhabitants. Festivals in Opobo/Nkoro LGA are celebrated during festive periods which usually are in the months of December, January, August and September. This shows that the communities have a time table for display of various attractions packaged in the form of events. The most cherished festival that attracts visitors globally is the Nwantam, which has a unique costume and cultural display.

Festivals give tourists the opportunity to access many tourist attractions like cultural artifacts and historic heritages of the study area (such as King Jaja's monument and monument of past heroes). These artifacts and monuments that have influence on the national and cultural heritage sites are well protected and opened only during festive periods. Festivals as tourist attractions in these areas have also influenced the development of tourist infrastructures like hotels and guests houses (of different standards) to satisfy the desires of various classes of visitors. The presence of these infrastructures has created employment for the youths in the community. This agrees with Cudny (2013) that festival gives access to tourist products that satisfies tourist needs. Similarly, the Argungun fishing festival has popularized the host community and local government area (Ijeomah, 2007). Island is a major tourist attraction in Ikuru town. The site is off the Atlantic Ocean and close to the rainforest in the community which has boundary with Queen's town in Opobo. It is fondly referred to as Atlantic beach which respondents perceived as the longest white sand beach in West Africa. Island attracts tourists from far and near. Many tourists visit Ikuru town every year to enjoy the serene beauty, cool breeze, sun bath, boat tour, boat regatta and night party that takes place at the beach. The Island is a habitat for large aquatic organisms like the whales, hippopotamus, crocodile and even the African elephant which sometimes comes out around the beach. This is similar to the report of Ijeomah and Emelue (2009) that the Pandam Lake inhabits hippopotamus (*Hippopotamus amphibious)* as evidenced by numerous and obvious footprints in front of the lake. Interaction with respondents revealed that, the island (Atlantic beach) attracted a large number of tourists in July, 2017, who visited to view the remains of Whale, a rare species that was washed ashore the beach on the 6th July, 2017.

Fishing is the major attraction in Oyorokotor community. This is because of the large fishing settlement in the community which respondents perceive to be the largest fishing port in West Africa. This fishing settlement has large inflow of visitors on daily basis. People visit the fishing settlement for different reasons such as observing the landing sites of fish, different types of nets and fishing

techniques. Some visit to view water body and take pictures, while others visit the areas for buying and selling of fishes and other sea foods. The presence of this fishing settlement in Oyorokotor has created a lot of employment opportunities for different people such as the marine transporters and traders. This corroborates the findings of Ijeomah (2007) that fishing is the major tourist attraction in Arugungun during the popular fishing festival in the area which has become recognized by the UNESCO. Some tourists are attracted and fascinated by different artifacts and monuments in the eco-destinations. Some of the instruments and artifacts show traditional means of warfare, communication, entertainment, transportation; ways of recreation; punitive measures and styles of sanctions; symbols of judgment; traditional ways of honour and compensation, attributes and peculiarities of kingdoms and chiefdoms, organization and strengths of communities before civilization in the various communities. These artifacts confirm what many tourists have read and heard about communities in the study area especially Opobo. The Canon as an ancient firearm was used in fighting war. It was used to defend the Opobo people against their enemies and external aggressors. It is found in the town square, King Jaja's palace and in compounds of chiefs who were known to be warriors. In the ancient era, war was usually fought on water as the people lived mostly on island. The Canon was therefore placed in the front and back of the war canoe. War canoe was built in such a way that it can accommodate all the warriors and also maintain stability on water. The presences of Canon and war canoe are indicators that Opobo is an ancient kingdom that fought wars. Manilla tree is a cultural artifact that was given to the people of Opobo by the Europeans during their independence. It signifies freedom and wealth. This implies that King Jaja and Opobo people were set free from the Europeans (after colonization) and thus expected to flourish in riches and wealth. The Manilla also serves as the symbol of authority that announces the arrival of the king in any place (palace, gathering or events) in Opobo kingdom. This is synonymous with the mace of the national Assembly and the traditional mace used by the Ibos.

War canoe houses are autonomous houses. It is only accorded to the houses which were involved during the Ibani war. There are a total of 67 war canoe houses with each having an Alagbo (Chief) and all the 67 Alagbo's make up the Alapu (Council of Chiefs) in Opobo kingdom with the king as the Amayanabo of Opobo kingdom.

The remains of king Jaja of Opobo ancient palace in King Jaja's compound, shows the people's value for culture and historic heritage. Similarly, Ijeomah *et al.* (2015) observed that most households in Oguta community preserve ancestral homes as ancient land marks and as relics to remember their history. The presence of King Jaja's monument and monuments of past heroes interests tourists and give insights about the history and culture of the people. Preservation of these cultural artifacts and historic heritage enhances continuous tourism - a tourist visiting the destination for the first time derives satisfaction and will want to visit again knowing that these tourist attractions will always be there. Similarly, the remains of Ezeawa, the traditional ruler of Awa who was killed on the throne for refusing to vacate the throne and migrate with His subjects to another community when Oguta invaded His abode is still intact in Oguta as a tourist attraction (Ijeomah *et al*, 2015). These monuments also show that the study area just like many communities in Africa had great leaders. The curiosities aroused by King Jaja's monument, and historical narrations given by experienced tour guides always brings a lot of satisfaction to numerous tourists

The ancient palace hall of the King Jaja of Opobo called Gula is a storey building built

with mahogany wood. The pillars, decking and beam were all built with non-polished wood over 100 years ago. The building portrays indigenous skills and crafts - local traditional technology in building. Observing King Jaja of Opobo's palace fascinates tourists as they commend the ancient organization of his kingdom. Similar fame of wisdom and skills manifested in organization of the palace of Solomon attracted many tourists including the famous Queen of Sheba (Bible, 2004; Ijeomah *et al*., 2005). Gigi is a traditional boat specially decorated for use only during important events such as chieftaincy coronation or in honour of an illustrious son or personalities. Young boys wear different attires paddle and perform some display on the river.

The study area is endowed with unique and colourful festivals that interest different types of tourists. Some cultural festivals ranked by respondents in Opobo and Andoni LGAs are similar in all the communities. This shows that the communities have similar history and are therefore culturally related.

Nwantam, the most cherished festival by respondents is common in the study area. It is normally celebrated from 25th of December to 1st of January. Nwantam festival is a very significant festival to any Opobo person. This is because it is celebrated to mark the establishment of Opobo kingdom in Opobo land, an event which took place on the 1st January 1870. Before the commencement of the Nwantam cultural display, members of the dance group known as Ntuma in Queens town and Mkpa in Opobo main town, go to the cemetery and sleep there for seven days to appease the spirit of the ancestors of the town (i.e. Ndi Itchie) and fortify themseves with power. And as part of the processes of fortification, members of the Nwantam masquerade abhor food prepared by a woman but rather feed on only cooked or roasted yam, corn or plantain prepared by themselves. In Opobo, Nwantam masquerade is different from others as it is the only masquerade that displays on the top of a roof without its heels touching the ground. It is believed that Nwantam masquerade festival brings good omen and grants protection to the town as it performs. In Andoni, Nwantam does not display on the roof but has its own unique cultural display. Other cultural festivals like Ukepke performed in Asarama, Oyorokotor and Ngo town on the 3rd of January and Ekparu (which is celebrated by Ikuru town on the 2nd of January every year), display on the top of a roof. This brings a lot of excitement to visitors especially children who normally watch with a lot of concentration. While the masquerade is displaying on the roof or is about to jump down, 'spiritually powerful' men from other visiting communities throw raw eggs and other types of charms on the masquerade as a way of testing his strength or his ability to withstand charms. This cultural display has been incorporated into a competition that attracts an award during Nwantam festival. The competition attracts a lot of tourists. Similar competition is performed among masquerades during the famous Ikeji festival in Arondizogu of Ideator North local government area, Imo state. However, in the case of Ikeji, with the aid of charm a goat is tied to a tree with a fragile thread, any masquerade that is able to untie and go home with the animal in the presence of other charm- carrying masquerades is termed the most powerful (Ijeomah *et al*, 2009; personal communication).

Efit-Ukpoo is another cultural festival but celebrated mainly at night. Its display starts from 10pm and last for three nights. Efit-Ukpoo is a kind of occult group owned by the ancient fathers. Before it displays, the group stays in the bush for three (3) days to perform rituals to fortify themselves. It is less cherished by tourists due to changes in religious beliefs and the time it is performed. Egbelegbe cultural festival is common in the study area. It comprises different masquerades

such as the male, female and daughter (Ada). The Egbelegbe male has one face while the Egbelegbe female has two faces. Ada Egbelegbe masquerade has a camp and puts on ear ring. It is the biggest masquerade and cultural festival in Ikuru town. It is celebrated every two years unlike Nwantam and other cultural festival that hold every year. This cultural festival starts two weeks after Nwantam and Ekparu cultural festival and lasts for 14 days. During its display, women are not allowed to be outside.

Boat regatta is a cultural festival that is held every 31st December in Opobo LGA. The boat used is fondly called Gigi. Boat regatta is an ancient practice in Opobo kingdom. During this period, chiefs in Opobo normally use it to visit their settlement in Ndoki and Akwa Ibom state. These settlements may include fishing ports, palm plantation and their markets for traders. Over time boat regatta has been adopted as a tradition. Presently, boat regatta has been incorporated as a competition in which each regatta boat has its own team with the team members all dressed in beautiful costumes and the brat well decorated. This festival attracts tourists from within and outside the country. This agrees with the report of Ijeomah *et al* (2015) in Oguta, a riverine community in Imo state where boat regatta is practiced.

Fongu festival is one of the festivals that is celebrated in Opobo kingdom between August and September every year in honour of water spirits that migrate between August and September to celebrate on land. Respondents believe that Fongu festival is a declaration and a ritual to appease the water spirits. During the period of the festival, the Fongu cultural group members make sacrifices in the river banks, while the sacrifice is on-going, no non Fongu group member is allowed at the river bank and no speed boat is permitted to anchor at the jetty to avoid disturbing the process of sacrifice. At this time, the sea becomes obviously very rough with unassuming increase in wave which the community believes is an indication that the spirits have accepted their sacrifice and therefore return home to celebrate. Most respondents believe that the Fongu festival prevents boats from capsizing or sinking and also promotes high harvest of fish during difficult seasons. Similarly Ijeomah *et al*.(2009) observed that during Akwu festival in Dikenafai community of Imo state, only members of Urashi cult are allowed to enter the Urashi River destination when sacrifices are taking place. Many tourists like listening to the tales of Fongu but dislike witnessing it.

Owu-ogbo festival is a festival that is coordinated by the Owu-ogbo society. Owu-ogbo is a central committee that is in charge of all cultural matters in Opobo community. This society was empowered by King Jaja and chiefs (who are also members of the Owu-ogbo society) to discipline citizens of the community who do not conform to cultural rules. This could be the reason the kingdom is relatively very peaceful and void of insecurity. This practice is in line with the principles of ecotourism (Ceballos - Lascurain, 1992). It monitors to ensure that cultures are preserved. This festival involves the participation of the entire masquerade dance group associated with the Owu-ogbo dance club. All the masquerades in the Owu-ogbo are drawn from different families by members of the compound who are in Owu-ogbo club. These masquerades participate in the festival that lasts for a maximum of 2 weeks. Each masquerade in the Owu-ogbo dance club takes the shape of a specific animal such as birds, hippopotamus, fish etc. During the festival, all masquerades appear from their places of seclusion and dance into the streets or open field to specific rhythm of the drums. The drum is played according to the type of animal the mask represents. In most cases the fish masquerade dances first followed by other different masquerades. Dancing of the fish masquerade before others can be attributed to

the fact that the environment is riverine community with abundance of fish. At the end of the two weeks of cultural display, the Owu-Mgbila declares the festival closed by cutting the Akassa (fish rack).

Weather condition can be a serious challenge to tourists visiting Island destinations especially during raining season. Nigeria has long period of rainfall and an increase in rainfall can affect the water level of Islands, thus making it difficult for speed boats to operate. It also causes flooding and makes the environment to be unpleasant for tourists. The wind also affects the movements of speed boats. Weather condition can affect transportation by water, hence affecting tourist's time of visitation to coastal destinations including beaches. This agrees with the report of Zangi (2005).

In communities like Opobo, Queen's town, Ilotumbi and Epellema, accessibility is the major challenge to tourism development. The means of access to these communities is mainly by water. Respondents who reside in these communities are used to water as their only means of transportation. However, they consider accessibility as a challenge to tourists who are afraid of water. Tourists with this kind of mind set would not want to visit these areas, rather will prefer destinations that are accessible by road. Despite these challenges the level of tourist visitation is high in these communities especially during festive period.

Having water as the only means of transportation affects the rate at which people visit Queen's town and Epellema. The low rate of visitation adversely affects availability of speed boat. People outside Queens town and Epellema board speed boat to these areas through Akwa-Ibom state (Ikot-Ekpene) or Opobo main town. According to respondents, getting passengers outside market days and none festive periods or non-occasion is not easy. This makes speed boat going to Queen's town and Epellema to be very scarce and thus making transportation to these areas very expensive. Majority of the respondents at Queen's town and Epellema emphasized that apart from the market days and festivals, they access the communities by speed boat only on chatter which is about twelve thousand naira (₦12,000:00) to and fro. Availability of good road networks in addition to the water ways can enhance easy access to coastal tourist destination and reduce the cost of visitation. This agrees with the work of Omisorie and Akande (2009).

Operation of sea pirate is one of the security challenges that affect the growth of tourism in the study area. Operations of pirates affect marine transportation, fishing and trading activities and make the environment unsafe for tourism to thrive. Sea pirates instill fear on marine operators and fishermen. The fear of being shot, robbed and thrown into the sea can affect sailing and tourist's decision to operate in a particular coastal area. The absence of marine boat operators in a particular route can as well affect tourism operation in that area. This could be the reason why the fishing settlement and other tourists' activities are not functional in Oyorokotor. This agrees with Ijeomah *et al.,* (2014) that coastal tourism can thrive in destinations where marine transportation and other activities are functional. Sea pirates can also affect the financial economy of the fishermen, traders, marine operators and the host communities. This confirms previous study by Ochia (2013) who concluded that anxiety and fear resulting from the activities of sea pirates affects the financial economy of the fishing enterprises and maritime operations.

Tourism cannot thrive where there is crisis. The issue of restiveness and community crisis is well pronounced in Andoni L.G.A unlike in Opobo/Nkoro L.G.A. Community crises and restiveness of youths, cult clashes and kidnapping affect the rate of tourists visitation in the study area. Awareness of different activities of restive youths on social media and radio in Ikuru, Oyorokotor and Asarama

scares and discourages visitation of both tourists and indigenes who reside outside the communities. Consequently, many indigenes of these communities have relocated to other parts of Rivers state considered to be peaceful. Other indigenes residing in Port-Harcourt city no longer visit their home town. Most of the communities are therefore filled with old men, women and children who have no place to stay in the city. This agrees with WTO, (2003) that insecurity affects tourist perception, choice of visitation and creates negative image among potential visitors. Ijeomah (2017) gave a similar report that many eco-destinations in Nigeria are faced with some forms of insecurity. These challenges can also be the reason for lack of development in Andoni as most of the infrastructures like roads have been abandoned by the Rivers state government; financial institutions are also unavailable. More so, the largest asset located in Oyorokotor community, the fishing port has been shut down due to cult clashes. This has affected respondents' source of livelihood which is fishing. Chukwuemeka and Vincent (2010) obtained a similar result. Due to crisis of leadership most communities in the Local government area have more than one traditional ruler. Each of the communities is fighting over the position of the community head and ownership of the area especially the largest fishing settlement which has been destroyed. Through oral interview respondents from Ilotumbi and Asarama are of the view that community crises have divided their communities into different segments with different chiefs and supporters. This implies that a tourist visiting this community for the first time might be directed to a wrong chief or ruler based on who he first approaches for direction.

CONCLUSION

Elephant (*Loxodonta africana*) is a potential major tourist attraction in Andoni and Opobo. Other attractions include Islands, rich cultural festivals and cultural historic heritage found in these areas. Tourists who visit these areas during festive period to witness the cultural festivals will gain more satisfaction from game viewing and sighting cultural artifacts and historic heritage. Other activities like Atlantic beach party, boat cruising, sun bathing can also be enjoyed by tourists who visit these potential tourist destinations. These activities can prolong tourist stay, motivate continuous visit to these destinations and create a good image that attract other tourists to visit the destinations. Preservation, protection and maintenance of the cultural festivals and heritage while improving the socio-economic status of the host communities and maintaining a healthy environment can enhance sustainable tourism development.

The study recommended that government should establish protected areas in Andoni local government area especially in Ikuru town to preserve the Elephant (*Loxodonta africana*) in the area. This will enhance game viewing and create job opportunities for the youths. Government should establish other tourist centers like museum in Opobo to preserve the cultural heritage in the area. This can as well expand the socio economic prestige of the host communities and generate revenue for the state. Government should intervene in the community crises and youth restiveness in Andoni Local Government Area to bring about peace in the area. This can help to speed up developmental projects, improve business activities, attract international investors and enhance the inflow of tourist visit to the area.

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Wildlife for Sustainable Development

Nigerian Journal of Wildlife Management

Nig. J. of Wildl. Mgt., 2020, 4(2): 55 - 70
https://wildlifesocietyng.org/ojs/index.php/wildlifesocietyng-journal/index
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ISSN 2735-9298 (PRINT) ISSN 2735-928x (ONLINE)

Relationship between Socio-Economic Characteristics, Perceived Value and Conservation Attitude of Visitors in Selected Ecotourism Destinations in Nigeria

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ABSTRACT
This study investigated the relationship between visitors' perceived value, socioeconomic characteristics, and conservation attitude in three ecotourism destinations in Northern Nigeria. Structured questionnaire was administered on 575 respondents: Chad Basin National Park (CBNP) 69, Gashaka Gumti National Park (GGNP) 165 and Yankari Game Reserve (YGR) 341. Data were analyzed descriptively and inferentially with Chi-square, correlation, and regression analyses. The visitors' mean perceived intrinsic value was 3.17 at CBNP, GGNP (3.66) and YGR (3.62). Mean non-use value was 4.28 at recorded at CBNP, GGNP (4.46) and YGR (4.45). Mean recreational value was 4.69 at CBNP, GGNP (4.28) and YGR (4.36). Mean use value was 3.76 at CBNP, GGNP (3.63), and YGR (3.76). The highest conservation attitude was "sustainability of wildlife lies in conservation" at CBNP (4.55), "wildlife should be valued as natural and cultural relics" at GGNP (6.20), and also at YGR (5.33). Furthermore, there was significant association between conservation attitude and intrinsic value ($r=0.442$, $p<0.01$), use value ($r=0.140$, $p<0.01$), and the overall perceived value ($r=0.289$, $p<0.01$). Conservation attitudes are thus formed from perceived values towards the eco-destinations.

Keywords: Perceived value, conservation attitude, visitors, ecotourism destination.

INTRODUCTION
Tourism has emerged as one of the quick and rapidly growing sectors worldwide playing a significant role in the economy while also contributing to the growth of other sectors and their economies (Osman & Sentosa, 2013). In 2013, tourism growth rate increased more than the growth in communication services as well as services involving manufacture, retail and finance. Ecotourism which is a subsector of world tourism has now become a constantly developing and improving phenomenon most especially in developing nations around the globe (Ogunjinmi, 2015).

Perceived value is the main strategy in comprehending visitors' behavior (Woo, Kim & Uysal, 2015) because it results in satisfaction, recommendation and revisit

intention of visitors which in turn form loyalty to the destination (Kim, Woo & Uysal, 2015). Also, perceived value in service term is important in service delivery during the consumption stage and decision-making (Prebensen, Woo & Uysal, 2014). Perceived value describes individual evaluation of tourism products such as price, quality, emotions as well as social factors (Chiu, Lee & Chen, 2014). Williams and Soutar (2009) identified dimensions of perceived value to include functional value, money value, emotional value, social value and novelty value. Explaining perceived value at natural destinations, Winter and Lockwood (2004) developed the natural area value scale to measure intrinsic, recreational, non-use and use values as subsets of perceived value. Visitors develop experiences with tourism destinations, thus, tourism destination attractions, resources, accessibility and infrastructural facilities have an impact on how these visitors perceive the destinations (Al-Ababneh, 2013). A tourism product involves a compilation of diverse elements like accommodation, feeding, entertainment, security and other supporting services at tourism destinations (Zabkar, Brencic & Dmitrovic, 2010).

Visitors develop experiences with tourism destinations, thus, tourism destination attractions, resources, accessibility and infrastructural facilities have an impact on how these visitors perceive the destinations (Al-Ababneh, 2013). Rousan, Ramzi and Mohamed (2010) posited that visitors build their experiences and values from their individual perceptions of services rendered at a destination.

Eco-destinations are gradually gaining prominence as significant areas that are instrumental for biodiversity conservation and management notwithstanding some salient issue that there is no straightforward link between designating a land for conservation and eventually achieving conservation goals (Hulme & Murphere, 2001). Despite this increasing prominence of eco-destinations serving as effective tools for conservation, studies have observed that eco-destinations have been unsuccessful in curbing threats to animal populations by humans (Craigie *et al.*, 2010). In many instances, national parks have been created so as to showcase and stabilize the natural environment depicting what a wild environment should resemble (Dunn, 2009). These parks have specifically been created in natural areas with high scenic attractions with accompanying great numbers of wildlife population. Tourism has thus been important so as to solicit required support and legitimacy in conflicting land use decisions for conservation which usually has huge impact on local population (Mowforth & Munt, 2005). This has often raised issues on the impact of tourism on conservation attitude of visitors with diverse socioeconomic attributes as well as the values perceived by these visitors when they visit eco-destinations.

As stated by Chen *et al.* (2011), education may have a positive influence on environmental conservation attitude of an individual. In a study in china, Chen *et al.* (2011) also found out that people of lower age groups are more likely to have positive conservation attitudes. Vicente-Molina, Fernández-Sáinz & Izagirre-Olaizola (2013) investigated the female gender's conservation attitude to be different from the conservation attitude of the male gender while investigating socioeconomic factors. Furthermore, Chiu *et al.* (2014) revealed the relationship between perceived value and conservation attitude. Reports have also suggested that perceived value obtained from nature experience could be a significant factor in improving conservation concern (Wells & Lekies, 2012).

Although, perceived value is essential in describing visitors' opinion and experiences (Moliner, Gil, & Ruiz, 2011), there is insufficient knowledge about what drives perceived value (Prebensen, Woo, Chen &

Uysal, 2012) and also its relationship with conservation attitude which has thus made this research important so as to investigate the relationship between perceived value, socio-demographic characteristics and conservation attitude in some selected eco-destinations in Northern Nigeria. The pertinent questions for this study are 1) What are visitors perceived values towards the selected eco-destinations? 2) Do visitors have positive conservation attitude towards the selected eco-destinations? and 3) Are there a relationship between visitors' perceived values, socio-demographic characteristics, and conservation attitude?.

Materials and Methods

Description of Study Area

The study was carried out at Chad Basin National Park (CBNP), Gashaka Gumti National Park (GGNP), and Yankari Game Reserve (YGR). These ecotourism destinations are located in the Northern part of Nigeria. CBNP is located in Borno and Yobe States, and has a total area of about 2,258km^2. The park is fragmented, with three sectors. The Chingurmi-Dugurna sector is in Borno State, in a Sudan Savanna ecological zone. The Bade-Nguru Wetlands and Bulatura sectors are in Yobe State in the Sahel ecological zone. The park combines the former Chingurmi-Dugoma Game Reserve, Gorgoram and Zurgun Baneri Forest Reserves, and Bulatura Oasis. The Chingurmi-Duguma sector is in the Bama Local Government Area of Borno State, adjoining the Waza National Park in the Republic of Cameroon located on latitude 11°27'52.71"N to 11°28'27.08"N and longitude 10°37'50.60"E to 10°37'26.89"E with an area of 1,228km^2.

The Bade-Nguru Wetlands sector is part of the Hadejia-Nguru wetlands, and has an area of 938 km^2. It is also located on latitude 12°51'17.96"N to 12°28'53.34"N and longitude 10°17'12.15"E to 10°34'14.49"E while the Bulatura sector is in the Yusufari Local Government Area of Yobe State with an area of 92 km2 located on latitude 11°33'26.37"N to 11°24'31.96"N and longitude 13°48'33.60"E to 13°53'8.42"E. Annual rainfall ranges between 200-600mm during the period late May-September with temperature between 18°C-42°C. Waters from the Dorma River flood much of the sector in the rainy season, creating flood-plain wetlands that attract waterbirds and other wildlife. The resident black crowned crane (*Balearica pavonina*), the helmeted guineafowl (*Numedia meleagris*), elephant (*Loxondonta africana*), Demoiselle cranes (*Grus virgo*), white storks (*Ciconia ciconia*) have been found in the park (Important Bird Area Factsheet, 2012)

Gashaka Gumti National Park was gazetted from two game reserves in 1991 and is Nigeria's largest national park. It is located in the eastern provinces of Taraba and Adamawa to the border with Cameroon. Geographically, the park is located on latitude 7°34'25.49"N to 7°17'56.03"N and longitude 11°29'12.13"E to 11°41'57.53"E. The total area covers about 6,402 km^2, much of the northern GGNP is savannah grassland, while the southern GGNP sector of the park has a rugged terrain characterized by very mountainous, steep slopes as well as deep valleys and gorges, and is home to montane forests (Chapman *et al*., 2004). The annual temperature range is approximately 21°C-32.5°C. The annual precipitation is around 1897 mm and its typical form is rain during the months of April to October. Fauna species include yellow-backed duiker, African golden cat (*Profelis aurata*), The African buffalo (*Syncerus caffer*), the largest population in Nigeria of chimpanzee (*Pan troglodytes*), the African elephant *(Loxodonta africana*), the klipspringer (*Oreotragus oreotragus*), the West African wild dog (*Lycaon pictus manguensis*), the hartebeest (*Alcelaphus buselaphus*), the world's largest antelope, the giant eland (*Taurotragus derbianus*), the roan antelope (*Hippotragus equinus*), the kob antelope (*Kobus kob*), the oribi (*Ourebia*

ourebi), and the rare Adamawa mountain reedbuck (*Redunca fulvorufula*) in larger stocks. The park is officially labelled as one of Africa's "Important Bird Areas" and with more than 500 species found. (Forshaw *et al.*, 2010)

Yankari Game Reserve is a large wildlife park located in the south-central part of Bauchi State, in northeastern Nigeria. It is located on latitude 9°52'4.56"N to 9°50'40.52"N and longitude 10°17'46.27"E to 10°19'12.29"E. It covers an area of about 2,244 K^2 (866 sq mi) and is home to several natural warm water springs, as well as a wide variety of flora and fauna (Ubaru, 2000). Annual rainfall in the park is between 900mm and 1,000mm. The rainy season is from May to September. Temperatures range between 18^0C and 35^0C. The park is an important refuge for over 50 species of mammals including African bush elephant (*Loxodonta africana*), olive baboon (*Papio anubis*), patas monkey (*Erythrocebus patas*), Tantalus monkey (*Cercopithecus aethiopicus*), roan antelope (*Hippotragus equinus*), western hartebeest (*Acelaphus buselaphus*), lion (*Panthera leo*) , African buffalo (*Syncerus caffer*), water buck (*Kobus defassa*), bushbuck (*Tregalaphus scriptus*) and hippopotamus (*Hippopotamus amphibius*). The vegetation of the park is mainly the Aphelia savanna woodland and shrub savanna.

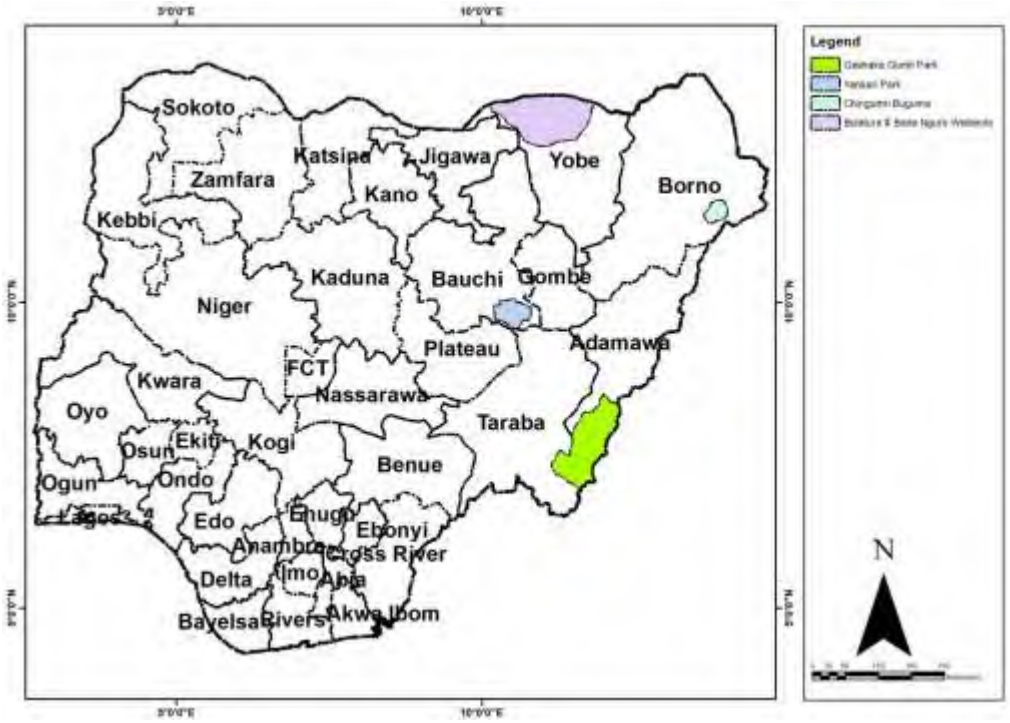

Figure 1: Map of Nigeria showing the location of the ecotourism destinations

Sample Design and Sample Size

The sample population for this study was visitors to Chad Basin National Park (CBNP), Gashaka Gumti National Park (GGNP), and Yankari Game Reserve (YGR). The sample size for the study was determined from 2017 arrival records of the selected study locations using Krejcie and Morgan (1970) method of sampling size determination. There were 98 visitors in CBNP in 2017, 367 in GGNP, and 42,520 in YGR. The sample size was 69 for CBNP, 165 for GGNP, and 341 for YGR. The overall sample size for the study was 575. Visitors that were at the destinations during the period of the study were randomly selected for the study.

Data Sources and Data Collection Methods

The study employed quantitative research methods in order to meet the research objectives. Structured questionnaire which was designed to capture information on perceived value and conservation attitude and visitors, was used to obtain information from the visitors. Perceived value measures were adapted from Winter and Lockwood (2004) while conservation attitude was measured using Ogunjinmi (2017) conservation attitudes scale and was rated on a 7 point scale. It was measured as strongly agree=7, Agree =6, somewhat agree=5, Undecided = 4, somewhat disagree= 3, Disagree = 2 and strongly disagree = 1. Reliability of the instruments was conducted to determine the internal consistency of the instrument. The Cronbach Alpha for perceived value was 0.60 and the Cronbach Alpha for conservation attitude was 0.71. The scale in the instrument had an acceptable internal consistency since Cronbach's Alpha scores were above the recommended 0.6 level (De Vellis, 1991). Data were from April to December 2018.

Data Analysis

In this study, data was analyzed using Statistical Package for Social Sciences version 23 (IBM Corp, 2015) and results were presented descriptively using frequency, percentage and tables. Inferentially, Chi square and correlation were used to test for association between selected socio-economic characteristic perceived value and conservation attitude of visitors while multiple linear regression was used to ascertain determinants of conservation attitude as multiple regression analysis helps in explaining how dependent variable changes as a result of a change in any of the explanatory variables (Koutsoyiannis, 2001)

RESULTS

Socioeconomic Characteristics of the Visitors

Table 2 reveals the socio-economic characteristics of visitors at Chad Basin National Park (CBNP), Gashaka Gumti National Park (GGNP) and Yankari Game Reserve (YGR). The highest percentage of the visitors were male at CBNP (72.5%) and YGR (53.1%) while the highest of the visitors were female at GGNP (77.6%). Most of the visitors were also within age 25-54 years at CBNP (68.1%), and YGR (48.7%) while most of the visitors were within age 15-24 years at GGNP (57%). Also, the visitors were mostly married at CBNP (53.6%), single at GGNP (35.8%) and single at YGR (52.5%). Majority of the visitors were earning ₦31,000-60,000 at CBNP (26.1%) and YGR (23.2%) while majority of the visitors were earning ₦121,000-150,000 at GGNP. Furthermore, 43.1% of the visitors at CBNP and 24.3% at YGR had BSc/ HND while 29.1% had ND/ NCE at GGNP. Majority of the visitors were civil servants at CBNP (59.4%), GGNP (97.6%) and YGR (70.4%) and Nigerians at CBNP (100%), GGNP (97.6%) and YGR (98.8%).

Table 2: Socio-demographic characteristics of visitors

Variables	CBNP (N=69)		GGNP (N=165)		YGR (N=341)	
	Frequency	%	Frequency	%	Frequency	%
Sex						
Male	50	72.5	37	22.4	181	53.1
Female	19	27.5	128	77.6	160	46.9
Age						
15-24	13	18.8	94	57.0	148	43.4
25-54	47	68.1	68	41.2	166	48.7
55-64	8	11.6	2	1.2	14	4.1
65 and above	1	1.4	1	0.6	13	3.8
Marital status						
Single	27	39.1	59	35.8	179	52.5
Married	37	53.6	44	26.7	100	29.3
Divorce	1	1.4	26	15.8	30	8.8
Widow/widower	4	5.7	36	21.8	32	9.3
Monthly income						
< N 30,000	17	24.6	1	0.6	79	23.2
N31,000-60,000	18	26.1	8	4.8	64	18.8
N61,000-90,000	15	21.7	11	6.7	71	20.8
N91,000-120,000	10	14.5	40	24.2	54	15.8
N121,000-150,000	4	5.8	91	55.2	54	15.8
N151,000 and above	6	7.2	14	8.5	19	5.6
Educational level						
Non formal	0	0	0	0	68	19.9
Primary school	3	4.3	40	24.2	50	14.7
Secondary	9	13.0	45	27.3	82	24.0
ND/ NCE	19	27.5	48	29.1	50	14.7
BSc./ HND	30	43.5	31	18.8	83	24.3
MSc./ Ph.D	8	11.6	1	0.6	8	2.3
Occupation						
Civil servant	41	59.4	161	97.6	240	70.4
Self employed	16	23.2	2	2.4	44	12.9
Unemployed	12	17.4	0	0.0	53	15.5
Head department	0	0.0	0	0.0	4	1.2
Nationality						
Nigerian	69	100	161	97.6	337	98.8
Non-Nigerian	0	0.0	4	2.4	4	1.2
Level of visit						
First visit	46	66.7	121	73.3	129	37.8
Repeat visit	23	33.3	44	26.7	212	62.2

Visitors' Perceived Value of the Destinations

Table 3 reveals the visitors' perceived value at the destinations. The visitors' mean perceived intrinsic value was 3.17 at CBNP, GGNP (3.66), and YGR (3.62). Mean non-use value was 4.28 at CBNP, GGNP (4.46), and YGR (4.45). Mean recreational value was 4.69 at CBNP, GGNP (4.28), and YGR (4.36). Mean use value was 3.76 at CBNP, GGNP (3.63), and YGR (3.76). At CBNP, the perceived intrinsic value by the respondents revealed the statement with the highest mean was "the value of ecosystem only depends on what it does for humans" with a mean value of (3.77). The perception of the respondents on non-use values reveals that "natural areas are valuable to keep for future generation of humans" had the highest means with 4.61. For recreational values of eco-destination, it reveals the highest mean was "natural areas are important to me because I use them for recreation" with mean value of (4.74). The highest mean on use values was "forests are valuable because they produce wood products, job and income for people" with 4.62. At Gashaka Gumti National Park, the perceived intrinsic value by the respondents was "the value of nature exits only in the human mind, without people nature has no value" with a mean value of 4.29. For non-use value, the highest mean was "natural areas are valuable to keep for future generation of humans" with a mean of 4.64. The perception on recreational values reveals that the highest mean value was "natural areas are important to me because I use them for recreation" with a mean of 4.48. The respondents use values reveals that the highest mean was "to say that natural areas have values just for themselves is a nice idea but we just cannot afford to think that way: the welfare of people has to come first" with 4.67. At Yankari Game Reserve, the perceived intrinsic value by the respondents reveals that the highest mean was "the value of nature exits only in the human mind, without people nature has no value" with a mean value of 4.09. The perceived non-use values reveals that the highest mean was "natural areas are valuable to keep for future generation of humans" with a mean of 4.73. For the perceived recreational values, the statement with the highest mean was "natural areas are important to me because I use them for recreation" with 4.47 while the perceived use values reveals that the highest mean value was "it is better to test new drug on animal than humans" with a mean 4.40.

Table 3: Visitors' perceived value of the selected ecotourism destinations

Variables	CBNP		GGNP		YGR	
	Mean	SD	Mean	SD	Mean	SD
Intrinsic values						
Only humans have intrinsic value that is value for their own sake	3.35	1.012	3.87	1.105	3.94	1.053
The value of ecosystem only depends on what it does for humans	3.77	1.073	2.82	1.220	3.14	1.275
Ugliness in nature indicates that an area has no value	2.54	1.195	3.25	1.222	2.99	1.244
Places like swamps have no value and should be cleaned up	2.88	1.243	3.80	1.072	3.31	1.204
The only value that natural places has is what human can make from it	3.55	1.092	4.14	.993	3.76	1.244
The value of nature exits only in the human mind without people nature has no value	2.94	1.392	4.29	.634	4.09	1.074
Mean	3.17	1.199	3.66	1.028	3.62	1.204
Non use values						
There are plenty of natural places that are not very nice to visit but I am glad they exist	4.22	.764	4.41	.653	4.33	.754
Even if I don't go to natural areas I can enjoy them by looking at books or seeing films	4.22	.968	4.21	.991	4.26	.894
I am seeing natural areas the next generation of children may not see, and that concerns me	4.09	.836	4.57	.607	4.50	2.890
Natural areas are valuable to keep for future generation of humans	4.61	.548	4.64	.594	4.73	2.836
Mean	4.28	.779	4.46	.711	4.45	1.843
Recreational values						
Natural areas are important to me because I use them for recreation	4.74	.442	4.48	.704	4.47	.810
Natural areas must be protected because I might want them for recreation in the future	4.64	.664	4.09	.942	4.26	2.366
Mean	4.69	.553	4.28	.823	4.36	1.588
Use values						
I don't industries such as mining destroying parts of nature, but it necessary for human survival	3.72	.820	4.41	.930	4.21	.992
It is better to test new drugs on animal than on humans	3.90	1.319	4.37	1.055	4.40	.972
All plants and animals lives are precious and worth preserving but human needs are more important than all beings	3.99	1.194	3.45	1.368	3.65	1.432
Our children will be better off if we spend money on industry rather than on the natural environment	2.61	1.416	4.18	.975	3.78	1.288
To say that natural areas have values just for themselves is a nice idea but we just cannot afford to think that way: the welfare of people has to come first	3.75	1.181	4.67	.608	4.32	.980
Forest are valuable because they produce wood products, job and income for people	4.62	.893	0.7	.554	2.23	2.319
Mean	3.76	1.137	3.63	.915	3.76	1.330

Conservation Attitudes of the Visitors to the Selected Ecotourism Destinations

Table 4 shows the conservation attitude of the visitors at the sites. At CBNP, the highest mean was "sustainability of wildlife lies in conservation" with a mean of 4.55, followed by "protected areas make significant contribution to the planets natural and cultural resources conservation" (4.46) and "wildlife should be valued as natural and cultural relics" (4.46). At GGNP the perception on conservation attitude; the statement with the highest mean is "wildlife should be valued as natural and cultural relics" (6.20), followed by human activities are the main cause of wildlife habitat destruction and population decline" (4.67). At YGR, the highest conservation attitude was "wildlife should be valued as natural and cultural relics" (5.33), followed by human activities are the main cause of wildlife habitat destruction and population decline" (4.57).

Differences in Visitors' Perceived Value and Conservation Attitude among the Destinations

The result from the analysis (Table 5) reveals that conservation attitude ($F=16.754$, $p<0.01$) of the visitors differ significantly by the selected ecotourism destinations while perceived value is not statistically different ($p>0.05$).

Relationship between the Selected Socioeconomic Characteristics, Perceived Value and Conservation Attitude

Table 6 reveals the relationship between the selected socio-economic characteristics and conservation attitude of the visitors. Education ($\chi^2=322.968$, $p<0.01$), and Occupation ($\chi^2=331.520$, $P<0.01$) have significant relationship with conservation attitude of the visitors. Table 7 reveals the relationship between selected socio-economic characteristics, perceived values and conservation attitudes of the visitors using Pearson correlation. There is significant association between conservation attitude and monthly income ($r=0.085$, $p<0.05$), intrinsic value($r=0.442$, $p<0.01$), use value ($r=0.140$, $p<0.01$) as well as conservation attitude and overall perceived value ($r=0.289$, $p<0.01$).

Determinants of Visitors' Conservation Attitude

Table 8 reveals the determinants of conservation attitude through multiple linear regression analysis using conservation attitude as dependent variable and socio-economic characteristics and perceived values as explanatory variables fitted into the data. The resulting model produced R^2 of 0.259 showing that the explanatory or independent variables did not explain the visitors' conservation attitude entirely but contributed marginally. Also, monthly income ($\beta=-0.586$, $p<0.05$), education ($\beta=-1.203$, $p<0.01$), occupation ($\beta=-1.324$, $p<0.05$), intrinsic value ($\beta=0.676$, $p<0.01$), non-use value ($\beta=-0.267$, $p<0.01$), and use value ($\beta=0.475$, $p<0.051$) were the determinants of conservation attitude of the visitors.

Table 4: Visitors' conservation attitude

Variables	CBNP		GGNP		YGR	
	Mean	SD	Mean	SD	Mean	SD
Human activities are the main cause of wildlife habitat destruction and population decline	4.62	.709	4.67	.522	4.57	.777
Uncontrolled economic development impact negatively on wildlife population status	4.36	.484	4.50	.816	4.55	.678
Sustainability of wildlife lies in conservation	4.55	.718	3.85	1.180	4.26	1.007
Wildlife resources have the ability to replenish themselves regardless of human pressures	3.35	1.096	3.37	1.620	3.73	1.400
Humans have unlimited right to exploit wildlife resources for their benefits	2.96	1.439	4.12	.893	3.84	1.251
Wildlife and the ecological systems that support them are intricately interwoven and the balance needs to be maintained	4.20	.815	4.12	.851	4.19	.873
Future global sustainable economic development depends on the viability of wildlife resources	3.80	.797	3.35	1.248	3.51	1.254
The contribution of wildlife resources to human well-being is over-rated	3.59	1.082	3.07	1.248	3.11	1.306
No human intervention is required to restored wildlife habitats and population	2.64	1.137	3.75	1.027	3.57	1.258
The rate of wildlife depletion is alarming	3.81	.862	3.53	1.039	3.71	1.090
Present human needs and well-being are more important than conserving wildlife for the future	3.12	1.345	4.05	1.055	3.83	1.175
IUCN Red list indicating the status of wildlife species is a scientific and ecological hoax	3.45	1.145	4.10	.871	4.06	1.029
Global governance pays less attention to conservation and protection of wildlife diversity	3.87	1.282	3.24	1.320	3.50	1.334
Protected areas (such as national parks and game reserve) do more harm to local human populations than the benefits derived.	2.46	1.251	3.90	.989	3.75	1.244
Humanity is a threat to the survival of wildlife species.	3.48	1.208	3.95	.977	4.13	.920
Enforcement of treaties on endangered species and trades in wildlife is locally and globally weak	3.38	1.177	4.22	.781	4.12	.908
Global effort is needed in combating wildlife crime	4.28	.906	4.28	.764	4.32	.831
Wildlife is a free gift of nature, prohibiting its use in any form is not appropriate	3.87	1.110	4.26	.680	4.21	.967
Protected areas make significant contributions to the planets natural and culture resources conservation	4.46	.797	4.38	.667	4.40	.694
Wildlife should be valued as natural and cultural relics	4.46	.797	6.20	.919	5.33	1.299
Total conservation attitude	74.58	8.234	80.91	7.778	80.65	8.548

Table 5: Differences in visitors' perceived value and conservation attitude by the destinations

Variables	Mean square	F	P value	Decision
Perceived value	147.118	1.918	0.148	**NS**
Conservation attitude	1153.383	16.754	0.000	**S**

**P<0.01. NS-Not significant, S-Significant

Table 6: Relationship between the selected socioeconomic characteristics and Conservation Attitude

Variable	χ^2 value
Sex	128.597
Education	322.968**
Occupation	331.520**
Level of visit	183.459

*P<0.01

Table 7: Relationship between perceived values and conservation attitude

Variable	r value
Age	0.005
Monthly income	0.085*
Intrinsic value	0.442**
Non-use value	0.035
Recreational value	-0.057
Use value	0.140**
Overall Perceived value	0.289**

*P< 0.05 **P< 0.01

Table 8: Determinants of conservation attitude

Independent Variable	β-value	t-value
Sex	0.182	0.302
Age	0.144	0.307
Monthly income	-0.586	-2.256*
Education	-1.203	-4.226**
Occupation	-1.324	-2.535*
Level of visit	0.105	0.257
Intrinsic value	0.676	8.904**
Non-use value	-0.267	-3.124**
Recreational value	-0.198	-1.303
Use value	0.475	4.515**
R	0.509	
R^2	0.259	
Adjusted R^2	0.245	
R^2 Change	0.259	
Standard Error	7.402	
F change	19.672	
DF	574	
Sig.	0.000	

*** P<0.05, ** P<0.01**

DISCUSSION

The dominant male figure in this study is in line with the estimated sex ratio of 1.04 male to 1 female in Nigeria (CIA, 2018). Majority of the visitors were educated at tertiary level as supported by Coghlan (2011) that the tourists of Australia's Great Barrier Reef were educated. Also, majority of the visitors were employed but earning low income and is inconsistent with Dolnicar, Crouch and Long (2008) who found that environmentally friendly visitors have high income levels. The visitors were mostly Nigerians indicating low level of international visits which could be attributed to insecurity incidences affecting the northern part of Nigeria. This low level of foreign visitors is inconsistent with findings by Oom do Valle, Silva, Mendes and Guerreiro (2006) who reported majority of foreign tourists.

Findings from this study revealed the visitors affirmed that they enjoy the recreational benefits of natural areas. This is in line with McCormack and Rock (2010) that there are several factors associated to park visitation, and these are socioeconomic background, recreational opportunities and attributes of the park that attract people. The visitors also affirmed that the value of ecosystem depends on what it does for humans and that without people, nature has no value. This is in line with Sutton (2004) who stated that environmental sustainability is the ability to sustain the qualities (e.g., clean water and air, non-renewable resources) that are necessary to maintain the living conditions of human being and other species in the physical environment. Ecotourism destinations provides diverse use for the public such as medicine production as supported by Stolton and Dudley (2010) that medicinal herbs has reduced drastically in some regions and the only strategy available is to source for them in national parks. Dudley, Mansourian, Stolton and Suksuwan (2008) also recorded the use of nature-based areas for emergency food supplies in some parts of Africa. The visitors also affirmed that eco-destinations are valuable because they provide wood products, job and income for people and that welfare of people has to come first in the values of eco-destinations so that eco-destinations can be preserved for future generation. This is in line with Amogne (2014) that Ecotourism is credited with promoting the conservation of natural resources, provides local economic benefits (employment opportunities) while also maintaining ecological integrity through low-impact, non-consumptive use of local resources. Hunter and Heywood (2011) also posited that biodiversity provides more than aesthetic or ethical values; it also provides diverse raw materials for an array of products including the pharmaceuticals.

The visitors affirmed that sustainability of wildlife lies in conservation and that protected areas make significant contribution to the planet's natural and cultural resources conservation as supported by Kuuder, Bagson and Aalangdong (2013) that many National parks allow tourists an opportunity to enjoy and appreciate majestic parks rich in wildlife, sensitize tourists on the value and need for conservation of wildlife (Borokini, 2013). They also opined that wildlife should be valued as natural and cultural relic while also agreeing that human activities are the main cause of wildlife habitat destruction and population decline. Therefore, eco-destination management should intensify efforts in reducing the population decline and habitat destruction of wildlife as this might have a decrease in the revenue generated by the destinations and thus have a negative impact on wildlife tourism. This is consistent with UNWTO (2015) that the long-term effects of poaching on tourism may be devastating from an economic, social and ecological perspective and since tourists associate Africa with the Big Five, not being able to experience these animals would result in tourist decline with severe economic implications for profit, taxes

and contribution to Gross Domestic Product. Eco-destinations should also involve all stakeholders in the merits derived from conservation and not just the struggles involved in conservation alone. This will encourage, restore confidence in the stakeholders' minds and make them realize their efforts are yielding positive outcomes which is in line with Bennett (2016) that equal distribution of social costs and merits of conservation among stakeholders is capable of encouraging positive attitudes and support for conservation projects. This study further revealed that there is relationship between perceived value and conservation attitudes at the destinations. These perceived values were formed due to the visitors' experience at the destinations and thus developed positive conservation attitude as supported by Snyman (2012) that people who have perceived benefit from tourism have greater positive attitudes towards conservation.

CONCLUSION

This study concludes that the visitors perceived that natural areas are valuable to keep for future generation of humans and those natural areas are important to them because they are used for recreation. The visitors also agreed that forests are valuable because they provide wood products, job and income for people. They however opined that they are concerned that the future generation might not see the natural areas. This calls for strategic measures of conservation for sustainability of eco-destinations in order for them to retain their ascribed values. The visitors also opined that sustainability of wildlife lies in conservation and that wildlife should be valued as natural and cultural relics while also stating that human activities are the main cause of wildlife habitat destruction and population decline. Conservation education should be taken as top priority by the management of eco-destinations in order to imbibe core conservation values in the hearts of visitors.

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Wildlife for Sustainable Development

Nigerian Journal of Wildlife Management

Nig. J. of Wildl. Mgt., 2020, 4(2): 71 - 83
https://wildlifesocietyng.org/ojs/index.php/wildlifesocietyng-journal/index
©2020 Copyright Wildlife Society of Nigeria
ISSN 2735-9298 (PRINT) ISSN 2735-928x (ONLINE)

Pattern of Occurrence, Abundance and Threats to the Common Hippopotamus (*Hippopotamus amphibious*) along Oli River, Kainji Lake National Park, Nigeria

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ABSTRACT
This study determined the common hippopotamus occupancy, abundance and threats in Kainji Lake National Park (KLNP), Nigeria. Data obtained through line transect method, point count method and oral interview were analyzed using descriptive statistics, ANOVA and QGIS. Six pools along the Oli river were occupied by Hippopotami during the dry season. The mean population size for hippos during the late dry season was 22±1.35 (84% adults and 16% calves) with a population density of 0.69hippo/km, while the early rainy season mean population size was 4±0.00 (100% adults). The difference in the mean number of hippos was significant at $P<0.05$ across the pools. Hippopotamus in KLNP are threatened by poaching, pollution, uncontrolled burning, and severe weather condition. The number of hippos recorded was low, and may be connected to the varying threat factors impacting the population. There is a potential of future increase, if the threats are greatly reduced or eliminated.

Keywords: Hippopotamus, occupancy, abundance, threats

INTRODUCTION
Conservation of wildlife is in crisis as species are declining worldwide. The major causes of declines in wildlife in developing countries are human population growth, habitat fragmentation, inadequate land use practices and management, lack of economic alternatives, social and political conflicts, and unsustainable use of resources (Kideghesho *et al.*, 2007; Plumptre *et al.*, 2008). Assessment of wildlife populations, distribution and ecology is an important way to determine the sources and impacts of human actions on natural environment and to understand the natural rates of wildlife changes (Balmford *et al*., 2003). Monitoring the distribution, abundance and ecology of large mammals like hippopotamus is a prerequisite for better management because they can detect the ecosystem health (Wanyama *et al*., 2009).

Hippopotami are even-toed ungulates, hoofed mammals in the order Artiodactyla. The name hippopotamus comes from the Greek words 'hippos' and 'potamus' meaning horse and river respectively. Members of the family Hippopotamidae are non-ruminants artiodactyls whose mode of life makes them unique in Africa among the large mammals

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(Cerling *et al.,* 2008). The common hippopotamus (*Hippopotamus amphibious)* is a semi-aquatic artiodactyl of sub-Saharan Africa and, historically, was widely distributed throughout the region (Feldhake, 2005; Lewison and Oliver, 2008). Common hippopotamus is the third largest herbivorous African mammal next to African elephant (*Loxodonta africana)* and Rhinoceros (*Diceros bicornis*).

Lewison and Pluhacek (2017) reported that an estimated global population of 115,000 - 130,000 individuals currently occurs in fragmented populations in rivers, lakes and other wetlands of eastern, western and southern Africa. Of the 36 countries where the common hippopotamus is known to occur, 20 have confirmed declining populations, seven (including Nigeria) have populations of unknown status, nine have stable populations and three (Algeria, Egypt and Mauritania) have experienced recent extinctions. Based on the estimated global population, coupled with intensifying threats of poaching for meat and ivory from the large canines and incisors (Lewison, 2007; Williamson, 2004), progressive habitat loss and persecution because of conflicts with people, the hippopotamus was still categorized as Vulnerable on the IUCN Red List in 2016 (Lewison and Pluhacek, 2017). It was found that populations most at risk were those in West Africa, where the distribution was particularly fragmented (Lewison, 2007). Trampling and crop raiding by hippopotami led to early and determined efforts to exterminate them (Herbison and Frame, 2008; Kendall, 2011). As a result, the Convention on International Trade in Endangered species of Wild Fauna and Flora (CITES), has placed hippopotamus in Appendix II where international trade is regulated through issuance of CITES permits and conducting non detriment findings which facilitates setting of sustainable quotas.

Protected areas have been regarded as pillars for global conservation efforts (Craigie *et al*., 2010). Across the world, the number of tourists seeking interactions with wildlife in their natural environment is increasing and there is a significant literature describing the revenues generated from wildlife tourism (Ayodele, 2002; Meduna *et al.,* 2005; Lindsey *et al.,* 2007). Thuiller *et al*., (2006) noted that National Parks are among the key conservation areas for protecting species. Kainji Lake National Park (KLNP) is one of the few protected areas in Nigeria set aside for biodiversity conservation and known to be a frequently visited destinations for nature based tourism. The choice of visiting the park stems from the array of fauna resources of the park; especially the hippopotamus, and the scenic view of the riparian forest around the Oli river, hence the need to estimate density of hippopotami in Kainji Lake National Park. Therefore, a detailed knowledge of the distribution, ecology and threats is needed in order to effectively protect the common hippo in KLNP and provide requisite information for future research on the species within the park and hippopotamus conservation in Nigeria at large.

MATERIALS AND METHODS

Study Area

Kainji Lake National Park is located between latitude $9^0\ 40^1$ and $10^{\ 0}\ 30^1$N and longitude $3\ 50^1$ E and has a total land mass of 5,370.82km^2 (Figure 1). The establishment of KLNP in 1976 marked the first attempt at managing wildlife for recreation in Nigeria. Kainji Lake National Park has a savanna climate. Night temperature can be as low as 7^{o}C near Oli river. The drainage system in the two sectors of Kainji Lake National Park is maintained by the Oli, Menai and Doro Rivers (Borgu sector) and Manyara and Nuwa Zurugi Rivers (Zurguma sector). The two major features of the climate of the park are the division into wet and dry seasons and the

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variability from year to year. The wet season extends from May to October. The mean annual rainfall varies from 1,100mm in the eastern part to 1,200mm in the western part. The lowest temperature of the park of about 10^{o}C occurs between December and January, and the highest mean maximum temperature occurs during months of February, March and April and is about 30^{o}C. The trend surface analysis of the mean annual rainfall in Borgu sector indicates a decrease in rainfall from the south to the north and increasing rainfall toward the west and east (Milligan, 1978). KLNP harbours diverse fauna resources, and notable among them are Baboon, Patas monkey, Green monkey, Lion, Buffalo, Grimm's Duiker, Warthog, Red flanked Duiker and Hippo.

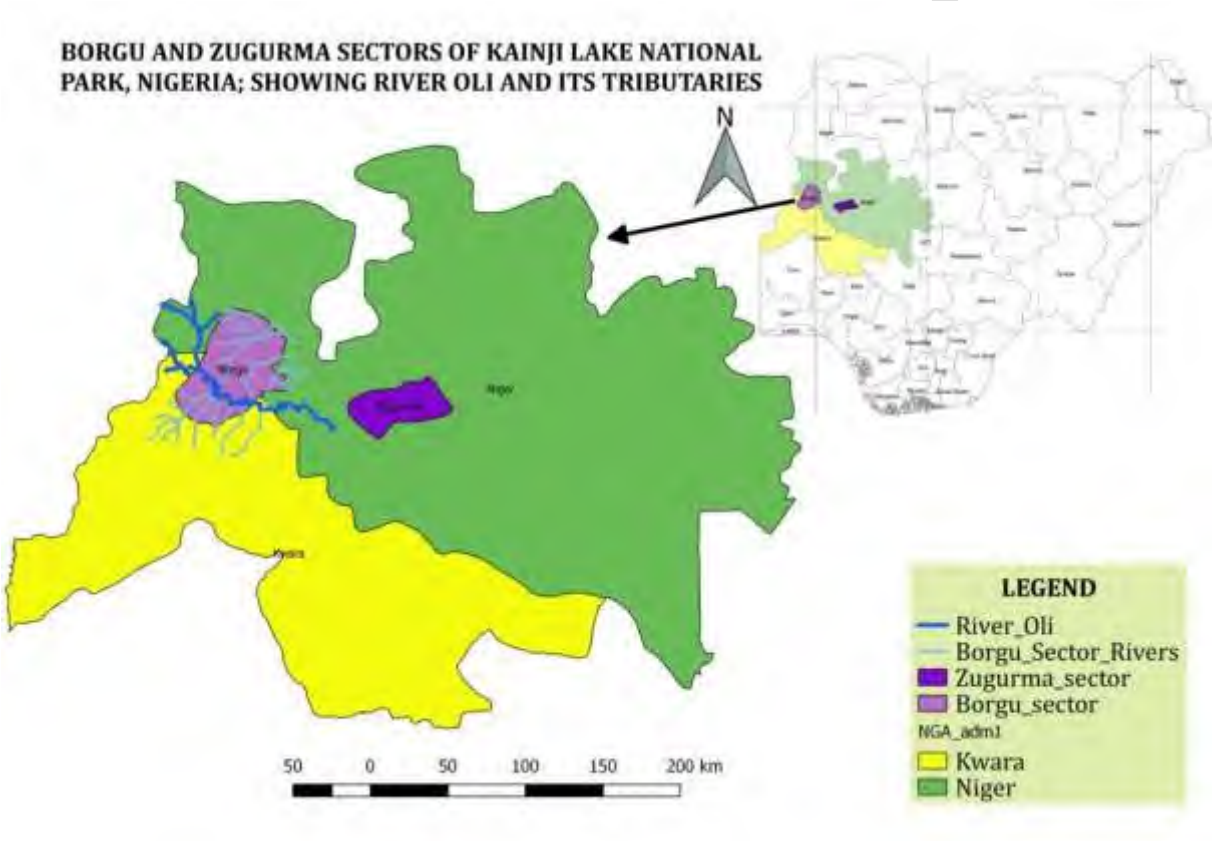

Figure 1: Map of Kainji Lake National Park showing Oli river and its tributories

Data Collection

Determination of hippopotamus distribution along Oli river

The distribution of hippopotamus along Oli river (the only perennial River) was assessed using line transect method as described by Stommer *et al.* (2016). The research team moved along the river bank to document the number of pools and to identify those occupied by hippo, where detailed survey (hippo counting) was carried out. A total of 32km shore length was covered along Oli river and surveyed repeatedly for one week per month. During the survey, the following information were collected: number of pools formed along the river, number of pools occupied by hippo, the size-surface area of the pools, signs of hippo presence such as grazing activity, fecal dropping, footprints and hippo trail. Also recorded were, the presence of human activities such as hunter's camp, spent cartridge, fishermen camp, fishing nets set and

sign/odour of chemicals used in fishing as well as signs of dead fishes on water surface. The GPS coordinates of the pools occupied by hippo was recorded. This was done for a period of five months, from January to May, 2018 covering late dry season and early wet season.

Estimating the population structure and density of hippopotamus

Ground count survey through point count/scanning method as described by kanga *et al*. (2011) was adopted for determination of hippopotamus abundance in the identified hippo pools along Oli river between January to May, on 30 survey days in the year 2018 both during mornings (7-10am) and evenings (3-6pm) surveys. This period was chosen because it spanned the dry season when water levels in the river are lowest and visibility of hippopotamuses in the water is highest. Hippos were counted by scanning each pool at three monitoring points for at least twenty minutes using binoculars. This minimum observation period was used because hippos can stay submerged for up to seven minutes (Leivestad *et al.,* 1973). Upon sighting individuals or groups of hippopotamuses at each hippo pool, the group size, number of adults and number of calves were recorded. Calves were distinguished by their small body size relative to adults.

The mean population size and density of common hippopotamus were calculated using the formula described by Onyango and Plews, (2005) as follows:

a) Mean Population size = Σx/n **……**Equation 1
   Where:
   Σ*x* is the sum of values (number of hippos recorded per count); and
   n is the number of observations
b) Hippopotamus population density was calculated as follows:

D = N/ L**……...**Equation 2
   Where:
   D is density;
   N is the number of hippopotami; and
   L is the shore length.

Identifying threats to hippo in KLNP

The level of threats to the hippopotamus population was assessed by direct field observation and oral interview while secondary data from record of arrest was also collected from the park. Field observation was carried out to determine the presence of anthropogenic activities like hunting, fishing, cattle grazing, farming, late burning etc (Ertiban, 2016). Also presence of human activities such as hunter's camp, spent cartridge, fishermen camp, fishing nets set and sign/odour of chemicals used in fishing as well as signs of dead fishes on water surface was recorded. Oral interview was conducted with the park rangers and secondary data from administrative records (threats recorded, nature of threat, frequency of threat) at the litigation unit was also collected (Chomba, 2013).

Data Analysis

Data analysis was carried out using the statistical package SPSS for Windows, version 20 and were presented with descriptive statistics such as tables and frequencies. ANOVA was used to compare the difference between the abundance of hippos at the different monitoring locations while regression analysis was done to check whether hippo abundance is dependent on pool size (water surface area). GPS points were analyzed and mapped using QGIS.

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RESULTS

Spatial Distribution of Hippopotamus along Oli River

A total of 20 pools with water surface area not less than 6,000 square meters was recorded during the study. However, Hippopotami were observed to occupy six pools along the Oli river during the dry season. Hippos were sighted at the pools at kilometers 3, 5, 8, 12 and 28 from the Oli base camp; along the Shehu Shagari track, and were also sighted at the Zaure hippo pool, but during the early rainy season, hippos were only sighted directly at kilometres 5 and 8 in less number. The monitoring locations, GPS coordinates and surface area of each pool are as shown in Table 1.

Table 1: GPS coordinates of the Kainji Lake National Park dry season hippo pools and their surface area

S/N	HIPPO POOL	LATITUDE (°N)	LONGITUDE (°E)	SURFACE AREA (M^2)
1	Km 3	9.90316	3.97343	11,993
2	Km 5	9.91157	3.95355	9,595
3	Km 8	9.90059	3.99532	9,345
4	Km 12	9.8878	4.0121	8,995
5	Km 28	9.91301	3.95542	13,792
6	Zaure	9.90728	3.94138	6,996

Fresh hippo signs (hippo trails, footprints and dung) were observed along the river bank in both seasons. The most recorded signs were the foot prints (53.8%), followed by the hippo trails and dung having 23.1% occurrence each (Plate 1). Figure 2 shows the distribution of hippopotamus along the river.

Plate 1 : Foot prints (left) and fecal droppings (right) of common hippos in KLNP

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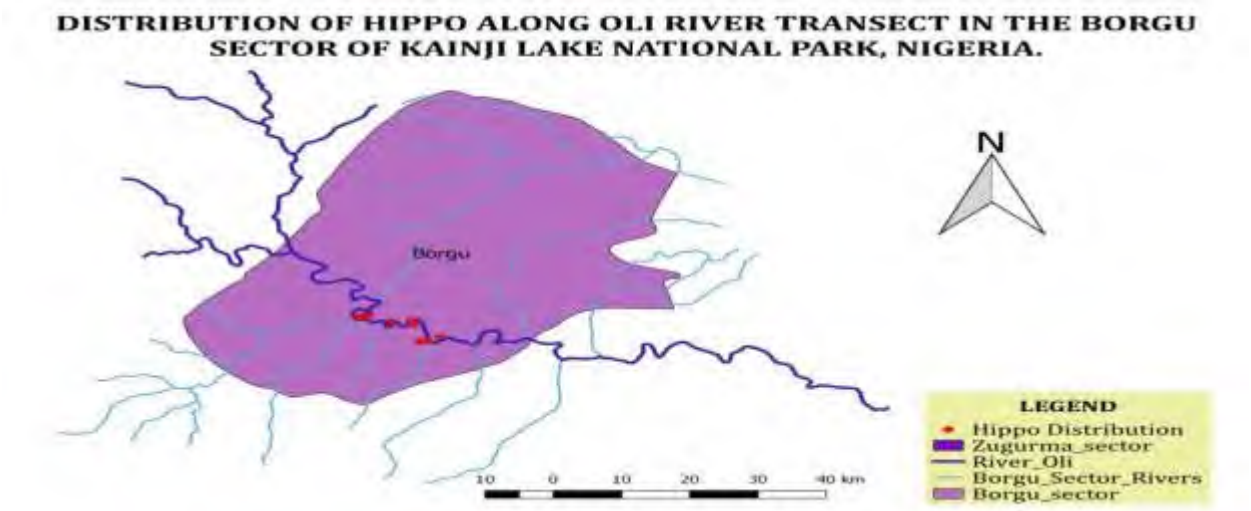

Figure 2: Distribution of common hippo along the Oli river in Kainji Lake National Park, Nigeria

Hippo Abundance and Age Population Structure

The mean population size of the hippos during the late dry season was 22±1.35; comprising 84% adults and 16% calves, while the early rainy season mean population size stood at 4±0.00; comprising 100% adults and no calves, as shown in Table 2 and Figures 3 and 4. The population density during the late dry season was 0.69/km and at the early wet season was 0.13/km.

Table 2: Summary of hippo abundance

LOCATION	Pool size (M^2)	LATE DRY SEASON MEAN ABUNDANCE	EARLY RAINY SEASON MEAN ABUNDANCE
Km 3	11,993	3±0.13	0
Km 5	9,595	3±0.06	2±0.00
Km 8	9,345	2±0.05	2±0.00
Km 12	8,995	5±1.22	0
Km 28	13,792	6±0.53	0
Zaure	6,996	3±0.025	0
TOTAL		22±1.35	4±0.00

The mean hippo abundance at each of the hippo pools statistically and significantly varied across the locations and between seasons (Zeros inflated Negative binomial model, log-likelihood ratio test, test statistic=176.71, n=192, P<0.0001), with the hippo pools at km 5,12 and 28 being more significantly different from the other hippo pools as shown in Tables 3 and 4.

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Table 3: Test of Model Effects for hippo abundance in each of the location between the two seasons

Source	**Wald Chi-Square**	**df**	**P-value**
Season	155.14	1	0.00
Location	30.88	5	0.00

Dependent variable: Hippo abundance Model: Season, Location

Table 4: Mean Hippo abundance between locations across seasons

Location	**Wald Chi-Square**	**df**	**P-value**
Km 3	1.39	1	0.24
Km 5	10.22	1	0.00
Km 8	1.86	1	0.17
Km 12	11.61	1	0.00
Km 28	20.79	1	0.00
Zaure	-	-	-

The mean value is statistically different at $P<0.05$

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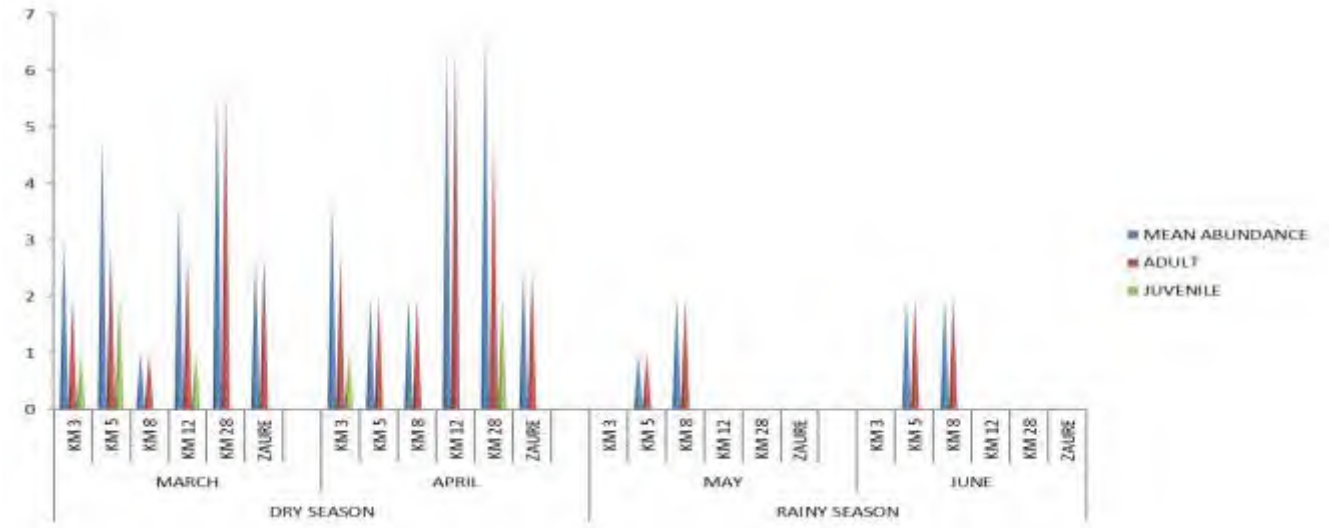

Figure 3: Age population structure (Mean) of hippopotamus at the different pools in Kainji Lake National Park

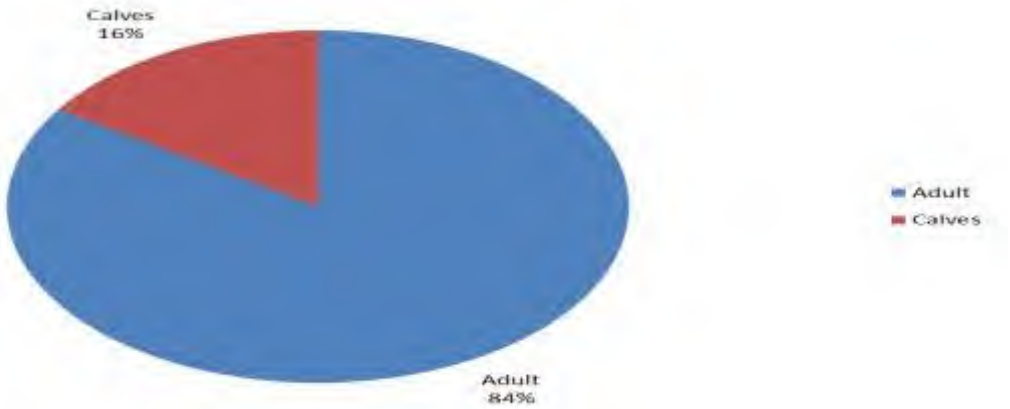

Figure 4: Age structure of hippopotamus recorded along Oli river in KLNP during the study

Plate 2: Common hippos in Oli River, KLNP

Threats to common hippos in KLNP

Direct field observation, administrative records and interviews showed that common hippopotamus in Kainji Lake National Park are faced with threats in form of poaching, pollution, uncontrolled burning and severe weather condition. Records from the park litigation unit and field observation showed

that hippos of the park have been faced with series of poaching activities in the past few years; with the most recent one happening in the course of this study (Plate 6). 75% of hippo deaths were recorded as a result of poaching activities, while the 25% was attributed to an unknown course. Also, presence of human activities such as hunter's camp, spent cartridge, fishermen camp, fishing nets set and sign/odour of chemicals used in fishing as well as signs of dead fishes on water surface were recorded (Table 5). More so, inadequate food materials within the park due to severe weather condition and uncontrolled burning leads to the migration of hippos to larger water bodies and farmlands as well as communities outside the park, which exposes the species to human-wildlife conflicts.

Table 5: Identified hippo threat factors in Kainji Lake National Park

Threat factors	Frequency of Occurrence	Ranking	Means of Identification
Active fishing net	22	1st	Field observation
Gunshots	12	4th	Field observation
Fishermen camp	5	6th	Field observation
Spent Cartridge	14	3rd	Field observation
Poacher's fire	2	8th	Field observation
Hunter's camp	4	7th	Field observtion
Hippo killing	1	9th	
Polluted pools	7	5th	
Sand dunes from erosion	15	2nd	

Plate 3: Poachers activity at marguba range in Kainji Lake National Park

Plate 4: Poachers' fishing net recovered during anti-poaching patrol

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Plate 5: Hippo killed outside the park boundary
Source : From social media

DISCUSSION

Spatial Distribution of Hippopotamus along the River bank

When the water level in the rivers within the park becomes very low during the dry season and break into pools, the hippos are forced to occupy only the Oli river to look for the pools that have enough water to meet their daily need, thereby occupying some pools in groups, while some individuals move out of the park in search of deeper waters and fresh food materials. This is in support of Christopher (2012) and other previous studies that reported that hippo species depend highly on water for its daily activities, with dependency on physical requirements like appropriate water level, size and the riparian forest cover. Hippos in Kainji Lake National Park are widely distributed along the Oli river. At both seasons, activities of the hippos are seen along the river and far into the upland areas where they visit for grazing and other activities. Hippo trails, foot prints and dung were the major activities seen in the course of this study. In line with the observation of Stommel *et al.* (2016), the distribution of hippos during the dry season favoured the pools with larger amount of still water or water moving at a low current and parts of the river that have dense riparian forest cover that helps to shield the pools from the excessive heat of the sun; as was observed along the river at km 12 and 28. The upstream part of the river; as it takes it flow from the Republic of Benin had shallow pools during the late dry season and continued to the downstream where the pool size increased and emptied into the lake Kainji. At this time, though their night foraging activities were seen upstream, the hippos of the park populated the downstream where they had enough water for their daytime rest. Minimum inter-individual distances or maximum aggregations were recorded during the dry season, and as the wet season advanced, there was less aggregation as water receded, as supported by Christopher (2012). This dry season aggregation tends to put serious pressure on the quality and quantity of the forage resources available within or close to their habitat, and may expose individuals to conflicts within the group or make them move out of the park in search of food. During the rainy season, the water level in the major river increased and the hippos became free to move from one part of the park to the other, and sometimes, move out of the park along the river channel. The water current at some of the monitoring locations probably became too high for the hippos, making it a little bit difficult to say precisely where the hippos can be found at any particular time, as supported by the earlier report of Christopher (2012) that stated that during the wet season, hippopotami spread out, possibly to avoid deeper and fast moving

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waters and increased distances exist between them, unlike during the dry season when they can be easily located at their dry season pools.

Hippo Abundance and Age Population Structure

Hippo abundance varied significantly between seasons and locations. The ratio of hippos sighted between the late dry season and early rainy season stood at about 6:1; informing the most appropriate time to bring visitors in for hippo viewing. Christopher (2012) reported that during the wet season, hippos spend more day time actively feeding, hence a more spread activity budget over the times of the day. This may account for the smaller number of hippos found at the monitoring locations during the early rainy season. It was observed that the hippo pool at Km 28 that was known to accommodate the largest number of hippos during the dry season because of its large pool size became inconvenient for the hippos as the water current increased at the start of the rainy season, and hippos moved out of the location. The presence of the minimum of 22 hippos within the park; with about 16% being the young calves showed that the environmental conditions within their habitat were favourable enough for breeding; requiring that proper management plans be put in place to maintain a healthy population of the species. Consistent with the findings of Stommel *et al.* (2016) and other studies on other hippo populations in Africa, the results of this work indicate that highest mean population was observed at the monitoring location with the highest water surface area during the late dry season.

Threats to common hippos in KLNP

In line with previous studies (Graham, *et al.*, 2002; Lewison and Oliver, 2008) that have suggested that habitat loss and poaching are the biggest threat to hippos, poaching activities for bush meat sales and consumption contributed the biggest threat to the hippos of Kainji Lake National Park as observed in the course of this study; with several threat factors pointing to high hunting pressure. Seasonal changes in water level of the part of the river within the park boundary increased the rate of exposure of the hippos to further threats outside the park. Severe weather condition resulting in increase in temperature and inadequate food materials also adersely affect the species, as hippos were also observed to move out of the park in search of fresh forage resources during the dry season, which also contributed a level of threat to their safety.

CONCLUSION

This study has shown that common hippopotamus is one of the large mammals that can still be readily found in Kainji Lake National Park, all year round, but at more specific locations during the dry season. Evidence of reproduction as shown by the presence of juveniles indicates that they have a population that has the ability to grow sustainably if proper management practices are focused on their safety and perpetuation. The information that this study provides on the abundance and distribution of the hippos of KLNP forms a step in the right direction at documenting the relevant information long required by the IUCN to conserve common hippopotamus within their natural ranges in Nigeria and other part of the sub Sahara Africa. The populations and locations of hippos at specific time of the year that this study has revealed can benefit the ecotourism sector of the park in taking visitors for hippo viewing, as informed by the most appropriate period of the year when visitors can be assured of enjoying the scenic view of this species, since seasonal changes have been confirmed to affect the spatial and temporal activities of the hippos of KLNP.

ACKNOWLEDGEMENT

My gratitude goes to Almighty God for the success of this work. Many thanks Dr O.S. Odewumi for his mentorship and support through supervision and other invaluable contributions towards the success of this research. My special appreciation goes to E. E. Ofuya, F. O. Obasuyi and E. O. Adekola for their useful contributions to this research.

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I hope to continue to have all of you as pillars of support.

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Wildlife for Sustainable Development

Nigerian Journal of Wildlife Management

Nig. J. of Wildl. Mgt., 2020, 4(2): 84 - 94
https://wildlifesocietyng.org/ojs/index.php/wildlifesocietyng-journal/index
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ISSN 2735-9298 (PRINT) ISSN 2735-928x (ONLINE)

Sediment, Particle Size and Population Distribution of *Uca tangeri* (fiddler crab) from Two Brackish Water Ecosystems in Rivers State, Nigeria

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ABSTRACT

The influence of sediment particle size on the population distribution of *Uca tangeri* was studied at Bonny Rivers and the New Calabar River in Rivers State. A quadrant of 20 X 20m were made at the stations. The study stations were visited once a week for 12 weeks. A total of 24 (One) sediment samples was collected from the burrow upon each visit and analyzed for % particle size composition. A total of 720 (360) from each station. *Uca tangeri* samples were collected, age with sediment particle size. Spearman's correlation was used to check for the relationship between sediment particle size and population distribution of *Uca tangeri.* The result from Bonny samples showed that, there is strong correlation between adult male samples and silt-clayey sediment (silt 0.15 and clay 0.22) rich in organic matters (0.77). Samples collected from New Calabar Rives showed that, adult female and juvenile male samples show preference to sandy sediments (0.28 and 0.057). Juvenile female samples prefer silt sediment (o.076) It was concluded that resource sharing, strength of the setae and burrowing capacity influence habitat and sediment utilization.

Keywords: Population distribution, *Uca tangeri,* setae, brackish water, ecosystems

INTRODUCTION

The genus *Uca tangeri* Leach, 1804 are inhabitants of intertidal mud flats and marine habitats in tropical countries. In the Niger Delta, they are found in estuarine areas where they are submerged depending on tidal cycles. The species is a critical member of the mud flats playing key role in structure and function of the system. As a component of the intertidal mud flat, they are important in distribution of vegetation, substratum, food, salinity, tidal exposure and presence of other mammals (Ribeiro *et al.*, 2005; Cesar *et al*., 2005; Arruda, *et al.*, 2006). They serve as a link in the mangrove trophic level. They are food for young crocodiles, Otters, civets, birds, crustaceans, fishes and mammal (Coelho, 1965; Colpo and Negreiro-Fransozo, 2003, Castiglioni *et al*., 2010; Colpo and Negreiro-Fransozo, 2013; Numbere, 2020). *Uca tangeri* constitute a major component of zooplankton linking the food chain in the mangrove habitat. Mangrove habitats provide an excellent sediment and habitat structure for their

development (Nielsen *et al.*, 2003; Kristensen, and Alongi, 2006). Although *Uca tangeri* modifies sediment particle size, porosity and water content of the mud flats through their activities of burrowing, they are one of the most effective aspects of the estuarine habitat (Numbere, 2020). Spatial variability of sediment properties and heterogeneity create different niches for different species to occupy. While some species may favour fine sand grains, some tends to occupy coarse grain areas (Ens *et al.*,1993; Daleo *et al*., 2003; Ribeiro *et al.*, 2005; Checon & Costa, 2017). Their ability to occupy different niches is dependent on the setae type on their second maxilliped. These setae have the ability to sort food from fine grains and to eliminate sand particles (Okon and Sikoki, 2014). Investigation into the seasonal abundance, population density and frequency distribution in size classes, birth rate, sex ratio, reproductive period, fecundity, burrow distribution, nutrient, sand grain and juvenile recruitment on the survivability of fiddler crabs in the ecosystem had been reported by Castiglioni and Negreiros-Fransozo, (2004); Masunari, (2006); Costa, (2000); Castigolini, *et. al.*, (2010); and Steibl, S. (2020) observe that while the geographical distribution of *Uca* is influenced primarily by regional hydrology, geomorphology and climate, ocean current patterns help regulate larvae dispersal and thus direct gene flow and affect connectivity. Connectivity according to him, in turn can influence intraspecific variation both with and among marine populations (Costa, (2000). Historically low intraspecific genetic diversity according to Felder and Station, (1994) is a hallmark in fiddler crabs.Study of the population abundance of fiddler crab in an estuary has been reported to be beneficial to the researcher and ecosystem service. The earlier reports of Koch, *et. al.,* (2005) was that adult *Uca* crabs could reach a population size of 260 individuals per square meter as well as 140 juveniles per square meter. Density of crab in an ecosystem could depict the healthiness of the habitat and area with high fiddler crab density and such habitat show high productivity level (Costa, 2000; Thanamalini and Shyla, 2018). The sex ratio of fiddler crab population has been a topic of high debate for many years. Some early sex ratio studies found that fiddler crab to be dominated by female in all size range (koga, *et al.,* 1995; Milner, *et al.,* 2010), while Ahmed, (1979) reported a dominant male situation. However, a more recent study by Kaeda (2004) reported an adult male dominant scenario, with percentage of male increasing with size while juvenile stage tends to be dominated by female. This was agreed by Bergey and Weis (2008). Previous studies by Diele, *et al.* (2005); Diele and Koch, (2010); and Numbere, (2020), suggested a size frequency population distribution change resulting from recruitment of larva and reproduction. In tropical region, they suggested a unimodal size-class distribution of individual population, suggestion a suitable population with constant mortality and recruitment rates (Fernando *et al.,* 2018). Geo-ecological factors have been studies as one of the factors affecting distribution and population abundance of *Uca tangeri.* There has been inadequate knowledge of the behaviour of *Uca tangari* with respect to geo-ecological factors particularly the impact of sediment grain size on the abundance of *Uca tangeri* in different habitats in Rivers State, Nigeria. This study therefore aimed at amongst

others to elucidate the impact of particle size on abundance of *Uca tangeri* in the study stations.

Materials and Methods

Study Area

This study was carried out in two stations along the tributaries of New Calabar and Bonny River of Rivers State, Nigeria (Figure 1). The study stations along the New Calabar River are located on $04^{0}48^{1}33.7^{11}$ N and $06^{0}55^{1}43.2^{11}$E, while that along the Bonny River is located on $04^{0}46^{1}51.5^{11}$N and $006^{0}58^{1}41.1^{11}$E. All study stations are in Obio-Akpor Local Government Area of Rivers state. Red mangrove (*Rhizophora mangle*)characterize the study stations and other emerging vegetations such as *Nymphaea and Paspalum spp* are common along the study stations.The mangrove forests are inundated by saline water during tidal flow. During flooding usually in the rainy season, the water channel loses definition and become continuous with the floodplain. Like other tropical estuary, these rivers are under periodic tidal movement thereby exposing the intertidal area for approximately 6 hours daily. The study stations are importance to the local coastal communities as it serves majorly for transportation, aesthetics, recreation, cultural and fishing activities. The major communities along the study area include Rumulumini and Eagle Island. Fishing serves majorly as a source of protein supply and finance to the local communities. Artisanal fishing with small fish mesh seine, baited hook and line as well as basket traps are the basic fishing gear seen around the area.

Figure 1: Map of Rivers State showing the study stations

Sampling Techniques and Data Analysis

An initial data of tidal flow at the study stations was Rivers State University of Science and Technology marine department. The tidal flow data was used to plan sampling during the study. During the sampling period, the study stations were visited once weekly for three months (September – November, 2019) at tidal ebbing. A quadrant of 20m X 20m were laid at the stations. Samples were collected from the study stations and transferred to the laboratory for further analysis in a cool box. Each sample was given a unique identifier.

Fiddler Crab (*Uca tangari*) Sampling

Thirty (30) fiddler crabs were randomly handpicked in each quadrant. A total of three hundred and sixty (360) fiddler crab samples were collected from each study stations during the study window.

Fiddler samples were transferred in coolbox to the laboratory for sexing and aging. The collected fiddler crabs were sexed as male, female and aged as adult and juvenile by morphological observation of claw size and abdominal regions for separation into male and female while juveniles were based on morphometric measuration (Ayo-Olalusi, 2014). These were used to estimate the population structure. Weighing scale was used to estimate their weight (specify model of weighing balance used) while morphometry was measured with vernier caliper and measuring tapes to the nearest ±00.1mm.

Sediment Particle Size Analysis

Sediment samples (N=12) were collected at 0.5cm and 0.8cm in each quadrant. Each sample collected were homogenize to have a representation of the stations. Each sample was given an identifier and transfer in cool box to the laboratory for analysis. Soil organic matters was determined by weighing 1.00g of soil and emulsified in 500ml flask containing 10ml of 1M $NK_2Cr_2O_7$ and stir gently to dispense soil. 20 ml $H_2SO_{4\ (conc)}$ was added to the mixture and stir gently until there is a homogenous mixture. This was allowed to stand for 30 minutes. 300ml distill water was added and allowed to stand for 30 minutes. 25 ml of 0.5M $FeSO_4.7H_2O$ was pipette and added in the solution (Gavlak, *et al*., 2005; Krzysztof, *et al*., 2018). A blank control solution was prepared without soil as in the steps described above. The suspension was titrated with 0.500M $KMnO_4$ using illumination from bulb-lamp. The end point was calculated from the titre value using the formula:

%OC =N(T-B)/W x 0.390; Where N= Normality (conc) of $KMnO_4$; T= Titre (sample); B= Titre (blank); W= Weight of soil used; %OC= percentage organic carbon. Percentage organic matter was calculated by multiplying % organic carbon by 1.724 (Laker, and Dupreez, 1982).

Statistical Analysis

The Spearman's ranking was used to correlate the abundance of fiddler crab with sediment particle size. All analyses were done at 95% significance level.

RESULTS

In this section, the result for sediment samples and population distribution of *Uca tangari* is presented. In Tables 1 and 4 is the result for soil particle size analysis for sediment samples collected from the Bonny and New Calabar River. Table 2 and 5 shows the population abundance of *Uca tangari* across the sample station. Table 3 and 6 is the Spearman's

correlation between population abundance of *Uca tangari* and sediment particle size.

Sediment Particle Size

Sediment samples (N=12) collected for laboratory analysis. Sediment samples collected from Bonny River. The result is presented in Table 1 below.

Table 1: Sediment Collected from Bonny River (%Particle size)

s/no	Sample ID	%OC	%OM	%Sand	%Silt	%Clay	Textural Class
1	BR-1	0.78	1.34	89.7	3.5	6.8	Sand
2	BR-2	0.62	1.07	91.7	3.5	4.8	Sand
3	BR-3	0.7	1.21	89.7	3.5	6.8	Sand
4	BR-4	0.62	1.07	91.7	3.5	4.8	Sand
5	BR-5	0.47	0.81	89.7	5.5	4.8	Sand
6	BR-6	0.61	1.44	88.9	3.5	4.8	Sand
7	BR-7	0.33	1.09	90.6	3.2	5.3	Sand
8	BR-8	0.71	1.3	91.2	3.6	4.8	Sand
9	BR-9	0.79	1.39	87.7	3.5	6.8	Sand
10	BR-10	0.66	1.08	90.3	3.4	5.2	Sand
11	BR-11	0.67	1.23	89.6	3.7	5.1	Sand
12	BR-12	0.5	1.09	89.9	3.5	5.1	Sand
Mean		0.62	1.18	90.06	3.66	5.43	

BR=The identifier for Bonny River; OC=Organic carbon; OM=Organic matters

The result shows that the sediment is made of sand (90.06%), clay (5.43%) and silt (3.66%) while organic matter (1.18%) and organic carbon was (0.62%). Also, sediment samples collected from New Calabar River was analyzed to compose of sand (69.96%), silt (12.17%) and clay (17.52%) while organic carbon (3.63%) and organic matter (5.7%).

Table 2: Sediment particle size analysis for New Calabar study station

s/no	Sample ID	%OC	%OM	%Sand	%Silt	%Clay	Textural Class
1	NC-1	2.15	3.71	71.7	11.5	16.8	Sandy loamy
2	NC-2	4.29	7.4	73.7	11.5	14.4	Sandy Loamy
3	NC-3	2.93	5.05	75.7	9.5	14.8	Sandy Loamy
4	NC-4	3.51	6.05	71.7	11.5	16.8	Sandy loamy
5	NC-5	5.07	8.74	57.7	17.5	24.8	Sandy Clay Loamy
6	NC-6	4.86	7.6	72.18	11.2	16.7	Sandy loamy
7	NC-7	3.22	3.8	71.67	11.3	13.5	Sandy loamy
8	NC-8	2.16	5.2	75.4	8.5	15.6	Sandy loamy
9	NC-9	3.67	6.5	71.22	11.3	16.9	Sandy Clay Loamy
10	NC-10	2.92	5.3	57.67	18.2	25.3	Sandy Clay Loamy
11	NC-11	5.01	3.4	70.93	11.9	17.1	Sandy loamy
12	NC-12	5.2	6.3	76.02	8.4	14.8	Sandy Clay Loamy
		3.62	5.7	69.96	12.17	17.52	

BR=The identifier for Bonny River; OC=Organic carbon; OM=Organic matters

Geo-spatial Distribution of Fiddler Crab

A total of n=720 fiddler crabs were sampled from the study stations during the study window. At the Bonny River Study station, n=360 samples were collected. 230 samples were adults male, while 51 were juvenile male. 58 were adult female while 21 were juvenile female. Of the n=360, 221 were adult female collected from the New Calabar River, 83 were adult male, 35 were juvenile female while 21 were juvenile male. The relationship between soil particle size, organic matter and fiddler crab geospatial distribution across the study stations are presented in Tables 5 and 6.

Table 3: *Uca tangeri* collected from Bonny River

weeks	Nr of Samples	M	F	Ad M	Ad F	Ju M	Ju F
week 1	30	30	0	30	0	0	0
week 2	30	20	10	19	8	1	2
week 3	30	22	8	20	5	2	3
week 4	30	25	5	16	4	9	1
week 5	30	22	8	16	6	6	2
week 6	30	25	5	21	3	4	2
week 7	30	24	6	16	5	8	1
week 8	30	25	5	20	5	5	0
week 9	30	22	8	20	4	2	4
week 10	30	21	9	14	6	7	3
week 11	30	21	9	18	7	3	2
week 12	30	24	6	20	5	4	1
n=	360	281	79	230	58	51	21

M= Male; Ad M= Adult male; Ad F = Adult female; F = Female; Ju M = Juvenile Male; Ju F = Juvenile Female

Table 4: *Uca tangeri* collected from New Calabar River

weeks	Nr of Samples	M	F	Ad M	Ad F	Ju M	Ju F
week 1	30	11	9	2	19	18	1
week 2	30	8	7	1	22	18	4
week 3	30	8	5	3	22	20	2
week 4	30	7	5	2	23	17	6
week 5	30	6	3	3	24	23	1
week 6	30	12	11	1	18	16	2
week 7	30	9	7	2	21	18	3
week 8	30	3	2	1	27	23	4
week 9	30	13	11	2	17	14	3
week 10	30	12	11	1	18	15	3
week 11	30	9	8	1	21	17	4
week 12	30	6	4	2	24	22	2
n=	360	104	83	21	256	221	35

M= Male; Ad M= Adult male; Ad F = Adult female; F = Female; Ju M = Juvenile Male; Ju F = Juvenile Female

Table 5: Spearman's correlation of sediment texture and *Uca tangari* for samples collected from Bonny River

			OC	OM	Sand	Silt	Clay
Spearman's rho	Ad M	Correlation Coefficient	0.456	.772**	-0.441	0.152	0.22
		Sig. (1-tailed)	0.068	0.002	0.075	0.319	0.246
	Ad F	Correlation Coefficient	-0.27	-.608*	0.301	0.227	-0.279
		Sig. (1-tailed)	0.198	0.018	0.171	0.239	0.19
	Ju M	Correlation Coefficient	-.569*	-0.449	0.407	-0.18	-0.388
		Sig. (1-tailed)	0.027	0.072	0.095	0.288	0.107
	Ju F	Correlation Coefficient	0.15	-0.005	-0.47	-0.1	0.269
		Sig. (1-tailed)	0.321	0.493	0.061	0.378	0.199

Table 6: Spearman's correlation of sediment texture and *Uca tangari* for samples collected from New Calabar River

			OC	OM	Sand	Silt	Clay
Spearman's rho	Ad M	Correlation Coefficient	-0.138	-0.057	-0.437	0.326	0.312
		Sig. (2-tailed)	0.669	0.861	0.155	0.301	0.323
	Ad F	Correlation Coefficient	0.06	-0.004	0.469	-0.339	-0.378
		Sig. (2-tailed)	0.853	0.991	0.124	0.282	0.226
	Ju M	Correlation Coefficient	0.072	0.06	0.057	-0.107	-0.055
		Sig. (2-tailed)	0.825	0.852	0.861	0.741	0.865
	Ju F	Correlation Coefficient	-0.086	-0.172	-0.016	0.076	-0.095
		Sig. (2-tailed)	0.791	0.593	0.96	0.815	0.769

*. Correlation is significant at the 0.05 level (1-tailed).

OC=Organic Carbon; OM=Organic Matter

DISCUSSION

Sediment, particle size and population distribution of fiddler crab (*Uca tangeri*) was studied across two stations (The Bonny and New Calabar Rivers) in Rivers State Nigeria. Sediment particle formation and *Uca tangeri* population were not evenly distributed across the study station. The Bonny Rivers sediment particle size analysis shows sand (90.06%), clay (5.43%) and silt (3.66%) while organic matter (1.18%) and organic carbon was (0.62%). Of the n-360 *Uca tangari* samples collected from Bonny Rivers, adult male dominated the population (n=230) followed by adult female (n=58), juvenile male (n=51) and juvenile female (n=21). Also, adult male show positive correlation with clayey sediment (0.22) and silty sediment (0.152) while adult female samples were positively correlated with silt (0.23) and sand (0.30), table 5. The preference of male *Uca tangari* to silt-clayey sediment rich in organic matters and organic carbon was not unconnected with their burrowing and foraging behaviour. The maxillary setae are well developed in adult male which enable them to sort food from within rich clayey sediment. The report of number and development of setae on the second maxilliped was responsible for high population and survivability of *Uca tangari* in muddy sediment Mokhtari *et al.* (2015). Silty-clayey sediment coupled with high organic matters and organic carbon content present an excellent substrate for burrowing and growth of suitable food sources. Burrowing increases the survivability as it serves for escape from predators, exploitation, copulation and hash environmental conditions (Coelho, 1965; Warner, 1969; Coasta, 2000).

Of the n=360 samples harvested from the study stations Adult female show dominance (n=256), followed by juvenile male (221), juvenile female (35) and adult male (21) respectively. The sediment granulometry presented organic carbon (3.62%), organic matters (5.7%), sand (69.96%), silt (12.17%) and clay (17.52%). Sand (69.96%), silt (12.17%), and clay (17.52%). In table 6, the correlation between sediment composition and population distribution of *Uca tangari* was presented. The New Calabar River sediment formation is basically silty-sand. There was more juvenile male (221) and positively correlated with sandy sediments rich organic matters (0.06) and high organic carbon content (0.07), than other age class. Adult female (n=256) show preference to silty (0.28) and sand (0.23) while juvenile female show positive correlation to silty sediment (0.076). This may be as a result of habitat speciation, poorly developed setae, escape from aggressive adults, environmental factor and harvesting. Juvenile prefer to forage in the open on sandy environment and can easily manipulate the sandy shore. Resources sharing may be responsible for juvenile and adult *Uca tangeri* to share the same habitat. The adult female samples were positively correlated with sediments rich in organic carbon and sandy shore while juvenile female show positive correlation with silt sediments (Mokhlesi, 2011). This result agrees with the reports of Coelho (1965) and Warner (1969) that female *Uca thayeri* was only in shaded areas composed of fine sand and very fine sand (Costa, 2001; Koch *et al.*, 2005).

Tables 3 and 5 show a low number of juveniles encountered in this study. This could result from habitat stratification (Negreiros-Fransozo, 2003), sampling techniques, overlooking, visual hand digging, brooding and breeding could account. Juvenile fiddler crabs use different habitat as trade-off of competition and aggressive behaviour of adults. The juvenile prefers to stay in a different habitat until maturity to compete.

Such alteration was earlier reported in some species such as *Uca purgilator* were juvenile were seen in muddy habitat and adults inhabit sandy areas (Mokhlesi, 2011). Such evasive mechanism is important according to Pardo *et al.* (2020), as they lack specialized mouth part to sieve through a more formed substratum. Sharing same habitat with adults could predispose them to fishing, predation, heat stress, cannibalism, competition, and desiccation (Numbere, 2020).

CONCLUSION

The research illustrated that sediment particle size affects the spatiotemporal distribution of *Uca tangeri* along the shores of Bonny and New Calabar Rivers in Port Harcourt, Rivers State. Sediment particle size and morphology influences habitat speciation. While juvenile prefer sandy sediment, adult male prefer clayey sediment. Burrow formation, which is used to escape from predation, habitat weather condition and copulation during reproduction window influences distribution. Sediment preference is also be connected with predation, aggressive behaviour and tidal action. The immatures are too feeble to compete and are driven by tidal action. The juvenile mouth parts are not well developed to burrow sediment rich in clay but can maneuver through sandy environment.

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