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Effects of Wetlands Type and Size on Bird Diversity and Abundance at the Hadejia – Nguru Wetlands, Nigeria

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Abstract: *Bird diversity and abundance at the Hadejia – Nguru Wetlands, Nigeria was studied within an eleven week period in 2011 to determine the effects of wetlands size and type. Thirty two wetlands within the Hadejia – Nguru Wetlands complex were surveyed. The study involved recording birds at predefined wetlands within the Hadejia- Nguru wetlands complex. Point counts were used to survey birds. Bird count was from 06:30h to 11:00h in the morning and 16:00h to 18:00h in the evening. Data collected was explored for normality and Shannon-Wiener index was used to determine the diversity. Bird diversity and abundance determined by counting birds was related to wetlands size and type. A total of 110,162 of 119 bird species were recorded. Bird species richness and diversity varied across wetland types: Marshes had the highest number of bird species compare to Ponds and lakes whereas bird diversity was significantly higher in ponds than lakes but was similar to the diversity of marshes. Wetlands size decreased bird diversity.*

Keywords: *Marsh, Pond, Lake, Size, Wetlands.*

1. INTRODUCTION

Wetlands are one of the most productive ecosystems in the world [1]. They provide important functions in erosion control, flood control, aquifer recharge and nutrient absorption [1]. Wetlands are important water filters (www.ducks.ca). They also provide habitats for large number of fauna and flora [2]. The vast numbers of invertebrates such as worms and small shellfish contained in the mud provide food for internationally important populations of migratory water birds [3].

Widespread use of wetlands and their resources is common among diverse bird taxa of the world [4]. Water birds have some unique features that enable them survive better in their environment. These adaptations make birds better equipped as a group to exploit wetland resources. They are also conspicuous and so are often used as indicator of conditions within a wetland ecosystem [4]. Wetlands birds perform important functions in the ecosystem as main vectors maintaining biotic connection between catchments for aquatic plant and invertebrates [5], but also reflect the ecosystem functionality of the habitat: birds are therefore environmental indicators [6].

One of these very important wetland areas in West Africa is the Hadejia-Nguru Wetlands (HNW), an extensive area of floodplain located in the North-Eastern Sudano-Sahelian zone of Nigeria. The Wetlands harbour large numbers of diverse species of wildlife, particularly Palaearctic and Afrotropical migrant water birds. The wetlands support over 60 water bird species from 15 families [7] and are considered to be of international importance as habitats for waterfowl populations. A total of 377 wetland bird species have been recorded in the wetland and a total of 259,767, 201,133 and 324,510 water birds were recorded during January water bird censuses in 1995, 1996 and 1997, respectively [8].

Wetlands such as Hadejia-Nguru support large populations of waterbirds because of a suite of abiotic and biotic characteristics. There have been many studies that have identified key landscape scale habitat variables in relation to wetland bird abundance [9], [10]. Wetland size [11], water depth [12], perimeter-to-area ratio [13], interspersion [14] and various vegetation metrics [15], [16] and other wetland-scale variables can affect the abundance and reproductive success of wetland breeding birds. Among these variables wetland size is seen as the most important [17], [18]. This study investigates the effect of wetlands size and type on determining the abundance and community of wetland birds at the Hadejia – Nguru wetlands,

2. MATERIAL AND METHOD

2.1. Study Area

This research was carried out at the Hadejia – Nguru Wetlands (HNW) which lies along a central coordinates of Longitude 10° 33' East and Latitude 12° 39' North, with altitude of 152 – 305m. It is an extensive area of floodplain located in the north-eastern Sudano-Sahelian zone of Nigeria, covering an area of approximately 3,500 square kilometres. The Hadejia-Nguru Wetlands are located in the middle reaches of the Hadejia and Jam'are rivers, where the two rivers converge. The two rivers originate at the Jos Plateau and flow northwards in well established river beds on impermeable bedrock where they enter the sand and gravel deposits of the very flat Chad formation. The rivers start to flow less swift and cause seasonal inundations shortly after the rainy season. This seasonal inundation known as flooding is most pronounced in the area between the towns of Hadejia, Nguru, Gashua, Baturia, and Katagum which is over 5,100km2 in size. This area consists of permanent and seasonal locustrine lakes and a complex pattern of palustrine floodplain, mud-flats and marshes. The Yobe River, which is formed by the convergence of the Jam'are and Hadejia rivers, leaves the wetlands at Gashua and drains into Lake Chad, for a detailed description of the areas origin, hydrology, economy and ecology, [7] can be referred to.

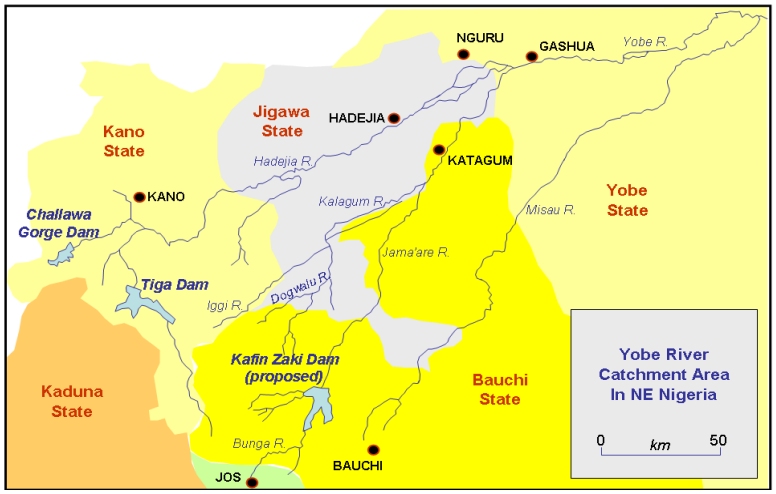

Fig1. *Map of Hadejia-Nguru Wetlands*

3. METHOD

This survey was carried out from May 17th – August 2nd, 2009. Point counts were used to record birds within study sites [6],[19],[20]. This involved recording birds at predefined wetlands within the Hadejia- Nguru wetlands complex. Point counts were used because it allows the observer travel within the area and stop at predefined spots, allow the bird's time to settle, and then record all the birds seen or heard for a predetermined time, ranging, at the extremes, from 2 to 20 min. Other advantages are: Point count suits populations at higher density and more species rich as well as suited to situations where access is restricted. Although time is lost moving between points, counts gives time to spot and identify shy and cryptic birds.

Bird count was from 06:30h to 11:00h in the morning and 16:00h to 18:00h in the evening. Upon arrival at a site, care was taken not to flush or disturb the birds. Global Positioning System (GPS) was used to mark location of each point. A total of 70 point counts were carried out across the wetlands. Sites were visited in the morning and repeated in the evening. These sites were revisited, in the first visit; number of points within each surveyed wetland depends on wetlands size (minimum of 1 and maximum of 11 points). Each point was surveyed for a period of 10 minutes with 2 minutes wait period and 150m interval between points. In the second visit, these points were reduced to two at most and surveyed for a period of 10 minutes in 6 repeats at each point. But for wetlands with more than four points (5 to 11), the number of points and methods remained the same as in the first visit.

Wetland types were recorded as Lakes, Ponds and Marshes as a result of variation in their depth. Wetland depth was measured to nearest 0.1cm using a measuring stick that was placed at the middle of each wetland and recorded in centimeters. For large and inaccessible wetlands, size was estimated in hectares, while for small and accessible Wetlands, size was measured by walking along the

boundaries with a Garmin GPS 60 using its tracking function. The data was then downloaded to a computer to create a digital map using Arc View 3.1.

Bird identification was aided by the use of a pair of Binoculars (8 × 40) and a field guide to West African Birds [21].

4. DATA ANALYSIS

Data was analyzed using R-Statistical package (version 2.12.0). The data was first explored for normality. The total number of birds was calculated as the number of birds seen plus the number of birds heard. Shannon-Weiner diversity index was used to measure species diversity [22].

$$H = -\sum_{i=1}^{s} \rho i \ln(\rho i)$$

- S: total number of species
- ρi : the proportion of the total number of specimens
- "i" as a proportion of the total number of species for all the species sampled in the ecosystem.

Linear Mixed Effect models (LME) was used to test the effect of variables on bird species diversity and abundance. Point was set as a random effect in other to account for unequal sampling and repeated measurements. Two separate models were used to test the effect of wetlands size and type on bird abundance and diversity. Mean number of birds seen and diversity index were dependent variables (in two separate models) while wetlands size and type were the explanatory variables. Models of bird abundance and diversity were run with the aforementioned explanatory variables; non-significant variables were deleted one after the other following the AIC value until the smallest AIC was reached.

Raw data were used to illustrate results. Tukey multiple comparison tests were used to evaluate which factors were significantly different and all P values quoted are adjusted using the single-step Scheffe method. Box plots were plotted to show the relationship between species abundance and diversity with categorical variables such as wetlands types (Ponds, Marshes, and lakes), while scatter plots were used to show relationship between continuous variables such as wetlands size.

5. RESULTS

Total of 110162 of 119 bird species from 32 wetlands were recorded which is an indication that the area has a considerably high number and diversity of bird species.

Wetland sizes do not have a significant effect on bird species abundance, but had a significant effect on bird diversity (Figure 2). For every 2 hectares increase in wetlands, bird diversity decreases by 0.02.

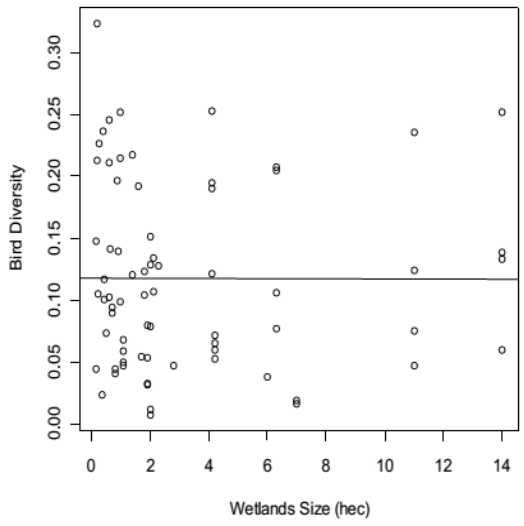

Fig2. *Relationship between bird diversity and Wetlands size.*

Wetland types were found to have a significant effect both on bird abundance (Figure 3) and diversity (Figure 4). Marshes (15.3 ± 3.7) had the highest number of bird species compare to Ponds (6.2 ± 4.5) and lakes (7.0 ± 3.3) while differences between Lakes and ponds were insignificant. Bird diversity was significantly higher in ponds (0.1 ± 0.03) than lakes (0.02 ± 0.03), but was similar to the diversity of marshes (0.07 ± 0.03), while diversity between marshes and lakes was similar.

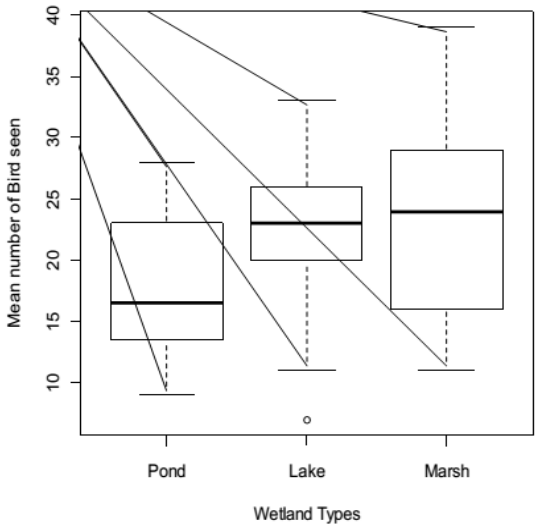

Fig3. *Relationship between mean number of bird seen and wetland types.*

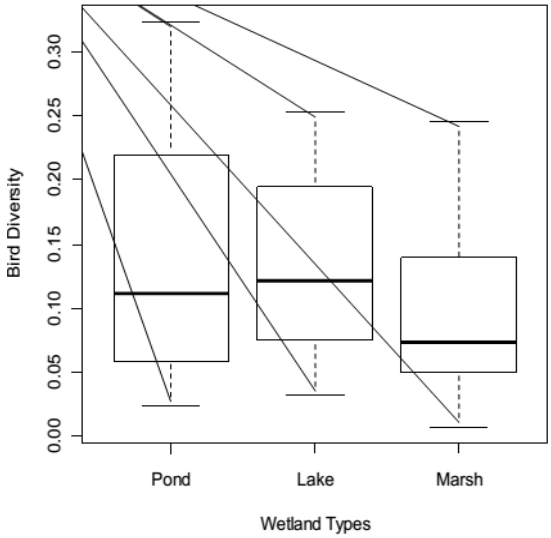

Fig4. *Relationship between bird diversity and Wetland types.*

6. DISCUSSION

Total of 110162 of 119 bird species from 32 wetlands recorded is an indication that the area has a considerably high number and diversity of bird species. Number of bird species may increase as a result of increase in habitat heterogeneity [23], [24]. A more heterogeneous range of habitats allow the co-occurrence of more species because they meet the habitat requirements of more species. Also more species may occur in areas of more diverse habitat because of spatial segregation that reduces competition [25].

This study found that wetland size had no significant effect on bird abundance. Increased number in bird abundance with wetlands size has been reported for ducks in small prairie and forested wetlands [23]. More so, [26] found that Swamp Sparrows increased with increasing wetland size in Michigan. Increased species richness with size of wetland has been reported for birds in many types of wetlands and lakes [27], [28], [29], [30]. On the contrary, my result shows bird diversity decreases with increase in wetlands size i.e for every 2 hectares increase in wetlands, bird diversity decreases by 0.02. Though, sizes of wetlands are often a crucial determinant of its species richness and abundance [31]. Decreasing diversity and increasing numbers in response to isolation were observed by [17] who found that wetland size and isolation account for 75% of the variation in species richness observed

within prairie marshes. According to [32], bigger wetlands can provide more microhabitats, thereby attracting a greater number of species. However [33] and [7] showed that smaller wetlands maintained higher waterbird density and diversity than larger ones.

In a study of waterbird use of Florida Lakes, species richness increased with surface area of the lake, the relationship was thought to be due to an increased sampling area or near-shore habitat heterogeneity [29]. [28] Found that piscivorous birds were particularly sensitive to wetland surface water area and suggested that larger wetlands may provide more open water for diving species. Fish abundance and diversity on small lakes (<50 ha) may also be positively correlated with wetland area [34].

Wetland types were found to have a significant effect both on bird abundance and diversity. Marshes had the highest number of bird species compare to Ponds and lakes. Gregarious species like cattle egret (*Bubulcus ibis*) which had the highest number were recorded in marsh wetlands where herd of cattle graze, this could possibly account for the higher number of bird species in marsh wetlands. Non-diving waterbirds, such as wading and dabbling birds, generally require shallow water to forage, and their access to foraging habitat is limited by water depth. Species like African Jacana (*Actophilornis Africana*) were recorded more in marsh wetlands, this is because water depth affects the net energy intake of waterbirds because foraging efficiency decreases with increasing water depth. [35] Indicated that for wading birds that forage on prey in the water column, the locomotion of the birds might be slowed in deep water because of increased water resistance with depth. The number of bird species was insignificantly different in Lakes and ponds. It is unlikely that a single wetland will provide suitable habitat for all species of waterbirds [36], [4] or for all the annual life cycle needs of a single species (i.e., nesting, migration, and moulting or wintering habitat needs, [4]. Likewise, birds select microhabitats such as specific foraging or nesting sites within the chosen wetland complex that will meet their immediate needs [4].

Habitats with deeper water support the greatest density of waterbirds in areas where diving birds are dominant [37], and where the wetlands provide roosting sites for waterfowl [38]. Bird diversity was significantly higher in ponds than lakes, but was similar to the diversity of marshes while diversity between marshes and lakes was insignificant. Most ponds at the Hadejia – Nguru wetlands complex were associated with human activities and were mostly found around villages and farms. Majority of farmland and upland bird species in addition to waders and diving species recorded in ponds may be responsible for the higher bird diversity vis-à-vis ponds with gentle sloping sides can also increase topographical variation and attract both short and long legged wading birds [39].

7. CONCLUSION

Bird abundance and diversity is fundamentally affected by attributes of wetland size and types. Although the wetlands face pressures from anthropogenic activities, their effect on bird diversity and abundance is apparently of small biological effect.

8. RECOMMENDATION

The results of this study have further relevance when considering conservation of the Hadejia - Nguru wetlands and its bird. International bodies such as Ramsar Convention, Birdlife International, RSPB, Wetlands International and other donor agencies should come with technical and financial assistance to improve the management of the wetlands.

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