SEASONAL DYNAMICS IN THE DIVERSITY AND ABUNDANCE OF AVIFAUNA IN AGROECOLOGICAL LANDSCAPES IN NWIKPEBA, RIVERS STATE, NIGERIA

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ABSTRACT

Agricultural intensification as a result of population pressure in tropical ecosystems is a prevailing cause of deforestation and habitat loss for wildlife species. There is a dearth of information on birds of the agroecosystems in the Niger delta region of Nigeria. This study seeks to explore relevant data to close the gap required to design conservation programs for birds whose survival is based on the rapidly changing agroecosystems. This study therefore aims at assessing the seasonal dynamics in diversity, abundance and distribution of avifauna in agroecological landscapes in Nwikpeba, Khana Local Government Area of Rivers State, Nigeria. An ecological survey was carried out in the study location to determine the diversity, abundance and distribution of avifauna in selected farm sites. Twelve (12) farm sites consisting of four (4) monocrop cassava, four (4) monocrop yam and four (4) mixed farms (cassava, corn and vegetables; corn, vegetables and yam; cassava, corn and okro; and cassava, okro and vegetables). Point count method was used bi-weekly for a period of 12months to monitor bird populations. Microsoft Office Excel and PAST software were used for data analysis. A total of 61 species belonging to 28 families were recorded. At the monofarms, a total of 777 and 1089 individuals belonging to 18 families were recorded during the wet and dry seasons, respectively - 32species were recorded in the wet season while 38species were recorded in the dry season. At the mixed farms, 1108 and 1688 individuals belonging to 28 families were recorded during the wet and dry seasons, respectively- 49 species were recorded in the wet season and 61species recorded in the dry season. The family Accipitridae had the highest number of bird species, 10 in number, followed by the Nectariniidae family with 8 species. Two species of conservation importance; *Necrosyrtes monachus* and *Psittacus erithacus* which are critically endangered were also recorded during the survey. This study suggests that agroecological landscapes could be of high conservation value for bird species considering the diverse habitats; edges, shrubs, patches, trees which are good sites for roosting, nesting and foraging. Proper farmland management practices could be adopted to further protect and conserve the bird species. More studies on the avian interactions in agroecological landscapes need to be carried out frequently.

Keywords: Agroecosystems, avifauna, conservation, farmland management, habitat

INTRODUCTION

Birds are well regarded in various cultures and lifestyles; symbols of National pride, motivation and status across Africa. They are the subjects of many proverbs, riddles, stories and songs. Tribal groups use colourful and extravagant plumes to decorate themselves (Collar *et al*.,2007; Whelan *et al*.,2008; Alawa *et al*., 2018). They are also used as ornaments for some titled men in Nigerian cultural settings; typical among the Ijaws of the Niger Delta Region in Nigeria, the Igbos of South Eastern Nigeria and Ibibio/ Efik in Akwa Ibom State, Nigeria (Alawa *et al*., 2018). The Zulus (South Africa) once wore turaco feathers as headdresses. The King of Swaziland and traditional Maasai men in Kenya still wear feathers. In Cameroon, a porcupine quill and red flight feather from Bannerman's Turaco *Tauraco bannermani* in a man's black hat indicate his position as a traditional council member (Collar *et al*., 2007; Whelan *et al*., 2008).

There is a special relationship between birds and many local communities in Sub-Saharan Africa. Example, the Greater Honey guide indicator leads local people to active beehives. After successful harvesting of honey, a piece of the honeycomb is left as a reward for the bird (Collar *et al*.,2007; Whelan *et al*.,2008). Large flocks of Black Kite *Milvus migrans* and Abdim's Stork *Ciconia abdimii* are used by farmers to predict the onset of dry and rainy seasons, respectively. These two species also predate on large numbers of locusts during outbreaks in the Sahel, thus contributing to pest control. The Pied crow alerts natives who go out to pick periwinkles in the mangroves of the Niger delta of on-coming rain (Collar *et al*.,2007; Whelan *et al*.,2008; Alawa *et al*., 2018).

The value of birds ranges from scientific, ecological, economic and cultural (Diamond, 1987); chicken, guinea fowl, pigeons and their eggs provide protein security. Birds like sunbirds help to pollinate flowers as they pass from one to another seeking nectar in the same way as bees carry out pollination. This enables man's vegetative food supply to flourish (Nabhan and Buchann, 1997; Narang *et al.*, 2000). Birds contribute to ecosystem services through their foraging behaviour (Whelan *et al*., 2008). Some birds visit plants for their fruits thus serving as dispersers of such plant seeds (Krebs, 2001); the seeds of the umbrella tree *Musanga cecropioides* pass through the gut of a bird before it is dispersed. Birds as agents of dispersal of these plant species may convey the seeds of these plants to degraded areas. This contributes to the restoration of forest patches particularly in human modified landscapes (Mayfield *et al*. 2006). The droppings of some species of birds mainly seabirds serve as a source of fertilizer for farmers as the droppings popularly called 'guano' are rich in sulphate and phosphate (Croll *et al.*, 2005).

These rich and abundant ecosystem services by birds are currently under threat by agricultural practices (Krebs *et al*., 1999; Foley *et al*., 2005; Blamford *et al*., 2012). According to Myers (1986), the loss of the tropical ecosystem is particularly disturbing because it houses over half of the world's species. These losses have been linked to agricultural encroachment and unsustainable forestry practices (Blockhus *et al*., 1992). In Nigeria and other African countries, many avian studies have concentrated on non-agricultural landscapes (Ash, 1991; Elgood *et al.*, 1994; Ezealor, 2001 and 2002; Manu *et al.*, 2005, Manu *et al*.2007, Manu *et al.*, 2010; Evidence from many studies in Africa and temperate regions show that low intensity agriculture (small farms with diverse annual crops, orchards and small woodlots) increases abundance of forest birds during winter (Elsen *et al*., 2017). If correctly managed, agricultural lands can play an important role in biodiversity conservation in tropical forest–agricultural ecosystems (Rodrigues *et al*., 2013). Given the current trend in land use dynamics, relying solely on protected areas to protect biodiversity is insufficient (Siebert, 2002). Diverse agricultural areas have been shown to have the capacity to support biological variety in studies, and their integration into conservation plans is emphasized (Schroth, 2004; Perfecto & Vandermeer, 2008). There is a dearth of information on birds of the agroecosystems in this part of Nigeria (Niger delta region) that has a combination of both land and water. This study therefore aims at assessing the seasonal dynamics in diversity, abundance and distribution of avifauna in agroecological landscape in Nwikpeba, Rivers State. This study seeks to explore relevant data to close the gap required to design conservation programs for birds whose survival is based on the rapidly changing agroecosystems.

MATERIALS AND METHODS

STUDY AREA

This study was carried out in Nwikpeba (Fig. 1), Kono located betwee and 007.29º-007.30ºE; an Ogoni community situated in Khana Local Government Area in Rivers State. Ogoni is a region covering some 1,000 km^2 in the South-east of the Niger Delta basin. It has a population of close to 832,000, according to the 2006 National Census, consisting mainly of the Ogoni people. The Ogonis are a distinct people who have lived in the Niger Delta for hundreds of years. They live in close-knit rural communities; they are also predominantly farmers and fishermen (UNEP, 2011; National Bureau of Statistics, 2006; Saro-Wiwa, 1995; UNPO, 2009; and World Bank, 2010)

Kono is a village situated on the coast in the eastern flank of Khana Local Government Area, about 45 miles (72.4 km^2) from Port Harcourt. Commonly cultivated crops include Cassava *Manihot esculenta*, yam *Discorea sp*, Maize *Zea mays*, Cucumber *Cucumis sativus*, fluted pumpkin *Telfairia occidentalis*, okra *Abelmoschus esculentus*, pepper *Capsicum sp*, groundnut *Arachis hypogaea*, garden egg *Solannum melongenia* and melon *Cucumeropsis mannii*. Among the homestead trees and crops in the area are; African bush mango *Irvingia gabonensis*, African oil palm *Elaies guineensis*, banana *Musa sapientum*, plantain *Musa paradisiaca*, coconut *Cocos nucifera*, mango *Mangifera indica*, orange *Citrus sinensis*, pineapple *Ananas comosus*, soursop *Annona muricata*, white star apple *Chrysophyllum albidum* and native pear *Dacryodes edulis*, most of which attract birds. By low tide, carnivorous and sea bird go to pick food on the intertidal zone of the Kono waterside. Among the food hunted are; polychaete worms, molluscs, crabs, prawn/shrimps, dead fish amongst others.

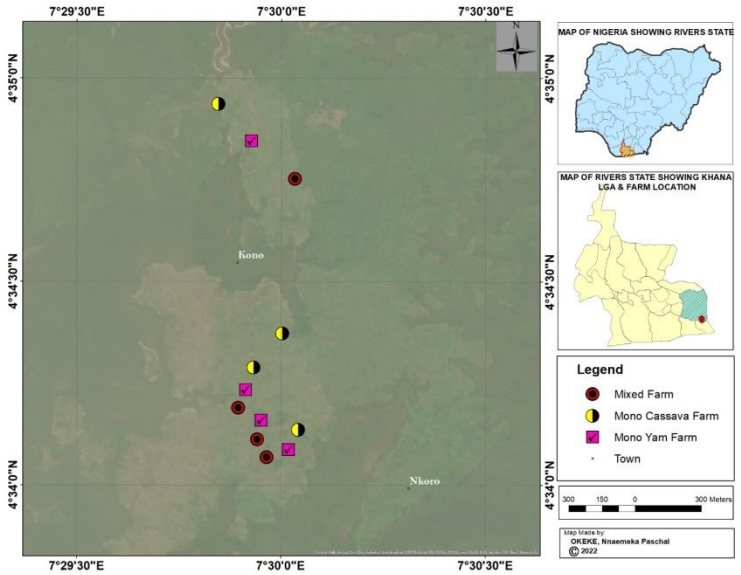

Fig 1: Map of Study Area

SURVEY DESIGN

This Ornithological field survey was conducted from April 2020 to March 2021, in twelve selected farmlands; monofarms and mixed farms at Nwikpeba, Kono, Rivers State for a period of 12 months. "Point count method was used to monitor the density, diversity and relative abundance of bird species in different habitats (Blake 1992; Purcell & Verner, 1999). This method involves the visual and auditory detection of birds within fixed or variable radius plots and provides information on species abundance (Codesido & Bilenca, 2012). However, the detections of birds varied depending on foliage density, canopy cover, visibility and perception of sounds and the observer's skill (Blake & Loiselle, 2001). The geocoordinates of locations were recorded using a handheld GPS (Garmin etrex10, Heather and Robertson 2000). The bi-weekly 1-day surveys were conducted with three (3) well trained observers in each site for 4 hours after sunrise (Leveau *et al*., 2015).

Bird species were counted in 25m fixed-radius plots; a short radius minimizes the probability that the same bird is counted twice on successive points (Jimenez, 2000, Vergara unpubl data). At each point, bird movement observed by sight or sound were recorded within an interval of 10minutes (Sutherland, 2000). Counts were made during the wet and dry season in the different farm types. All identification was accomplished using the various bird identification

guides (Borrow and Demey, 2014). A pair of high-powered binoculars (Eyeskey10x42) and Canon camera was used for photographic documentation when the opportunities arose.
In each trip and each station bird count was conducted at sunrise because this is the time when birds vocalize most known as "dawn chorus". It is also a time of maximum bird movement.

Data Analysis

Avian species diversity was calculated using the Simpson index (1-D), Shannon Weiner index (H′), abundance was deduced as relative abundance, evenness. Species richness (S) were counts of species number.

Calculation of Relative abundance

$$Species\ Relative\ Abundance = \frac{\text{Species abundance X 100}}{\text{Total abundance}} \quad \ldots (i)$$

Calculation of Shannon Weiner index (H′) (Shannon and Weaver, 1949) $H' = -\sum pi\ ln(pi)$ ……..……(ii)

Pi = $\frac{\text{Number of individuals of ith species}}{Total\ abundance\ of\ species}$

ln = natural log

Calculation of Simpson Index (1-D)

$$D = 1 - \frac{\sum(\boldsymbol{n}-\mathbf{1})}{\boldsymbol{N}(\boldsymbol{N}-\mathbf{1})} \quad \ldots\ldots(iii)$$

D = Dominance index

N = total number of entities in the dataset

Evenness Index (E) refers to how close in numbers each species is in an environment. It describes the level of uniformity in the population sizes of different species in a biotic community is and calculated as:

$$\frac{H}{Hmax} \quad \ldots\ldots (iv)$$

E = Evenness index

H′ = Shannon Weiner index

Hmax = the highest value of Shannon Weiner index

RESULTS

Species diversity: At the monofarms, a total of 777 and 1089 individuals were recorded during the wet and dry seasons, respectively; belonging to 18 families- 32species recorded in the wet season while 38species were recorded in the dry season. At the mixed farms, 1108 and 1688 were recorded during the wet and dry seasons respectively; belonging to 28 families- 49 species recorded in the wet season and 61 species recorded in the dry season. The family Accipitridae had the highest number of bird species; 10 in number, followed by the Nectariniidae family with 8 species as shown in Table 1. The dominant species across all farms in both seasons were the Estrildid finches, followed by the pied crow and village weaver bird. The least occurring species in the mixed farms during the wet season were the bat hawk, yellow-throated long claw, superb sunbird and pin-tailed whydah; for the monofarms it was the blue-breasted kingfisher, hooded vulture and pin-tailed whydah. The least occurring species in the mixed farms during the dry season was the African fish eagle, diederik cuckoo and common kestrel while the monofarms had the woodland kingfisher and the African green pigeon as the least occurring species for the dry season (Figs 2&3). Five Palearctic visitors namely: *Milvus migrans, Falco tinnunculus, Actitis hypoleucos, Sterna hirundo and Hirundo rustica* were recorded, two Intra-African migrants- *Merops albicollis* and Milvus *migrans parasitus* were recorded and two species of conservation importance (critically endangered)- *Necrosyrtes monachus* and *Psittacus erithacus* were also recorded during this survey (Table 1). Figs 4&5 show the rank abundance distribution of the species in the wet and dry season respectively. *Lonchura bicolor, Lonhura cucullata and Streptopelia senegalensis* had the highest rank respectively during the wet season while *Cinnyris superbus, Vidua macroura and Ploceus nigerrimus* were the least ranking species. The dry season had *Lonchura bicolor, Streptopelia senegalensis* and *Lonhura cucullata* as the highest occurring species respectively during the dry season while *Ceryle rudis, Vidua macroura and Ploceus nigerrimus* were the least ranking species.

Table 3 details the diversity indices of the two farm types in both the wet and dry seasons. The mixed farms had the highest Shannon-wiener index; 3.48 during the wet season and 3.20 during the dry season. Also, a higher Species richness index of 8.07 during

the dry season (mixed farm) and 6.85(mixed farm) in the wet season.

The monofarms had Shannon-wiener values of 3.07 during the wet season and 2.01 for the dry season; Species richness index of 5.29 (dry season) and 4.70 (wet season).

DISCUSSION

The study has shown a rich diversity of birds within the area of interest which falls in the Niger Delta rainforest zone. The inventory of a total of sixty-one (61) species belonging to twenty-eight (28) families is approximately nineteen percent (19%) of the total number 320 species observed by Elgood (1994), for the Niger Delta area. The study is also approximately 66% of the total birds observed by Ezealor, 2001 who recorded about 92 and 94 species (respectively) after a survey of Upper Orashi and Biseni forests in Rivers State. The records by Alawa in 2018 of 38 species within three local government areas of Obio-Akpor, Phalga and Ikwerre is at variance with the numbers recorded in this study. This might be as a result of the non- contiguity between the local government areas and Khana LGA from where the current study observations were made. However, the results from this study agrees closely with the records by Efenakpo *et al.,* 2019 who documented 36 bird species belonging to 20 families at Choba community and Bunza *et al.*,2021; 93 species belonging to 35 families at Bonny, all in Rivers State, Nigeria.

The family Accipitridae comprising of Raptors had the highest species occurring in both seasons, the result is in conformity with the findings of Okosodo *et al*., (2016) who reported Accipitridae as the richest family in his studies conducted at South Western Nigeria. Grande *et al*., 2018 reports prey diversity and habitat heterogeneity among other factors as important determinants in the distribution, status, and diversity of raptors in an ecosystem. This study recorded a high number of the raptor species occurring at the onset of farming when the land was been cleared and also after harvest due to the availability of varieties of food sources; insects, lizards, rodents, squirrel and others. The presence of trees which are good nesting and roosting sites for the raptors and habitat heterogeneity surrounding the farms were favorable for the species. The presence of the raptors served as a biological control to crop pests like rodents, squirrels and other small vertebrates that were seen to dig up and eat the cassava and yam tubers. Having a reasonable number of raptors recorded in these sites indicate a favorable environment for them to thrive. According to the IUCN Red List for birds 2022, two critically endangered species (*Necrosyrtes monachus* and *Psittacus erithacus*); a raptor and parrot respectively were recorded.

The families of Estrildidae and Columbidae are represented by the abundance of finches (*Lonchura bicolor, Lonchura cucullata* and *Estrilda melpoda*) and doves (*Streptopelia senegalensis*) as the most abundant in number of individuals. Estrildid finches are known seed eaters, feeding on seeds, which helps to reduce or control weed on farms (Adang *et al*., 2018). The rank abundance distribution within these two families showed that during the wet season *Lonchura bicolor, Lonhura cucullata* and *Streptopelia senegalensis* were the highest occurring species while *Cinnyris superbus, Vidua macroura* and *Ploceus nigerrimus* were the least ranking species. In contrast during the dry season *Lonchura bicolor, Streptopelia senegalensis* and *Lonhura cucullata* were the highest occurring species while *Ceryle rudis, Vidua macroura* and *Ploceus nigerrimus* were the least ranking species.

Another group of birds that were abundant are the weaverbirds belonging to the family Ploceidae. These are represented by three (3) species namely; *P. cucullatus, P. nigricollis* and *P. nigrrimus*. As one of the resident species, their highest abundance is associated with the periods during the year when maize is harvested. Additionally, many other birds are associated with this period of harvest because of the abundance of insects namely; African thrush (*Turdus pelios*), Tit hylia (*Pholidornis rushiae)*, Common bulbul (*Pycnonotus barbatus*), Laughing dove *(S. senegalensis*) and Red-eyed dove *(S. semitorquata*), Common sandpiper *(Actitis hypoleucos)*, Plain-backed pipit *(Anthus leucophyrs*), Senegal coucal *(Centropus senegalensis*), Yellow-throated longclaw (*Macronyx croceus*).

Table 1: Checklist of Avifauna recorded along with their conservation and migratory status

Family name	Scientific name	Common name	Conservation status	Migratory status
Accipitridae	*Milvus migrans*	Black kite	Least Concern	Palearctic visitor
	Milvus migrans parasitus	Yellow-billed kite	Least Concern	Intra-African migrant
	Accipiter tachiro	African goshawk	Least Concern	Resident
	Kaupifalco monogrammicus	Lizard buzzard	Least Concern	Resident
	Necrosyrtes monachus	Hooded vulture	Critically endangered	Resident
	Macheiramphus alcinus	Bat hawk	Least Concern	Resident
	Gypohierax angolensis	Palmnut vulture	Least Concern	Resident
	Polyboroides typus	African harrier hawk	Least Concern	Resident
	Haliaeetus vocifer	African fish eagle	Least Concern	Resident
	Elanus caeruleus	Black shouldered kite	Least Concern	Resident
Columbidae	*Treron calva*	African green pigeon	Least Concern	Resident
	Streptopelia semitorquata	Red-eyed dove	Least Concern	Resident
	Streptopelia senegalensis	Laughing dove	Least Concern	Resident
Scopidae	*Scopus umbrette*	Hamerkop	Least Concern	Resident
Falconidae	*Falco tinnunculus*	Common kestrel	Least Concern	Palearctic visitor
Numididae	*Guttera edouardi*	Crested guineafowl	Least Concern	Resident
Scolopacidae	*Actitis hypoleucos*	Common sandpiper	Least Concern	Palearctic visitor
Laridae	*Sterna hirundo*	Common tern	Least Concern	Palearctic visitor
Psittacidae	*Psittacus erithacus*	African grey parrot	Critically endangered	Resident
Psittaculidae	*Psittacula krameri*	Rose-ringed parakeet	Least Concern	Resident
Alcedinidae	*Halcyon malimbica*	Blue-breasted Kingfisher	Least Concern	Resident
	Halcyon senegalensis	Woodland Kingfisher	Least Concern	Resident
	Ceryle rudis	Pied kingfisher	Least Concern	Resident

	Corythornis cristatus	Malachite kingfisher	Least Concern	Resident
Coraciidae	*Eurystomus glaucurus*	Broad-billed roller	Least Concern	Resident
Meropidae	*Merops albicollis*	White-throated Bee-eater	Least Concern	Intra-African migrant
Bucerotidae	*Tockus fasciatus*	African Pied hornbill	Least Concern	Resident
Hirundinidae	*Hirundo nigrita*	White-throated blue swallow	Least Concern	Resident
	Hirundo rustica	Barn swallow	Least Concern	Palearctic visitor
Motacillidae	*Macronyx croceus*	Yellow-throated longclaw	Least Concern	Resident
	Anthus leucophyrs	Plain-backed pipit	Least Concern	Resident
Pycnonotidae	*Pycnonotus barbatus*	Common bulbul	Least Concern	Resident
	Andropadus virens	Little Greenbul	Least Concern	Resident
Turdidae	*Turdus pelios*	African thrush	Least Concern	Resident
Remizidae	*Pholidornis rushiae*	Tit hylia	Least Concern	Resident
Sylviidae	*Camaroptera brachyura*	Grey-backed Camaroptera	Least Concern	Resident
	Hylia prasina	Green Hylia	Least Concern	Resident
Nectariniidae	*Anthreptes seimundi*	Little Green Sunbird	Least Concern	Resident
	Chalcomitra fulginosa	Carmelite Sunbird	Least Concern	Resident
	Cinnyris cupreus	Copper sunbird	Least Concern	Resident
	Cinnyris chloropygius	Olive-bellied sunbird	Least Concern	Resident
	Chalcomitra adelberti	Buff-throated sunbird	Least Concern	Resident
	Anthreptes rectirostris	Green sunbird	Least Concern	Resident
	Cinnyris superbus	Superb sunbird	Least Concern	Resident
	Cyanomitra cyanolaema	Blue-throated brown sunbird	Least Concern	Resident
Sturnidae	*Lamprotornis splendidus*	Splendid Glossy Starling	Least Concern	Resident
Ploceidae	*Ploceus nigricollis*	Black-necked Weaver	Least Concern	Resident
	Ploceus nigerrimus	Vieillot's Black Weaver	Least Concern	Resident
	Ploceus cucullatus	Village Weaver	Least Concern	Resident

	Malimbus rubricollis	Red-headed Malimbe	Least Concern	Resident
Estrildidae	*Lonchura bicolor*	Black-and-white Mannikin	Least Concern	Resident
	Lonchura cucullata	Bronze mannikin	Least Concern	Resident
	Lagonosticta rufopicta	Bar-breasted firefinch	Least Concern	Resident
	Estrilda melpoda	Orange-cheeked waxbill	Least Concern	Resident
Viduidae	*Vidua macroura*	Pin-tailed whydah	Least Concern	Resident
Passeridae	*Passer griseus*	Northern grey-headed sparrow	Least Concern	Resident
Corvidae	*Corvus albus*	Pied crow	Least Concern	Resident
Apodidae	*Apus affinis*	Little swift	Least Concern	Resident
	Cypsiurus parvus	African Palm Swift	Least Concern	Resident
Cuculidae	*Centropus senegalensis*	Senegal Coucal	Least Concern	Resident
	Chrysococcyx caprius	Diederik Cuckoo	Least Concern	Resident

Table 2: Relative abundance of birds in each farm type for each season

Species name	Monofarm		Mixed farm	
	Dry season	Wet season	Dry season	Wet season
Black kite	10	0	18	0
Yellow-billed kite	26	21	56	33
African goshawk	0	8	39	15
Lizard buzzard	11	7	18	13
Hooded vulture	5	1	29	20
Bat hawk	3	0	5	2
Palmnut vulture	6	3	5	3
African harrier hawk	7	2	7	4
African fish eagle	0	0	1	0
Black shouldered kite	8	7	31	20
African green pigeon	2	0	12	4
Red-eyed dove	38	22	54	42
Laughing dove	36	30	66	52
Hamerkop	0	0	7	3
Common kestrel	0	0	2	0
Crested guineafowl	40	32	52	70
Common sandpiper	0	0	36	0
Common tern	0	0	10	0
African grey parrot	0	0	14	10
Rose-ringed parakeet	30	0	34	0
Blue-breasted Kingfisher	6	1	16	11
Woodland Kingfisher	2	3	7	3
Pied kingfisher	1	0	12	9
Malachite kingfisher	0	0	8	7
Broad-billed roller	0	0	28	22
White-throated Bee-eater	22	0	48	0
African Pied hornbill	10	5	22	20
White-throated blue swallow	0	0	28	22
Barn swallow	0	0	22	0
Yellow-throated longclaw	0	0	8	2
Plain-backed pipit	0	0	14	19
Common bulbul	32	40	38	35
Little Greenbul	12	8	28	20
African thrush	24	16	32	26
Tit hylia	0	0	16	9
Grey-backed Camaroptera	0	0	12	3

Green Hylia	0	0	21	12
Little Green Sunbird	0	0	16	10
Carmelite Sunbird	29	9	23	15
Copper sunbird	21	7	16	12
Olive-bellied sunbird	19	5	11	13
Buff-throated sunbird	10	18	16	12
Green sunbird	0	0	3	0
Superb sunbird	0	0	6	1
Blue-throated brown sunbird	0	0	11	7
Splendid Glossy Starling	22	25	28	19
Black-necked Weaver	38	39	45	32
Vieillot's Black Weaver	0	0	3	0
Village Weaver	70	57	63	50
Red-headed Malimbe	0	0	14	8
Black-and-white Mannikin	103	96	124	88
Bronze mannikin	119	100	128	91
Bar-breasted firefinch	6	0	6	0
Orange-cheeked waxbill	78	66	58	84
Pin-tailed whydah	2	6	1	3
Northern grey-headed sparrow	54	36	33	20
Pied crow	75	58	45	61
Little swift	51	25	69	51
African Palm Swift	24	14	32	16
Senegal Coucal	24	13	18	19
Diederik Cuckoo	0	0	1	0

Diversity indices

Table 3: Comparison of Species Richness and diversity of raptors recorded during dry and wet season in the different farm types

Parameters	Shannon(H)	Evenness	Richness	Abundance
Monofarm (Wet)	3.07	0.67	4.70	777
Mixed farm (Wet)	3.48	0.68	6.85	1108
Monofarm (Dry)	2.01	0.64	5.29	1089
Mixed farm (Dry)	3.20	0.71	8.07	1688

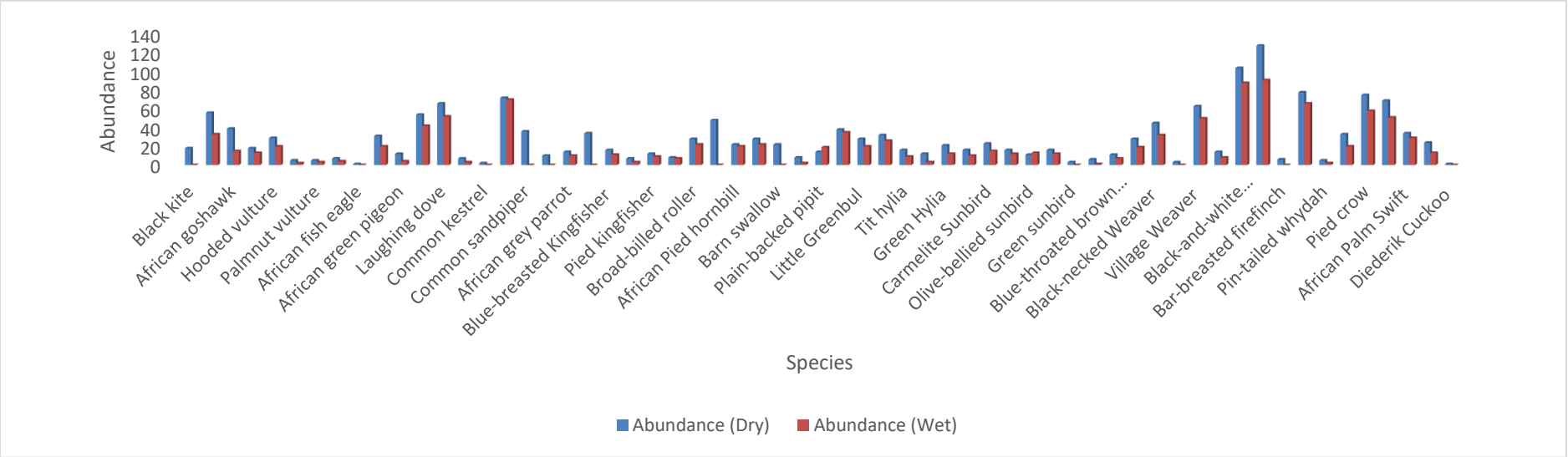

Fig 2: Avian Species abundance in the mixed farm for dry and wet season, Nwikpeba, Kono, Rivers State, Nigeria

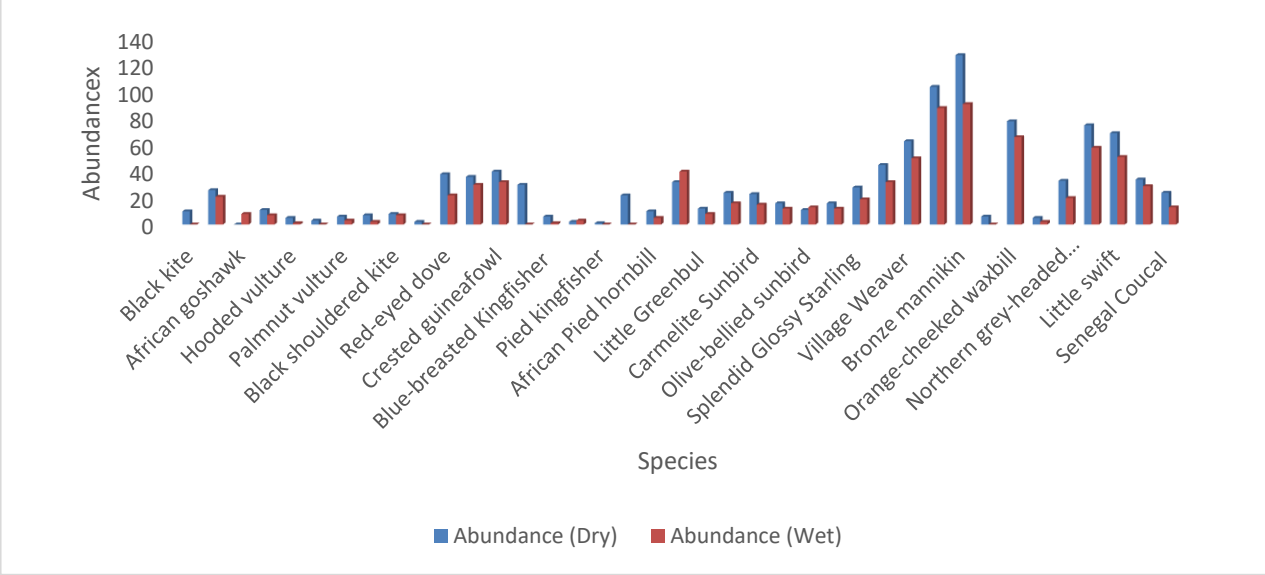

Fig 3: Species abundance in the mono farm for dry and wet season, Nwikpeba, Kono, Rivers State, Nigeria

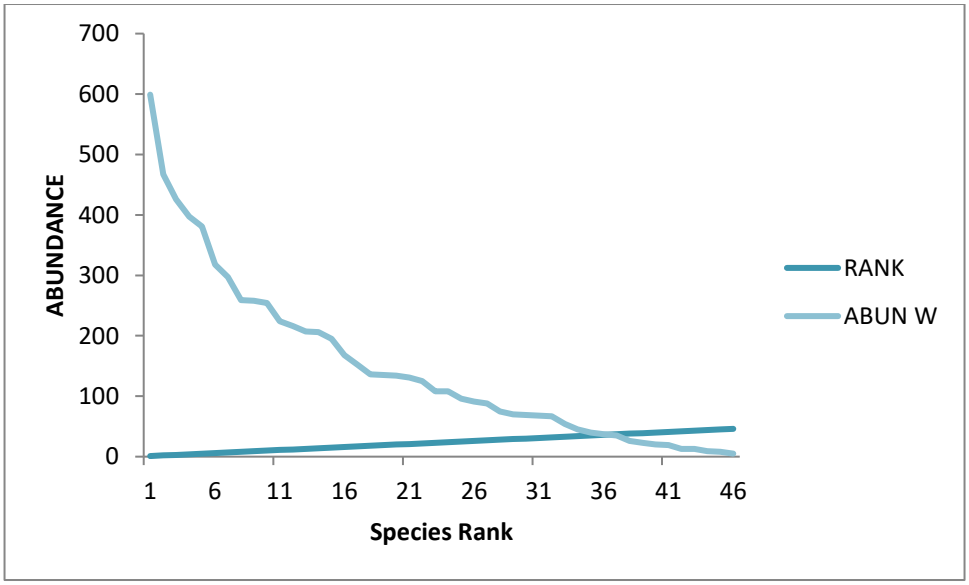

Fig 4: Rank Abundance Distribution (Wet Season), Nwikpeba, Kono, Rivers State, Nigeria

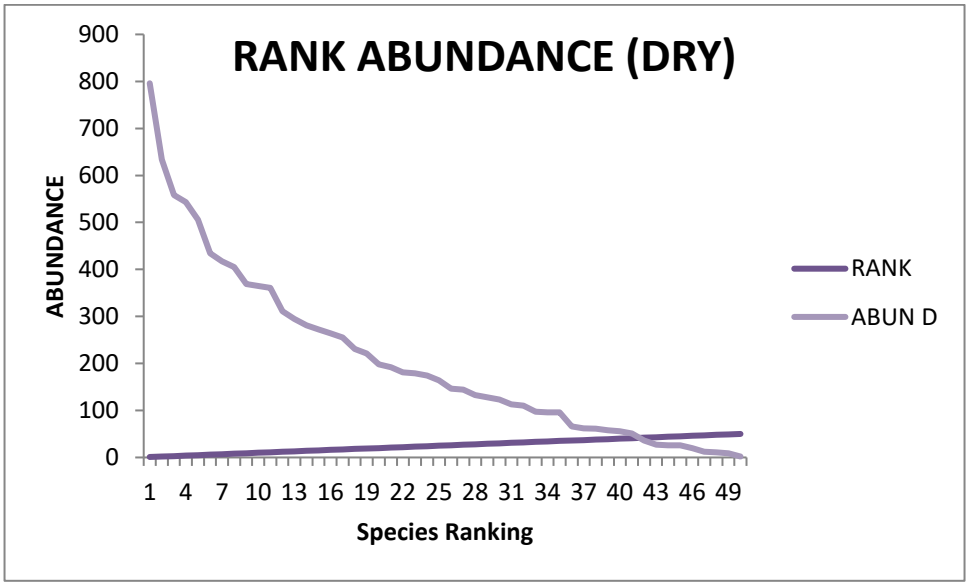

Fig 5: Rank Abundance Distribution (Dry Season), Nwikpeba, Kono, Rivers State, Nigeria

In general, the species diversity across all farm types were high with the Shannon-wiener index of 3.48 in the mixed farm types in the dry season and 3.20 in the wet season. The Margalef index with values 8.07 for dry season and 6.85 for wet season shows that the bird species were diverse in the mixed farms irrespective of seasons. However, Zelelew and Bekele (2008) suggested that weather and season affect bird species diversity as more birds were recorded in the dry season as compared to the wet season at the southern tip of Lake Tana, Ethiopia. In the mono farms the Shannon-Weiner index of 2.01 in the dry season and 3.07 in the wet season also indicate that diversity was high irrespective of season. Also, the Margalef index with values of 5.29 in the dry season and 4.70 in the wet season support the high diversity.

Species diversity was higher in the dry season than the wet season; easy availability of food during land management practices-clearing and preparation, foraging ground and migration of species might be the reason for high species diversity during the dry season. The relative abundance of bird species during the dry season might also be related to the availability of food, conducive habitat condition and breeding environment for the species. Meanwhile, the distinct seasonality of the rainfall and variation in the abundance of food resources resulted in seasonal changes in the species abundance of bird, an idea which is not at variance with Gaston *et al.* (2000). The high density of resident birds, together with seasonal influx of winter migrants, contributed to high bird population in the dry season all year round.

According to Birdlife (IUCN Red List for birds) 2022, two critically endangered species (*Necrosyrtes monachus* and *Psittacus erithacus*) were recorded. Further studies should be carried out using this preliminary data to understand the population ecology and diverse ecosystem services of avian species in agroecological landscapes.

CONCLUSION

This study suggests that agroecological landscapes could be of high conservation value and refugia for bird species considering the diverse habitats; edges, shrubs, patches, trees which are good sites for roosting, nesting and foraging. Proper farmland management practices could be adopted to further protect and conserve the bird species. More studies on the avian interactions in agroecological landscapes need to be carried out frequently.

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