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DIVERSITY AND STATUS OF FAUNA SPECIES IN THE ZOOS OF SOUTHWEST NIGERIA

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Abstract
The increasing awareness on biodiversity conservation has given rise to the growing need for ex-situ cultivation and in view of the current global biodiversity crisis with limited economic resources to combat it, zoos are becoming a viable option as complementary conservation strategy. Inventory, species diversity, conservation status, and ecological representation of wild animals in the zoos of Southwest Nigeria were studied and catalogued as "buffer" for in-situ conservation. Data were gathered from nine (9) Zoos across five States through direct field survey. Results were presented with descriptive statistics and diversity indices was calculated using Shannon-Weiner diversity index. A total of 497 individual animals comprising of 74 species belonging to 43 families were observed in all the selected zoos. Among which 47 species are least concerned, Vulnerable (9), Near threatened (2), Endangered (7), Critically endangered (3) and Not evaluated (6). The highest diversity index H of 3.75 was recorded in University of Ibadan zoological garden and Agodi garden (1.56) had the least. Fauna species in the Zoos were representatives across different ecological zones comprising of 42 species from savannah, wetland (15), Rainforest species (12), and 5 dual habitats (forest and savannah). Zoos in the Southwest Nigeria have been effective in conserving biological resources as they present ambassadors of animals in the wild to inspire visitors to care for and understand the natural ecosystems and the threats that these systems face.

Key Words: *Diversity, Fauna, Conservation, Zoo, Nigeria*

Introduction

Recent estimates indicate that humans use more than 40% of the terrestrial components and significantly modified global biodiversity (Debela, 2007). As a consequence, many species of living organisms are classified as threatened today and this has become a central concern for conservation (Frakham *et al*., 2002). Among the two conservation measures in vogue, viz., ex-situ (outside natural habitat) and in-situ (within natural habitat), the first one is the older practice since ancient times. Due to huge hue and cry made by the naturalists and the scientists from various disciplines regarding the climate change accusing the gross outrage over the natural ecosystem

for the last five decades or so, the latter has got prominence and the outcome is the establishment/declaration of different conservation systems (Borokini *et al.*, 2010).

Ex-situ conservation deals with protection of biological diversity components outside their natural habitats (Borokini, 2013). It is the process of protecting an endangered species of plant or animal by removing part of the population from a threatened habitat and placing it in a new location, which may be a wild area or within the care of humans (Anegbeh *et al.*, 2004). It is used as valuable tools in studying and conserving biological resources (plants, animals, and microorganisms) for different purposes (Antofie, 2011) through different techniques such as zoos, captive breeding, aquarium, botanical gardens, and gene banks (Kjaer *et al.,* 2001). Zoo is a common example of ex-situ conservation. They are considered by universal thinkers and environmentalists as important means of conserving biodiversity (Ratledge, 2001 and Melfi, 2012). Zoos breed many endangered species to increase their numbers. Such captive breeding in zoos has helped to save several species from extinction. The role in education and raising awareness, supporting research initiatives and collaborating with in-situ efforts are remarkable (Melfi, 2012). Management of animals in zoos includes animal identification, housing, husbandry, health, nutrition as well as addressing and interaction with the public (Ratledge, 2001).

Despite various efforts from government, cooperate bodies and individual to enhance ex-situ conservation in Nigeria to serve as buffer for in-situ conservation, comprehensive information on the fauna resources under zoo facilities in the country is limited. Therefore, this study seeks to survey fauna diversity of the zoological gardens, whilst seeking specifically to determine the ecological zones the species represent and their conservation status.

Methodology

Study Area

The Southwestern part of Nigeria constitute the major settlements found in Lagos, Osun, Ogun, Oyo, Ondo and Ekiti States (Figure 1). The climate in southwest Nigeria is characterized by both wet and dry seasons and relatively high humidity. The mean annual rainfall is about 1200mm (Olaniran, 2002). The study was conducted in five of the six States in Southwest Nigeria where zoos and wildlife parks are found. Nine out of the eleven zoos representing 82% were selected for the study as shown in Table 1.

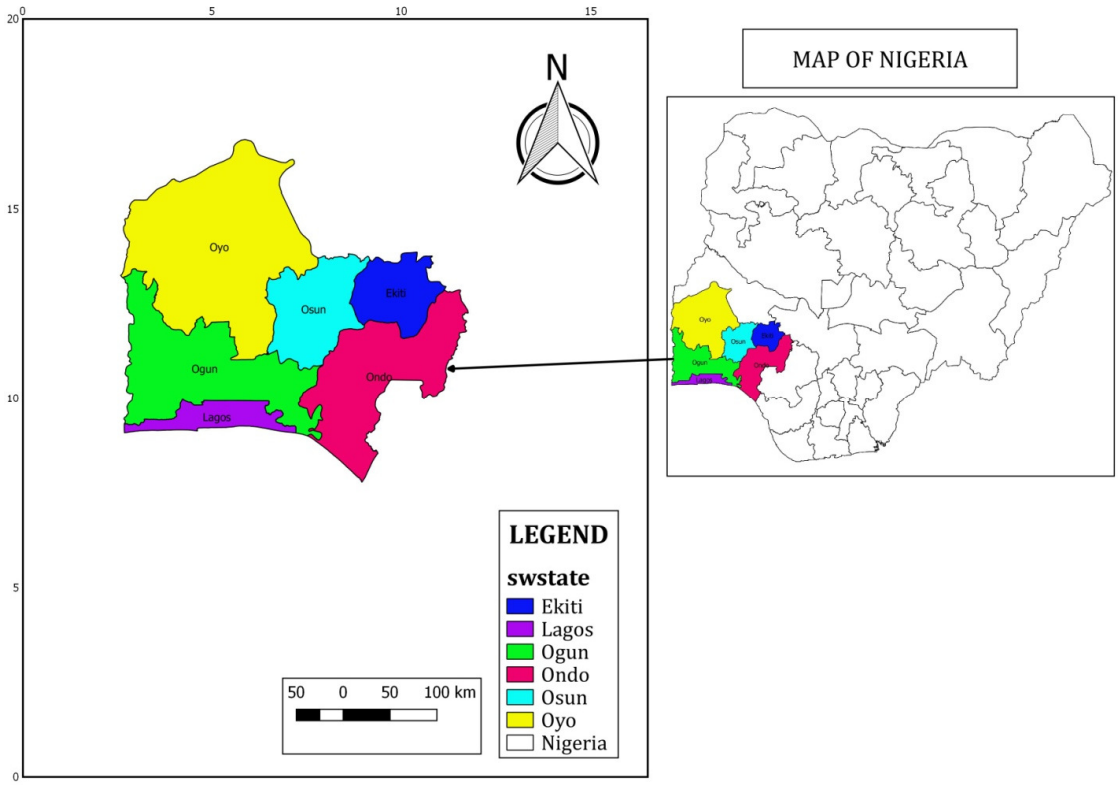


Fig. 1: Map of Nigeria showing south western states

Table 1: Zoological Gardens in Southwest, Nigeria

Southwest States	Number of Zoo Available	Names of Zoos/Wildlife Parks	Locations	Selected Site
Ondo State	2	T.A. Afolayan Wildlife Park, FUTA (FUTA)	Federal University of Technology, Akure	**
		Wesley University Zoological Garden (WESLEY)	Wesley University Ondo	**
Oyo State	2	University of Ibadan Zoological Garden (UI)	University of Ibadan, Ibadan	**
		Agodi Gardens (AGODI)	Agodi GRA, Ibadan	**
Lagos State	4	Origin Zoos and Garden (ORIGIN)	Prince Abiola Kosoko close, Ikorodu	**
		Q Brat Zoo and Garden (QBRAT)	Lagos-Badagry express way, Badagry	**
		Omu Resort (OMU)	Ibeju-Lekki	
		Shodex Garden (SG)	Ikorodu road, ilu peju	
Ogun State	2	Olusegun Obasanjo Presidential Library Wildlife Park (OOPL)	Olusegun Obasanjo Presidential library, Abeokuta	**
		Federal University of Agriculture Abeokuta, Zoo park (FUNAB)	Federal University of Agriculture Abeokuta	**
Osun State	1	Obafemi Awolowo University Zoological Garden (OAU)	Obafemi Awolowo University, ile-ife	**
Ekiti State	NA	NA	NA	

** Selected zoos for the study, NA- Not Available

Method of Data Collection

Direct field observation was employed to conduct an inventory of fauna resources available in the selected zoos. Species characteristics were noted on a data sheet which included species and number of individuals. Wild animal species observed were categorized based on their family, conservation status classification according to International Union for Conservation of Nature IUCN red list data, 2018 and habitat ecology were identified and classified on the basis of Nigeria ecological zones as rainforest, savannah/grassland and wetland.

Data collected were analyzed using Shannon-Weiner diversity index, H: which was used to measure community diversity and species evenness. Species diversity is the number of different species in a particular area (species richness) weighted by some measure of abundance such as number of individuals or biomass (Price, 1997).

The formula for Shannon diversity index is,

$$H = \sum_{i=1}^{s} Pi(InPi)$$

Where,

H = The Shannon diversity index

Pi = fraction of the entire population made up of species *i*, i.e. *pi* is the proportion (*n/N*) of individuals of one particular species found (*n*) divided by the total number of individuals found (*N*)

S = Numbers of species encountered

ln = natural logarithm

Σ = sum from species 1 to species *S*

Margalef's richness index $= \frac{(S-1)}{In(n)}$

Where,

S is the number of taxa, and

n is the number of individuals

Results

Fauna Species Composition of Zoos in Southwest, Nigeria

The University of Ibadan Zoological Garden, Ibadan had the highest number of individuals (142), species (52) and families (13) and Agodi Zoo and Garden, Ibadan had the least, number of individuals (6), species (5) and families (4) as shown in Figure 2. The family Cercopithecidae and Crocodylidae were represented in all the zoos while the families Ciconiidae, Strigidae, Odontophoridae, Rallidae, Falconidae, Trionychidae, Pelomedusidae, Achatinidae, Elipidae, Giraffidae, Suidae, Mustelidae were only recorded in University of Ibadan zoological garden, Leponidae was only recorded in Obafemi Awolowo University zoological garden, family Pelecanidae and Hystricidae were also recorded only in Olusegun Obasanjo Presidential library wildlife park, Ardeidae only in Q brat zoo and garden and family Alligatoridea in Origin zoo and garden. In addition, the conservation status of the species of animals as designated by International Union for Conservation of Nature IUCN red list data, 2018 identified 47 species as least concerned, Vulnerable (9), Near threatened (2), Endangered (7), Critically endangered (3) and Not evaluated(6). University of Ibadan zoological garden had the highest number of species for each of the category while Agodi garden had the least (Table 2).

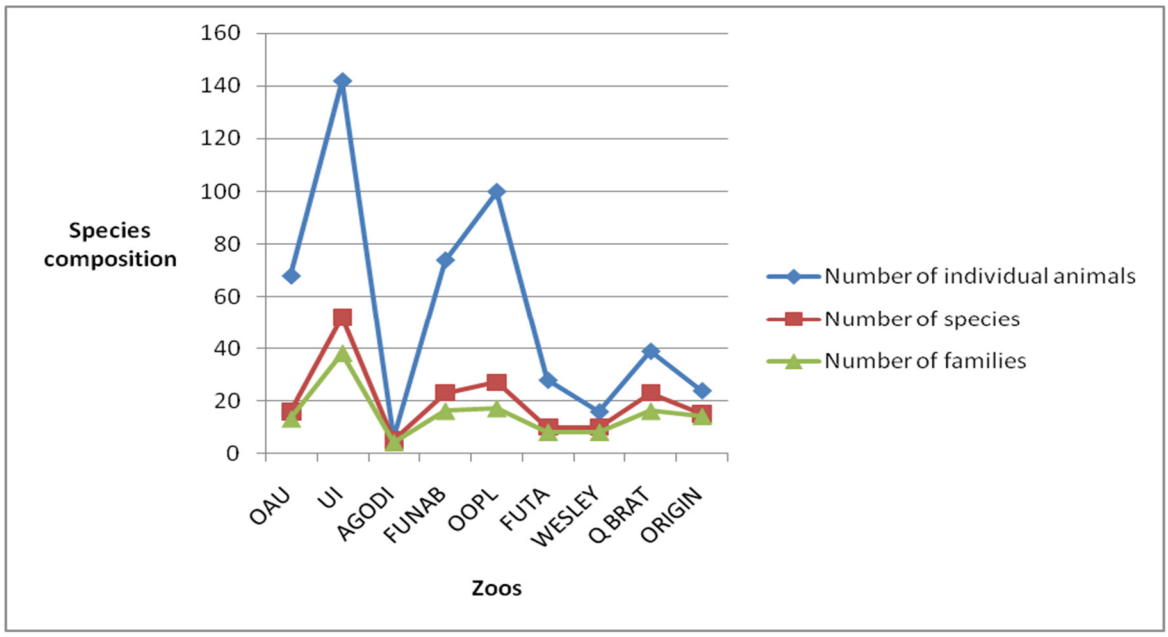


Fig. 2: Species composition of fauna resources in the Zoos of Southwest Nigeria

Table 2: Conservation Status of the Fauna Species in the Zoos of Southwest Nigeria

Family	Species	IUCN Status	UI	AG	OAU	WZ	FU	OZ	QZ	FZ	OPL
	Aves										
Psittacidae	*Psittacus erithacus*	EN	√	√	√	√	√	×	√	√	×
	Numida meleagris	LC	×	×	√	×	×	×	×	×	×
	Poicephalus senegalus	LC	√	×	×	×	×	×	×	×	×
	Ara chloropterus	LC	×	×	×	×	×	×	×	×	√
Ciconiidae	*Leptoptilos crumenifer*	LC	√	×	×	×	×	×	×	×	×
	Ciconia ciconia	LC	√	×	×	×	×	×	×	×	×
Anatidae	*Anser caerulescens*	LC	√	√	×	×	×	√	√	×	×
	Plectropterus gambensis	LC	√	×	×	×	×	×	×	×	√
	Dendrocygna viduata	LC	√	×	×	×	×	×	×	×	√
	Anas platyrhynchos	LC	√	×	×	√	√	×	√	√	√
	Cygnus spp	LC	×	×	×	×	×	×	√	×	×
	Ardea herodias	LC	×	×	×	×	×	×	√	×	×
Strigidae	*Tyto alba*	LC	√	×	×	×	×	×	×	×	×
Accipitridae	*Milvus aegyptius*	LC	√	×	×	×	×	×	×	×	×
	Necrosyrtes monachus	CE	√	×	×	×	×	×	√	×	×
	Milvus migrans	LC	×	×	×	×	×	×	×	√	×
	Haliaeetus leucocephalus	LC	×	×	×	√	×	√	×	×	×
Odontophoridae	*Ptilopachus petrosus*	LC	√	×	×	×	×	×	×	×	×
Psittaculidae	*Melopsittacus undulates*	LC	√	×	×	×	×	×	×	×	×
	Psittacula krameri	LC	×	×	×	×	×	×	×	√	×
Gruidae	*Balearica pavonina*	VL	√	×	√	×	×	×	×	×	×
	Balearica rugulorum	VL	×	×	×	×	√	×	×	√	×
Phasianidae	*Pavo cristatus*	LC	√	×	×	√	√	√	√	×	√

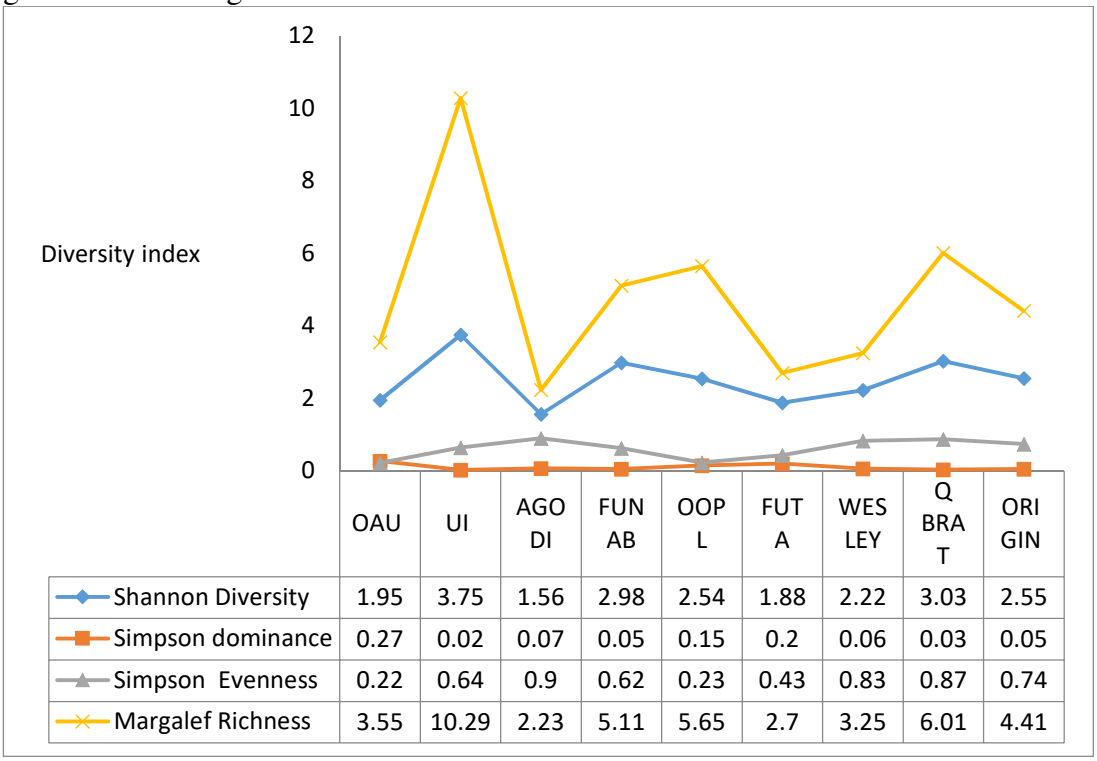
Rallidae	*Porphyrio madagascariensis*	LC	√	×	×	×	×	×	×	×	×
Columbidae	*Columba guinea*	LC	√	×	×	×	×	×	×	×	√
Ardeidae	*Buteo jamaicensis*	LC	×	×	×	×	×	×	√	×	×
Falconidae	*Falco tinnunculus*	LC	√	×	×	×	×	×	×	×	×
Struthionidae	*Struthio camelus*	LC	√	×	√	√	√	√	×	√	√
Casuariidae	*Dromaius novaehollandiae*	LC	√	×	×	×	×	√	×	×	√
	Reptiles										
Trionychidae	*Trionyx triunguis*	VL	√	×	×	×	×	×	×	×	×
Crocodylidae	*Crocodylus niloticus*	LC	√	√	√	√	√	√	√	√	×
	Osteolaemus tetraspis	VL	√	×	×	×	×	×	√	√	√
Cheloniidae	*Chelonia mydas*	EN	×	×	√	×	×	×	√	√	×
Testudinidae	*Centrochelys sulcata*	VL	√	×	√	×	√	√	√	√	√
Pythonidae	*Python sebae*	NE	√	×	×	×	×	√	√	×	√
	Python regius	LC	√	×	√	×	×	×	×	√	×
Varanidae	*Varanus spp*	LC	√	×	×	×	×	×	√	√	√
Viperidae	*Causus rhombeatus*	NE	√	×	×	×	×	×	×	×	×
	Bitis gabonica	NE	√	×	×	×	×	×	×	√	×
Pelomedusidae	*Pelusios castaneus*	LC	√	×	×	×	×	×	×	×	×
Achatinidae	*Achachatina marginata*	NE	√	×	×	×	×	×	×	×	×
Pelecanidae	*Pelecanus erythrorhynchos*	LC	×	×	×	×	×	×	×	×	√
Elipidae	*Naja spp*	NE	√	×	×	×	×	×	×	×	×
Alligatoridae	*Alligator spp*	EN	×	×	×	×	×	√	×	×	×
	Primates										
Cercopithecidae	*Chlorocebus sabaecus*	LC	√	×	×	×	×	×	√	√	×
	Erythrocebus patas	LC	√	√	√	×	×	√	×	√	√
	Chlorocebus tantalus	LC	×	√	×	√	×	×	×	×	√
	Cercopithecus nictitans	LC	×	×	×	×	×	×	×	√	×
	Cercopithecus erythrogaster	VL	√	×	×	×	×	×	×	×	×
	Cercopithecus mona	LC	√	×	√	√	√	×	√	√	×
	Cerocebus torquatus	EN	√	×	×	×	√	×	×	√	×
	Mandrillus leucophaeus	EN	√	×	×	×	×	×	×	×	×
	Papio Anubis	LC	√	×	√	√	√	√	√	√	√
Hominidae	*Pan troglodytes*	EN	√	×	×	×	×	√	×	×	×
	Ungulates										
Giraffidae	*Giraffa camelopardalis*	VL	√	×	×	×	×	×	×	×	×
Suidae	*Phacochoerus africanus*	LC	√	×	×	×	×	×	×	×	×
	Potamochoerus porcus	LC	√	×	×	×	×	×	×	×	×
Bovidae	*Gazella dorcas*	VL	√	×	×	×	×	×	×	×	×
	Philantomba monticola	LC	×	×	×	×	×	×	×	×	√
Equidae	*Equus ferus*	EN	√	×	×	×	×	×	√	×	√
	Equus africanus	CE	√	×	×	×	×	×	√	×	√
	Equus asinus	CE	×	×	×	×	×	×	×	√	×
Camelidae	*Camelus ferus*	CE	√	×	×	×	×	×	√	×	×
	Carnivores										
Viverridae	*Civettictis civetta*	LC	√	×	×	√	×	×	×	√	×

	Nandinia binotata	LC	×	×	×	×	×	×	×	×	√
Mustelidae	*Mellivora capensis*	LC	√	×	×	×	×	×	×	×	×
Felidae	*Panthera leo*	VL	√	×	√	×	×	√	×	×	√
	Caracal caracal	LC	×	×	×	×	×	×	×	×	√
Hyaenidae	*Crocuta crocuta*	LC	√	×	√	×	×	√	√	×	√
	Hyaena hyaena	NT	×	×	×	×	×	×	×	×	√
Canidae	*Canis auceus*	LC	√	×	×	×	×	×	√	×	×
	Rodents										
Leporidae	*Oryctolagus cuniculus*	NT	×	×	√	×	×	×	×	×	×
Erethizontidae	*Erethizon dorsaum*	LC	×	×	√	×	×	√	√	√	×
Hystricidae	*Hystrix cristata*	LC	×	×	×	×	×	×	×	×	√
Caviidae	*Cavia porcellus*	NE	×	×	√	×	×	×	×	×	√

Present - √, Absent – x, Critically Endangered (CE), Engangered (EN), Near Threatened (NT), Vulnerable (VL), Least Concern (LC) Not Evaluated (NE)

Diversity Indices

The University of Ibadan zoological garden had the highest value of Shannon Werner Diversity Index (3.75) and Marglef Richness (10.29) with the least value of Simpson Dominance (0.02), Obafemi Awolowo university biological garden had the highest Dominance values (0.27) and the least value of Evenness (0.22) while, Agodi garden had the highest value of Evenness (0.90) and the least value of Shannon Werner Diversity (1.56) and Qbrat zoo and garden had the highest values of Simpson Evenness (0.87) as presented in Figure 3.



	OAU	UI	AGODI	FUNAB	OOPL	FUTA	WESLEY	QBRAT	ORIGIN
Shannon Diversity	1.95	3.75	1.56	2.98	2.54	1.88	2.22	3.03	2.55
Simpson dominance	0.27	0.02	0.07	0.05	0.15	0.2	0.06	0.03	0.05
Simpson Evenness	0.22	0.64	0.9	0.62	0.23	0.43	0.83	0.87	0.74
Margalef Richness	3.55	10.29	2.23	5.11	5.65	2.7	3.25	6.01	4.41

Fig. 3: Diversity Indices of Selected Zoos in Southwest Nigeria

Ecological Representation of Fauna Resources in the Zoos of Southwest Nigeria

The habitat ecology of species identified show that 42 species were from savannah ecosystem, 15 species were from wetland which include marine, freshwater and in-land water, Rainforests or forest habitat species (12), dual environment were 5 species which include both forest and savannah.

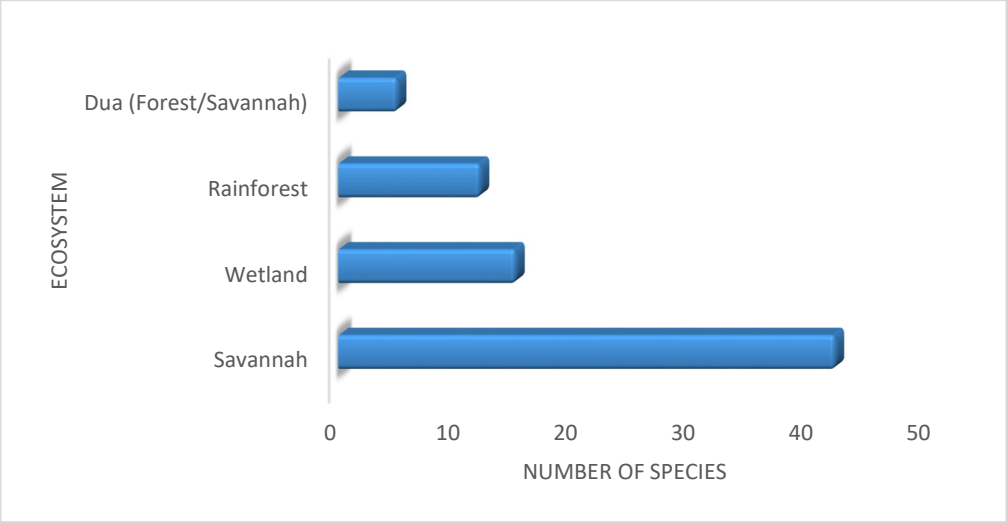


Fig. 4: Habitat ecology of species in all the selected zoos in Southwest Nigeria

Discussion

The concept of ex-situ conservation in Zoo is fundamentally different from that of in-situ conservation; nevertheless, both are important complementary methods for conservation of biodiversity (Borokini *et al*., 2010). This study enumerated the various fauna species found in the zoos of Southwest Nigeria and the results on the diverse wild animal species further re-emphasized the assertion of Shepherdson et al. (1998) that zoo must be reservoirs of rare wildlife and of parkland support in order to fulfil their conservation potentials. The family Cercopithecidae represented by Mona monkey (*Cercopithecus mona*) and Baboon (*Papio anubis*) and Crocodylidae as Nile crocodile (*Crocodylus niloticus*) appeared in all the Zoos, which agreed with the findings of Yager *et al*. (2017) in their study of fauna species diversity of Makurdi Zoological Garden, Benue State, Nigeria which reported that Mammalian class was dominated with the family Cercopithecidae and the reptilian with family Crocodylidae this could be attributed to the conservation status of most of the identified species of these families as least concerned.

As opined by Wagner (1995) that prevention of further species extinction requires that many zoos and aquaria become the last potential refuge for species at risk. Findings from this study corroborate this accretion as wildlife species categorized as vulnerable were 9, near threatened (2), endangered (7) and 3 critically endangered species found refuge in the Zoos of Southwest Nigeria among which are Chimpanzee (*Pan troglodytes*), Drill Monkey (*Mandrillus leucophaeus*), African Grey Parrot (*Psittacus erithacus*), Crown crane (*Balearica rugulorum*),

Dorcas Gazelle (*Gazella dorcas*), Lion (*Panthera leo*). This is also consistent with Ofuya *et al*. (2016) who identified 57 species of animals in U.I Zoo of which 18.75% were vulnerable, 4.17% as threatened and 8.33% as endangered while Adetola and Tunde-Ajayi (2015) identified 6% as near threatened and 25% as vulnerable species out of the 16 fauna species identified in OAU Zoo.

Typical Shannon index values are generally between 1.5 and 3.5 in most ecological studies, and the index is rarely greater than 4 (Magurran, 2004). The Shannon index increases as both the richness and the evenness of the community increase. All the selected zoological gardens have high species diversity as Shannon index is greater than 1.5, this is an indication of the richness in fauna species in the zoos, this agrees with the findings of Olaniyi *et al*. (2015) at the T. A. Afolayan Wildlife Park, Ondo State, Nigeria which shows Shannon index for fauna resources as 2.28.

The ever increasing population in Nigeria may mean that more people will encroach on the few remaining natural ecosystems for wild animals. These larger populations are concentrated in the forested areas of the south and the large urban centres of the far north (Idowu and Morenikeji, 2015), this could be a contributing factor to low number of rainforest/forest species recorded under ex-situ conservation in the zoo and also, majority of endangered species are rainforest species or inhabit both rainforest and savannah ecosystem. Representative species catalogue the distribution of the zoo animals which serves as ambassador for species from different ecological zones in Nigeria.

Conclusion

The study has shown the high diversity of fauna resources under ex-situ conservation in selected zoological gardens in Southwest, Nigeria which comprises of four hundred and ninety-seven individual animals of seventy-four species belonging to 43 families, with majority of the species found in both forest and savannah environment. These Zoos stand a good chance for the conservation of a considerable part of the nation's biodiversity for captive breeding, education and raising awareness, supporting research initiatives and collaborating with in-situ conservation efforts. More research should be carried out on the other parts of the country to provide a comprehensive checklist and documentation of a reliable database of fauna species under *ex-situ* conservation in Nigeria.

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