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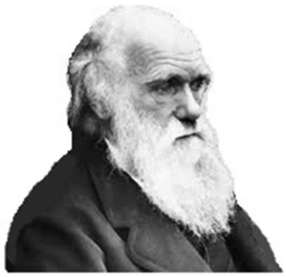

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Ecological influence of habitat structure on the diversity of fauna in Rivers State, Nigeria

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ABSTRACT

Natural habitats are being degraded on a daily basis due to the increase in population and the need to put them to alternative use. This has caused a downturn in biodiversity. The habitat structure, however, plays a key role in species distribution and diversity, hence, the need for its protection. Animal species diversity has been reported to be dependent on the structure of the habitat. However, information on wildlife species in relation to habitat structure within Bonny Island forest has not been adequately documented. Therefore, wildlife diversity in Bonny Island was assessed. Herein, flora and fauna surveys were carried out on fixed transect lines using point centre quarter and line transect methods, respectively, in both the dry and wet seasons. The data were analyzed using descriptive statistics and correlation analysis. Abundance of trees, shrubs, grasses and aquatic plant species in BSS (24, 13, 10, and 8, respectively) were higher than in BIs (8, 10, 10, and 10). Anthropogenic activities: hunting, fishing and other agricultural practices exerted higher pressure of 20.0%, 60.0%, and 10.0%, respectively, on the wildlife resources during the dry rather than the wet seasons (17.5%, 43.8%, and 38.70%, respectively). Higher density index of avian, amphibian, reptiles, and mammals were recorded in BSS (3.2, 3.3, 4.4, and 2.1, respectively) compared to BIS (0.2, 0.7, 0.5, and 0.6). Moreover, there were more catch values in the dry than in the wet seasons (t=0.935). In addition, a higher diversity index (t=2.18) was recorded in BSS than in BIs. Generally, more species diversity was observed in the BSS block than the BIs and this is attributed to the habitat structure which is more structurally complex and less fragmented.

***Keywords*:** habitat, degradation of environment, structure of environment, flora and fauna

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1. INTRODUCTION

It has been discovered that habitat structure or heterogeneity have, in one way or the other, affected the diversity and distribution of wild fauna. For example, Bazzaz, (1975) assumes that structurally complex habitats may provide more niches and diverse ways of exploiting the environmental resources and thus increase species diversity. Also, according to reviews by Lawton, (1983), and McCoy & Bell, 1991), in most habitats, plant communities determine the physical structure of the environment, and therefore, have a considerable influence on the distributions and interactions of animal species. Considering an area like Bonny in Rivers state, a small island located just offshore with predominantly freshwater swamp and mangrove forests that has suffered a major anthropogenic activities, it is unarguable that species will be affected from the after-effect of habitat alteration, such as change vegetation cover.

Apart from the gar flaring activities in Bonny Island, which can affect the health of wildlife, the prevalent activities also can result to habitat fragmentation and, in a way, changes the habitat structure which can have a long-term effect on the abundance and diversity of the animals. There is no doubt that industrialization, such as oil mining in an environment such as Bonny Island, has significant biological impacts on the general environment. The importance and extent of the effects depend on a wide range of factors, including the location of the exploitation area, the method and rate of extraction, the design of the machinery, as well as the nature of the surface, the sediment, the coastal processes, and the sensitivity of habitats and species. In this study we consider habitat structure, as plant and trees parameters, such as crown cover, shrubs, grasses and other component like forest type and farmland within and around the study area. Understanding the link between habitat and its associated fauna is an important concept within ecological research, one that is vital for the conservation of increasingly degraded and fragmented habitats (Bentley *et al*. 2000; Hauser *et al*. 2006). As the structural complexity of a habitat reduces, assemblage shifts have been reported from comprising mostly habitat specialists, to assemblages dominated by habitat generalists that are able to deal with the altered habitat (Bentley *et al*. 2000). This study, however, provides the species list of fauna in the different habitat types after the inception of the oil mining activities in Bonny Island.

2. MATERIALS AND METHODS

Study area

Bonny is a town and a Local Government Area in Rivers State, southeastern Nigeria. It is on the Bight of Biafra within Latitude 4°26'0" N and Longitude 7°10'0" E. It is approximately 56 km from upland Port Harcourt, the capital city of Rivers State Niger Delta (**Fig. 1**). A small island, located just offshore with predominantly freshwater swamp and mangrove forests, Bonny Island, is a major export point for crude oil and gas. The region produces a type of crude oil known as Bonny Light oil. Much of the crude oil extracted onshore in Rivers State is piped to Bonny for export. Due to its strategic position, the island hosts various multi-national oil and gas companies, whose continuous expansion impact directly on the forest ecosystem. The study is conducted within the axis Bonny Local Government Area which consists of mainly the Bonny Island (BIs) and Bonny satellite towns and villages/fishing settlements (BSS) surrounding the Island. Bonny Island (BIs) is a highly built up area housing, the big companies facilities, and so highly degraded and disturbed. Bonny satellite settlement (BSS) has few permanent building and infrastructures, no paved roads, and hence, very slightly disturbed and degraded.

Data collection

The study was undertaken within 2 years (2009-2011) using four seasons of distinct wet and dry seasons (November – March), dry, and (April – October) wet season. Sampling zones were identified and later sampled in 2010 and 2011. Vegetation types were identified along the established transects with a proper description. The area covered were rainforest, freshwater swamp forest, sparse bush fallows with farmlands, and mangrove swamps. Species composition and density were studied in detail using the quadrate and Belt Transect Method. All observations and sampling points were geo-referenced using hand-held global positioning system GPS. Field survey lasted for 11 days in the dry season (26th – 31st March, and 7th – 11th April, 2011) and 10 days in the wet season (18th – 22nd and 25th – 29th August 2011).

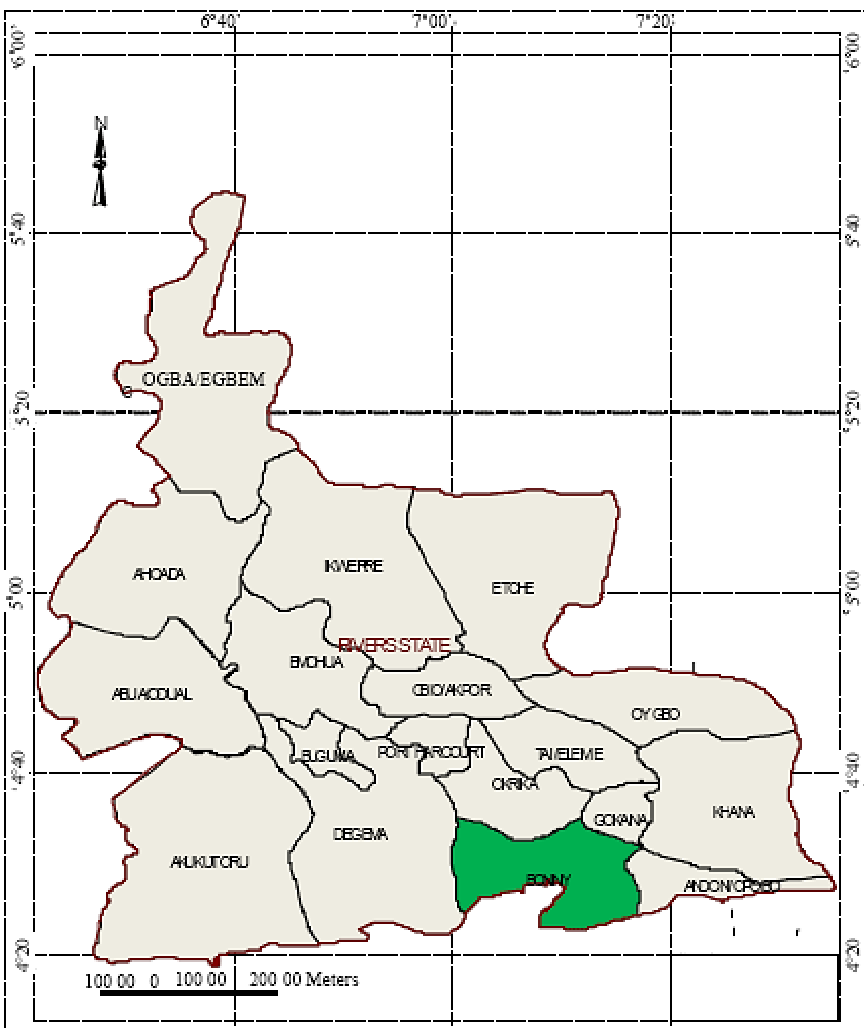

Fig. 1. Map of River State showing the study area

The entire study area was traversed with the aid of a GPS, vehicle, boat and occasionally by foot, using a map with pre-determined sampling points. This helped with the identification of the various vegetation types within the field from the land locations to the end of the swamp locations in Bonny, covering a distance of 40 km. Plant species were identified in 10 × 10 m quadrants laid within the vegetation. During sampling, the dominant species along 300 × 3000 m transects were noted. Estimation of the wildlife species of the area was carried out through direct in indirect methods**,** interviews with local hunters, and reference to specialist institutions and experts, both local and international.

3. RESULT AND DISCUSSION

For comparison, the study area was divided into two: the Bonny Satellite Settlement (BSS), and Bonny Island (BIs) which are both reasonably endowed with various species of wildlife. This is explainable by the heterogeneous nature of the vegetation which supports the wildlife. There is an adequate cover for social and other activities, adequate forage species for grazing and browsing species. The relative humidity favours occurrence, establishment, and distribution of all the classes of animals – both vertebrates and invertebrates. **Figure 2** shows the areas of no vegetation cover which include bared ground, river courses, ponds, springs, road/bridges wellheads/gas flare points, and built up areas.

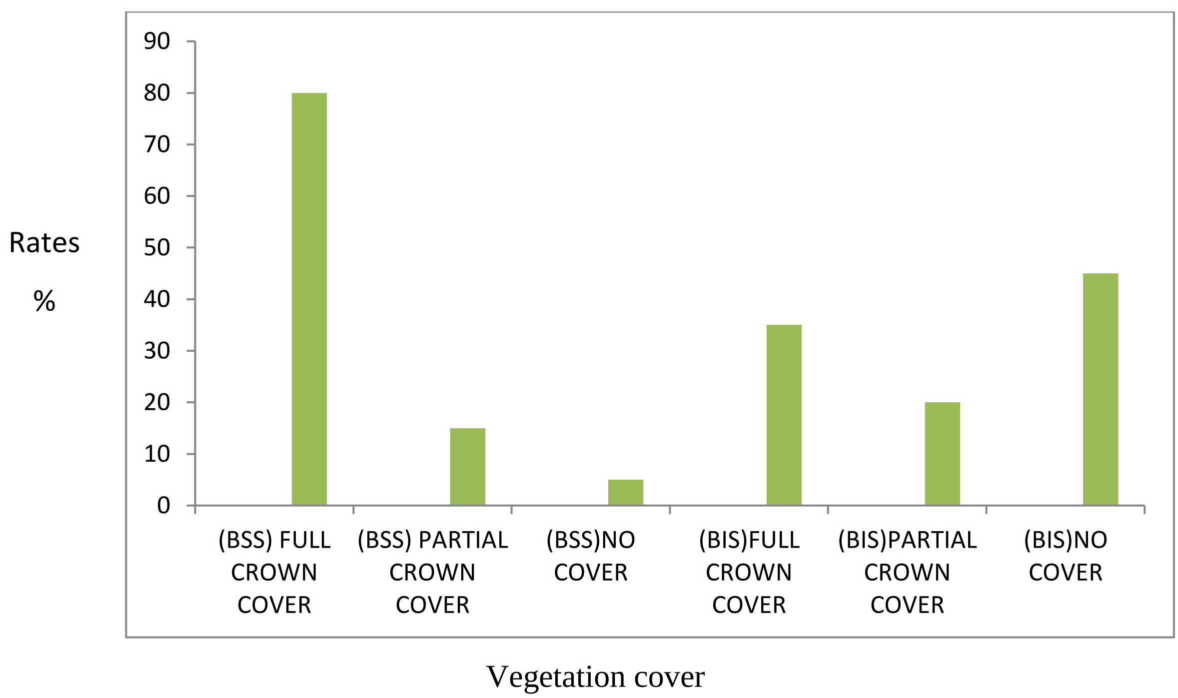

Figure 2. Vegetation cover expressed in full or partial crown cover in the blocks

BSS block has a reduced area with no cover, that is bare ground compared to BIs. Generally, there is a clear cut difference in the vegetation parameters of BSS when compared to BIS block having the highest full crown cover (79%) and a limited area of partial crown (12%), as observed in BIs.

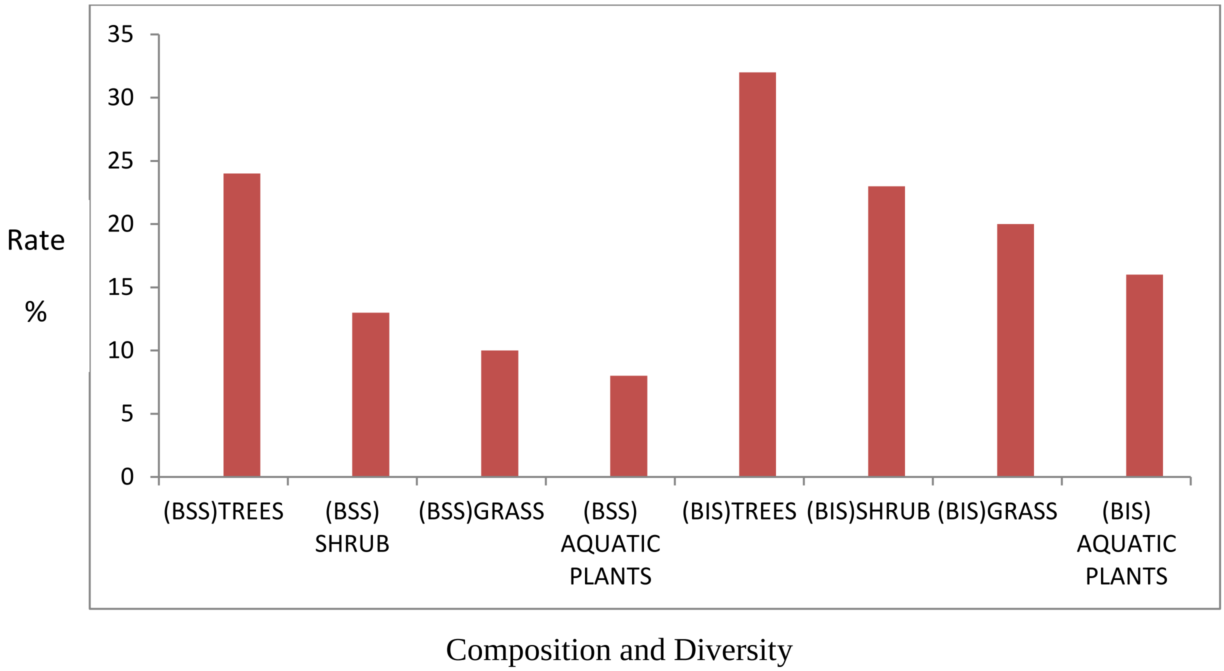

Figure 3. Vegetation composition and species diversity

Figure 3 shows that BIs has more vegetation diversity when compared to BSS but in fragments, due to the high level of anthropogenic activities, in the area. The compositions of trees, shrub, grasses, and aquatic plant are lesser and more homogenous, that is, having more dominant species in BSS compared to the species observed in BIs block. The vegetation can be largely divided into three types:

(1) Mangrove swamp forest
(2) Freshwater swamp forest
(3) Farm and tree crop species.

A checklist of wildlife observed in the area and their conservation status is presented in **Table 1** to **4**. A total of 71 vertebrate species were recorded of which mammals constitute 4, Avian 26, reptiles 17, and amphibians 6. The wildlife of the Bonny Island (BIs), however, presents differently when compared to the fauna species, presented in BSS. The near total absence of the mammalian species in BIs is attributed to many factors which include loss of vegetation cover, influx of people from diverse background and cultures, (poaching pressures), development of infrastructural facilities – roads camps, residential and plant areas, bridges and jetties, as well as establishment of social and utility amenities. Increase in noise, vibration and air pollution coupled with differential lighting conditions have cumulatively forced social stress which can reduce breeding and diminish general activities of mammals.

Table 1. Avian Fauna of the Study Area.

S/N	Scientific name	English name	Local name	Block	Status			
					Normal	Threatened	Endangered	Extinct
1	*Psittaus arithacus*	Grey parrot	Okoko	BSS		x		
2	*Pteronetta Hortlaubii*	Hartlaub's duck	Migigogo	BSS	x			
3	*Tauraco macrorhynchus*	Verreaux's Touraco	-	BSS	x			
4	*Toichus fasciatus semifasciatus*	Black & white hornbill	Apiapia	BSS BIs	x			
5	*Halcyon malibica*	Blue kingfisher	Okialala	BIs	x			
6	*Ceryle rudis*	Pied kingfisher	Kiara elele	BSS	x			
7	*Corythaeola Cristata*	Blue plantain Eater	Okpoko	BSS BIs	x			
8	*Falco cuvieri*	African hobby	Kala-ikulu	BSS		x		
9	*Gypohierx angolensis*	Palm nut vulture	Ugo	BSS BIs		x		
10	*Polyboroides radiates*	Harrier hawk	-	BSS		x		
11	*Bubulcus ibis*	Cattle egret		BIs	x			
12	*Casmerodius albus*	Great while Egret		BIs		x		
13	*Lophoceros semifasciatus*	Hornbill		BSS BIs	x			
14	*Charadruis marginatus*	Plover		BIs BSS	x			
15	*Milvus nigrans*	Black kite	Egule	BSS		x		
16	*Actophilornis africanus*	Lily trotter		BSS BIs	x			
17	*Pelecanus sp.*	Pelican		BSS	x			
18	*Phalacrocorax africanus*	African Cormorant		BSS	x			
19	*Scopus umbrella minor*	Harmmerkop		BSS		x		
20	*Ceryle maxima*	Giant kingfisher	Kiara-elele	BSS	x			
21	*Stigmatopeda senegalensis*	Dove		BIs	x			

22	*Concomer vocifer*	Eagle	Igo	BIs	x			
23	*Alcedo leucogaster*	White-bellied kingfisher	Kudapre	BSS BIs	x			
24	*Ardea cinerea*	Grey heron	Gbunabulo	BSS		x		
25	*Ardea goliath*	Goliath heron	Gbunabulo	BIs		x		
26	*Asio capensis*	African marsh owl	Ikpikpi	BSS	x			

Table 2. Reptiles observed in the study area

S/N	Scientific name	English name	Local Name	Block	Status			
					Normal	Threatened	Endangered	Extinct
1	*Python sebae*	Rock python	Odum	BSS			x	
2	*Trionyx irienguis*	Softshell turtle	Obo	BSS	x			
3	*Varanus niloticus*	Nile monitor lizard	Gidi	BSS BIs			x	
4	*Crocodylus nitoticus*	Nile crododile	Siki	BIs			x	
5	*Dendraspis viridis*	Green mamba	Bi-akparafi		x			
6	*Grayia smythi*	Smyth's water snake		BSS BIs	x			
7	*Pelusios niger*	Mud turtle	Alakaki	BSS	x			
8	*Lepodochelys olivacea*	Olive ridley turtle	Obo-erem	BSS	x			
9	*Python Regis*	Royal python	Abi Ekukuru	BSS BIs			x	
10	*Crocodylus cataphractus*	Slender-snouted crocodile		BSS BIs	x			
11	*Osteolaemus tetraspis*	Dwarf crocodile	Obahcha	BSS	x			
12	*Naja melanoleuca*	Black cobra		BSS BIs	x			
13	*Naja nigrocollis*	Spitting cobra		BSS BIs	x			
14	*Cheloma mydas*	Green turtle		BIs	x			
15	*Kinixys sp.*	Tortoise		BIs	x			

16	*Mabuya affins*	Skink		BIs			x	
17	*Blusios niger*	Black forest turtle		BSS			x	

Table 3. Amphibians in the Study Area.

S/N	Scientific name	English name	Local name	Block	Status			
					Normal	Threatened	Endangered	Extinct
1	*Bufo regularis*	Common toad	Ngungu	BSS BIs	x			
2	*Rana temporalis*	Green frog	-	BSS	x			
3	*Xoenopus tropicalis*	Web-toad frog	Ngungu – ibo-umpo	BSS BIs	x			
4	*Hyperolius vividigulosus*	Tree frog	Dua-Ngungu	BSS BIs	x			
5	*Gigantorina goliath*	Goliath frog	-	BIs		x		
6	*Ptychodena sp.*	Long-legged frog	Akiri	BSS BIs	x			

Table 4. Mammals observed in the study area

Common Name	Scientific Name	BLOCK	Conservation Status
Water chevrotain	*Hyemoschus aquaticus*	BSS	Vulnerable
Sitatunga	*Tragelaphus spekii*	BSS & BIs	Vulnerable
Cape-clawless otter	*Anonyx capansis*	BSS	Vulnerable
Mona monkey	*Cercopithecus mona*	BSS	Vulnerable

In view of the above results, it is understandable that all organisms needs a place to stay and to carry out their normal activities, some may be too large or too small depending on the home range and territory of the species. More so, the habitat structure is an important factor: different herbivorous species have their unique requirements in terms of tree types, crown cover, under storey, and the general structure of the habitat, and also their connectedness within the ecosystem. The presence and kind of herbivorous species in an environment also determines the kind of carnivore that will be available. This continues until there a diverse species. However, when natural habitat becomes fragmented as a result of landscape changes, small isolated patches are often too small to sustain viable populations. These small, local populations are always at risk from extinction, due to local disasters or stochastic processes, for example pollution, or fire. However, when local populations are connected in an ecological network, the total area of habitat patches can offer possibilities for persistent populations of species. Species richness and diversity are important components in describing plant community composition, which when combined with species abundance, give a strong indication of habitat quality (Noss, 1990).

Different structural variables can be used as indicators of disturbance regime and/or management practices in forests (Zumeta, 2000; Larsson, 2001) as seen in the result: both blocks have three distinct habitats. The first habitat, which is the mangrove swamp, is at the fringe of banks of rivers, creeks, and brackish water bodies. This is more observed in the BIs blocks due to the high level of anthropogenic activities. This vegetation is poor in species diversity, as only three types, namely: *Rhizophora, Acrostichum* and *Avicenia* species are both common and dominant. However, the fourth type, *Laguncularia* was observed dotting about the *Rhizophora* species. Also *Nypa fruticans* (a palm), and *Paspalum vegination* (a grass) were common place on the mangrove forest threshold. Structurally, *R. racemosa* are tall reaching heights of 20 m and more usually found at the fringes of river banks in undisturbed areas with the density range of 3-4 stands per 10 m^2 in sparsely, and up to 8-10 stands per 10 m^2 in densely vegetated areas. The average diameter at breast height (DBH) is about 20 cm. There are also some short mangrove species, e.g. *R. harrisonii* and *R. mangle* which are less than 10 m tall but of average density of 25 stands per 10 m^2 and DBH of less than 20 cm. The physiognomic feature of possession of stilt roots in the *Rhizophora* allows a firm grip of the rather soft alluvial soil, passage of water and nutrient, and a filter against salt is as unique as in ability to hold its propagule germinating while still attached to the parent tree to develop a radicle before falling into the soft soil below to establish itself. This area, as can be seen from Tables 1 to 4, does not support more species as compared to the BSS (Thomaz *et al*. 2008; Mormul *et al*. 2011).

Another type which was observed in the BSS block is the Freshwater swamp forest. This vegetation type is heterogeneous and rich in species diversity. It is in lowland and highland, with seasonally or permanently flooded forest floor. These attributes ensure a reasonable measure of wildlife diversity, as seen in Table 1-4 (Pierre and Kovalenko, 2014).

The floristic composition and structure show a distinctive profile by the vertical and spatial distribution of tree species. Stratification of canopy covers is evidenced by upper, middle and lower arrangements. In some areas, a simple two-layer profile was recorded. The upper most layers are composed of tall trees with height above 20 m and scattered distribution pattern, resulting in their canopies hardly touching. These emergent species include: *Alstonia boonei, Ceiba petandra, Afzelia africana, Terminalia superba, Sterculia tragecantha*, and so on. The second layer of trees is between 10-20 m but the trees have their crowns touching directly or with the aid of the many associated epiphytic forms, climbers and creepers, such as *Combretum racemosa*, *Griffonia calycine* and *Psycortia sp.* The trees of this layer are *Annona squamosa*, *Gareinia kola*, *Lophira alata*, and *Xylopia ethiopica*.

Floor of this type of forest is usually partially or completely herbs, ferns, grass, and still accommodate few hydrophytes which include *Typha Sp.*, *Pennisetum purpureum*, *Ludwigia decurrens*. A light penetration here is very slight due to undergrowth, dangling tendrils, prop roots and other climbers. The relative humidity, therefore, is generally high. Grass spp. are seldom encountered as that is leafy litter, which is usually wet and decaying. And lastly, there is the area with farmland and tree crop species: so much forestland had been cleared for agricultural purposes. Trees were felled and topsoil removed in some cases. Subsistence farming had taken over most of these lands. Tree crops, such as *Cocos nucifer* (coconut) and cashew are common on the site, whereas plantain and banana of the Musa genus, yam and cocoyam are common tuber plants. Vegetables and cassava are about the most abundant. *Vernonia sp*. and other medicinal herbs are also cultivated on pocket of open lands that pass for farmlands. This type of vegetation often gives rise to the vast areas of bare ground after a couple of farming sessions. The soils of this area are readily drained and lose their nutrients fast. However, palm (oil palm) and coconut estates are known to exist on the island and at the west satellite villages.

4. CONCLUSION

The study presents the animal species in the Bonny Island, specifically for aves, reptiles, amphibians, and mammals in relation to the habitat. All the mammals recorded on the Bonny Island (BIs) are either vulnerable or endangered. Out of the species of mammals only few are on the Island (BIs). The BSS, with minimal disturbance, recorded high species in all the animals studied. There is a general downturn of incidence and distribution of animals in Bonny Areas (BIs & BSS). This is attributed to human activities through the Companies and Industries in the area, as well as uncontrolled harvest of forest products by the community dwellers.

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