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THE ABUNDANCE OF PISCIVOROUS BIRDS AROUND THE FISH PONDS IN JOSEPH SARWUAN TARKA UNIVERSITY, MAKURDI

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ABSTRACT
This research aimed to investigate the abundance of piscivorous birds around the fish pond in Joseph Sarwuan Tarka University, Makurdi, with specific objectives including the assessment of species composition and abundance, identification of factors influencing distribution patterns in the Joseph Sarwuan Tarka Experimental Fish Farm. The sampling techniques included a Point Count method, Line Transect method, and direct observation, conducted twice daily over six weeks. Data collection involved timed surveys at dawn and dusk, species observation with binoculars photography with Nikon D7200, and avian location tracking using a BENQ GPS device. Analysis parameters included relative abundance, Shannon-Weiner Diversity Index, and Evenness Index. Statistical approaches such as mean, median, and standard deviation were employed to understand species-specific abundances and evenness. The results revealed seven piscivorous bird species in the study area, with Pied Kingfisher and Senegal Thick-Knee being the most frequently observed, each constituting 22.5% of total observations. Factors influencing abundance included habitat preferences, food availability, and sensitivity to disturbances. The discussion highlighted the diversity of piscivorous bird species, emphasizing the adaptability of Pied Kingfishers to various aquatic habitats as an indicator of aquatic ecosystem health. The study identified a diverse community of piscivorous bird species in the fish pond environment, reflecting the richness of the ecosystem. Recommendations for habitat protection, regular monitoring, community engagement, and evidence-based decision-making were proposed to ensure the long-term conservation of piscivorous birds and their ecosystems at Joseph Sarwuan Tarka University, Makurdi.
Keywords: *abundance, piscivorous birds, JOSTUM fish farm.*

INTRODUCTION
Piscivorous birds, also known as fish-eating birds, play a significant ecological role in aquatic ecosystems. Their presence and abundance around fish ponds can have both positive and negative impacts on fish populations and overall ecosystem dynamics. Understanding the abundance and distribution patterns of piscivorous birds in specific fish pond environments is essential for effective management and conservation efforts.

These are a diverse group of avian species that have adapted specialized beaks, talons, and hunting strategies to capture and consume fish as their primary food source (Burger, 2019). These birds can include various species such as herons, egrets, cormorants, and kingfishers (Delany *et al.,* 2019). Their feeding habits and foraging behaviours make them ecologically important as they can regulate fish populations and influence the structure of aquatic food webs (Post, 2018).
Studies conducted in different aquatic environments have demonstrated the significance of piscivorous birds in fish population dynamics. For instance, research by Rasmussen *et al.* (2016) in a freshwater lake found that piscivorous bird abundance had a direct negative correlation with fish populations, acting as a top-down predator control. Conversely, other studies have shown that the presence of piscivorous birds can lead to increased fish growth rates through selective predation on smaller and weaker individuals, resulting in a healthier and more robust fish population (Madsen *et al.,* 2021; Caro *et al.,* 2018).

However, the relationship between piscivorous birds and fish populations is complex and context-dependent. Several factors can influence the abundance of piscivorous birds around fish ponds. Food availability, including the abundance and diversity of fish species, is a crucial factor influencing their presence and abundance (Kear, 2015). Habitat characteristics, such as vegetation cover, water depth, and shoreline structure, also play a role in attracting and supporting piscivorous bird populations (Kushlan, 2019). Additionally, human activities, such as fishing practices and disturbance, can impact the foraging behaviour and abundance of piscivorous birds (Boyd *et al.,* 2019).

While research on piscivorous birds and their interactions with fish populations is well-documented, studies specifically focusing on fish ponds are relatively limited. Fish ponds represent controlled aquatic systems where human intervention is involved in fish production and management. Understanding the abundance of piscivorous birds in fish ponds is crucial for balancing their ecological role with fish production goals.

In the context of J.S Tarka University's fish pond in Makurdi, investigating the abundance of piscivorous birds is essential for effective management and conservation efforts. By quantifying their abundance and distribution patterns, potential ecological implications can be identified. This research aims to fill the existing knowledge gaps in piscivorous bird abundance in fish pond ecosystems and contribute to the broader understanding of their ecological role in the specific context of J.S Tarka University fish pond in Makurdi.

The abundance of piscivorous birds around fish ponds provides valuable insights into the ecological dynamics of these systems. The findings can inform management strategies, such as stocking programs and habitat management, to ensure a balance between fish production goals and the conservation of piscivorous bird populations.

By conducting research in J.S Tarka University's fish pond in Makurdi, this study will contribute to the scientific understanding of piscivorous bird ecology and aid in the sustainable management of fish pond ecosystems.

The lack of comprehensive research on the abundance of piscivorous birds around the fish pond at J.S Tarka University, Makurdi, has resulted in fragmented knowledge regarding their morphological adaptations, feeding behaviors, ecological roles, and habitat requirements. This knowledge gap limits our understanding of the ecological significance of piscivorous bird species and hampers the development of effective conservation and management strategies.

Therefore, this study aims to conduct a comprehensive examination, gathering detailed information through field observations, data analysis, and literature reviews. By providing a comprehensive profile of piscivorous bird species in the specific context of the J.S Tarka University fish pond, the study will contribute to filling the knowledge gap and support evidence-based decision-making, conservation initiatives, and the implementation of habitat protection measures. This research is crucial for ensuring the long-term survival of these avian predators and maintaining the overall health of the aquatic ecosystems they depend on.

MATERIALS AND METHODS

The Study Site Makurdi is bounded by Latitude 7°30'N and Longitude 8°10'E with a tropical Savannah climate showing distinct wet (April - October) and dry (November - March) seasons. The annual rainfall ranges from 973mm to 1,324mm 'Whereas, the mean monthly temperature ranges from 23°C to 32°C. The relief ranges from 100m above mean sea level to 133m above mean sea level and it lies within the River Benue flood plain Makurdi is underlaid by the recent alluvium and turonian rocks.

The vegetation of the study area is the Southern Guinea Savannah type. The Joseph Sarwuan Tarka Experimental Fish Farm is located East of the University's Raw Water booster station on the Northern bank of River Benue. It consists of six small ponds of 0.06ha each with a depth ranging from 120cm to 140cm. It has a small catchment area of about 30%- 35%. The ponds were constructed in 2016 on a gentle slope so that their full capacity is achieved both by excavation and by closures with Earth dykes. The ponds are arranged adjacent to each other so that the runoff is limited to the dykes delimiting the ponds. The dykes were grassed to 103 check soil erosion and mud turbidity. The primary water source to the pond is the Joseph Sarwuan Tarka University raw water booster station. The Eastern outlet carries water in a 6" AC pipe used for filling and maintaining the ponds. The fish ponds consist of alluvial and clayish soil. The alluvial soil occurs at the topsoil horizon. The alluvium is underlaid by sand clay (about 51% clay, 38% sand and 11% silt)

that has shale material. Oreochrornis naotieus, Clarias grviephinus and Helerotis nucleus were cultured in the ponds at a stocking density of 1.5m^2 (ratio 2:1:2: respectively). The fish were fed with 19% crude protein feed.

The fishponds were subjected to comprehensive surveying twice daily to assess the variety of bird species. This sampling process took place monthly, extending from September 2023 through November 2023. Each month, the study site was visited twice, constituting the primary sampling events. Three distinct methods were employed for these sampling occasions: the Point Count method, the Line Transect method, and direct observation. These techniques formed the foundation for gathering the necessary data regarding bird populations.

The data collection procedures during these sampling events involved specific practices. Surveys were timed at dawn (6 am to 10 am) and dusk (4 pm to 6 pm) to coincide with peak bird activity periods. Binoculars with 42x magnification were used for species observation, while a Nikon D7200 with a Sigma 150-600 mm lens facilitated bird photography. Avian locations were tracked using a BENQ GPS device.

Helms field guide to the birds of Western Africa (Borrow and Demey, 2004) was used for identification of the birds.

The analysis of piscivorous bird abundance around fish ponds in JOSTUM was determined by a range of statistical methods to derive meaningful insights. Fundamental descriptive statistics including mean, median, and standard deviation were used to determine the central tendency and variability of species-specific abundances. Shannon-Weiner Index (Shannon, 1948)was used to evaluate the bird species diversity and evenness in the proportion of each species occurring within the different fish ponds in the study area

(i) The relative abundance (RA) of each bird species was determined using the formula:

$$RA(\%) = (n / N) \times 100 \quad \ldots\ldots (1)$$

Where:

RA = Relative Abundance

n = the number of individuals of a particular species recorded during the surveys

N = Total number of individuals sighted of all bird species recorded during the surveys

The data was also used to assess diversity and evenness:

(ii) The following formula was used to calculate the Shannon diversity index:

$H' = - \Sigma (Pi * \ln (Pi))$ …… (2)

Where H′ is the Shannon-winner index, pi is estimated as ni/N, where ni is the proportion of the total population of the birds species and $N = -\sum ni$. This uses proportions rather than absolute abundance values to reduce the effects of order of magnitude difference in bird numbers between species (iii) Evenness Index (J) will be calculated as:

$J' = H'/\ln(S)$…… (3)

Where J' is the Evenness index, H′ is the Shannon winner diversity index and S is species richness. This index gauges the equitability of species abundances within the ecosystem.

The incorporation of spatial analysis techniques contributed to identifying potential geographic patterns in species distribution. The selection of these techniques attuned to the specifics of the available data, research design, and consultation with domain experts, ensuring a robust analysis of piscivorous bird abundance patterns around the fish ponds in JOSTUM.

RESULTS

Tables 1 and 2 below provide an analysis of the abundance and distribution of Piscivorous bird species around Fishponds in JOSTUM.

Table 1: Species Composition and Abundance of Piscivorous Birds

S/N	Common Name	Scientific Name	Family	$\bar{x}$	Sd	Sd Error	Percentage Occurrence
1.	Pied Kingfisher	*Ceryle rudis*	Alcedinidae	4.88	1.96	0.69	22.5
2.	African Black Duck	*Anas Sparsa*	Anatidae	1.75	1.58	0.56	12.6
3.	Little Ringed Plover	*Charadrius dubius*	Charadriidae	2.5	1.60	0.57	13.5
4.	Senegal Thick-Knee	*Burhinus Senegalensis*	Burhinidae	4.34	2.32	0.82	22.5
5.	Goliath Heron	*Ardea goliath*	Ardeidae	2.00	1.07	0.377	11.7
6.	Hammerkop	*Scopus umbrette*	Ardeidae	0.9	1.13	0.4	4.5
7.	White-faced Tree-Duck	*Dendrocygna viduata*	Anatidae	1.75	2.05	0.73	12.6
	Total						**100**

Source: Field Work, 2023

Table 1 shows the species composition and abundance of piscivorous birds in the study area, The mean abundance ($\bar{x}$) indicates the average number of individuals observed, while the standard deviation (Sd) measures the degree of dispersion around the mean. The standard error (Sd Error) reflects the precision of the mean estimate. Additionally, the percentage occurrence signifies the proportion of each species relative to the total observed.

The Pied Kingfisher (*Ceryle rudis*) had the highest mean abundance of 4.88 individuals, with a moderate standard deviation of 1.96, suggesting a relatively consistent presence. The African Black Duck (*Anas Sparsa*) follows with a mean abundance of 1.75 and a higher standard deviation of 1.58, indicating more variability in its occurrence. The Little Ringed Plover (*Charadrius dubius*) and Senegal Thick-Knee (*Burhinus Senegalensis*) have mean abundances of 2.5 and 4.34, respectively, with varying degrees of variability. Goliath Heron (*Ardea goliath*) and White-faced Tree-Duck (*Dendrocygna viduata*) display mean abundances of 2.00 and 1.75, respectively, with associated standard deviations and standard errors.

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The total percentage occurrence sums to 100, emphasizing that these species collectively represent the entire observed piscivorous bird population in the study area.

Table 2: Factors Influencing the Abundance and Distribution Patterns of Piscivorous Birds in the Study Area

S/N	Bird Species	Total Frequency	Percentage Occurrence	Influencing Factors
1.	Pied Kingfisher	25	22.5	1.Prefers freshwater bodies with fish-rich environments. 2. Requires suitable perching sites near water for hunting. 3.Abundance of fish, especially smaller species, influences foraging success.
2.	African Black Duck	14	12.6	1. Prefers wetlands with ample vegetation for cover and nesting. 2.Prefers shallower waters for dabbling and feeding. 3.Sensitive to disturbances during nesting and foraging, impacting distribution.
3.	Little Ringed Plover	15	13.5	1. Frequents shores and mudflats for foraging. 2. Prefers open areas for breeding, with minimal vegetation. 3. Feeds on aquatic insects; abundance influences presence.
4.	Senegal Thick-Knee	25	22.5	1. Nocturnal forager; suitable habitats for nighttime hunting are essential. 2. Prefers open areas with short grass for feeding. 3.Vulnerable to human disturbances; avoids areas with high human activity.
5.	Goliath Heron	13	11.7	1.Prefers larger wetlands with abundant fish resources. 2.Requires tall vegetation for nesting and roosting. 3. Distribution influenced by the presence of suitable fish in the habitat.
6.	Hammerkop	5	4.5	1. Wetland Vegetation: Prefers habitats with dense vegetation for nesting. 2. Foraging Behavior: Efficient forager; influenced by prey availability, including fish, frogs, and insects. 3. Habitat Stability: Prefers stable habitats for nesting and long-term residency.
7.	White-faced Tree-Duck	14	12.6	1.Prefers shallow waters for dabbling and feeding. 2. Requires shoreline vegetation for cover and nesting. 3.Sensitive to disturbances during breeding, impacting nesting success.

Table 2 shows the factors influencing the abundance and distribution patterns of piscivorous birds in the study area. The data showcases six bird species, including the Pied Kingfisher, African Black Duck, Little Ringed Plover, Senegal Thick-Knee, Goliath Heron, Hammerkop, and White-faced Tree-Duck. For each species, the table provides the total frequency and percentage occurrence, along with specific influencing factors. For instance, the Pied Kingfisher is attracted to freshwater bodies rich in fish, requiring suitable perching sites and exhibiting a dependence on the abundance of smaller fish for foraging success. The African Black Duck prefers wetlands with ample vegetation for cover and nesting, along with shallower waters for feeding, and is sensitive to disturbances during nesting and foraging. The other bird species also show distinct preferences and dependencies, such as the Little Ringed Plover's affinity for mudflats and open breeding areas, and the Senegal Thick-Knee's vulnerability to nocturnal disturbances. Overall, the table offers a comprehensive insight into the ecological preferences and behaviours of the studied piscivorous bird species concerning their abundance and distribution in the given environment.

Table 3: Summary of Piscivorous Birds sighted in JOSTUM Ponds

Common name	Scientific name	Family	Abundance	Frequency	Relative Abundance
Pied Kingfisher	*Ceryle rudis*	Alcedinidae	25	25	0.3846
African Black Duck	*Anas Sparsa*	Anatidae	15	14	0.2307
Little Ringed Plover	*Charadrius dubius*	Charadriidae	9	15	0.1384
Senegal Thick-Knee	*Burhinus Senegalensis*	Burhinidae	7	25	0.1076
Goliath Heron	*Ardea goliath*	Ardeidae	5	13	0.07692
Hammer kop	*Scopus umbrette*	Ardeidae	3	5	0.0461
White-faced Tree-Duck	*Dendrocygna viduata*	Anatidae	1	14	0.0153

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Table 4: Summary of Pi*ln(Pi)

Common name	Pi	ln(pi)	Pi*ln(Pi)
Pied Kingfisher	0.38	-0.967	-0.367
African Black Duck	0.23	-1.469	-0.337
Little Ringed Plover	0.13	-2.040	-0.265
Senegal Thick-Knee	0.10	-2.30	-0.23
Goliath Heron	0.076	-2.57	-0.195
Hammer kop	0.04	-3.21	-0.128
White-faced Tree-Duck	0.01	-4.60	-0.046

H= 1.568

DISCUSSION

A total of 7 bird species belonging to 5 families were encountered on the entire JOSTUM fishpond site. Notably, the Pied Kingfisher (*Ceryle rudis*) had the highest abundance, the highest frequency and the sighting index, followed by the African Black Duck (*Anas Sparsa*) with abundance while the White-faced Tree-Duck (*Dendrocygna viduata*) had the least abundance. The overall, Shannon Wiener diversity index was H` = 1.57.

The notably high mean abundance of the Pied Kingfisher (*Ceryle rudis*) at 4.88 individuals indicates a consistent presence of this species in the environment. This aligns with research by Johnson *et al.* (2020), where an increased abundance of Pied Kingfishers was associated with favourable aquatic conditions and prey availability. The moderate standard deviation of 1.96 suggests relatively stable occurrences, supporting the notion that the Pied Kingfisher thrives in this particular habitat.

The African Black Duck (*Anas Sparsa*) exhibits a lower mean abundance of 1.75 and a higher standard deviation of 1.58, implying greater variability in its occurrence. This finding is consistent with studies by Smith, *et al.* (2018), which highlighted the sensitivity of African Black Ducks to habitat changes and human disturbances. The species' preference for wetlands with ample vegetation aligns with its ecological requirements, as indicated by the standard deviation and standard error values. Such variability in abundance underscores the species' adaptability to specific environmental conditions and emphasizes the importance of habitat preservation.

In Table 2, the factors influencing the abundance and distribution patterns of piscivorous birds further elaborate on their ecological preferences. The provided data underscores the importance of understanding specific habitat requirements for each species. For instance, the Pied Kingfisher's preference for freshwater bodies with abundant fish aligns with findings from a study by Chen, *et al.* (2019), emphasizing the importance of prey availability in shaping the distribution of piscivorous birds. The information presented in Table 2 contributes to a more comprehensive understanding of the ecological dynamics, preferences, and vulnerabilities of piscivorous birds in the study area, providing a foundation for targeted conservation and management efforts.

CONCLUSION

The results of this study revealed the presence of seven distinct piscivorous bird species belonging to five different bird families. This reflects the richness of the fish pond environment and is consistent with findings in other wetland ecosystems. The study identified the most frequently occurring species, such as the Pied Kingfisher (*Ceryle rudis*) and Senegal Thick-Knee (*Burhinus Senegalensis*), each constituting 22.5% of the observed individuals. The high abundance of Pied Kingfishers may serve as a valuable indicator of aquatic ecosystem health due to their adaptability to various aquatic habitats. On the other hand, the Hammerkop (*Scopus umbrette*) was the least frequently observed species, representing only 4.5% of the total observations. This lower abundance may be attributed to specific nesting preferences or solitary behaviour.

Based on the findings of this study, several recommendations can be made to support the conservation of piscivorous bird species and the aquatic ecosystems they inhabit at Joseph Sarwuan Tarka University, Makurdi:

1. **Habitat Protection:** Given the diversity of piscivorous bird species observed, it is imperative to implement habitat protection measures around the fish pond. This includes preserving the natural features of the habitat, maintaining water quality, and conserving appropriate nesting sites. Such measures will contribute to the long-term conservation of these avian species and their ecosystems.
2. **Monitoring and Research:** Regular monitoring of piscivorous bird populations in the study area is essential to track any changes over time. Future research should focus on understanding the specific habitat characteristics and food availability preferences of these species, as well as the impact of human activities on their populations.
3. **Community Engagement:** Involving local communities and university stakeholders in the conservation efforts can help raise awareness about the significance of these birds and their role in maintaining healthy aquatic ecosystems. Engaging the community in conservation initiatives can lead to improved protection of the study area and its avian inhabitants.

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