SEASONAL DYNAMICS IN THE DIVERSITY AND ABUNDANCE OF RAPTORS FOUND IN AGROECOLOGICAL LANDSCAPES IN KONO, RIVERS STATE, NIGERIA

Alawa, G., Akani, G.C., Ebere, N., Bobmanuel, K.N.O and Onwuteaka, J.N.
Department of Animal and Environmental Biology, Rivers State University, Port Harcourt, Nigeria.
Corresponding author: Email: grace.alawa1@ust.edu.ng

Article History

Received: 20.10.2022
Accepted: 10.11.2022
Published: 23.11.2022

Journal Homepage
https://www.iiarpub.org

ABSTRACT: Raptors occupy the highest niches in a food web and little is known about their population and ecology in agroecological landscapes. This research was aimed at assessing the seasonal dynamics of raptors, their diversity and population distribution in agroecological landscapes to establish a live data observatory which can serve as a baseline for conservation of these species. Line transect method was used to investigate the occurrence, diversity, and habitat use of raptors in Kono farms comprising monofarms and mixed farms. 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. Nine raptor species belonging to the family Accipitridae were found to be inhabiting the agroecological space; *Kaupifalco monogrammicus* (lizard buzzard) had the highest abundance while *Haliaeetus vocifer* (African fish eagle) was the least abundant. One Intra-African migrant (*Milvus migrans parasitus*-Yellow-billed kite), one Palearctic visitor (*Milvus migrans* -Black kite) and one critically endangered species (*Necrosyrtes monachus* -Hooded vulture) were recorded. The results show there were variations in the abundance of the species between the wet and dry seasons. The species diversity for both seasons varied amongst the two types of farms with Shannon (H) index and evenness having higher values of 2.312 and 1.31 for mixed farms(dry) and 1.96, 0.79 as the least values in the monofarms. The mixed farms supported the highest species abundance; *Necrosyrtes monachus* (Hooded vulture) recorded the highest abundance in the mixed farms for each season while *Kaupifalco monogrammicus* (Lizard buzzard) recorded the highest abundance in the monofarms for each season. *Haliaeetus vocifer* (African Fish Eagle) and Yellow-billed kite *Milvus migrans parasitus* were the least occurring species in the monofarms during the dry season. *Macheiramphus alcinus* (Bat hawk) and *Polyboroides typus* (African Harrier-Hawk) were the least recorded species in the mixed farms for both seasons. This study serves both to highlight the importance of agroecological landscapes as a home for raptors and to emphasize the importance of conservation programmes to create awareness for these umbrella species.

Keywords: Seasonal dynamics, raptors, agroecological, landscape, niches

INTRODUCTION

Birds of prey, raptors, include species of bird that primarily hunt and feed on vertebrates that are large relative to the hunter. They have keen eyesight for detecting food at a distance or during flight, strong feet equipped with talons for grasping or killing prey, and powerful, curved beaks for tearing flesh. In addition to hunting live prey, most also eat carrion, at least occasionally, while vultures and condors eat carrion as their main food source (Bashir *et al*., 2021). Because of their role as apex predators in food webs, birds of prey are particularly vulnerable to environmental changes. Many raptor populations have experienced steep declines and are now endangered (Newton, 2010a; Birdlife, 2022).

Bashir *et al*., 2021, reported anthropogenic environmental impacts as having serious impact on raptor species. Human activities are responsible for the catastrophic decline and extinction of thousands of animal and plant species throughout the world, and this loss is occurring at unprecedented rates (Ripple, 2014; Dirzo, 2014; Ceballos *et al*., 2020; Pimm, 2014). Human activities change habitat structures, mainly by modifying previously natural landscapes (Xu *et al*., 2018). In recent decades, the expansion of logging in forests and the widespread introduction of intensive farming have brought about major habitat changes in the vicinity of human settlements, where traditional mosaic-like landscapes have been replaced by crop monocultures (Grant, 2007; Beuchley, 2019; McClure, 2018). Such habitat transformation results in the loss of biodiversity, including that of breeding bird communities (Devictor *et al*., 2007; Aronson *et al*., 2014; Seress and Liker, 2015; Morelli *et al*., 2016).

The main causes of raptor mortality are poaching, poisoning, collisions with electric power facilities and wind turbines (Guil *et al*., 2015; Maciorowski *et al*., 2019a), as well as natural factors connected with weather conditions and the hardships of migration (Berthold, 2001; Newton, 2010b). Population declines are also related to the loss of suitable wintering and breeding grounds (Moreau, 2009; Maciorowski *et al*., 2019b).

Prey diversity and habitat heterogeneity among other factors play an important role in the distribution, status, and diversity of raptors in an ecosystem (Grande *et al*., 2018). Their declining numbers and economic relationships warrant additional interest, and studies of total raptor populations are needed as a means by which we may elucidate their responses to changing pressures and environmental conditions (Zilio *et al*., 2013). The global loss of raptors is worrying, not just because of their charisma and flagship role (Sergio *et al*., 2008), but also because reduced abundance of raptors can have cascading effects on ecosystem functioning through changes in the numbers and behavior of their prey (Şekercioğlu, 2006). Raptor decline may also lead to loss of ecosystem services (Grzegorz, 2018).

Birds usually select foraging habitats based on the availability of their main prey items and understanding habitat preferences provides critical information for species conservation (Okosodo *et al*., 2016). Birds depend on various landscapes for foraging, nesting, roosting as well as breeding. Nigeria is divided into six (6) major vegetation zones; information on birds developed over the years has lacked inclusion of the mangrove and fresh water swamp forest. Agroecosystems vary across the different vegetation zones in the country and as such the birds associated with the different landscapes also vary. There is a dearth of information on birds of the agroecosystems in this part of Nigeria (Niger delta region) that has a combination of land and water.

This study therefore aimed at assessing the seasonal dynamics of raptors, their diversity and population distribution in agroecological landscapes to establish a live data observatory which can serve as a baseline for conservation of these species and help build the local expertise needed to monitor them.

MATERIALS AND METHODS

STUDY AREA

This study was carried out in Nwikpeba, Kono, located between 04.34°-04.35°N and 007.29°-007.30°E; an Ogoni community situated in Khana Local Government Area in Rivers State, Nigeria. 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 *Dioscorea 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 birds 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. Mixed cropping is the general farming practice in this area where some fields have trees and/or hedgerows. Other fields are open without trees or hedgerows. The entire area covered was approximately 100 km^2.

SURVEY DESIGN

Line Transect method was used for the bird survey. This method proved most efficient in terms of data collection per unit effort (Yallop *et al*., 2003). The line transect census involves an observer moving slowly along the routes and recording all birds detected on either side of the route. A field survey was carried out in twelve selected farmlands; monofarms and mixed farms at Kono, Rivers State from October, 2020 to July, 2021. The existing routes in the area was used as transect lines with lengths ranging from 1km to 1.5km. At each site, transects were placed at least 200m apart. The observations were conducted by long watches along the transect line (about 15minutes), the binoculars (Eyeskey10x42) and telescope (T&J 16X52) were used to scan the surroundings for any raptors seen flying or perched. The number of the raptors seen flying around and perching were identified using the West African field guide (Borrow and Demey, 2014). Efforts were made to avoid double counts of birds observed by noting the direction in which the last counted individual disappeared from sight and the flock size. Counts were made during the wet and dry seasons in the different farms. The coordinates of each

observation point were recorded. Surveys were carried out in the morning around 8am to 11am when the temperature was relatively cool and bird's activities are high (Bibby *et al*., 2000) and between 12noon to 2pm; when the raptors make use of thermals to soar. Garmin 760CSx Global Positioning System (GPS) was used to collect coordinates of the sampled locations.

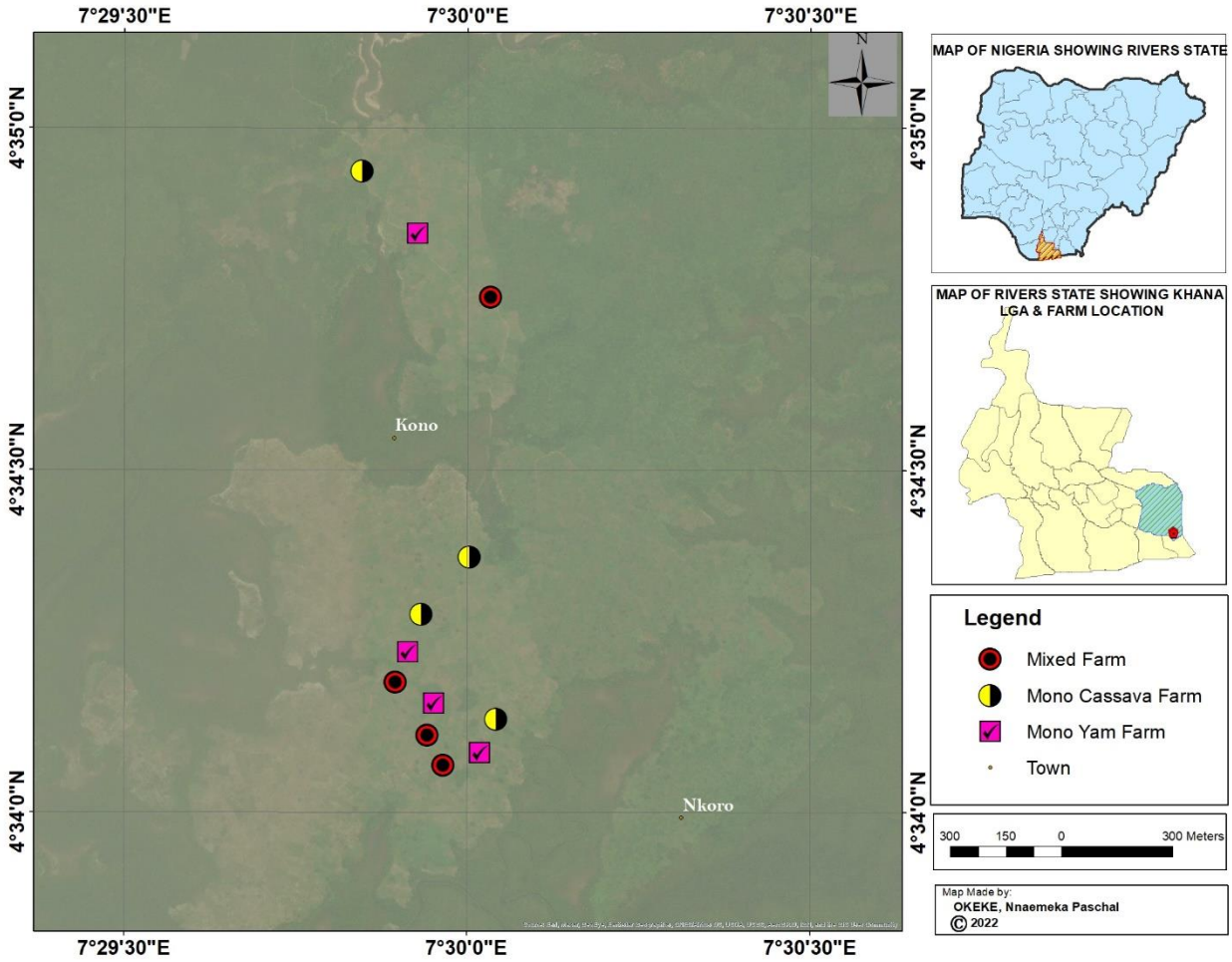

Fig 1: Map of Study Area

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

$Species\ Relative\ Abundance$ =

Species abundance X 100

Total abundace ……(i)

Calculation of Shannon Weiner index (H′) (Shannon and Weaver, 1949)

$H' = -\sum pi\ ln(pi)$ ……..……(ii)

Pi = Number of individuals of ith species

$Total\ abundance\ of\ species$

ln = natural log

Calculation of Simpson Index (1-D)

$D = 1 - \frac{\sum \boldsymbol{n(n-1)}}{\boldsymbol{N(N-1)}}$

……..……..……(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:

$\frac{H}{Hmax}$ …….…….. (iv)

E = Evenness index

H′ = Shannon Weiner index

Hmax = the highest value of Shannon Weiner index

RESULTS

During this study, nine raptor species belonging to the family Accipitridae were observed in the monofarms and mixed farms. *Kaupifalco monogrammicus* (Lizard buzzard) was the most abundant species followed by *Necrosyrtes monachus* (Hooded vulture) while *Haliaeetus vocifer* (African Fish Eagle) was the least species recorded. One Intra-African migrant (*Milvus migrans parasitus*-Yellow-billed kite), one Palearctic visitor (*Milvus migrans* -Black kite) and one critically endangered species (*Necrosyrtes monachus* -Hooded vulture) were recorded (Table 1). *Necrosyrtes monachus* (Hooded vulture) recorded the highest abundance in the mixed farms for each season while *Kaupifalco monogrammicus* (Lizard buzzard) recorded the highest abundance in the monofarms for each season, too. *Haliaeetus vocifer* (African Fish Eagle) and Black kite *Milvus migrans* were the least occurring species in the monofarms during the wet season; *Haliaeetus vocifer* (African Fish Eagle) and Yellow-billed kite *Milvus migrans parasitus* were the least occurring species in the monofarms during the dry season. *Macheiramphus alcinus* (Bat hawk) and *Polyboroides typus* (African Harrier-Hawk) were the least recorded species in the mixed farms for both seasons (Table 2).

Figure 1 shows the species abundance in the different farms while Figures 2 and 3 show the relative abundance of the species in the different farms for the wet and dry season respectively. Table 3 shows a comparison of the diversity indices of the different farms during the two (2) seasons. The highest species abundance was observed in the mixed farms during the dry season with an abundance of 652 especially in areas with closed cover trees as these trees provided a good site for nesting and roosting. The species diversity for both seasons varied amongst the two types of farms with Shannon (H) index and evenness having higher values

of 2.312 and 1.31 for mixed farms(dry) and 1.96, 0.79 as the least values in the monofarms.

Table 1: Raptor Species recorded in Kono farms along with their migratory, conservation status and frequency of occurrence

S/No	Family	English Name	Scientific Name	Migratory status	Conservation status	Freq
1	Accipitridae	Bat Hawk	*Macheiramphus alcinus*	Resident	LC	55
2	Accipitridae	Black-shouldered Kite	*Elanus caeruleus*	Resident	LC	79
3	Accipitridae	Black Kite	*Milvus migrans*	Palearctic visitor	LC	68
4	Accipitridae	Yellow-billed Kite	*Milvus migrans parasitus*	Intra-African migrant	LC	75
5	Accipitridae	Palmnut Vulture	*Gypohierax angolensis*	Resident	LC	79
6	Accipitridae	Hooded Vulture	*Necrosyrtes monachus*	Resident	CR	121
7	Accipitridae	African Harrier-Hawk	*Polyboroides typus*	Resident	LC	59
8	Accipitridae	Lizzard Buzzard	*Kaupifalco monogrammicus*	Resident	LC	128
9	Accipitridae	African Fish Eagle	*Haliaeetus vocifer*	Resident	LC	5

Key: Freq- frequency, LC- least concern, CR- critically endangered

Table 2: Frequency of occurrence of raptors in each farm type for each season

	Monofarm		Mixed farm	
Species	**Dry season**	**Wet season**	**Dry season**	**Wet season**
Bat Hawk	12	14	19	10
African goshawk	10	12	34	23
Black Kite	21	2	29	16
Yellow-billed Kite	8	7	37	23
Palmnut Vulture	24	16	24	15
Hooded Vulture	30	22	41	28
African Harrier-Hawk	16	19	21	13
Lizzard Buzzard	39	27	38	24
African Fish Eagle	3	1	1	0
	163	120	254	162

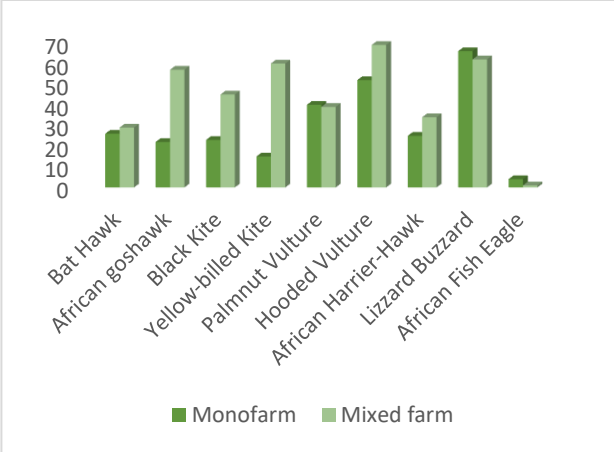

Fig 2: Species abundance in the different farm types

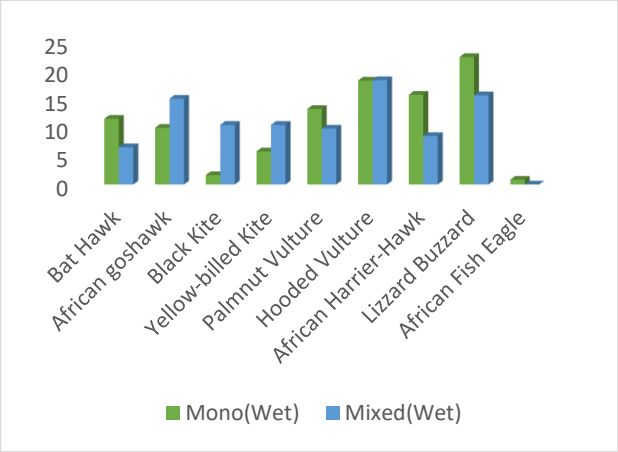

Fig 3: Relative abundance of species in the farm types (Wet season)

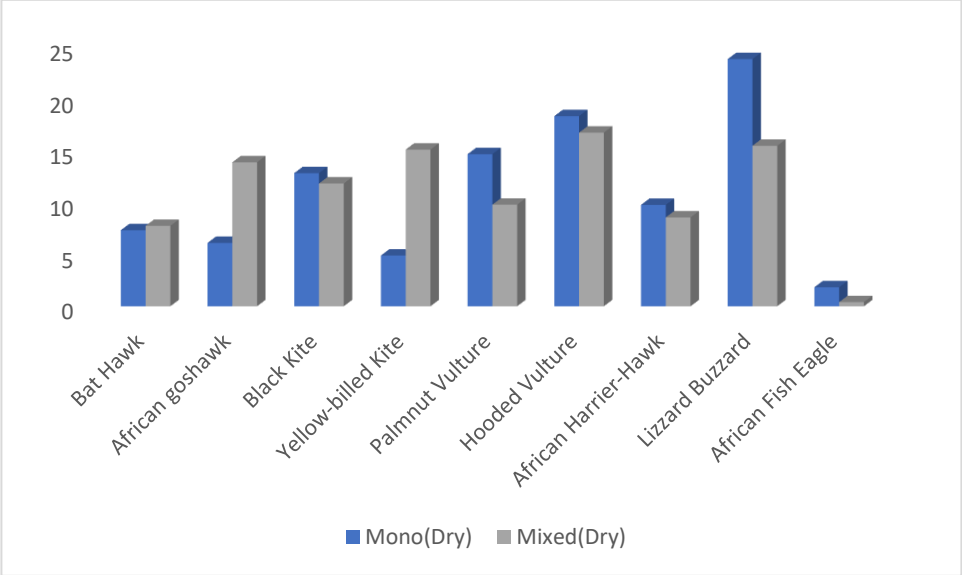

Fig 4: Relative abundance of species in the farm types (Dry season)

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

Parameters	Shannon(H)	Evenness	Richness	Abundance
Monofarm (Wet)	1.96	0.79	1.75	120
Mixed farm (Wet)	2.11	0.93	1.53	162
Monofarm (Dry)	2.01	0.83	1.7	163
Mixed farm (Dry)	2.31	1.31	1.8	254

DISCUSSION

The results presented in Table 1 above showed the outcome of transect survey of birds of prey species population distribution in Kono farms from October 2020 – July, 2021. Transect line survey method detected a total of 699 individual birds of prey that belong to nine (9) species of one (1) family during this study indicating that Kono farms area is an important breeding, roosting, and feeding habitat for several raptors.

This 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. It is also in agreement with Kabir (2013) who conducted his research in Bangladash and reported Accpitradae as the richest family.

The findings of this study agreed with several other studies; Lameed (2011), Ringim *et al*., (2017) and Odewumi *et al*., (2020). Lameed (2011) recorded nine (9) birds of prey species in his research on Species diversity and abundance of wild birds in Dagona-Waterfowl Sanctuary. Ringim *et al.,* (2018) also recorded 8 birds of prey species in his studies on species diversity of migrant birds between protected and unprotected areas of the Hadejia-Nguru wetlands. Odewumi *et al*., (2020) identified 11 birds of prey species in similar research in Akure metropolis, Ondo State. Wickramasinghe *et al*., (2021) recorded 9 birds of prey species of 2 families (Accipitridae and Falconidae) in Bolgoda Lake, Sri Lanka in his study on spatial ecology of raptors in an urban wetland; Zilio *et al*., (2013) recorded a total of 1,890 individuals' birds of prey of 18 species in Southern Brazil; Onoja *et al*., (2014) recorded 886 individuals of 37 species in Yankari game reserve with the grasshopper buzzard, dark chanting goshawk, African fish eagle, grey kestrel, lizard buzzard and black kite as the commonest species. Similarly, Okosodo *et al*. (2016) recorded 39 birds of prey species and owls belonging to 3 families in South western Nigeria with black kite as the commonest species while hooded vulture and tawny eagle had the lowest number of individuals and Tinajero *et al*., (2017) recorded 332 individuals' birds of prey belonging to 14 species in Scrubland of Northern Central Mexican Dryland environment. Seasonal effect and sampling effort/ intensity could be responsible for the variation in numbers encountered by the different authors.

All the 9 raptor species recorded in this study were common to both wet and dry seasons. There was little difference in the number of birds recorded between months probably because most of the species recorded are residents or have resident populations.

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 farming activities during land preparation provides a lot of pests such as rodents, lizards, millipedes, centipedes, earthworms in the field which are common sources of food small and medium sized raptors recorded in this study. 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 the IUCN Red List for birds 2022, one critically endangered species (*Necrosyrtes monachus*) was recorded. It was observed that there was a significant increase in the abundance of raptors occupying edges compared to the other landscapes around the farms which could be related to the availability of nesting and feeding opportunities. Boal, 2018, reported that garbage dumping sites and cultivation lands can positively influence the food availability for raptors. Further studies should be carried out using this preliminary data to understand the distribution, abundance and diversification of raptors in habitat edges and the ecological significance of this phenomenon to conserve the raptors in agroecological landscapes.

CONCLUSION

In summary, the current study provides important insights into the diversity and habitat use of raptors in varying agroecological landscapes. The diversity of species recorded highlights the significance of the farms as a potential habitat for breeding, nesting, and stopovers. The habitat heterogeneity of the agroecological landscapes also makes it a haven for many species of raptors. As raptors can act as umbrella species in a selected ecosystem, proper farmland management strategies could conserve raptors and in turn other birds. The findings of our study call for more investigations on raptors and their ecological needs as well as a raptor monitoring programme which are essential for the conservation of these charismatic predators.

REFERENCES

- Aronson, M. F. J., La Sorte, F. A., Nilon, C. H., Katti, M., Goddard, M. A., Lepczyk, C. A., Warren, P. S., Williams, N. S. G., Cilliers, S., Clarkson, B., Dobbs, C., Dolan, R., Hedblom, M., Kooijmans, K. S., Kühn, I., MacGregor-Fors, I., McDonnell, M., Mörtberg, U., Pyšek, P., Siebert, S., Sushinsky, J., Werner, P. and Winter, M. (2014). A global analysis of the impacts of urbanization on bird and plant diversity reveals key anthropogenic drivers. *Proceedings of the Royal Society of Biology* 281:20133330.
- Bashir B. S., Salisu. M. and Mustapha K. (2021). A Comparative Study of Raptors Species Diversity between Protected and Unprotected Areas of Hadejia Nguru Wetlands, Nigeria. *Confluence Journal of Environmental Studies*,14 (1): 116-125
- Berthold, P. (2001) Bird migration: a general survey. Oxford University Press on Demand, Oxford
- Bibby, C. J., Burgess, N., Mustoe, S.H. and Hill, D.A. (2000). Bird Census Techniques. London Academic Press.
- BirdLife International (2022) IUCN Red List for birds. Downloaded from http://www.birdlife.org on 23/08/2022.
- Boal, C.W., Dykstra, C.R. (2018). Urban raptors: ecology and conservation of birds of prey in cities. Washington D.C., Island Press.
- Borrow, N. and Demey, R. (2014). Field Guide to the Birds of Western Africa. Princeton University Press, United States.
- Buechley, E.R. (2019). Global Raptor Research and Conservation Priorities: Tropical Raptors Fall Prey to

Knowledge Gaps. *Diversity and Distributions*, 25, 856–869

- Ceballos, P. R. Ehrlich, P. H. and Raven, C. (2020). Vertebrates on the Brink as Indicators of Biological Annihilation and the sixth Mass Extinction. *Proceedings of the National Academy of Science U.S.A.*, 117, 13596–13602.
- Devictor, V., Julliard, R., Couvet, D., Lee, A. and Jiguet, F. (2007). Functional homogenization effect of urbanization on bird communities. *Conservation Biology*, 21:741–751.
- Dirzo, R. (2014). Defaunation in the Anthropocene. *Science*, 345, 401–406
- Gaston, K.J., Blackburn, T.M., Greenwood J.D., Grerory x, R.D., Rachel, M.Q., and Lawton, J.H. (2000). Abundance occupancy relationships. *Journal of Applied Ecology*, 37: 39-59.
- Grande, J.M., Orozco-Valor, P.M., Liébana, M.S., Sarasola, J.H. (2018). Birds of prey in agricultural landscapes: The role of agriculture expansion and intensification. In Birds of Prey, Springer, Cham, pp:197-228.
- Grant, S.M. (2007). The importance of Biodiversity in crop sustainability: a look at monoculture. *Journal of Hunger, Environment and Nutrition* 1:101–109.
- Grzegorz, K. (2018). Ecological Distribution and Population Densities of Raptors in the inner and outer zone of a Central European city. *Ukrainian Journal of Ecology*, 8(1): 772– 779.
- Guil, F., Colomer, M.A., Moreno-Opoc, R. and Margalida, A. (2015). Spacetime trends in Spanish bird electrocution rates from alternative information sources. *Global Ecology Conservation*, 3:379–388.
- Kabir, A. (2013). Abundance and Distribution of the Raptors in Bangladesh. *Global Journal of Poultry Farming and Vaccination*, 1: 007-010.
- Lameed, F. (2011). Species Diversity and Abundance of Wild Birds in Dagona-Waterfowl Sanctuary Borno State, Nigeria. *African Journal of Environmental Science and Technology*, 5: 855-866.
- Maciorowski, G., Galanaki, A., Kominos, T., Dretakis, M. and Mirski, P. (2019a). The importance of wetlands for the Greater Spotted Eagle *Clanga clanga* wintering in the Mediterranean Basin. *Bird Conservation International* 29:115–123.
- Maciorowski, G., Kosicki, J.Z., Polakowski, M., Urbańska, M., Zduniak, P. and Tryjanowski, P. (2019b). Autumn migration of immature Red Kites *Milvus milvus* from a central European population. *Acta Ornithology* 54:45–50.
- McClure, C.J. (2018). State of the World's Raptors: Distributions, Threats, and Conservation Recommendations. *Biological Conservation*, 227, 390– 402.
- Moreau R. E. (2009). Changes in Africa as a Wintering area for Palaearctic Birds. *Bird Study*, 17:95–103.
- Morelli, F., Benedetti, Y., Ibáñez-Álamo, J. D., Jokimaki, J., Mänd, R., Tryjanowski, P., Møller, A.P. (2016). Evidence of evolutionary homogenization of bird communities in urban environments across

Europe. *Global Ecology Biogeography*, 25:1284–1293.

- National Bureau of Statistics. (2006). Retrieved from Federal Republic of Nigeria, 2006 Population Census, via: *www.nigerianstat.gov.ng/nbsapps/Connections/Pop2006.pdf* on 12/06/21.
- Newton, I. (2010a). The migration ecology of birds. Elsevier, London
- Newton, I. (2010b). Population ecology of raptors. A&C Black, London
- Odewumi, O.S., Adekola, O.E. and Aladesiun, O.A. (2020). Diversity and Abundance of Birds of Prey in Akure Metropolis, Ondo State, Nigeria. *Journal of Forest Science and Environment*, 5: 1 – 10.
- Okosodo, E.F., Orimaye, J. O. and Odewumi, O.S. (2016). Diversity and Abundance of Birds of Prey and Owls in Four Selected Areas in South Western Nigeria. *International Journal of Environment, Agriculture and Biotechnology*, 1(2): 2456-1878
- Onoja, J.D., Tende, T., Omotoriogun, T.C., Ottosson, U., Manu, S.A. and Mwansat, G.S. (2014). Raptors in Yankari Game Reserve and surrounding unprotected area, Nigeria. *Malimbus*, 36:67-75.
- Pimm, S.L. (2014). The biodiversity of Species and their Rates of Extinction, Distribution and Protection. *Science*, 344(6187):1246752.
- Ringim, A. S. and Aliyu, D. (2018). Bird Species Richness, Relative Abundance and Conservation Statuses in Protected and Unprotected Areas of the Hadejia- Nguru Wetlands. *Proceedings of the 6th NSCB Biodiversity Conference, Uniuyo* :13-18pp
- Ripple, W. L. (2014), Status and Ecological Effects of the World's Largest Carnivores. *Science* 343:1241-48.
- Saro-Wiwa, K. (1995). Complete statement by Ken Saro-Wiwa to Ogoni Civil Disturbances Tribunal. Rat Haus Reality Press: Roslindale, Massachusetts. Retrieved from *http://www.ratical.org/corporations/KSWstmt.pdf* on 12/06/21.
- Sekercioglu, C.H. (2006). Ecological Significance of Bird Population in: Handbook of the Birds of the World. Volume II: Old World Flycatchers to Old World Wablers. Lynx edition.
- Seress, G. and Liker, A. (2015). Habitat urbanization and its effects on birds. *Acta Zoological Academy of Science Hung* 61:373–408.
- Sergio, F., Caro, T., Brown, D., Clucas, B., Hunter, J., Ketchum, J., McHugh, K. and Hiraldo, F. (2008). Top Predators as Conservation Tools: Ecological Rationale, Assumptions, and Efficacy. *Annual Review of Ecology Evolution and Systematics*, 39: 1– 19.
- Shannon, C. E. and Weaver, W. (1949). *The mathematical theory of communication.* University of Illinois Press.
- Tinajero, R., Barraga, F. and Chapa-Vargas, L. (2017). Raptor Functional Diversity in Scrubland-Agricultural Landscapes of Northern-Central-Mexican Dryland Environments. *Tropical Conservation Science*, 10:1–18.
- UNEP (2011). Environmental Assessment of Ogoni. United Nations Environment Programme. Retrieved from *www.unep.org* on 12/07/21.
- UNPO (2009). Ogoni. Retrieved from United Nation:

http://www.unpo.org/members/ogoni.htm on 13/07/21.

- Wickramasinghe, D., Weerasinghe, Y., Fernando, S. (2021). Spatial ecology of raptors in an urban wetland: A case study from Bolgoda Lake, Sri Lanka. *Ukrainian Journal of Ecology*, 11 (7): 174-178.
- World Bank (2010). Retrieved from http://www.worldbank.org on 20/03/2022
- Yallop, M.L., Connell, M.J. and Bullock, R. (2003). Waterbirds Herbivory on a Newly Created Wetland Complex: Potential Implication for Site Management and Habitat Creation. *Wetland Ecology Management*, 12: 395-400.
- Xu, X., Xie, Y., Qi, K., Luo, Z. and Wang, X. (2018). Detecting the response of bird communities and biodiversity to habitat loss and fragmentation due to urbanization. *Science of the Total Environment*, 624:1561–1576.
- Zilio, F., Bolzan, A., de Mendonça-Lima, A., Oliveira da Silva, C., Verrastro, L. and Borges- Martins, M. (2013). Raptor Assemblages in Grasslands of Southern Brazil: Species Richness and Abundance and the Influence of the Survey Method. *Zoological Studies*, 52: 27.

Cite This Article: Alawa, G., Akani, G.C., Ebere, N., Bobmanuel, K.N.O. and Onwuteaka, J.N. (2022). Seasonal dynamics in the diversity and abundance of raptors found in agroecological landscapes in Kono, Rivers State, Nigeria. IJBRA (2), 22-33.