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WATER INHABITING BIRDS OF MAIGANGA POST COAL MINING PONDS AND ARTIFICIAL WETLAND

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ABSTRACT

Wetlands play a significant role in bird conservation and generally support biological diversity. Historically, bird community assessment has been employed in monitoring and identifying areas for conservation actions. In this study, we examined two post mining ponds and one artificial wetland in Maiganga Coal Mine, Gombe State for wetland avifauna. We focused on water birds (i.e. bird species that depend wholly or partially on water and wetland ecosystems for their survival). Survey was conducted during the onset of dry season in October 2021 to September 2022. Point count technique was used for the survey. A total of 626 individuals of 23 species from 19 genera, 10 families and 6 bird Order were recorded. The White-faced whistling duck was the most abundant bird species and was restricted to the active-mine pond (AMP). AMP was the most diverse of the three water bodies surveyed. However, some species were exclusive to either of the three sites. Similarly, AMP was the most abundant site with 426 individuals from 16 bird species, followed closely by the sedimentation pond with 147 individuals drawn from 15 bird species. The results suggest that water depth, age of establishment and surrounding vegetation structure could be a major determinant of bird species composition and abundance in the study area. The study highlights the importance of restorative actions aimed at recovering modified landscapes, through tree planting and creation of wetlands. This is evident in the presence of waterbirds in Maiganga, a location that was previously devoid of perennial water bodies and water birds prior to mining.

Keywords: Maiganga, Coal Mine, Water birds, Species diversity, Wetland

INTRODUCTION

Habitat structure is a major determinant of biotic diversity and one of the most fundamental drivers of habitat selection by animals and accounts significantly for the distribution of species (Sol *et al*, 2014, Basile *et al*, 2021). Most habitats are characterized by a major feature such as expansive grass cover (grassland), availability of water in part or whole (aquatic habitat), dense trees and vegetation cover (forest) large body of sea and ocean (marine). The nature and functional characteristics of any given habitat therefore depends on the keystone predominant feature and the suite of organisms that depend directly or indirectly on it (Basile *et al*, 2021).

Water is a crucial resource in every habitat known to man. It is required for survival of species and for several other key life processes such as breeding, roosting, feeding, movement etc., depending on the organism.

Aves (birds) are the most mobile, most studied and ubiquitous organisms among extant vertebrates (Gill, 2007). Birds inhabit both terrestrial and aquatic environments. Their distribution ranges from extreme hot (deserts) to extreme cold (Arctic and Antarctic) regions of the earth. Hence birds are the most often seen, most studied taxa and a constant biotic feature of any given habitat known to man (Sinclair, 2004). Birds are useful as indicators of healthy ecosystems and the presence of other species or taxa (Bibby and Johnsonm, 2000).

This paper focuses on a modified arid Savannah landscape which apart from seasonal streams was devoid of large expanse of water that is perennial. However, the commencement of coal mining in 2006 led to profound modifications which resulted in the formation of ponds in 2007, and construction of an artificial wetland in 2020. Unlike the Active mine pond, the artificial wetland was purposefully designed as a remedial measure to treat polluted water before discharge as safe water for alternative use such as irrigation agriculture etc (Nsor *et al*, 2022b). This paper seeks to examine the Avifaunal changes that have occurred as a result of the presence of these water bodies created after mining and the implication for overall Avifaunal diversity of the Maiganga landscape.

Wetlands are among the most biologically diverse and productive of all ecosystems (Ramsar Convention, 2018). Wetlands serve as home to a wide range of plant and animal species. Birds, especially waterfowl, depend on wetlands for nesting, breeding, feeding, molting and roosting (Kumar and Gupta, 2009). Wetlands not only provide refuge for resident bird species, but also serve as an important wintering and stopover ground for migratory bird species (Ramser Convention, 2018; Ringim *et al*., 2017, Sabo et al, 2021). Wetlands are extremely diverse in nature, depending on their method of formation, geographical location and altitude. However, the primary factor that distinguishes wetlands from other land forms or water bodies is the characteristic of the aquatic vegetation (Butler *et al*, 2010). Functionally, wetlands are important in water storage, water filtration and recycling, erosion control, carbon sink, and soil enrichment. In terms of provisions, wetlands are a major source of medicinal plants, aquatic organisms such as fish, crustaceans, and serve as repository for raw materials that are crucial to the everyday needs of humans (Sulaiman *et al*, 2015). However, despite its value, wetlands are fast disappearing due to global warming and face other avoidable threats as a result of pervasive and obnoxious human activities in recent decades, such as agricultural intensification, over-harvesting of wetland resources, and introduction of invasive and exotic species (McCauley *et al*. 2013).

Birds on the other hand use wetlands for diverse reasons. Apart from the basic function of wetlands as a habitat of choice for water dependent bird species, they also provide specific functions required for crucial life support processes such as breeding (Sulaiman *et al*, 2014). For instance, birds

use of wetlands during breeding cycles ranges widely; some birds depend on wetlands almost totally for breeding such as grass birds, freckled duck, white bellied sea-eagle etc., nesting such as egrets, cormorants, herons, etc., feeding such as spoonbills, pelicans, black swans, or shelter during their breeding cycles. Birds that need functional access to a wetland or wetland products during their life cycle, especially during the breeding season, can be called "wetland dependent". Other birds use wetlands only for some of their needs which may range from diurnal feeding, roosting, save grounds (cover) etc. Few species are exclusively water dependent as they may use both wetland and dry land habitats.

About 147 of the nearly 1000 bird species that occur in Nigeria are wetland dependent (Bird Life International 2022); of these number about 89 % are fresh water dependent species while the remaining species occupy seashores, estuaries and oceans.

The total area of Nigeria's 11 major wetlands (Ramser sites) is about 1,076,728 hectares (Ramser Convention, 2018). In the southern region, several coastal wetlands and lagoons are found. Some of which are; Apoi Creek Forests in Bayelsa State, Upper Orashi Forests in Rivers State, Oguta Lake in Imo State; of these wetlands, the Niger Delta is the most prominent. The Niger Delta is the largest wetland in Africa and the third largest mangrove forest in the world (Bird Life International, 2022). The region is known for its richness in biodiversity as well as its oil and gas resources. Unfortunately, this wetland is threatened by oil spillage.

In Northern Nigeria, several wetlands exist, prominent among them is the Hadejia-Nguru Wetlands in Yobe State, northeast Nigeria. This ecologically important wetland is threatened by reduced rainfall due to growing human population, overgrazing and upstream dam construction (Ringim and Aliyu, 2018). Other wetlands in the region include: Lake Chad Wetlands in Borno State, Dagona Birds Sanctuary in Yobe State, Maladumba Lake in Bauchi State, Baturiya Wetlands in Jigawa State, Padam and Wase Lakes in Plateau State, and Forge Island in Kebbi State (Ezealor, 2002).

In Gombe where this study is focused, the Dadin Kowa river and surrounding flood plains is the major habitat for wetland birds (Adang *et al.* 2015). However, apart from Dadin Kowa River, Gombe state has several water bodies that may potentially serve as important habitats for birds; incidentally, these wetland habitats have not been extensively surveyed and in most cases not even once. This is why studies of this nature are expedient in order to have a full understanding of wetland avifauna in the state. In recent times, Nsor *et al*. (2022a), looked at Avifaunal composition and distribution taking into account all the various habitat types (tree plantations, ponds, artificial wetlands, natural remnant vegetation and environs of the Maiganga community). However, this present study focused only on water habitats. The study emphasizes the ecological significance of additional landscape features such as (water) as a habitat for birds; species that would otherwise be absent from Maiganga but for the creation of artificial wetlands and the post mining ponds.

MATERIALS AND METHODS

Study Area

The Maiganga Coal mine is located in Maiganga village in Akko Local Government Area of Gombe State. The village/Coal mine is located 8 km off Gombe – Yola Road; west of Kumo town between Latitude 09^{o} 18', and Longitude 11^{o} 59'E. The total area originally occupied by the community covers an area of about 48.16 Km^{2}. However, as at 25th September, 2021, the Active Mine area was about 16.5 hectare. Similarly, all areas with trees are about 31.32 hectare, while area filled with top soil is about 3.18 hectare (Lafarge Sustainability report, 2021).

The study area is typically distinct as dry Savannah, predominated by grasses, shrubs and thorn-scrub interspersed by few trees; example *Pakia biglobosa*, *Tamarindus indica*, *Balanites aegyptiaca*, *Butyrospermum paradoxa*, *Afzelia africana* and *Adansonia digitata* (Nsor *et al*, 2022b).

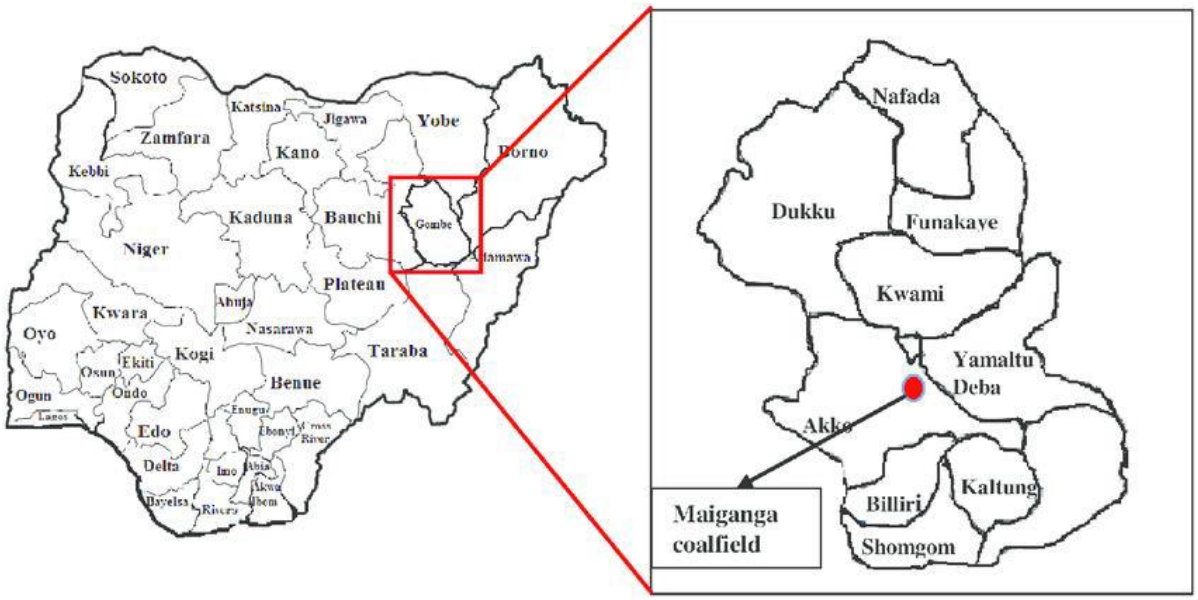

Figure 1: Map of Study area showing location of the coal mine in Akko LGA

Study Design

The three water bodies were monitored using point count census technique to record bird species seen or heard (Bibby *et al*, 2000). The study was conducted in the morning (6:30-10:30 am) and evening (3:30-5:30 pm). A pair of Focus binoculars was used for focal observation. Birds were identified easily through their appearances, calls and jizz (i.e. immediately recognizable characteristics of a bird). The field

guides to Birds of Western Africa (Borrow and Demey, 2014) was used to confirm species with confounding features.

Data Analysis

We used SPSS (Statistical Package for Social Science version 21.0) to explore and analyze the data. Simple descriptive statistics was used to determine frequencies, averages and to generate abundance data (sum).

Relative abundance = $\frac{Abundance\ of\ a\ bird\ species}{Total\ abundance\ of\ all\ bird\ species}$ x 100

Species Richness was calculated as the total number of species recorded in a given site or habitat.

RESULTS AND DISCUSSION

At the end of the survey, a total of 626 individuals of 23 species from 19 genera, 10 families and 6 bird order were recorded across the three water bodies; two ponds and one artificial wetland (Table 1).

Table 1: Abundance and diversity of focal species across the three sites in the study area

Species	Total No. Seen	Relative Abundance	Sedimentation Pond	Active Mine	Artificial Wetland
Grey-headed Kingfisher	7	0.011182109	7	0	0
African Pigmy Kingfisher	5	0.00798722	5	0	0
White Face Whistling Duck	218	0.348242812	23	195	0
Fulvous Whistling Duck	6	0.009584665	0	6	0
African Pigmy Goose	10	0.015974441	0	10	0
Knob Billed Duck	22	0.03514377	0	22	0
Squacco Heron	9	0.014376997	9	0	0
Black Headed Heron	15	0.023961661	5	8	2
Intermediate Egret	4	0.006389776	1	3	0
Grey Heron	92	0.146964856	35	51	6
Cattle Egret	21	0.033546326	8	4	9
Little Egret	10	0.015974441	2	6	2
Black Crown Night heron	14	0.022364217	10	0	4
Three Banded Plover	11	0.017571885	0	11	0
Spur winged Lapwing	67	0.107028754	9	51	7
African Jacana	7	0.011182109	0	0	7
Long Tail Cormorant	73	0.116613419	28	41	4
Black Winged Stilt	5	0.00798722	0	5	0
Common Sandpiper	7	0.011182109	2	5	0
Little Stint	1	0.001597444	0	1	0
Hamerkop	9	0.014376997	1	7	1
Abdim Stork	8	0.012779553	2	0	6
Black-headed Lapwing	5	0.00798722	0	0	5

The most abundant and perennially visible species was the white-faced whistling ducks (218 individuals) and accounted for 35% of the total species abundance in this study. Similarly the most species rich Genera, Family and Order were Ardea (3 species), Ardeidea (7 species), Palecariformes (8 species); for genera, family and bird order respectively (Table 2).

Table 2: Taxonomic Distribution and Diversity of Water-dependent Bird Species in Maiganga.

S/N	Species	Scientific Name	Genus	Family	Order
1	Long Tail Cormorant	*Microcarbo africanus*	*Microcarbo*	Phalacrocoracidae	Suliformes
2	Black Crown Night heron	*Nicticorax nicticorax*	*Nycticorax*	Ardeidae	Pelecaniformes
3	Squacco Heron	*Ardeola ralloides*	*Adeola*	Ardeidae	Pelecaniformes
4	Cattle Egret	*Bubulcus ibis*	*Bubulcus*	Ardeidae	Pelecaniformes
5	Little Egret	*Egretta garzetta*	*Egretta*	Ardeidae	Pelecaniformes
6	Intermediate Egret	*Ardea intermedia*	*Ardea*	Ardeidae	Pelecaniformes
7	Grey Heron	*Ardea cinerea*	*Ardea*	Ardeidae	Pelecaniformes
8	Black Headed Heron	*Ardea melanocephala*	*Ardea*	Ardeidae	Pelecaniformes
9	Hamerkop	*Scopus umbrette*	*Scopus*	Scopidae	Pelecaniformes
10	Abdim Stork	*Ciconia abdimii*	*Ciconia*	Ciconiidae	Ciconiiformes
11	Fulvous Whistling Duck	*Dendrocygna bicolor*	*Dendrocygna*	Anatidae	Anserifomes
12	White Face Whistling Duck	*Dendrocygna viduata*	*Dendrocygna*	Anatidae	Anserifomes
13	Knob Billed Duck	*Sarkidiornis melanotos*	*Sarkidiornis*	Anatidae	Anserifomes
14	African Pigmy Goose	*Nettapus auratus*	*Nettapus*	Anatidae	Anserifomes
15	African Jacana	*Actophilornis africanus*	Actophilomis	Jacanidae	Charadriiformes
16	Black Winged Stilt	*Himantopus himantopus*	*Himantopus*	Recurvirostridae	Charadriformes
17	Three Banded Plover	*Charadrius tricollaris*	Charadrius	Charadriidae	Charadriformes
18	Spur winged Lapwing	*Vanellus spinosus*	*Vanellus*	Charadriidae	Charadriformes
19	Black-headed Lapwing	*Vanellus tectus*	*Vanellus*	Charadriidae	Charadriformes

20	Little Stint	*Calidris minuta*	*Calidris*	Scolopacidae	Charadriformes
21	Common Sandpiper	*Actitis hypoleucos*	*Actitis*	Scolopacidae	Charadriformes
22	African Pigmy Kingfisher	*Ispidina picta*	*Ispidina*	Alcedinidae	Coraciformes
23	Grey-headed Kingfisher	*Halcyon leucocephala*	*Halcyon*	Alcedinidae	Coraciformes

(Bird species are listed in taxonomic order) (Borrow and Demey 2014)

The most species rich and abundant site was the Active Mine Pond, followed by the Sedimentation Pond. Relatively new and yet to be fully established artificial wetland was the least in terms of species richness (Figure 2).

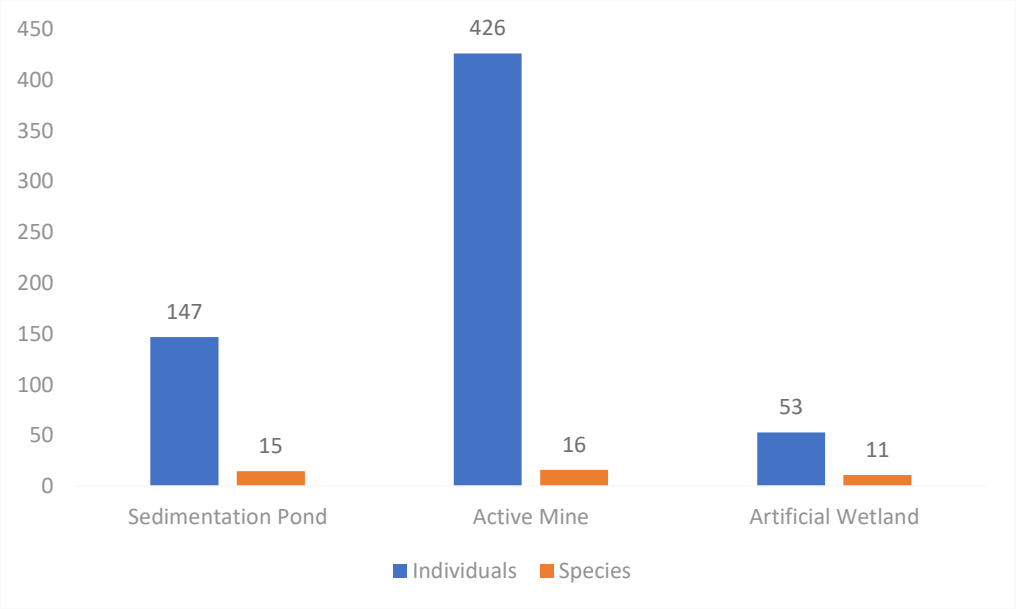

Figure 2: Species abundance and Richness across the three sites.and abundance

Nineteen (19) of the 23 water birds recorded in this study are listed as priority species by AEWA (African Eurasian Wetland Agreement). Similarly 14 species depend on water fully, while nine use water partially (Table 3). Results also reveal that 12 species were migratory (either Palearctic or intra -African). The rest were Normadic (2) and resident (9) (Table 3).

Table 3: Summary of Ecology and Conservation Status of Bird Species

Species	Migration	Feeding style	Food Type	Breeding Grounds	Use of water	AEWA
Abdim Stork	African Migrant	Stalker	Insects, small reptiles, amphibians and eggs	Trees, Rooftops and cliffs	Partial	Yes
African Jacana	Normadic	Wader	Mollusc, flying insects, crustaceans, seeds	Floating rafts, partially submerged under shady trees	Full	No
African Pigmy Goose	Normadic	Browser	Seeds and aquatic plants, waterfowl pellets	Tree cavities, termite mounds, thatched roofs	Full	Yes
African Pigmy Kingfisher	Intra-African M	Predatory	Insects, Crustaceans	Burrows, termite nest	Partial	No
Black Crown Night heron	Migratory/ Resident	Opportunistic	Fish, Insects, birds, rodents, snakes	Tree, bushes, reed beds	Full	Yes
Black Headed Heron	Migratory	Wader/stalker	Fish, small birds, rabbits	Nest high on trees including palms	Partial	Yes
Black Winged Stilt	Palearctic M	Wader	Aquatic invertebrates, amphibians, snails, tiny fish, seeds	Bare spot, on ground near water	Full	Yes
Black-headed Lapwing	Resident/SM	Wader	Insects and other invertebrates	Ground Scrape	Partial	Yes
Cattle Egret	Migratory	Wader	Insects, worms, invertebrates	Tree, bushes, reed beds	Partial	Yes
Common Sandpiper	Palearctic M	Wader	Aquatic invertebrates, terrestrial insects, small molluscs	Vegetation by water side	Full	Yes

Fulvous Whistling Duck	Resident	Filter Feeder	Plant materials, gleans seeds, waste, corn grains in fields	Trees and Tree holes	Full	Yes
Grey Heron	Resident/PM	Apex Predator	Fish, birds, rabbits, lizards	Tree, bushes, reed beds	Full	Yes
Grey-headed Kingfisher	Intra-African M	Predatory	Insects, Small lizards	Holes in Steep Riverbanks	Partial	No
Hamerkop	Resident	Wader	Fish, amphibians, crustaceans, invertebrates	Biggest nest of any bird in Africa on trees with various materials even plastics	Partial	No
Intermediate Egret	Resident	Wader/stalker	Fish, frogs, insects and other invertebrates	Colony nesters on trees, reed beds, shrubs	Partial	Yes
Knob Billed Duck	Resident/SM	Grazer	invertebrates, small fish, and seeds/rice grains	Tree Holes, Tall Grass	Full	Yes
Little Egret	Migratory	Wader	Insects, worms, invertebrates	Tree, bushes, reed beds	Full	Yes
Little Stint	Palearctic M	Wader	Invertebrates, larvae of mosquitoes and craneflies	On ground in dry grassy areas, nest is a scrape	Full	Yes
Long Tail Cormorant	Resident/SM	Predatory	Fish, frogs, invertebrates and small birds	Trees, Rocky outcrops	Full	Yes
Spur winged Lapwing	Resident	Prodder	Insects, worms, Inset larva, invertebrates, small lizards	Small hole dug in the ground in sparse vegetation	Full	Yes
Squacco Heron	Migratory	Wader/stalker	Fish, Frogs, insects	Trees, platforms and shrubs	Full	Yes
Three Banded Plover	Resident	Prodder	Insects, worms, invertebrates	Scrape in sand, mud or shingle	Full	Yes
White Face Whistling Duck	Resident	Wader	Seeds and plant materials	Depression in ground/grass	Full	Yes

(All species are of Least Concern according to IUCN criteria). SM= Seasonal Migrant, M= Migrant, P= Palearctic.

Results show that the water bodies varied in depth, age of establishment and size. The oldest water body is the Active Mine pond, while the largest and deepest is the sedimentation pond (Table 4)/

Table 4: Description and physical parameters of the water bodies (sites) See appendix (1-3)

Site	Age	Size	Average Depth	Vegetation	Native Flora
Active Mine	1st (2007)	*≈39,125m^2	>5ft	Nearly Bare	Non within vicinity
Sedimentation Pond	2nd (2007)	41,250m^2	>6ft	Surrounded by Tree Plantation	Several
Artificial wetland	3rd (2020)	10,800m^2	<0.1 ft	Typha grass/Trees	Few natives

* = Not fixed, constantly changing with mining activity and season.

Discussion

Thus far, 23 water birds of the 147 water bird species that occur in Nigeria (Bird Life International, 2022) were recorded across the three water-bodies (wetlands) of Maiganga post coal mined landscape; interestingly 19 of these species are among the 255 species listed under the African-Eurasian Water-bird Agreement (AEWA). The agreements core objective is the conservation of African-Eurasian Migratory Water-birds and their habitats. These birds are ecologically dependent on wetlands for at least part of their annual cycle (CMS, AEWA (2020) www.unep-aewa.org). All AEWA species cross international boundaries during their migrations and require good quality habitat for breeding as well as a network of suitable sites like Maiganga and other allied habitats to support their annual journeys. International cooperation across their entire migratory range is therefore essential for the conservation and management of migratory water-bird populations and the habitats crucial for their survival (CMS, AEWA, 2020). Although Nigeria has 11 Ramsar sites of global importance (Ezealor, 2002), habitats like Maiganga are essential in the overall well-being of migratory species as continuous shrinkage of major wetlands including major Ramser sites such as Hadeja Nguru wetlands may push these species of Palearctic migrants to sub-optimal sites within their migratory routes. The abundance records of the 23 species of water-dwelling birds and diversity of birds from other guilds in Maiganga is a proof of the ecological benefits and transformation of the landscape which was once contiguous dry Savannah reminiscent of the semi-arid region of the North Eastern Nigeria (Nsor *et al*., 2022a).

The Maiganga reclaimed landscape may become more ecologically viable than its previous semi-pristine form (Nsor *et al*, 2022b). The introduction of three water bodies and tree plantation has attracted species like White faced whistling ducks, Fulvous whistling ducks, Knob billed goose etc., that spends most of their day in water and banks of the pond, swimming and sunbathing respectively. These and 20 other species recorded in this survey would have been absent in the overall Avifaunal checklist but for the creation of an artificial wetland and two ponds. Studies have shown that vegetation structure is a major determinant of habitat selection by birds (Suleiman *et al*., 2014; Turshak *et al*., 2011). The record of African Jacana exclusively in the artificial wetland is an indication of the importance of habitat heterogeneity and complexity (Turshak *et al*., 2011). The wetland has floating vegetation, marshy areas and tall Typha grasses that supports the fundamental niche of the Jacana and many other waders (Suleiman *et al*., 2014). The availability of several tree species

within the banks of the wetland and ponds makes it suitable for tree nesting birds like the Jacana to easily establish a thriving population.

The results also suggest that the period of existence (age of water body) has a positive association with wetland bird diversity and abundance. Accordingly, the older the water body, the more likely it is to have more species of birds than relatively newer ones. Previous studies had demonstrated a positive association between depth of water, size of wetland with Avifaunal abundance and diversity (Sulaiman *et al*, 2015). It is evident that more species will be attracted to Maiganga as the wetland becomes fully established to complement the two relatively older ponds. The diversity so far recorded highlights the need to maintain a heterogeneous landscape as this will offer the species most, or all of their daily ecological requirements for survival and persistence in a given habitat or landscape. For instance, the ecology and reproductive biology of most of the species in this study indicates that a heterogeneous habitat will cater for the needs of a diverse array of bird species. For instance, while some birds nest on bare or sparsely vegetated grounds (e.g. Black Headed Lapwings), other species nest on trees (e.g. Black Headed Heron, Hamerkop, Grey Heron etc.). In the same vein, several species make use of shrubs, bushes and tall grasses (e.g. Black Crown Night Heron, Squacco Heron), roofs, trees and cliffs (e.g. Abdim stork), burrows and termite nests (e.g. African Pygmy Kingfisher), Depressions on ground (e.g. White Face whistling ducks), Scrapes in mud, sand or shingles (Three Banded Plover), holes on trees (Fulvous whistling Ducks, Knob Bill Duck) etc., for their nesting needs.

The Avifaunal composition as seen in the results of this study is relatively diverse in terms of feeding guilds and underscores the need to maintain a sustainable approach to land use by adopting agricultural systems and practices that run contiguously with biodiversity conservation. For example, studies have shown that farmlands close to remnant natural vegetation and forest, benefit more ecosystem services from birds and bees than those far away (Tella *et al*, 2021). For instance, water birds like the Fulvous whistling ducks, forages on corn fields after harvest, defecating in the process thereby enriching the soil before the next planting season. Similarly, most water-dependent birds feed largely on both aquatic and terrestrial insects and can serve in pest control both at the pre-adult (larvae) and adult stage. The diet of the birds so far recorded include but not limited to amphibians, reptiles, invertebrates, mammals such as rabbits (eaten by Grey Heron), small birds (eaten by Grey Heron, Black Headed Heron, Black crown night heron), Crustaceans, as well as Phyto and zooplanktons. The implication of the diverse trophic and feeding guilds ranging from carnivores, herbivores, omnivores, insectivores, granivores and piscivores is that it highlights the presence of other taxa by proxy. In addition, it shows that more faunal diversity can be accommodated. These findings are green flags that serve as indicators of the health of the ecological system in the progressively reclaimed Maiganga post -mining landscape. The ecosystem service of pest control, water purification, and soil enrichment (fecal deposits) on land and water is an invaluable contribution to agricultural productivity and ecosystem balance (Elphick and Oring, 2003). Several studies have shown the importance of rice fields as a wintering site for waterbirds in different locations around the world (Lourenco and Piersma, 2008). Furthermore, rice fields are used by a variety of waterbirds as breeding sites (Fasola and Ruiz, 1996), although much more as foraging sites (Czech and Parsons, 2002). Nevertheless, there are also agricultural benefits derived from having waterbirds in rice fields, since they improve post harvest material decomposition (Bird *et al*., 2000) or weed control (Van Groenigen *et al*., 2003). In terms of environmental sanitation, the Hamerkop incorporate a variety of materials in building it's nest. This nest, apart from its size, being one of the largest bird nests among African bird species is composed of discarded fabrics, synthetic and non-biodegradable materials etc. This bird literally makes use of nearly anything it finds thereby ridding the environment of waste materials especially the non-biodegradable plastic waste.

We recommend more planting of trees around the wetland area and ponds as a water shed management strategy. Also, yearly assessments should be conducted at least twice (rainy and dry season), to monitor avian diversity and abundance.

CONCLUSION

Maiganga post coal mining landscape, especially the wetland is unarguably an important wintering ground for Palearctic and Afro-tropical Migratory birds. The presence of waterbirds that would otherwise be absent from Maiganga but for the presence of the ponds and artificial wetland underscores the importance of habitat engineering and reclamation especially in the face of human anthropogenic disturbance. The fact that these bird species are ecologically dependent on the wetland for their survival, calls for more conservation focused actions in Maiganga and similar landscapes.

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APPENDIX

Figure 3: Sedimentation Pond

Figure 4: Active Mine Pond

Figure 5: Artificial wetland