

SEASONAL VARIATIONS IN SPECIES COMPOSITION, ABUNDANCE AND DIVERSITY OF WILDLIFE SOLD AT OMAGWA BUSHMEAT MARKET IN RIVERS STATE, NIGERIA

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Abstract

Effects of seasons on species composition, abundance and diversity of wildlife brought for sale at Omagwa bushmeat market in Rivers State, Nigeria, was studied in 2018 for a period of seven months covering the Late Dry Season (January to February), Early Rainy Season (March to May) and the Peak Rainy Season (June to July). Enumerations of species of wildlife brought for sale in the market were carried out twice in a month during this study. A total of 1888 individuals belonging to 15 species were enumerated during the period. *Thryonomys swinderianus* (Cane Rat) was the most abundant species in all the seasons while *Herpestes ichneumon* (Egyptian mongoose) was the second most abundant species during the Early and Peak Rainy Seasons, and *Cricetomys emini* (Emin's giant rat) the second most abundant during the Late Dry Season. The least abundant species was *Python regius* (Royal python) followed by *Vulpes vulpes* (Fox), and *Crocodylus niloticus* (Crocodile) respectively. The average monthly abundance of wildlife was 5.19% and 35.39% higher during the Peak Rainy Season than during the Early Rainy Season and the Late Dry Season, respectively. Average monthly species diversity was generally low with the Late Dry Season having the highest index (Shannon $H = 1.94$) followed by Early Rainy Season (Shannon $H = 1.87$) and the Peak Rainy Season (Shannon $H = 1.86$). Average monthly species richness was 12, 12.67, and 13 species for the Late Dry Season, the Early Rainy Season, and the Peak Rainy Season, respectively. Similarity in species composition was high between months across seasons and ranged from 70% (February/June) to 96% (March/July & April/July). The seasonal effect on wildlife brought to the market for sale was more distinct on species abundance than on species composition and diversity.

Keywords: Wildlife trade, seasonal population dynamics, species richness, diversity, Omagwa

Introduction

Wildlife includes all undomesticated living plants and animals while the term 'wildlife' applies strictly to undomesticated animals. The interdependence of living organisms, including human beings and the lower animals cannot be overemphasized. Wildlife generally, is of immense importance to man as it constitutes source of food, clothing, medicine, ecotourism, research, pet, raw materials, among many others. However, the sustainability of these benefits, to a large extent, depends on man whose responsibility it is to develop effective strategies for the management and utilization of wildlife resources. By effectively managing and sustainably utilizing wildlife, humans are maintaining a healthy world for all life forms, including man who is on top of the food chain.

Bushmeat is a name for wild animals that are hunted for human consumption. Hunting and bushmeat consumption are age-long activities, although hunting was mainly carried out at a subsistence level in the distant past. In many parts of Africa especially West, Central and East Africa, bushmeat constitutes a large

proportion of animal protein to rural communities (Robbinson & Benneth, 2000; Brashares *et al* 2004; Wilkie, *et al.*, 2005; Kiringe *et al.*, 2007; Bifarin *et al.*, 2008, Rist *et al.*, 2008; Okiwelu *et al.*, 2009; Olupot *et al.*, 2009). The supply of bushmeat originates from the forest and the grass land (Ape Alliance, 1998; Bowen-Jones *et al.*, 2003; Okiwelu *et al.*, 2009). It provides a source of income (Cowlshaw *et al.*, 2005), and has always been a staple in the diet of rural populations in West Africa (Fa *et al.*, 2002, Wilkie *et al.*, 2005). Research has also shown that bushmeat consumption is deeply rooted in cultural preference and that consumers show more willingness to pay for it than domestic meat (Njiforti 1996, Trefon and de market, 1999; Rose 2002, Wilkie *et al.*, 2005). The preference and high demand for bushmeat are mainly responsible for commercial bushmeat trade (Ape Alliance, 1998; Fa *et al.*, 2002; de merode *et al.*, 2004; Okiwelu *et al.*, 2009). Thus, hunters try to maintain supply irrespective of the conservation status and the decreasing populations of many species of wildlife. Illegal trade in wildlife generally has been a source of concern to the international community because of the huge socioeconomic, environmental, and security issues associated with it (CITES, 2014).

In Omagwa community, bushmeat is an essential source of animal protein which is constantly in large demand by people including many from outside the community. Consumption of bushmeat is not bad, and can hardly be stopped but the sustainability depends on its availability in the market as influenced by the production potential of respective species in the wild. Populations of wildfauna are affected by so many factors such as climate change, unregulated hunting and poaching activities, pollution, over exploitation of the forest due to poverty, deforestation and burgeoning human populations. The importance of wildlife stock and habitat evaluation has long been emphasized (Van Horne 1983; Garshelis 2000). Although some authors (e.g. Okiwelu *et al.*, 2009, 2010; Onu and Ijeomah 2010) had conducted surveys to ascertain the species composition, seasonal abundance, and cost of wildfauna sold in Omagwa bushmeat market, no study so far has evaluated the effect of different seasons on the diversity of wildfauna brought to the market for sale. Moreover, the need for a periodic assessment of species composition, diversity and abundance of wild animals available for sale in bushmeat markets cannot be overemphasized. Such information will not only guide the consumers on their preferences and demands for bushmeat on monthly and seasonal bases, but will

also provide information that may help the conservation of rare and threatened species. This study therefore evaluated the monthly and seasonal variations in species composition, abundance, and diversity of wildfauna sold at Omagwa bushmeat market in Rivers State, Southern Nigeria, and compared the results with previous studies to ascertain the prevailing trends in the status of the evaluated variables.

Materials and Methods

Study Area

The study was carried out at a popular bushmeat market located in Omagwa, Ikwerre Local Government Area of Rivers State, Nigeria. The area is located at latitude 4°58'59"N and 6°42'20"E. The study area lies in the lowland rainforest, dominated by secondary vegetation and fragmented farms (Okiwelu *et al.*, 2009). The Omagwa bushmeat market is located along the Owerri-Port Harcourt Highway, near Port Harcourt City. The location of the market near the express-way and the Port Harcourt City makes it a very popular bushmeat market as it enjoys patronage from travelers going to and fro Port Harcourt (Okiwelu *et al.*, 2009). The people of Omagwa are predominantly farmers, hunters and palm wine tappers. Figure 1 is the map of Ikwerre Local Government Area showing the study area.

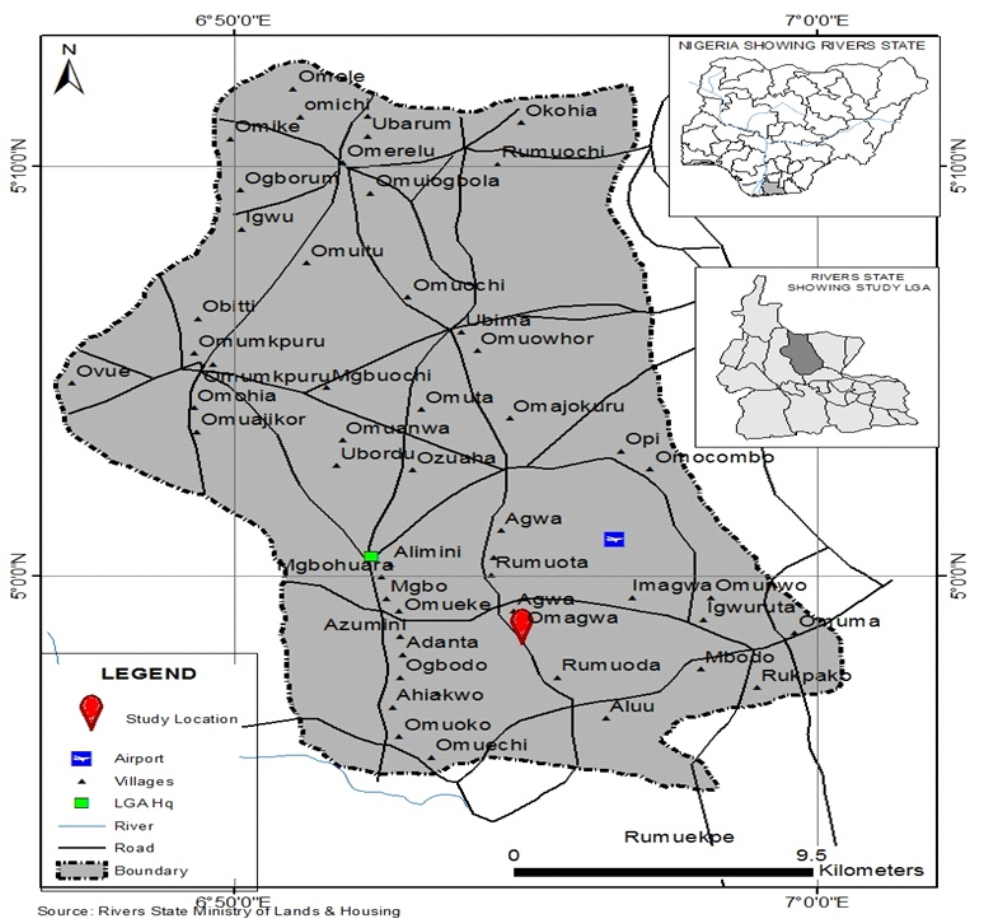


Figure 1: Ikwerre Local Government Area showing the location of Omagwa (Inset: Map of Nigeria showing the location of Rivers State and map of Rivers State showing the Study Local Government Area)

Data Collection

The market was visited twice a month (on the 1st and the 3rd Saturdays) between 06.00 and 11.00 hours, for a period of seven months (January to July, 2018) for the enumeration (100%) of wildfauna brought to the market for sale by the hunters and suppliers. Each species of wildfauna encountered was identified to species level and the number of individuals counted. The identification of wildfauna was done by a wildlife taxonomist with the help of The Kingdon Field Guide To African Mammals by Kingdon (1997).

Data Analysis

Species Diversity

The diversity of species of wildfauna brought for sale in the market for each month was calculated using Shannon-wiener diversity index after Odum (1971) as shown in Equation 1.

$$H = - \sum_{i=1}^s p_i \ln p_i \text{ -----Eqn. 1}$$

Where: H = Shannon-Wiener Diversity Index. p_i = the proportion of individuals in the i th species of wildfauna. s = total number of species of wildfauna.

Similarity in Species Composition

The extent of similarity in species of wildfauna brought to the market for sale between months across seasons was calculated using Sorensen's similarity index after Margurran (2004) and expressed as percentages (Equation 2).

$$SI = [2a / (2a + b + c)] \times 100 \text{ -----Eqn. 2.}$$

Where: SI = Sorensen's Similarity Index
 a = number of species of wildfauna present in both months under consideration.
 b = number of species of wildfauna present in month 1 but absent in month 2.

c = number of species of wildfauna present in month 2 but absent in month 1.

Classification of Months/Seasons of Study Based on their Species Composition

Cluster dendogram classification of the months reflecting different seasons, was done based on the similarity in species of wildfauna brought to the market for sale such that months/seasons with more similar species showed closer association while those with less similar species showed a distant association. Cluster dendogram classification was done using PAleontological STatistics (PAST) software.

Results

Seasonal Variations in the Abundance of Wildfauna brought to the Market for Sale

The abundance of wildfauna brought to the market for sale during the study period is presented in Table 1. For the Late Dry Season, the most abundant species was the Cane Rat (128), followed by Emin's Giant Rat (62) and Egyptian Mongoose (48). In the Early Rainy Season the most abundant species was the Cane Rat (349), followed by Egyptian Mongoose (119) and Bush -Tailed (107). Porcupine, while the most abundant species during the Peak Rainy Season was also the Cane Rat (226), followed by Egyptian Mongoose (116) and Emin's Giant Rat (111). Across all the months and seasons, the abundance of wildfauna brought for sale in the market was highest for the Cane Rat, followed by Egyptian Mongoose and Emin's Giant Rat, respectively. Average monthly abundance of wildfauna brought for sale in the market was highest during the Peak Rainy Season (308), followed by the Early Rainy Season (292) and the Late Dry Season (199).

Table 1: Monthly and Seasonal Abundance of Species of Wildfauna brought for sale in the Market

Species	Common name	Abundance													
		Late Dry Season			Early Rainy Season			Peak Rainy Season			Grand Total				
Scientific name		Jan	Feb	Total	Mean	Mar	Apr	May	Total	Mean	Jun	Jul	Total	Mean	Total
<i>Thryonomys Swinderianus</i>	Cane rat	32	96	128	64	138	110	101	349	116.33	92	134	226	113	703
<i>Cricetomys emini</i>	Emin's Giant rat	22	40	62	31	10	15	29	54	18.00	45	66	111	55.5	227
<i>Numida meleagris</i>	Guinea fowl	7	8	15	7.5	6	5	0	11	3.67	0	9	9	4.5	35
<i>Cercopithecus mona</i>	Mona monkey	2	14	16	8	7	5	1	13	4.33	0	6	6	3	35
<i>Xerus erythropus</i>	Ground Squirrel	15	16	31	15.5	26	25	0	51	17.00	32	5	37	18.5	119
<i>Atherurus africanus</i>	Brush-tailed porcupine	10	12	22	11	28	16	63	107	35.67	15	17	32	16	161
<i>Civettictis civetta</i>	African civet cat	1	5	6	3	11	5	3	19	6.33	3	3	6	3	31
<i>Vulpas vulpas</i>	Fox	0	2	2	1	4	0	8	12	4.00	0	0	0	0	14
<i>Francolinus bicaratus</i>	Bush fowl	0	0	0	0	4	10	7	21	7.00	5	4	9	4.5	30
<i>Tragelaphus spekei</i>	Situatunga	8	25	33	16.5	11	13	18	42	14.00	9	5	14	7	89
<i>Crocodylus niloticus</i>	Crocodile	0	2	2	1	3	0	2	5	1.67	0	9	9	4.5	16
<i>Sylvicapra grimmia</i>	Duiker	14	12	26	13	6	28	22	56	18.67	21	15	36	18	118
<i>Patamochoreus porcus</i>	Red river hog Egyptian	2	5	7	3.5	6	5	5	16	5.33	0	3	3	1.5	26
<i>Herpestes ichneumon</i>	Mongoose	20	28	48	24	32	32	55	119	39.67	25	91	116	58	283
<i>Python regius</i>	Royal Python	0	0	0	0	0	0	0	0	0	1	0	1	0.5	1
Total		133	265	398	199	292	269	314	875	292	248	367	615	308	1888

Seasonal Variation in the Diversity of Species of Wildfauna Brought for Sale in the Market

The wildfauna diversity indices for the different months across seasons are shown in Table 2. Average monthly species richness was almost the same for all the seasons with a total of 13 species recorded during the Peak Rainy Season, 12.67 species in Early Rainy

Season and 12 species in the Late Dry Season. The average monthly diversity of wildfauna sold in the market was also almost the same but highest in the Late Dry Season (Shannon H = 1.94) followed by the Early Rainy Season (Shannon H = 1.87), and lowest during the Peak Rainy Season (Shannon H = 1.86).

Table 2: Diversity of Wildfauna brought for sale in the Market

Index	Late Dry Season			Early Rainy Season				Peak Rainy Season		
	Jan	Feb	Average	Mar	Apr	May	Average	Jun	Jul	Average
Species richness	11	13	12	14	12	12	12.67	14	12	13
Abundance	133	265	199	292	269	314	291.67	248	367	307.5
Shannon H	1.90	1.97	1.94	1.90	1.81	1.90	1.87	1.90	1.81	1.86

Extent of Similarity in Species of Wildfauna brought for sale in the Market for Months across Seasons

The similarity in species of wildfauna brought for sale

in the market is presented in Table 3. The similarity in species between months across seasons was high and ranged from 70 % (February-LDS/June-PRS) to 96% (March-ERS/July-PRS and April-ERS/July-PRS).

Table 3: Sorensen similarity indices for different months across seasons

	January-LDS	February-LDS	March-ERS	April-ERS	May-ERS	June-PRS	July-PRS
JanLDS	*	0.92	0.92	0.92	0.78	0.76	0.92
FebLDS		*	0.90	0.88	0.88	0.70	0.92
MarERS			*	0.92	0.92	0.75	0.96
AprERS				*	0.83	0.81	0.96
MayERS					*	0.73	0.88
JunPRS						*	0.78
JulPRS							*

LDS = Late Dry Season, ERS = Early Rainy Season; PRS = Peak Rainy Season

Classification of the Months of Study based on Similarity of Wildfauna Species

The cluster dendrogram for the various months in the seasons based on the similarity of wildfauna species sold during the months and seasons is presented in Figure 2. The closest association was seen amongst

March, July and April while the farthest was observed between June and other months. January and February, which fall under the Late Dry Season associated closely while June showed a closer association with May than July.

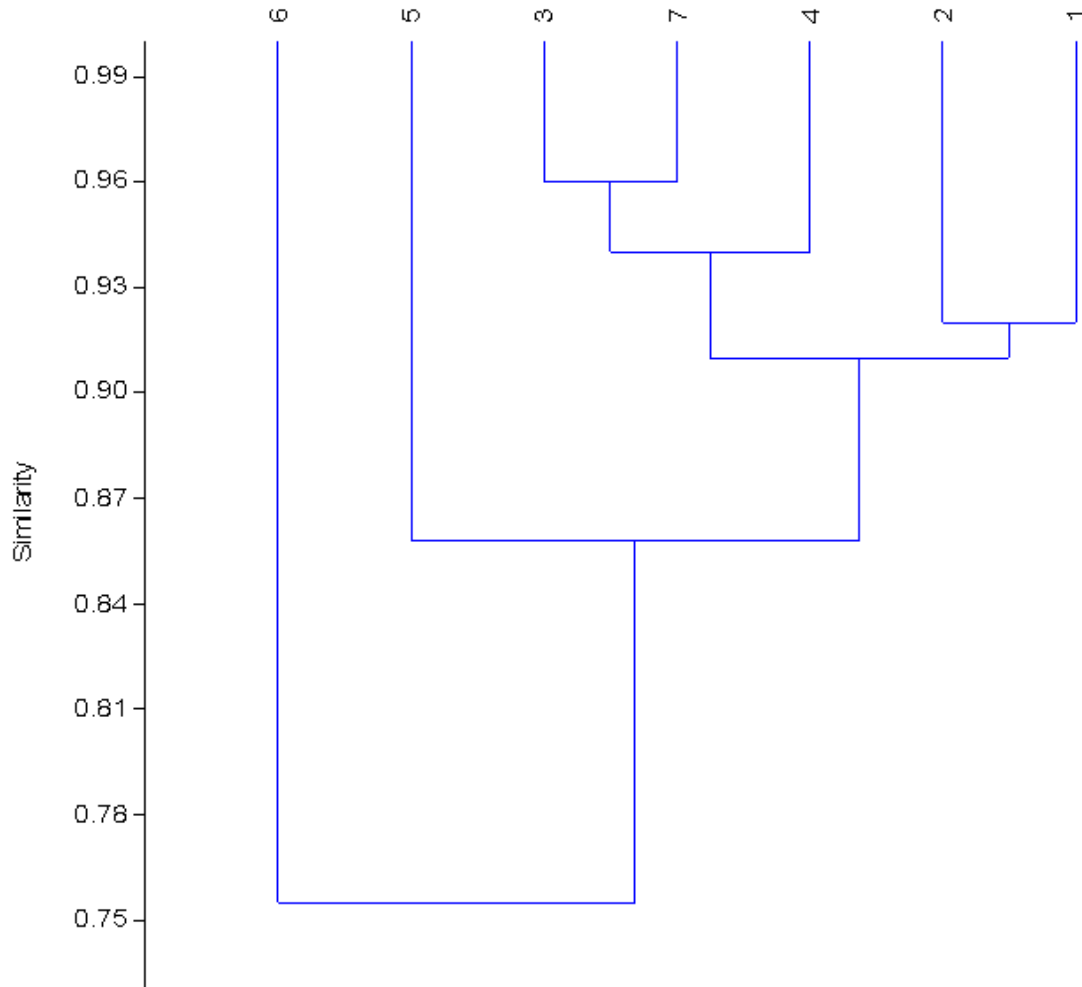


Figure 2: Cluster dendrogram based on the similarity of wildlife species encountered during the various months 1= January; 2= February; 3= March; 4= April; 5= May; 6= June; 7= July

Discussion

A total of one thousand, eight hundred and eighty-eight (1,888) individual carcasses of wildfauna belonging to 15 species were brought for sale at Omagwa bushmeat market within the seven-month period of the survey. This result differs from the result of a four-month survey (March – June) conducted in 2005 and reported by Okiwelu *et al.* (2009) in which a total of seven thousand, one hundred and twenty-seven (7,127) individual carcasses of wildfauna were enumerated at the same study site. The observed difference is mainly due to differences in the frequency of surveys in both studies. For instance, when the frequency of surveys was considered, it was observed that the average abundance per survey increased from 59.89 animal carcasses in 2005 to 134.85 in this study (conducted in 2018), equivalent to a phenomenal increase of 125.16 %. An increase of 163.62 % was also observed in the abundance of wildfauna brought to the market per day between Okiwelu *et al.* (2009 & 2010). At the species level, the Cane Rat, which was the most abundant species recorded by Okiwelu *et al.* (2009; 2010) still remained the most abundant species for all the seasons in this study. The number of the Cane Rats brought to

the market for sale per survey, was 60.26% and 51.70 % higher in this study than the number reported by Okiwelu *et al.* (2009 & 2010) respectively. An increase of 183.63 % on the average daily abundance of the Cane Rat brought to the market for sale was also observed between Okiwelu *et al.* (2009 & 2010).

The higher number and percentage of wildfauna generally and the Cane Rat in particular, recorded per survey in this study is indicative of higher harvesting rates and supply of wildfauna to the market. As a result of the continuous increase in demand for bushmeat, hunters and sellers adopt different strategies, including the use of sophisticated weapons, to increase supply in order to generate more income (Okiwelu *et al.*, 2009; Onu and Ijeomah, 2010). The continuous higher abundance of the Cane Rat over the years despite frequent and high rate of hunting could be attributed to the availability of the grasses and other plant materials which it feeds on, its resilience due to initial large population size, low mortality, higher rate of recruitment, among other reasons (Okiwelu *et al.*, 2009). There is also the possibility of domesticated Cane rats being brought to the market for sale. Other

authors (e.g. FAO, 1989; Ntiama-Baidu, 1998; Onadeko, 1998; Cowlishaw *et al.*, 2005; Okeke *et al.*, 2013; Halidu, 2019; Yisau *et al.*, 2019) have also reported the dominance of the Cane Rat in bushmeat trade in West Africa.

On the average about 135 animals were harvested and brought to the market for sale on each of the fourteen days the enumeration was carried out across the seven-months period. This number excludes those killed and consumed by different categories of people who are not involved in the bushmeat trade and those sold by the hunters and suppliers outside the market. Our observations showed that animals were killed irrespective of their conservation status; for instance, species like Python, Crocodile and Brush-tailed porcupine that are endangered species were among the species killed and brought to the market for sale. Yisau *et al.* (2019) also observed that wildfauna was harvested and sold as bushmeat regardless of the age and sex of the animals. The indiscriminate harvesting and sale of wild animals as bushmeat have been attributed to more intense hunting orchestrated by the ever increasing demand for bushmeat (Tee *et al.*, 2012)

On a seasonal basis there was a progressive increase in the average monthly abundance of wild animals sold in the market. The Late Dry Season (January-February) and the Peak Rainy Season (June – July) had the lowest and the highest mean monthly abundance respectively while the abundance during the Early Rainy Season (March – May) was intermediate. The increased population of animals caused by breeding in rainy season, the clustering of animals at food sources, and the unusual dry spell observed in July, may have led to an increase in hunting output. The availability of game for catch and sale in the market is normally a function of the season and effort by the hunters and trap setters. Season affects breeding of species and the hunters' level of success in catching them. The rainy season favours breeding while hunters' catches are supposed to be more during the dry season. The highest abundance recorded during the Peak Rainy Season in this study is in contrast with earlier studies by Okiwelu *et al.* (2009; 2010) who observed higher abundance during the dry season. Apart from an attempt to reflect the prevailing seasonal patterns, which led to a slight difference in the classification of seasons between this study and the previous ones, the observed change in trend with respect to seasonal abundance is most probably due to the effect of changing patterns in climate variability caused by climate change. There was a dry spell in July 2018 contrary to usual expectations since July falls within the peak of the rainy season. In the preceding month (June), the abundance of wildfauna brought to the market for sale dropped as expected because of frequent rains, however, it went up unexpectedly in July probably due to intensified hunting and more catches during the dry spell. In addition, as a result of economic challenges and increasing demand for bushmeat, hunters adopt different strategies, including the use of

sophisticated weapons, to increase their catches (Edderal & Dame, 2006; Okiwelu *et al.*, 2009; Tee *et al.*, 2012); irrespective of season.

The diversity indices for the three seasons were generally low but indicate that diversity of wildfauna brought to the market for sale slightly reduced from the Late Dry Season through Early Rainy Season to Peak Rainy Seasons. The slight variation in the diversity of wildfauna brought to the market for sale during the seasons shows that the number of species and the distribution of the individuals amongst the species were similar across the seasons. Wellner (2000) perceived diversity as representing a multitude of individual differences and similarities. Amubode (1996) also observed that species diversity implies the number of species and the number of individuals in a community but noted that one has to consider how the individuals are apportioned to the species. Thus, species diversity not only considers species richness but also the heterogeneity and/or evenness in distribution of the entire population in a community among the species. The generally low diversity of species of wildfauna brought to the market for sale across the seasons was due to high species dominance. A close look at the species abundance for the three seasons revealed that the Cane Rat, Emin's Giant Rat, Ground Squirrel, Bush Fowl, Brush-Tailed Porcupine and Egyptian Mongoose accounted for 79.65, 84.11, and 90.73 % of the total number of animals (abundance) brought to the market for sale in the Late Dry Season, the Early Rainy Season, and the Peak Rainy Season, respectively.

In terms of species richness, there was no distinct variation in the average monthly number of species brought to the market between seasons. However, the number of species recorded in this study is 15.38 % higher than the number of species reported in the 2005 survey but 16.67 % lower than the number of species reported in the 1995 survey by NDES (Unpublished). Tree Pangolin, Western Tree Hyrax and Giant Forest Squirrel recorded in 1995 were not encountered in this study. Egyptian Mongoose which was not among the species recorded in the 2005 survey was recorded in the present study. However, Egyptian Mongoose was also recorded in the 1995 survey. Python and Fox that were not recorded in 1995 survey and the 2005 survey were present in this study but only one Python was encountered and that was during the Peak Rainy Season. The presence of Python in the bushmeat market was somewhat surprising. This is because snakes although consumed in the South-eastern and South-southern parts of Nigeria are hardly sold in the market as bushmeat unlike in the South-western part of Nigeria. Crocodile which was recorded in this study was not observed during the 1995 and 2005 surveys; however, Crocodile is a common species in Rivers State. Forest Genet (*Genetta poensis*), Rufous Mouse-Eared bat (*Myotis bocagei*) that were present in 2005 survey were absent in this study. These observations illustrate the long-term dynamics in species composition of wildfauna sold in the market, which could be as a result of two possible

factors: availability/non-availability of the species in the wild, and/or the influence of consumers' preferences on the forces of demand and supply.

Similarity in the species composition of wildfauna brought to the market for sale was high between months across seasons. However, the lowest similarity indices were recorded between June (which falls within the Peak of Rainy Season) and the other months. On a general note, species abundance, diversity, and similarity between months and across seasons, mostly dropped in the month of June but suddenly went up in the month of July (which also falls within the Peak of Rainy Season). The drop in all these variables in June is probably due to frequent rains which may have retarded hunting activities. However, the indices suddenly went up in July most probably due to the dry spell that was experienced in July instead of the usual August. The dry spell experienced in July and the concomitant effect on the species composition of wildfauna brought to the market, is probably the reason why July associated more closely with March and April which are months in Early Rainy Season when rainfall is not as frequent as it is during the Peak Rainy Season. The fact that January and February which fall within the Late Dry Season showed closer association, and that June associated more closely with May than July because of the dry spell in July, lends credence to the influence of rainfall pattern on the species composition of wildfauna brought to the market for sale.

Conclusion

The seasonal effect was more distinct on the abundance of wildfauna sold in the market than on the species composition and diversity. The average monthly abundance of wildfauna brought to the market for sale was 5.19 % and 35.39 % higher during the Peak Rainy Season than during the Early Rainy Season and the Late Dry Season, respectively. The Cane Rat, Emin's Giant Rat, Ground Squirrel, Bush Fowl Brush-Tailed Porcupine and Egyptian Mongoose accounted for 79.65, 84.11, and 90.73 % of the total number of animals (abundance) brought to the market during the Late Dry Season, Early Rainy Season, and the Peak rainy Season, respectively. The species composition of wildfauna brought to the market for sale was similar between months across the three seasons with similarity ranging from 70 – 96%. Species diversity was generally low and slightly reduced from the Late Dry Season through Early Rainy Season to Peak Rainy Season. The unusual dry spell in July increased the abundance of wildfauna brought to the market during the Peak Rainy Season. The low diversity of species of wildfauna observed across seasons calls for measures to conserve and restore populations of wildfauna especially in their natural habitats. Further studies to ascertain the species composition, abundance and diversity of wildfauna during the Early Dry Season (November to December) and the Late Rainy Season (August to October), which were not covered in this study, are recommended.

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