

# Diversity of Avian Fauna in Lawkanandar Wildlife Sanctuary at Bagan, Nyaung U Township, Mandalay Region

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## Abstract

Diversity of bird species were observed at Lakanandar Wildlife Sanctuary, Bagan, Nyaung U Township, Mandalay. Survey was conducted from January 2019 to December 2019. Birds were collected from four allocated study sites by using point count method. A total of 133 species of birds belonging to 95 genera, 50 families and 15 orders were recorded. Among the total bird species recorded 91 species were terrestrial birds and 42 species were waterbirds. The highest bird species richness (d) was 10.964 found in Site II and the lowest was 6.833 in Site III. The highest bird species diversity and the most abundance ( $D = 0.03$ ,  $H' = 3.894$ ,  $N1 = 49.146$ ,  $N2 = 33.328$ ) were found in Site II, while the lowest were ( $D = 0.04033$ ,  $H' = 3.474$ ,  $N1 = 32.289$ ,  $N2 = 23.097$ ) in Site III. The highest bird species evenness was 0.07062 found in Site III and the lowest was 0.671 in Site II. The study area is relatively associated with Ayeyarwady River, having submerged vegetation and kaing grass. Thus, the study area Lawkananda Wildlife Sanctuary is related to the highly compatible environmental habitat conditions and climate changes for the birds to thrive. Therefore, birds were a need to maintain and preserve both the avifauna and the environment in which they thrive for the long term sustainability of the species.

**Keywords:** Birds, diversity, Lawkanandar Wildlife Sanctuary, Bagan

## Introduction

A bird has been described as a 'feathered biped' (Ali, 1996). Birds form a class of animals that includes over 10,000 species worldwide (Clements, 2007). Birds are the most successful groups of vertebrates (Clout and Hay, 1989, Sodhi *et al.*, 2011). They play an important link of food chain in ecological unit of nature, so they are the good indicators of ecological status of any given ecosystem (Gill, 1994; Hossain and Baki, 2015). Assessment of bird community is important tool in biodiversity conservation and identifications of conservation actions. Having knowledge on diversity and composition of bird communities is also crucial to determine the health status the local ecosystem or regional landscapes (Sethy *et al.*, 2015).

Birds are also indicators of biodiversity and monitors of environmental change such as level of contaminations and environmental impact (Sutherland, 2000). Birds occur on land, sea and freshwater, and in virtually every habitat, from the lowest deserts to the highest mountains (Rahbek and Graves, 2001). Birds constitute one of the common fauna of all habitat types, and because they are responsive to change, their diversity and abundance can reflect ecological trends in other biodiversity (Furness and Greenwood, 1993).

The most basic study of avifauna of a site is the preparation of a list of species. A list indicates the diversity of the site, and shows the presence of rare species if any. The number of rare and endemic species and the diversity of the species present at the site can be used as indicator of the importance of different sites or habitats for bird conservation (ICBP, 1992; Bibby *et al.*, 1998).

The world's biodiversity is increasingly under threat in many parts of the world. Currently, 24% of mammals, 27% of reptiles, 20% of amphibians and 30% of fishes are listed by IUCN as globally threatened with extinction. Concerning the bird species of the planet, about 12% of them (i.e. is one in 8) have a real risk of becoming extinct in the next 100 years (Avibase-Bird Checklists of the World, 2005).

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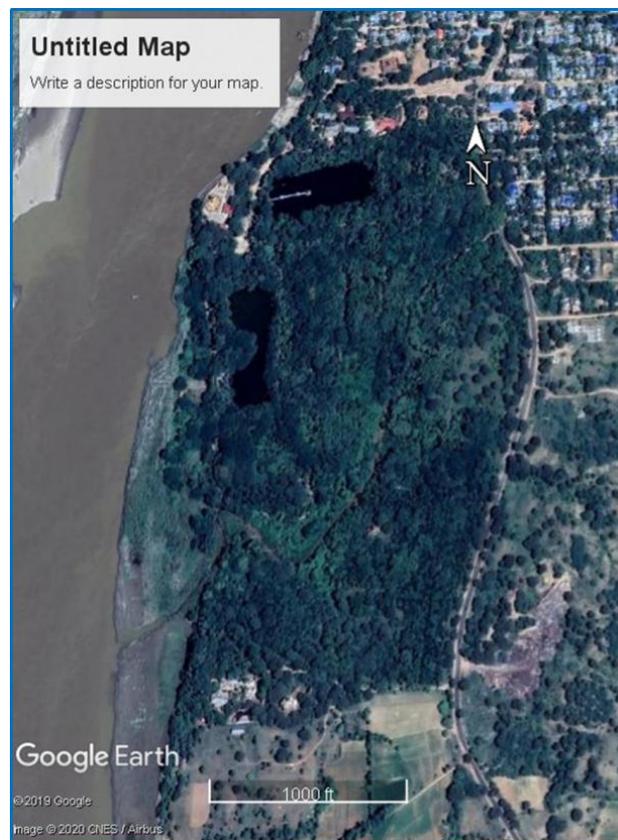
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Southeast-Asia (primarily containing Myanmar, Thailand, Cambodia, Laos, Vietnam, Malaysia, Singapore, Brunei and Indonesia) is a region of high bird diversity with 1327 bird species (Robson, 2015). Myanmar is recognized the greatest diversity of bird species in South-east Asia. The avian fauna of Myanmar includes 1114 species of which six are endemic (IUCN, 2015). In Myanmar contains 1112 species in which six species were endemics, 63 species were globally threatened and two species were introduced species (Avibase, 2018).

The study area; Lawkananda Wildlife Sanctuary, Bagan, Nyaung U Township, Mandalay Region is in the Central Dry Zone. Ayeyarwady River Bagan Section is one of the key biodiversity area in Myanmar Central Dry Zone, especially Bagan environs (Myanmar Invest Opportunities in Biodiversity Conservation, 2005). It is teemed with bushes, shrubs, woody trees and thorny scrubs. These area provide good habitat for birds to thrive. Therefore, this study area was chosen to investigate the species richness of avian fauna in Lawkananda Wildlife Sanctuary and to evaluate the diversity and evenness indices of avian fauna in the different study sites

## Materials and Methods



### Study Area

The study was conducted from June 2019 to December 2019. Lawka Nandar Wildlife Sanctuary is situated in Bagan, Nyaung U Township, Mandalay Region. It lies between Latitude  $21^{\circ} 7' 9.06''\text{N}$  to  $21^{\circ} 7' 45.03''\text{N}$  and Longitude  $94^{\circ} 50' 58''\text{E}$  to  $94^{\circ} 51' 20''\text{E}$ . The total area of the LNWS is  $0.437\text{ km}^2$  (43.67 hectares) (Fig. 1). Four study sites were allocated to conduct the data collection Site I (Kyaung Nanthar), Site II (Nandawin), Site III (Shwethamin) and Site IV (Thirigubyaukyee) (Plate 1).

## Study Design and Data Collection

Each site was visited once a month. The collection of data was made using point count method (Bibby *et al.*, 2000). Four point 200 m apart were randomly selected at study sites and from each point visible birds within 50 m were recorded and identified and also recorded by photographs. At least 10 minutes was spent at each point. Bird count was carried out from 6.00 to 10.00 am in the morning and 3.00 to 6.00 pm in the afternoon, when the activities of birds are prominent. Size, shape, color and plumage characteristics were also noted. For large flocks in flight or at a roost, counting was made by estimated blocks and then checked with photographs. For collection of data, aquatic birds could be assessed easily, the places where they usually alight for foraging. Identification was done based on the body color, morphological features, call and flight pattern. Identification and classification of the bird species followed that of Smythies, 2001. Robson 2011, and 2016.

Fig. 1 Map of study area Lawka Nandar Wildlife Sanctuary

## Species Richness Index

Species richness of bird species was determined using the formula of Margalef's species Richness (1958) as follows:

For Margalef's species Richness Index (1963),

$$d = \frac{S-1}{\ln(N)}$$

## Diversity Index

Species diversity was determined by using two formulae of Simpson's index of diversity "D" and Shannon-Wiener's information theory index, H'.

For Simpson's diversity index (1949),

$$D = \frac{\sum_{i=1}^s n_i (n_i - 1)}{n(n - 1)}$$

## For Shannon-Wiener Index (1948)

The Shannon index was developed by Shannon and Wiener in 1948. Higher number of species and more even distribution both increase diversity as measured by the Shannon index.

Shannon Index,

$$H' = - \sum_{i=1}^s \left[ \frac{n_i}{n} \right] \ln \left[ \frac{n_i}{n} \right]$$

## Evenness Index

The actual diversity value and the maximum possible diversity can be compared by a measurement the evenness value. Evenness usually ranges between 0 and 1.0.

For Hill's diversity number (1973),

$$\text{Number 0: } N_0 = S$$

$$\text{Number 1: } N_1 = e^{H'}$$

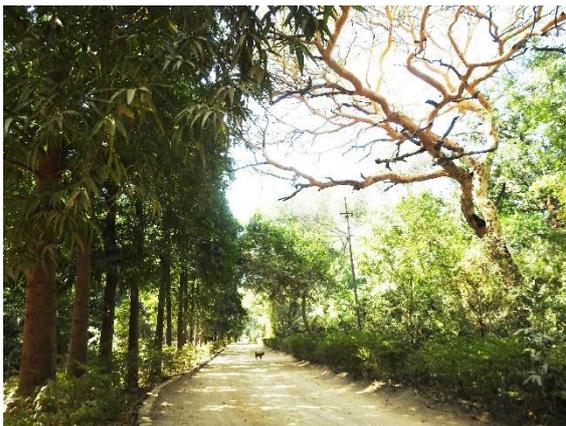
$$\text{Number 2: } N_2 = 1/D$$

Note that  $N_1$  is always being intermediate between  $N_0$  and  $N_2$ .

The effective number of species is a measure of the number of species in the sample where each species is weighed by its abundance.

The measure of bird species evenness or equitability (or relative species abundance) was determined by using the evenness index of modified Hill's ratio (1973).

$$E = \frac{N_2}{N_1}$$



A. Site I (Kyaung Nanthar)



B. Site II (Nandawin)



C. Site III (Shwethamin)



D. Site IV (Thirigubyaukyee)

Plate 1 Study sites

## Results

A total of 133 species of avian fauna belonging to 95 genera, 50 families under 15 orders were recorded. Out of recorded species, 42 species were water birds comprising under 30 genera, 12 families and six orders. The remained, 91 species of terrestrial birds belonging to 65 genera, 38 families and nine orders were recorded (Table 1). The highest bird species richness was 10.964 found in Site II and the lowest was 6.833 in Site III. The highest bird species diversity and the most abundance ( $D = 0.03$ ,  $H' = 3.894$ ,  $N1 = 49.146$ ,  $N2 = 33.328$ ) were found in Site II, while the lowest were ( $D = 0.04033$ ,  $H' = 3.474$ ,  $N1 = 32.289$ ,  $N2 = 23.097$ ) in Site III. The highest bird species evenness was 0.706 found in Site III and the lowest was 0.671 in Site II (Table 3). The dominant species was 87 species was found in Site II followed by 72 species in Site I, 52 species in Site IV and the lowest was found in Site III 51 species (Table 2).

Table 1 Bird species recorded of Lawkanandar Wildlife Sanctuary, Mandalay Region during January to December 2019

No.	Order	Family	Genus	Species
1	Galliformes	1	2	2
2	Anseriformes	2	3	3
3	Ciconiiformes	1	2	2
4	Pelecaniformes	2	8	13
5	Suliformes	1	2	3
6	Accipitriformes	3	8	8
7	Gruiformes	1	4	4
8	Charadriiformes	5	10	17
9	Columbiformes	2	3	5
10	Psittaciformes	1	1	2
11	Cuculiformes	1	4	4
12	Strigiformes	2	2	2
13	Coraciiformes	5	6	9
14	Piciformes	2	2	3
15	Passeriformes	21	37	56
Total		50	95	133

Table 3 Species richness, diversity and evenness of bird species in different study sites during January to December 2019

Month / Index	Site I	Site II	Site III	Site IV
Total no. of species	72	87	51	52
Total no. of individuals	2159	2550	1505	1520
d	9.2479	10.9640	6.8338	6.9611
D	0.0328	0.0300	0.0433	0.0424
H'	3.7934	3.8949	3.4748	3.5289
N1	44.4076	49.1462	32.2898	34.0865
N2	30.5032	33.3283	23.0976	23.6005
E	0.6797	0.6715	0.7062	0.6831

Table 8 Monthly species richness, diversity and evenness of bird species in Site I of Lawkanandar Wildlife Sanctuary, Mandalay Region during January to December 2019

Month / Index	January	February	March	April	May	June	July	August	September	October	November	December
Total no. of species	63	58	56	35	24	45	47	49	53	62	68	61
Total no. of individuals	178	178	158	118	89	190	181	157	201	264	216	211
d	11.9650	11.0001	10.8640	7.1269	5.1241	8.3857	8.8487	9.2937	9.8052	10.9398	12.4645	11.2111
D	0.0259	0.0290	0.0337	0.0595	0.0822	0.0312	0.0343	0.0294	0.0326	0.0268	0.0228	0.0270
H'	3.7888	3.6964	3.6327	3.1007	2.7470	3.5512	3.4881	3.5943	3.5864	3.7762	3.8937	3.7591
N1	44.2042	40.3002	37.8140	22.2136	15.5951	34.8542	32.7245	36.3892	36.1046	43.6496	49.0917	42.9112
N2	38.6103	34.4705	29.6722	16.7956	12.1615	32.0053	29.1413	33.9844	30.6402	37.2889	43.8941	37.0485
E	0.8705	0.8517	0.7788	0.7446	0.7647	0.9159	0.8871	0.9320	0.8443	0.8509	0.8919	0.8601

Table 9 Monthly species richness, diversity and evenness of bird species in Site II of Lawkanandar Wildlife Sanctuary, Mandalay Region during January to December 2019

Month / Index	January	February	March	April	May	June	July	August	September	October	November	December
Total no. of species	83	73	63	35	26	49	46	44	52	77	68	80
Total no. of individuals	252	261	336	120	93	179	169	160	220	257	241	262
d	14.8297	12.9391	10.6582	7.1018	5.5156	9.2532	8.7721	8.4726	9.4556	13.6960	12.2156	14.1873
D	0.0201	0.0316	0.1572	0.0538	0.0619	0.0274	0.0293	0.0366	0.0442	0.0237	0.0256	0.0228
H'	4.0602	3.7994	2.9183	3.1148	2.9127	3.6442	3.5874	3.4560	3.4570	3.9639	3.8480	3.9906
N1	57.9859	44.6744	18.5098	22.5289	18.4064	38.2522	36.1400	31.6900	31.7217	52.6623	46.8992	54.0873
N2	49.6484	31.6511	6.3593	18.5938	16.1434	36.4554	34.1250	27.2961	22.6197	42.1744	39.0283	43.8346
E	0.8537	0.7018	0.3061	0.8172	0.8700	0.9518	0.9427	0.8568	0.7037	0.7970	0.8285	0.8069

Table 10 Monthly species richness, diversity and evenness of bird species in Site III of Lawkanandar Wildlife Sanctuary, Mandalay Region during January to December 2019

Month / Index	January	February	March	April	May	June	July	August	September	October	November	December
Total no. of species	42	33	36	33	18	37	37	38	41	46	41	43
Total no. of individuals	113	92	95	47	51	155	140	151	152	174	155	151
d	8.6729	7.0768	7.6858	7.4348	4.3237	7.1380	7.2850	7.3745	7.9620	8.7225	7.9311	8.3492
D	0.0416	0.0506	0.0432	0.0485	0.0769	0.0364	0.0354	0.0372	0.0361	0.0397	0.0412	0.0390
H'	3.3735	3.1411	3.2531	3.1429	2.6144	3.3866	3.3873	3.3660	3.4107	3.4329	3.3612	3.3806
N1	29.1805	23.1293	25.8704	23.1710	13.6590	29.5653	29.5860	28.9624	30.2864	30.9663	28.8238	29.3884
N2	24.0608	19.7453	23.1347	20.6183	13.0102	27.5000	28.2849	26.9002	27.7198	25.2111	24.2581	25.6123
E	0.8183	0.8471	0.8943	0.8898	0.9487	0.9277	0.9545	0.9263	0.9124	0.8079	0.8359	0.8670

Table 11 Monthly species richness, diversity and evenness of bird species in Site IV of Lawkanandar Wildlife Sanctuary, Mandalay Region during January to December 2019

Month / Index	January	February	March	April	May	June	July	August	September	October	November	December
Total no. of species	48	45	34	22	13	40	39	38	38	46	43	46
Total no. of individuals	150	132	101	79	51	156	145	134	147	162	126	137
d	9.3800	9.0112	7.1504	4.8061	3.0520	7.7230	7.6355	7.5544	7.4142	8.8450	8.6844	9.1464
D	0.0338	0.0353	0.0505	0.0873	0.1169	0.0351	0.0394	0.0400	0.0379	0.0314	0.0356	0.0291
H'	3.5293	3.4862	3.1465	2.6344	2.2387	3.4453	3.3532	3.3621	3.3625	3.5508	3.4465	3.5816
N1	34.1001	32.6616	23.2545	13.9349	9.3811	31.3527	28.5941	28.8497	28.8613	34.8412	31.3903	35.9310
N2	29.5635	28.3475	19.8039	11.4535	8.5570	28.5142	25.4015	25.0309	26.3661	31.8073	28.1250	34.3764
E	0.8629	0.8637	0.8449	0.8082	0.9017	0.9065	0.8843	0.8629	0.9104	0.9103	0.8926	0.9555

## Discussion

Rodriguez-Estrella 2007 reconized that birds select habitats fit their requirements for successful reproduction and survival though some generalist species may utilize several habitats. This survey area (Lawkananda Wildlife Sanctuary) is situated at Bagan near Ayeyarwady River in Nyaung U Township, Mandalay Region and in the Central Dry Zone of Myanmar. Its habitat dominants with bushes, shrubs, woody trees and thorny scrubs and therefore provide good habitat for birds to thrive.

Zakaria *et al.* (2009) and Lameed (2011) stated that the vegetation types and abundant of food resources also play equal role in habitat preference by bird species. Throughout this study period, a total of 133 species of avian fauna belonging to 95 genera, 50 families under 15 orders were recorded. Out of recorded species, 42 species were water birds comprising under 30 genera, 12 families and six orders. On the other hand, 91 species of terrestrial birds belonging to 65 genera, 38 families and nine orders were also recorded. It is sound for bird species occurrence and diversity in this study area. Jankowski *et al.* (2009) reported that ecological studies show that lower altitude has more bird species than higher altitude while some species are restricted to certain zones and others occurring throughout the altitudes. This finding was agreed with Jankowski *et al.* (2009), since this study area is central dry zone and lower altitude than other area of Myanmar.

Ecological communities do not contain the same number of species, and one of the currently active areas of research in community ecology is the study of species richness or biodiversity (Wallace, 1878). In this study period, the highest number of species 87 was recorded in Site II, the next to this was 72 species in Site I, 52 species in Site IV and the lowest number of species 51 was recorded in Site III. All study sites were connected to tall and short woody trees, bushes, and seasonal vegetation habitats and also human settlement. Although human settlement areas have mixtures of built habitats and green patches, bird species have managed to exist and thrive in this complex habitat (Sandstorm *et al.*, 2005). The study Site II is associated with Ayeyarwady River. Thus, this condition is being more species were found in study site.

Regarding the diversity, Odum (1975) stated that in general, mature and stable communities will have high diversity values and unstable communities or communities under stress exhibit low diversity, usually near zero or a zero-to one. In the present study, species richness (d) of bird was the highest in Site II and the lowest in Site III. Sympon's index (D) ranged from 0.0300 to 0.0433 in Site II to Site III. The highest value was found in May at Site IV and while the lowest at Site II in January. While Shannon index (H') ranged from 3.474 - 3.894 at Site III to Site II in overall study Sites. It is clearly that Site II is more species diverse than the others sites due to habitat is favioured for any birds (Waterbirds and Terrestrials). Among the monthly recorded, the dominant diversity of Shannon-Wiener's index value (H') was 4.0602 in January at Site II and the lowest was 2.2387 found in May at study Site IV. It is because of the migration birds were increase in cold season, especially in January and December and decrease in hot season, especially in May.

The abundance values ( $N_1$ ) range from 32.289 to 49.146, at Site III to Site II. The highest value was 57.9859 found in January at Site II and the lowest in 9.381 in May at Site IV. The very abundance values ( $N_2$ ) were found in the range from 23.005 in Site IV to range from 33.328 in Site II. The highest value was showed in January at Site II and the lowest in March at also Site II. It may be the recorded migrate bird species increase in cold season and decrease in hot season.

In the case of evenness (E), Harrison and Laverty 2004 described that an ecosystem where some species are represented by many individuals, and other species are represented by very few individuals has low species evenness. In this observed, the range of evenness (E) was

from 0.06715 to 0.7062 and the range from Site II to Site III. The highest value was found in December at Site IV and the lowest in March at Site II in all study period.

It is concluded that the highest bird species richness was found in Site II and the lowest in Site III. The highest bird species diversity and the most abundance were found in Site II, while the lowest in Site III. The highest bird species evenness was found in Site IV and the lowest in Site II. It is due to Site II is near water (Ayeyarwady River) and Site III is near housing and close to human. In addition, a habitat with open water having submerged vegetation and kaing grass is the most suitable habitats and makes them free from human interference. Thus, the study area Lawkananda Wildlife Sanctuary is related to the highly compatible environmental habitat conditions and climate changes for the birds to thrive.

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