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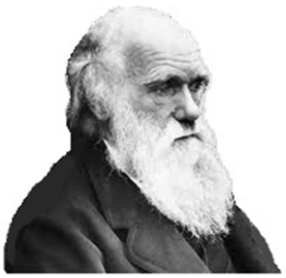

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Species richness and diversity of birds in Kainji Lake National Park, Nigeria

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ABSTRACT

This study focused on bird species richness and diversity in Borgu sector, Kainji Lake National Park, Nigeria. The study was undertaken to derive information on the species of birds utilizing the study area, and to determine the relative abundance and diversity of birds in the study area. The Line transect methods was used for the study. The result revealed that the present number and kinds of birds species in all the ranges sampled is very low, with Range 4 having the highest bird's species richness of (22.29%). A total of 3255 birds were inventoried in all the ranges. These belonged to 44 species from 28 families. Family *Ardeidae* contain the highest number of 593 birds, followed by the family *Sturnidae* and *Numididae* - having 392 and 351 birds, respectively. The findings indicate that birds' abundance is very low with many bird species displaying 0% relative abundance. The low abundance and diversity of birds indicates that Kainji Lake National Park birds in relation to habitat characteristics is very poor. *Furthermore, t*he result from the test prediction Output shows that the estimators predict that (after 5 samples) there will be 41 birds' family species in the habitat in future, since they (ACE, ICE, Chao2, Jack2) level off at 41. The result indicate that only the same birds species, instead of new birds species are presently seen in Kainji Lake National Park, which are poorly represented among 28 families sampled. It is, therefore, recommended that environmental education campaign on birds' conservation and protection should be carried out in the communities around the park so as to persuade residents to stop killing birds.

***Keywords*:** Birds, Species richness, Diversity, Kainji Lake National Park

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1. INTRODUCTION

Due to massive loss of native habitats around the globe, biodiversity is rapidly being eroded. Therefore, it is critical to understand which species will survive human onslaught and which will not. We also need to comprehend the composition of new communities that arise after the loss or disturbance of native habitats (Sodhi, 2005). The number of species that occurs in a particular area is called its species richness. Bird species richness therefore is the total number of bird species recorded in a habitat. It is just one of many measures of biodiversity used by many conservationists to survey the biodiversity of plants and animals in a given habitat (Sodhi, 2005). Kainji Lake National Park has a distinct physical and biological characteristics for instance the rivers in the park presents a unique tourist features that when properly harnessed could attract a lot of freshwater researchers as well as general tourists to the area, because this rivers has an impressive collection of birdlife unique around it, which serve as a complete tourist resort. This study therefore is to examine bird's species richness and diversity not only along the river side but in the entire Kainji Lake National Park. Current and adequate information on birds' species of Kainji Lake National Park is limited. Also there is relatively little information on the population distribution, abundance, and trends for Kainji Lake National Park bird's species. Thus more effort needs to be made to determine population trends of certain species for which there is currently insufficient information. This study will help enhance decision-making by resource managers and governments. The objectives includes to: Provide the species list of birds' species utilizing the study area, determine the abundance of birds' species utilizing the study area and determine the diversity of birds' species in the study area.

2. MATERIALS AND METHOD

2. 1. The study area

Kainji Lake National Park is located between latitudes 90°40'N and 10°30'N and longitudes 30°30'E and 50°50'E. The park covers a total area of 5340.82 sq·km. it is made up of two non-contiguous sectors, the Borgu and Zugurma sectors. The Borgu sector lies astride the Borgu and Baruten local government area of Niger and Kwara states respectively and covers an area of 3,970.02 sq.km. It is bordered in the east by the Kainji Lake and in the west by the Republic of Benin. The Zugurma sector on the other hand, occupies a relatively smaller area of 1,370.80 sq.km and is situated in the Mariga local government area of Niger state. This sector is bordered by Kontagora River on the Northwest side and by the Manyara River on the North side (Afolayan 1978).

The park lies at the extreme west of the wooded savanna region of Niger state, Nigeria, characterized by relatively sparse population and abundant wild animals. The major vegetation type of the Kainji lake National park is typically Northern Guinea Savanna Ecotype. The vegetation types are; *Burkia Africana / Detarium,* woodland, *Afzelia africana* woodland, *Isoberlinia tomentosa* woodland, *Terminalia macroptera* woodland, *Diospyros mespeliforms woodland,* Acacia complex, Oli complex and Riparian forest. Some of the fauna species found in the park includes; Roan antelope, Hippotamus- *Hippotragus equines,* Kob-*Kobus kob,* Serval cat - *Felis serval,* Ratel, Honey badger - *Mellivora capensis,* Hare - *Lepus capensis,* Green Monkey - *Cercopithecus aethiops,* - African Manatee - *Trichechus senegalensis,* Lizard buzzard - *Kaupifalco monogrammnicus* (Afolayan 1978).

2. 2. Study design

A 4 km length transect was established in five ranges namely Range 1 (*Burkia/Detarium macrocarpum* woodlands), Range 2 (*Taminalia macroptera* woodland), Range 3 (*Afzelia africana* woodland), Range 4 (*Isobelenia tomentosa* woodland) and Range 5 (Riparian forest/woodland) and was used to assess the birds species richness and diversity in Kainji Lake National Park. The project was carried out for a period of four (4) months. February- May. Each site was visited five (5) days in the month. Period of visit was between 7:00 am – 10:00 am in the morning and 4.00 pm - 6.00 pm in the evening. The materials used include: Bird field guide books (Serle and Morel, 1984; Nik and Ron, 2007), Field note book, and a pair of Binocular.

2. 3. Data collection techniques

Birds inventory

Both direct and indirect methods of census were used. Line transects was established using a sampling procedure (Plumptre& Reynolds, 1994). Line transects was chosen as sampling units due to the open nature of much of the area (Bibby *et al.* 2000).

Transects was walked at approximately 2.5 km/h, counting all groups of birds seen. The distance from the transect line to the centre of the group seen was measured and the number of birds seen in the group recorded (Plumptre & Reynolds 1994). The observer walking along transects and, on sighting bird's species waits for a few minutes to allow the distributed birds to settle. Counting was carried out for 10 minutes. Each individual bird was counted once and all birds seen or heard out-side the band but was identified and recorded, Birds, Indices, Feathers, calls was also be recorded.

2. 4. Data analysis

Objective 1 was achieved using descriptive analysis.

Bird species richness was calculated for each study site using Microsoft Excel. The relative abundance of bird species in each habitat was calculated thus:

$$A = n/N \times 100$$

where: A = Relative abundance
n = Quantity of each species present
N = Quantity of all species present.

Diversity of birds' species was achieved using Simpson's (1949) diversity index.
The index is mathematically stated thus:

$$D_{Sim} = \sum_{i-1}^{S} \frac{n_1(n_1 - 1)}{N(N - 1)}$$

where: D_{Sim} = Simpson's diversity index
n_1 = Total number of individuals in each species
N = Total number of individuals in all species

S = Number of species present
∑ = Summation sign.

Estimate S model was used to test the predictions on birds' species richness and diversity in the study area (Colwell, 2009).

3. RESULT AND DISCUSSION

The findings from this study show that a total of 3255 birds were inventoried in all the ranges belonging to 44 species from 28 families. Family Ardeidae contain the highest number of birds totaled 593 species followed by family Sturnidae and Numididae having 392 and 351 birds respectively. Hence throughout the world, there are over 9,000 species of birds of which Nigeria has approximately 840 species (Nason, 1992).

The result in Table 1 shows that the present number and kinds of bird species in all the ranges sampled is very low. With Range4 having the highest (22.29%) bird's species richness (the total number of species within a habitat) followed by Range2, (20.48 %,) bird species richness, while Range5, with (18.07%) has the lowest richness.

Table 1. Checklist of bird species in the study area.

S/N	Family name	Common name	Scientific name	Authority	Ranges				
					1	2	3	4	5
1	Accipitridae	African Harrier-hawk	*Polyboroides typus*	Smith, 1829	-	-	x	x	-
2	Accipitridae	Black Eagle	*Ictinaetus malayensis*	(Temminck, 1822)	-	-	x	-	-
3	Accipitridae	Hooded Vulture	*Necrosyrtes monachus*	(Temminck, 1823)	-	-	x	x	-
4	Alcedinidae	Little Paradise-kingfisher	*Tanysiptera hydrocharis*	(Gray, 1858)	x	x	x	x	x
5	Alcedinidae	African Pygmy-kingfisher	*Ceyx pictus*	(Boddaert, 1783)	x	x	x	x	x
6	Apodidae	Common Swift	*Apus apus*	(Linnaeus, 1758)	x	x	x	x	-
7	Apodidae	African Black Swift	*Apus barbatus*	(Sclater, 1865)		x	x	x	-
8	Ardeidae	Little Egret	*Egretta garzetta*	(Linnaeus, 1766)	x	x	x	x	x
9	Ardeidae	Cattle Egret	*Bubulcus ibis*	(Linnaeus, 1758)	x	x	x	x	x
10	Ardeidae	Rufous-bellied Heron	*Ardeola rufiventris*	(Sundevall, 1851)	x	x	-	-	-
11	Ardeidae	Grey Heron	*Ardea cinerea*	(Linnaeus, 1758)	x	-	-	x	-
12	Bucorvidae	Abyssinian Ground-hornbill	*Bucorvus abyssinicus*	(Boddaert, 1783)	x	-	-	-	x
13	Bucorvidae	African Grey Hornbill	*Tockus nasutus*	(Linnaeus, 1766)	x	x	-	-	x

14	Charadriidae	Hooded Plover	*Thinornis rubricollis*	(Gmelin, 1789)	-	-	x	x	x
15	Columbidae	Mourning Dove	*Zenaida macroura*	(Linnaeus, 1758)	x	x	x	-	x
1 6	Columbidae	Laughing Dove	*Stigmatopelia senegalensis*	(Linnaeus, 1766)	x	x	-	x	x
17	Columbidae	Red-eyed Dove	*Streptopelia semitorquata*	(Rüppell, 1837)	-	x	x	x	-
18	Columbidae	Vinaceous Dove	*Streptopelia vinacea*	(Gmelin, 1789)	x	x	x	x	-
19	Coraciidae	Abyssinian Roller	*Coracias abyssinicus*	(Hermann, 1783)	x	x	x	x	x
20	Cuculidae	Senegal Coucal	*Centropus senegalensis*	(Linnaeus, 1766)	x	x	x	x	x
21	Hirundinidae	Grey-rumped Swallow	*Pseudhirundo griseopyga*	(Sundevall, 1850)	-	x	-	x	x
22	Laridae	Lesser Crested Tern	*Sterna bengalensis*	(Lesson, 1831)	-	-	x	x	-
23	Malaconotidae	Sooty Boubou	*Laniarius leucorhynchus*	(Hartlaub, 1848)	-	x	x	x	-
24	Meropidae	White-throated Bee-eater	*Merops albicollis*	(Vieillot, 1817)	x	x	x	x	x
25	Musophagidae	Western Grey Plantain-eater	*Crinifer piscator*	(Carriker, 1933)	x	-	-	-	x
26	Nectariniidae	Scarlet-chested Sunbird	*Nectarinia senegalensis*	(Linnaeus, 1766)	-	x	-	x	-
27	Numididae	Helmeted Guineafowl	*Numida meleagris*	(Linnaeus, 1758)	x	x	x	x	x
28	Passeridae	Rufous-tailed Weaver	*Histurgops ruficaudus*	Reichenow, 1887	-	x	x	-	x
29	Phasianidae	Stone Partridge	*Ptilopachus petrosus*	(Gmelin, 1789)	x	x	x	x	x
30	Phasianidae	Black Francolin	*Francolinus francolinus*	(Linnaeus, 1766)	x	x	x	x	x
31	Picidae	Crimson-crested Woodpecker	*Campephilus melanoleucos*	(Gmelin, 1788)	-	x	-	x	x
32	Platysteiridae	Short-tailed Batis	*Batis mixta*	(Shelley, 1889)	x	x	x	x	x
33	Ploceidae	Black-billed Weaver	*Ploceus melanogaster*	Shelley, 1887	x	x	x	x	x
34	Psittacidae	Dusky Parrot	*Pionusfuscus*	(Müller,177 6)	x	-	-	x	-
35	Scopidae	Hamerkop	*Scopus umbretta*	Gmelin, 1789	x	-	-	x	-
36	Strigidae	Tawny-browed Owl	*Pulsatrix koeniswaldiana*	(Bertoni&B ertoni, 1901)	x	x	x	x	x
37	Sturnidae	Purple Glossy-starling	*Lamprotornis purpureus*	(Müller, 1776)	x	x	x	x	x
38	Sturnidae	Greater Blue-eared Glossy-starling	*Lamprotornis chalybaeus*	Ehrenberg, 1828	x	x	x	x	x
39	Sturnidae	Lesser Blue-eared Glossy-starling	*Lamprotornis chloropterus*	Swainson, 1838)	x	x	x	x	x

40	Sturnidae	Splendid Glossy-starling	*Lamprotornis splendidus*	(Vieillot, 1822)	x	x	x	x	x
41	Threskiornithidae	Hadada Ibis	*Bostrychia hagedash*	(Latham, 1790)	x	x	x	x	x
42	Trochilidae	Veraguan Mango	*Anthracothorax veraguensis*	Reichenbach, 1855	x	x	x	x	x
43	Tyrannidae	Black Phoebe	*Sayornis nigricans*	(Swainson, 1827)	x	x	x	x	x
44	Tyrannidae	Tufted Flycatcher	*Mitrephanes phaeocercus*	(Sclater, 1859)	x	x	x	x	x
Total					32	34	33	37	30
%					19.3	20.5	19.9	22.3	18.1

(X) represent present, (-) represent absent.

The finding in Table 2 shows the relative abundance of bird's species utilizing the study area. The finding indicates that birds' abundance is very low having many birds across the tracks with 0% relative abundance. Although from the table, *Streptopelia vinacea* and *Sayornis nigricans* had a relative abundance of (7.79 and 7.78%) respectively in Range1 being the highest, while *Bubulcus ibis* (33.81%) and *Numida meleagris*, (17.77%) relative abundance being the highest in Range 5. These findings show that most birds might have been extirpated from the site through competition and predationand therefore require monitoring. Monitoring of species is therefore important in determining if conservation actions resulting from set plans are effective in achieving population objectives (Stiling, 2001).

Table 2. Relative abundance of bird's species utilizing the study area

S/N	**Scientific name**	**Range 1**	**Range 2**	**Range 3**	**Range 4**	**Range 5**
1	*Polyboroides typus*	0	0	0.88	0.38	0
2	*Ictinaetus malayensis*	0	0	0.29	0	0
3	*Necrosyrtes monachus*	0	0	6.64	1.77	0
4	*Tanysiptera hydrocharis*	0.71	6.4	0.74	0.76	1.01
5	*Ceyx pictus*	5.66	0.94	0.88	1.39	0.58
6	*Apus apus*	0.71	12.62	7.67	1.52	0
7	*Apus barbatus*	0	0.56	3.1	0.76	0
8	*Egretta garzetta*	0.88	0.94	1.18	0.38	0.43
9	*Bubulcus ibis*	2.12	6.4	3.1	32.45	33.81

10	*Ardeola rufiventris*	0.35	0.38	0	0	0
11	*Ardea cinerea*	1.06	0	0	0.25	0
12	*Bucorvus abyssinicus*	0.71	0	0	0	0.72
13	*Tockus nasutus*	2.65	2.26	0	0	1.73
14	*Thinornis rubricollis*	0	0	0.88	0.63	0.58
15	*Zenaida macroura*	0.71	0.38	0.44	0	0.29
1 6	*Stigmatopelia senegalensis*	2.3	0.75	0	0.76	1.73
17	*Streptopelia semitorquata*	0	2.26	0.44	0.63	0
18	*Streptopelia vinacea*	7.79	4.33	2.1	0.51	0
19	*Coracias abyssinicus*	4.6	0.56	0.88	0.89	2.31
20	*Centropus senegalensis*	1.06	2.45	7.23	0.76	4.62
21	*Pseudhirundo griseopyga*	0	0.56	0	0.25	0.29
22	*Sterna bengalensis*	0	0	8.26	0.51	0
23	*Laniarius leucorhynchus*	0	2.45	1.77	0.38	0
24	Merops albicollis	4.78	0.94	0.88	3.17	0.87
25	*Crinifer piscator*	7.43	0	0	0	3.18
26	Nectarinia senegalensis	0	0.38	0	1.52	0
27	*Numida meleagris*	5.66	1.13	23.0	4.31	17.77
28	*Histurgops ruficaudus*	0	0.38	0.74	0	0.87
29	*Ptilopachus petrosus*	2.83	0.75	0.44	3.29	0.58
30	*Francolinus francolinus*	0.88	0.75	3.1	9.88	1.01
31	*Campephilus melanoleucos*	0	2.07	0	2.66	3.03
32	*Batis mixta*	7.61	2.26	4.72	2.91	5.06
33	*Ploceus melanogaster*	1.06	7.72	3.1	4.18	6.50

34	*Pionus fuscus*	0.71	0	0	0.38	0
35	*Scopus umbretta*	3.72	0	0	1.52	0
36	*Pulsatrix koeniswaldiana*	2.3	3.95	1.62	2.66	0.29
37	*Lamprotornis purpureus*	4.07	8.47	3.69	4.31	2.02
38	*Lamprotornis chalybaeus*	5.66	2.26	0.74	1.65	0.87
39	*Lamprotornis chloropterus*	3.19	4.56	3.54	0.76	1.01
40	*Lamprotornis splendidus*	1.06	4.89	0.74	5.45	4.62
41	*Bostrychia hagedash*	5.66	0.94	0.88	1.77	0.29
42	*Anthracothorax veraguensis*	0.35	0.75	0.44	0.13	0.43
43	*Sayornis nigricans*	7.78	10.55	3.69	2.66	1.73
44	*Mitrephanes phaeocercus*	3.89	4.52	2.21	1.77	1.73
Total		99.95	101.51	100.01	99.96	99.96

The finding in Table 3 shows the diversity composition of birds' species in the study area %. The finding indicates that Range 1 and Range 2 have the highest (20.63 and 16.68) species diversity respectively, while Range 5 has the lowest (6.23) species diversity. Despite this disparity in species richness, when comparing the area sampled, species diversity was virtually identical at the three sites, in Range (1), Range (2) and Range (3) (0.9515; 0.9400 and 0.9136) and between Range 4 and Range 5 (0.86988; 0.839376). Species evenness was highest at Range (1) 0.7349 and lower at Range (5) 0.3871. Hence even though the identities and densities of birds species generally differ markedly between tracks in these studies, the result shows that there is no significant difference (P>0.05) between the Ranges in birds species composition.

Table 3. Diversity indices within habitats in the study area.

Simpson index	Range 1	Range 2	Range 3	Range 4	Range 5
S.Index1-D	0.951535	0.940063	0.913609	0.86988	0.839376
Reciprocal index 1/D	20.63	16.6841	11.57	7.68	6.23
Evenness_e^H/S	0.7349	0.63	0.5569	0.4323	0.3871

3. 1. Habitat structure

For Kainji Lake National Park habitat structure, Range 1 (*Burkia/Detarium macrocarpum* woodlands) although low in species richness has the highest species diversity and evenness, because it is composed of many equally abundant species as seen in its relative abundance and diversity. The abundance ranges from 0 - 7% only. On the other hand, Range 4 (*Isobelenia tomentosa* woodland) having very few dominating species, such as Cattle Egret *(Bubulcus ibis)* with (32.45%) relative abundance makes the species diversity to be low. The lowest in species diversity is the Range 5 riparian forest/woodland. The range is being dominated *by Bubulcus ibis* with (33.81%) relative abundance and *Numida meleagris* with (17.77%) relative abundance while other species are low in number. Range 1, with its high species diversity, potentially indicates a complex community having more interactions among species (Stiling, 2001). The low abundance and diversity of birds in the Kainji Lake National Park indicates that the park birds relation to habitat characteristics is very poor, and that birds do not breed well in the area except for the *Bubulcus ibis* and *Numida meleagris* whose populations is a little bit high, the causes of this few population number of birds could be as a result of toxic chemicals obtained through farming activities by the communities around the park, also climate change and severe weather which is prevalent in the area.

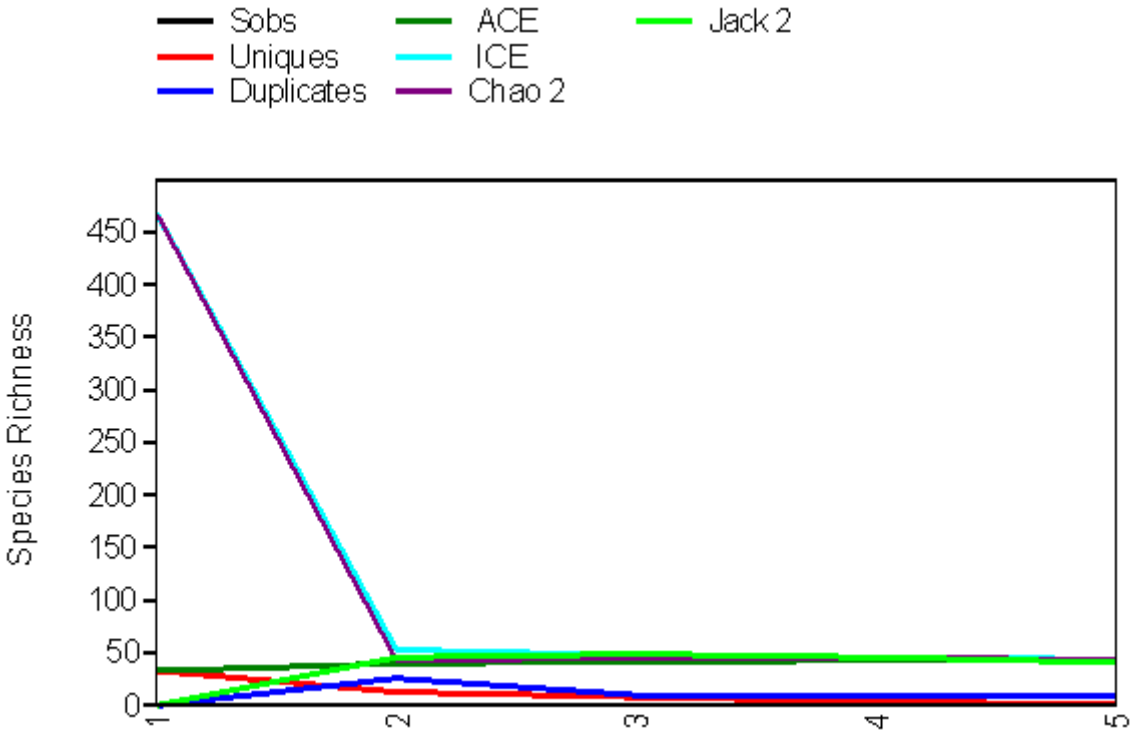

Fig. 1. Test prediction Output; using EstimateS to assess the diversity of birds' species in the study area.

Bootstrap analysis of our observed species, which is simply a statistical method based on repeated random sampling of an original set of samples using EstimateS (Colwell, 2014). The findings shows the test prediction Output while using EstimateS to assess the diversity and

species richness of birds in the study area. the program randomly picked 5 samples (50 times), added them up and took the average, which in this case was 41species (the total number of birds family species found) because all sites were sampled.

From the findings, the Sobs (number of species observed), the number of species is 41. This is because the same species are common throughout each of the sampling events. The numbers keep decreasing with each additional sampling event telling us that each time we sampled we did not get new species (Colwell, 2014).

The estimators is meant to generate predictions based largely on the total number of species found given a certain number of pooled samples, (in this case 1-5 pooled samples) we observed 41 species, and the estimators predict that (after 5 samples) there will be 41 birds species in the habitat since they (ACE, ICE, Chao2, Jack2) level off at 41).

In comparing uniques to duplicates from the fig also, (that is, comparing the number of species that occurred once in the pooled sample X number of species in the samples that occurred twice) the species unique increases at the beginning indicating that more new species are being added to the unit effort, but this increase sharply drop close to the sample 2 and finally cross the duplicates indicating that there is no new species added, this is also known as the actual point where the birds species has begins to asymptote or level off.

Finally the duplicates increases more than then the unique hence, there is the feeling of confident that we are getting more of the same birds species instead of new birds species in Kainji Lake National Park, which are poorly represented among 28 families sampled. The Kainji Lake National Park is therefore having very low number of birds species and is not expected to have an increase in the nearest feature unless drastic measures is applied to bring back the high recreational valued birds of the area including the secretary birds and the vultures which were seen in the past years.

Using estimator programs such as EstimateS helps us get a clearer understanding of the world around us because they tell us something of how well we actually sampled the diversity that makes up a given habitat or area of interest and helps us estimate how many organisms should really be out there (Colwell, 2014).

4. CONCLUSION

This study on the inventory of Kainji Lake National Park bird species has help us to know the major target species to focus on for conservation purposes, species such as the Numididae family which are in high demand by the hunters and bird traders in the study area but still exist in Kainji Lake National Park habitat in low numbers.

This study also indicates that the Kainji Lake National Park environment is quite stressful with relatively few ecological niches were only a few birds species are really well adapted to that environment.

While the few population number of birds could be as a result of toxic chemicals birds obtained through farming activities by the communities around the park. It is therefore imperative to ensure that proper conservation and management of the species habitat is enhanced for bird's species sustainability in the Kainji Lake National Park.

Recommendations

The following recommendations are made base on the findings;

- Environmental education campaign should be carried out in the communities around the park.
- The park authority should beef up anti-poaching patrol so as to stop humans from entering the park and killing most birds and other animals.

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