



Diversity and Abundance of Wet Land Bird Species in Lake Hora-Arsedi, Bishoftu, Ethiopia

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Authors' contributions

This work was carried out in collaboration between both authors. Author AG collected the data and makes the analysis. Author MA prepared the manuscript for publication. Both authors read and approved the final manuscript.

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ABSTRACT

The investigation of species diversity and abundance of birds in Lake Hora Arsedi Bishoftu town was conducted from September 2018 to July 2019. The aim of the study was to assess the diversity and abundance of bird species in Lake Hora Arsedi at Bishoftu town. Point count method was used to investigate the abundance of birds. Observation was conducted periodically walking along the study area early in the morning and late in the afternoon. Different diversity indices and statistical methods (Chi-square test and correlation) were used to analyze data collected during the field survey. Abundance of birds, their richness and evenness as well as birds' diversity recording were made. A total of 14 bird species grouped under 7 orders and 11 families were recorded. The month February had the lowest species diversity ($H' = 0.33$), species evenness ($E = 0.13$) and species richness (12). The highest species diversity, evenness and richness were recorded in March and April ($H' = 0.35$), ($E = 0.35$) and ($S = 14$), respectively. Variation in abundance of birds was statistically significant between months. Abundance score of frequency of bird species was high during rainy season and uncommon are high during small rainy seasons using encounter rate. Lake Hora Arsedi has a number of natural and human induced bird attractant features. The area possesses favorable places for birds to nest, rest, roost and a good access to food as well as water

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resources. The study recommends the maintenance of bird watching records to monitor the effectiveness of management and to ensure early detection of any impact on bird numbers or behavior; conservation of Lake Hora Arsed, its surroundings and making it free from human interference will enable us to conserve these valuable bird species. Hence, conservation measures by wildlife conservation authority and other concerned agencies are important to safeguard these species in the area.

Keywords: Abundance; birds; bishoftu; species diversity; species evenness; species richness.

1. INTRODUCTION

Birds are built for flight, a structural ability which allows them to move easily through the air and yet perfectly adapt to every environment that fits their requirements for successful reproduction and survival [1]. The flight enables them to access to new habitats with plenty of resources. Human interference in natural habitats greatly decreases the area of naturally functioning ecosystems worldwide [2]. Diversity and extent of natural habitats will continue to decline as human populations increase and alter lands for use [3]. Human beings change natural areas by establishing towns, buildings, gardens, which create entirely artificial environments. Factors determining which species can coexist with human settlement include the presence and patch size of native vegetation as well as competition with exotic species and non-native predators. The structure and floristic attributes of planted vegetation as well as supplementary feeding by humans affect the level of such coexistence [4]. Expanding anthropogenic activity is widely perceived to have negative consequences for wildlife beyond habitat loss. Distribution, abundance, reproductive success and behaviour of animals and bird species are often sensitive to habitat change caused by human activities.

Birds have been used as bio-indicators in a number of studies and have more recently been used as national indicators for sustainable development. They can indicate changes in vegetation extent, pattern and structure, water extent, depth, duration and seasonal frequency, water quality and disturbance. They have been particularly useful as indicators to evaluate effects of habitat change because they are easy to watch and the populations of many decrease or increase when the land is modified by different activities. They are well-known indicator taxa due to their sensitivity to environmental perturbations, relevance to ecosystem functioning and relative ease in sampling [5]. Wetland environments

provide birds with considerable quantities of food and roosting sites especially in gardens and parks [6]. Ethiopian Central Rift Valley area is known to have a number of lakes and hydrological features, watershed areas, the lakes are known to harbor millions of resident and migratory water-birds. However, these natural resources have been under threat by unregulated land-use changes taking place in the area [7,8].

Lake Hora Arsed, is one of such lakes that are under great threat of land-use changes mainly due to extensive building of houses surrounding the lake. Many bird species descend on wetlands to feast on the amphibians, shellfish and insect-buffers that hover in and around wetland waters.

Birds have adapted to life in wetland areas and look for food in grasses, fishes and waste dumps [9]. A diversity of wetland birds are attracted to a variety of wetlands based on the type of food and cover provided inside and near the vicinity of Lake Hora Arsed [6]. Birds, all over time, are drawn to the water for drinking, eating, bathing, roosting and protection; especially during the morning time. Wetlands have profound ecological and economic importance. The wetlands of Hora Arsed are facing tremendous anthropogenic pressure, which can greatly influence the structure of the bird community. Lake Hora Arsed harbors a variety of bird species. It is surrounded by forests which consist of different trees or woodlands, grasses and within the forests different houses cafeteria, hotels and other buildings.

Wetlands shelter countless species of fauna and flora, of which the most widely appreciated are the birds. In Ethiopia, 204 (25%) of the bird species are wetland-dependent. Although, many of these birds are known, much about their habitats remains unknown [10]. Human activities threaten the existence of many birds by destroying their habitat or directly affecting their survival and reproductive success. The current study aimed at gathering information on the

abundance, species richness, species evenness and composition in Lake Hora Aresdi.

2. MATERIALS AND METHODS

2.1 Study Area

Lake Hora is a crater lake that is surrounded by very steep and rocky hills and cliffs. Mohr (11), estimated the age of Lake Hora along with other Bishoftu crater lakes as early Holocene (≈ 7000 years). The catchment of the lake is formed from volcanic rocks of basalt, rhyolite and tuff. It is a crater lake formed by volcanic activity ~ 7000 years ago. It is located in Bishoftu town and is only 2 km from the center of the town and about 47 km southeast of Addis Ababa (Fig.1). Its altitude is 1850 m above sea level. It is located at $8^{\circ}44'4''N$ latitude and $38^{\circ}59'9''E$ longitude. The lake has a surface area of 1.03 km^2 , maximum depth 38 m and mean depth 17.5 m [11]. The average temperature of the surface water is about 22°C with a maximum of 24.5°C and minimum of 19.2°C , while the bottom temperature is almost constant (19.2°C - 19.4°C) [12].

The region around the lake is characterized by moderate rainfall, varying around 850 mm per annum, high incidence of solar radiation and low relative humidity [13]. The region has two rainy seasons, the short rainy season from February to April and the long rainy season from June to September. The soil type is characterized as andosol [14]. Its wealth of fish species and aquatic bird life give opportunities for fishing and bird watching.

Temperature and rainfall are major climatic elements that affect the distribution of vegetation used by birds. The area is located at an altitude of 1,900 m above sea level. The average monthly maximum and minimum temperature is 26.9°C and 8.38°C respectively. The highest average rainfall intensities occur in July and August (183.5 mm and 183.28 mm) and the lowest occur in December (0.0 mm), respectively.

2.2 Sampling Design

Point count method was used to study the abundance of birds in Lake of Hora Aresdi. The activities, numbers, types and locations of birds were also studied using the technique of repeated observation, hanging [15]. Birds were counted and recorded during a fixed period of time at each point. Station for the point count

method was selected depending on the abundance and activities of birds. This method was used for species that are small flocking and difficult to identify in most occasions. This count was carried out at different stations using boat on open water bodies, and on foot for vegetation and surrounding areas of the lake.

2.3 Data Collection

Data were collected from February to June in 2018. Observations were carried out for 136 hrs during the short and long rainy season. Before the actual study, a pilot survey was conducted to gather information about the distribution, abundances and richness as well as the evenness of wetland bird species on selected sample areas. Information about the distribution of wetland birds in the study area was gathered from fishermen and individuals who spent most of their time around the study area. Sample areas were randomly selected. To collect data on their abundance, repeated observations were made. Data were collected in the morning from 6:30 a.m. to 8:30 a.m. and in the afternoon from 4:00 p.m. to 6:00 p.m., when most of the avian species are active [16]. Activities were recorded using spotting scope sampling method throughout the study period and the scan method. During the observation period, a group or an individual bird was followed at a distance of 5-10 m. In this study; observation was the most important method to identify birds and it is used to collect the required data [15].

2.4 Data Analysis

Data were analyzed, using qualitative and quantitative descriptions. The data were collected mostly through observation by comparing method of Bird identification from Bird guides with the Birds in the lakes and also what are the different instruments? Information from secondary data, from different references and also analysis of the data was made possible using different diversity indices and encounter rates to estimate relative abundances. The species diversity in different duration was given interims of Shannon wiener diversity index. Shannon wiener diversity index is calculated as:

$$H' = -\sum (P_i \ln p_i)$$

where:

H' =Shannon-wiener index
 P_i =proportion of the i th species
 \ln =natural logarithm

Species evenness, which measures the pattern of distribution of the bird populations present in the study area, was evaluated using Shannon-Wiener evenness Index (E) as follows:

$$E = H' / H_{max}$$

where:

- E = Shannon-Wiener Evenness Index
- H' = Shannon-Wiener diversity Index
- H max = ln S= natural logarithm of the total number of species(S) in each duration

Encounter rate method was used to explain a species list with an index of relative Abundance based on the number of encounters with individuals per period of time. It was calculated as:

$$\text{Encounter rate} = \frac{\text{Total Number of Individual Birds Observed}}{\text{Period of Observation in Hours}}$$

Data collected were analyzed using SPSS (version 16.0) statistixs. Chi square was used to

investigate the effect of season on abundance of birds. Correlation was used to evaluate significant of difference between total species count and mean species count of each month of the study period. Graphs were used to explain results of the data analyzed using Microsoft Excel.

A checklist on data collected from February 2018 to July 2018 on Lake Hora Arsadi, that is along ashore line by marked three main sample areas (sample area A; at south eastern direction which measures 0.0009 km², sample area B; at North western direction which measures 0.000625 km², sample area C; at south western direction which measures 0.001225 km², and the other which is not marked is sample area D on the open water which measures 1.03 km², were presented on a table. Birds were counted and identified using a spotting scope technique or marked area and scan sampling method where the birds were found in large number. A systematic random sampling technique was used and observations were made from the shore of the lake side along the marked place at every 625 m²-1.03 km².The

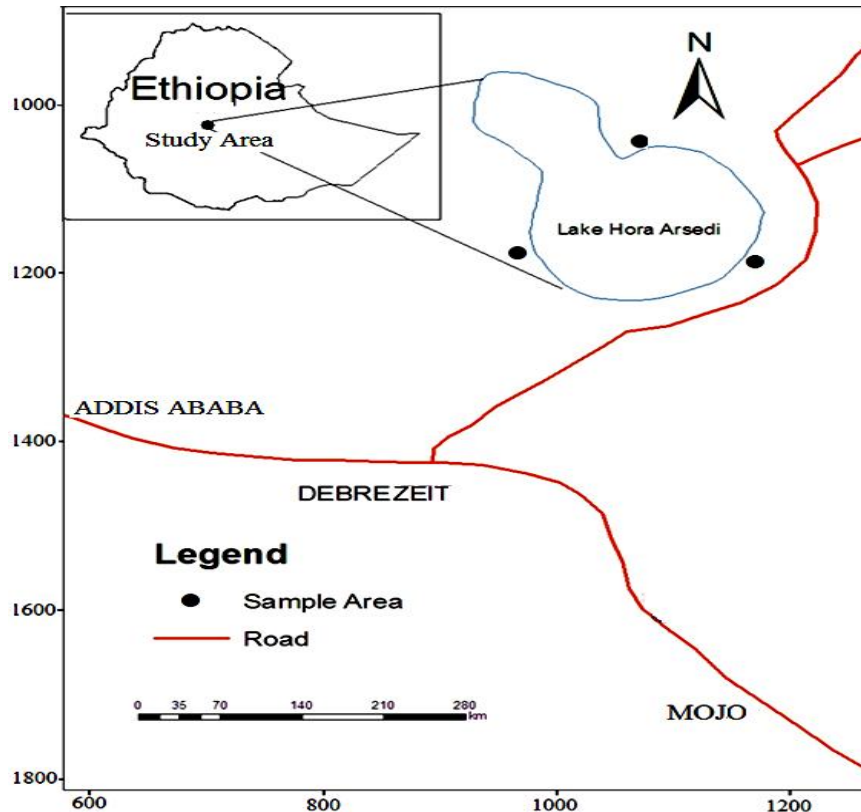


Fig. 1. Map of the study area
Source: Bishoftu Municipality, 2019

sighting distance varied on either side of the marked area depending on the species and habitat types. In the open area of the lake, bird sampling was done using boat along the lake, boat was slowly ($0.5 \text{ km}^2/\text{hour}$) driven to allow counting of birds. From the number of birds counted at sampled area 1.03275 km^2 then estimated the total number of birds from 1.75 km^2 . Birds in the study area were observed using naked eyes and binoculars for better identification as well as manual tally during counting. Moreover, photographs were taken for further identification of birds and to capture corresponding habitat types. Field identification of birds was aided by binocular and digital camera as well as field guide books [17]. Data were collected during the long and short rainy season at observation time; which showed the types of birds in four sample areas which cover 1.0327 km^2 .

3. RESULTS

Types and number of birds recorded or identified on each date of observation, time and their numbers in each month and the number of individual species in the study area are as on Tables, 1, 2, and 3.

3.1 Species Composition

A total of 14 species of birds belonging to 7 orders and 11 families were recorded or identified in the study area. The Family *Phalacrocoracidae* (26.8%), had the highest number of species. The lowest number of species was under the *Threkiornithidae* (2.9%) and *Accipitridae* (2%) families with a few species each. Most of the birds in the study area were observed throughout the study period (Table 4).

Bird species, Hammer Kops, white neck cormorant, Abdim's stork, Long tail cormorant, pink Back Pelican showed high number of individuals at restricted in period studied.

Few species of birds were observed only during restricted months of the study period and few of them were observed in very few numbers during restricted month (Table 5).

Gloss Ibis and Grey Heron were not observed in February month during the study period and Great White Egret was not observed in May and June Grey Heron and African fish Eagle were observed in very few numbers in May, June and February, May and June. The black crane was observed in few numbers in June.

3.2 Species Diversity

The highest diversity of birds were observed during March ($H' = 0.35$) and April ($H' = 0.35$) and the lowest diversity of birds was in February ($H' = 0.33$). The highest even distribution of birds was observed in March and April ($E = 0.14$), whereas the lowest was in February, May and June ($E = 0.13$) (Table 6).

3.3 Species Richness

The highest number of bird species was recorded in March and April (14) and the Lowest in February (12). The result obtained showed that, the mean number and the total number of bird species of each month correlated positively ($R^2 = 0.89$) (Table 7).

3.4 Abundance

Abundance of birds in the study area correlated with different seasons and months that had long and short rainy season. Individuals counted were 2408.76 and 862.28 during the small rainy season (February, March and April) and rainy season (May and June), respectively. Chi square test for the abundance of birds in the study area for each month showed that there was statistically significant difference between observed and expected counts of each species ($P < 0.05$).

Likewise, the Chi-square test for abundance of birds in the study period showed that there was statistically significant difference between observed and expected counts of each species in the main rainy season and small rainy season ($P < 0.05$).

3.5 Relative Abundance

Relative abundance of birds in the study area during the rainy season had high frequency (71.42%), uncommon bird-species (14.28%), common bird-species (7.14%) and rare bird-species (7.14%). During the short rainy season, 50% of the bird species were uncommon, 42.85% frequent and 7.14% common.

4. DISCUSSION

According to the results of this study, birds were observed both during the wet and dry seasons in the study area but exclusively during the rainy season. There was also bird species with high number of individuals at specific seasons in the area. This is due to the availability of resources and favorability of the climatic conditions. Food

Table 1. Bird species recorded in Lake Hora-Aksedi Bishoftu Ethiopia during the observation time

Date of Observation	Abdim's stork	Grey Heron	Hammer Kops	Long tailed Cromer	Egyptian	Whitten eked	Black Rake	African Darter	Great White	Pied king fisher	African fish	Pink back	Glossary Ibis	White breasted
18/06/17	10	--	25	10	4	13	3	6	6	--	1	9	--	6
19/06/17	12	--	26	10	3	12	3	--	4	--	2	8	--	6
25/06/17	9	--	25	5	4	12	4	9	4	--		8	--	3
26/06/17	8	--	23	8	4	15	3	9	6	4		7		5
2/7/2017	9	2	27	9	3	14	3	--	8	4		6	9	5
3/7/2017	9	3	25	9	2	14	4	7	--		4	6	4	4
9/7/2017	7	2	23	7	3	14	2	6	4		3	7	3	3
10/7/2017	8	3	24	8	3	10	3	6	4	5	3	7	5	4
16/07/17	6	2	26	8	4	10	2	6		5	2	8	3	3
17/07/17	9	1	25	6	4	10	4	2	2	5	2	7	3	4
23/07/17	6	2	26	5	2	9	2	9	4	4	-	7		4
24/07/17	8	4	28	6	3	10	4	9	2	6	-	6	2	4
30/07/17	7	5	28	6	2	11	3	7	4	3	4	6	4	3
1/8/2017	10	4	27	5	4	12	1	9	4	3	4	6	4	
14/08/17	15	2	24	4	2	10	2	8	2	5	4	7	3	4
15/08/17	12	1	26	4	4	9	4	6	3	5	4	7	2	4
21/08/17	15	2	27	5	4	10	4	5	2	3	2	6	2	4
22/08/17	13	2	25	4	2	10	3	4	3	6	3	6	3	6
28/08/17	11	4	25	4	2	9	5	5	2	5	3	6	3	2
29/08/17	10	1	24	5	2	9	4	4	3	4		6	2	5
5/9/2017	8	1	18	5	4	8	4	6				4	4	5
6/9/2017	9	1	15	5	2	8	4	3		4	3	3	1	4
12/9/2017	9		9	4	3	7	3	4		3		2	2	4
13/09/17	7		7	4	3	9	4	3		3	2	2	2	4
19/09/17	7		5	5	4	8	5	3		1	2	2	2	4
20/09/17	8		4	4	4	6	3	4		2		2	2	4
26/09/17	6		4	4	4	5	2	4			2	2	2	5
27/09/17	8		4	4	4	4	4	1		1		2	4	5
3/10/2017	8		12	5	2	6	2	3		4	4	5	3	6
4/10/2017	8	2	10	7	3	7	2	6		2	3	5	2	2

Date of Observation	Abdim's stork	Grey Heron	Hammer Kops	Long tailed Cromer	Egyptian	Whitten eked	Black Rake	African Darter	Great White	Pied king fisher	African fish	Pink back	Glossary Ibis	White breasted
10/10/2017	8	2	8	4	3	5	1	3		2	1	4	1	2
18/10/17	6		8	3	2	5	1	3		2		3		
24/10/17	5		6	4	1	5	1	1				2		
25/10/17	4		7		1	2						2		
Total	295	46	625	186	101	305	99	161	67	92	58	176	72	127

Source: Data collected from Lake Arsedi/primary data

Table 2. Types of birds and their number recorded in four sample areas in Lake Hora-Aksedi Bishoftu Ethiopia in each month

Types of birds	Types and number of birds in each month in the sample areas				
	Average monthly observation result				
	Feb	March	April	May	June
1. Abdum's stork	39	69	86	62	39
2. Grey heron	-	24	16	2	4
3. Hammerkops	99	232	178	66	50
4. Longtailed cormorant	33	64	31	35	23
5. Egyptian Goose	15	26	20	28	12
6. Whitenecked cormorant	52	99	69	55	30
7. Black Crake	13	27	23	29	99
8. African Darter	24	52	41	28	16
9. Great white egret	20	28	19		
10. Pied king fisher	4	32	32	14	10
11. African fish eagle	3	21	20	9	8
12. Pink back pelican	32	60	44	19	21
13. Glossy Ibis	-	28	21	17	6
14. White breasted cormorant	20	33	28	36	10

Source: Data collected from Lake Arsedi/primary data

Table 3. Number of individual bird-species in areas of Lake Hora-Aksedi Bishoftu, Ethiopia (1.75 km²)

Types of birds	Number of Individual species in the total study area (1.75 km ²)				
	Average monthly observation result				
	February	March	April	May	June
1. Abdum's stork	66.1	116.9	145.8	105.08	66.1
2. Grey heron	--	40.69	27.13	3.39	6.78
3. Hammerkops	167.7	393	301.6	111.8	84.7
4. Longtailed cormorant	55.89	108.39	52.5	59.27	38.95
5. Egyptian Goose	25.4	44.02	33.86	47.41	20.32
6. Whitenecked cormorant	87.97	167.5	116.7	93	50.75
7. Black Crake	22.06	45.8	39.03	49.2	11.9
8. African Darter	40.7	88.2	69.5	47.5	27.13
9. Great white egret	34.03	47.6	32.33	--	--
10. Pied king fisher	6.78	54.3	54.3	23.7	16.96
11. African fish eagle	5.08	35.59	33.9	15.3	13.5
12. Pinkback pelican	54.2	101.6	74.5	32.2	35.6
13. Glossy Ibis	--	47.4	35.6	28.8	10.2
14. White breasted Cormorant	33.9	55.9	47.4	60.9	16.9

Table 4. Bird species identified or recorded from areas of Lake Hora Arsed, Bishoftu Ethiopia

Bird species identified or recorded from Hora Arsed Lake, Bishoftu				
English name	Common name	Scientific name	Family	Order
Stork', Abdim's	Abdim's Stork	<i>Ciconia abdimii</i>	Ciconiidae	Ciconiiformes
Darter, African	African darter	<i>Anhinga rufa</i>	Anhingidae	Suliformes
Eagle, African fish	African Fish eagle	<i>Haliaeetus vocifer</i>	Accipitridae	Falconiformes
Crake, Black	Black Crake	<i>Amauornisflavirostra</i>	Rallidae	Gruiformes
Goose, Egyptian	Egyptian goose	<i>Alopochen aegytiaca</i>	Anatidae	Anseriformes
Ibis, Glossy	Glossy Ibis	<i>Plegadis falcinellus</i>	Threkiornithidea	Ciconiiformes
Egret, great white	Great white Egret	<i>Egretta alba</i>	Ardeidae	Pelicaniformes
Heron, Grey	Grey heron	<i>Ardea cinerea</i>	Ardeidae	Pelicaniformes
Hammer, Kop Kops	Hammer kops	<i>Scopus umbrella</i>	Scopidae	Pelicaniformes
Cormorant, long tailed	Long Tailed cormorant <i>Africanus</i>	<i>Phalacrocorax</i> Acidea	Phalacrocor Pelicaniformes	
Kingfisher, pied	Pied kingfisher	<i>Ceryle rudis</i>	Alcediinidea	Coraciiformes
Pelican, Pink- backed	Pink backed pelican	<i>Pelecanus</i> <i>onocrotalus</i>	Pelicanidea	Pelicaniformes
Cormorant, white breasted	White breasted Cormorant	<i>Phalacroxi lucidus</i>	Phalacrocor Acidea	Suliformes
Cormorant, white necked	White necked Cormorant	<i>Phalacrocor axidea</i>	Phalacrocor Acidea	Pelicaniformes

resources are the most important attractive features feature for the birds. According to Shannon-Wiener diversity index (H'), bird species diversity and abundance were different among stratified sample areas in the lake. The stratified sample areas were named as A, B, and C. Accordingly, very high bird species diversity was recorded on sample area "C" which is located in the eastern part of the lake. The south western direction of the sample was named as

"A' sample area' and North western side of was named as sample area 'B'. The sample area 'A' on south eastern side had very low bird species diversity. The result of this study suggests that bird species richness and abundances were influenced by local resource availability and human disturbance, vegetation composition, the size of habitat patches and pollution, particularly noise pollution, directly influenced the abundance of bird population in the lake. In general aquatic

Table 5. Species of Birds population and Abundance between February and June in Lake Hora Arsed, Ethiopia

Species name	Months				
	Feb	March	April	May	June
Gloss Ibis	N	P	P	P'	P'
Great white Egret	P	P	P	N	N
Grey heron	N	P	P	P'	P'
African fish eagle	P'	P	P	P'	P'
Black crane	P	P	P	P'	P'

(P = Present, p'= present in a few number, N = absent)

Table 6. Bird species diversity in Hora Aresdi Lake, Ethiopia

Months	Species richness	H'	Hmax	E
February	12	0.33	2.48	0.13
March	14	0.35	2.6	0.14
April	14	0.35	2.6	0.14
May	13	0.34	2.56	0.13
June	13	0.34	2.56	0.13

Table 7. Species of birds observed in areas of Lake Hora Arsed, Bishoftu Ethiopia

Months	Total species	Mean \pm SE (Corretion factor)
February	12	9.77 \pm 4.40
March	14	8.4 \pm 2.09
April	14	10 \pm 2.66
May	13	11 \pm 5.5
June	13	10.5 \pm 6.67

birds are greatly influenced by complex characteristics including water chemistry, aquatic vegetation, invertebrate fauna and physical features in the lake.

Boats will displace birds directly by occupying their foraging areas as well as frightening them away from their preferred habitat. They can also degrade important habitat and food sources of water birds, such as shoreline nesting sites and roosting sites. Different species of birds will respond differently to disturbances. Species richness of birds in Hora Arsed Lake for each month did not show significant difference. The highest species richness was recorded in March and April. This was due to the favourable weather conditions for most birds that were observed at the time of the study period. The least species richness was recorded in February, which may be due to the less Favourability of the weather conditions for most birds. The abundance of birds in the study area showed that there was statistically significant variation between months as well as between different seasons. This was also determined by the presence and absence of resources on which birds depend at different times of the year and the weather conditions.

Frequency and uncommon bird species were very abundant in the area because of the favorability of the area to satisfy their requirements during the study period. These birds were observed foraging on food and water resources available with in and around the study area. These include fishes, grasses, different fruits in the forest like as ficus and cactus around the lake. Trees and different vegetables provide roosting habitats for species of small, flocking birds. Trees also provide nesting sites for raptors which are commonly struck at Hora Lake [18]. The birds usually perch and roost on trees in and around Lake Hora Arsed as well as, on the standing boats, around the shore line of the lake on the larger stone and others. The birds were usually observed with in habitats on the sides of the north-west of the lake, around the shore line of the lake and in the forest, due to the availability of such resources. Egrets (*Ciconiiformes*) which forage on insects and worms disturbed by their hooves, while grazing. African darter often nests with herons, egrets and cormorants. It often foraging fishes and swims with only the neck above water, hence, named as snake bird. The African fish-eagle is a proficient hunter, with live fish accounting for the bulk of its diet. It typically

hunts from a high perch on a water side tree, where it can watch for fish moving close to the water's surface. Their nests and roosts may be only a few hundred meters apart from lake. The black crane was forage in the open water or climb reeds to find prey including flying insects. It feeds on a wide range of invertebrates, small fish, frogs and seeds. Glossy ibises were observed foraging around shore line area as well as flying above the open water. Abdim's storks, on the other hand, forage on worms and other invertebrates between grasses and reeds surround the lake. Cormorants, geese and pelican swim and forage in the water body found in the study area. All species are fish-eaters, catching the prey by diving from the surface. Cormorants nest in colonies around the shore, on trees, islets or cliffs. After fishing, cormorants go ashore, and are frequently seen holding their wings out in the sun. Egyptian geese perch readily on trees and on different dry wood fall and stand surround the lake. It feeds on leaves, grasses, and plant stems. It nests in a large variety of situations, especially in holes in mature trees park. The white egret feeding mainly on fish, frogs, occasionally small reptiles and insects, spearing them with its long, sharp bill most of the time by standing still and allowing the prey to come within its striking distance of its bill which uses it as a spear.

Heron would feed on a variety of live aquatic prey. Their diet includes a wide variety of aquatic animals, including fish, reptiles, amphibians, crustaceans, mollusks, and aquatic insects. Their nests are usually found near or above water. They are typically placed on trees and shrubs although, the nests of a few species have been found on the ground. The kingfisher feeds mainly on fish, although, feeds on crustaceans and large aquatic insects. The main food of pink-backed pelicans is fish; in addition they feed on a variety of small invertebrates and amphibians. Weathers in the months of the years and time of the day determine the significance of activity of birds. Activity of birds is prominent early in the morning and late afternoon hours. During the study period, birds were observed with less significant activities when the weather condition was cold, cloudy and very windy. The result of this study agrees with [19] identified factors that may cause fluctuations in the bird's activities that may include variation in weather conditions, food supply, ability of individuals to disperse to new areas and species interactions such as predation or competition.

Hammer kops white necked cormorant and African darter were observed in large numbers during March and April due to the presence of well weather conditions. Flock foraging was observed in cormorant and Egyptian geese. These birds move around the shoreline of the lake and forage on the open water of the lake around in large groups. Movement pattern was investigated for those birds that usually cross the study area, in particular from the shore line to the forest. This pattern was correlated with the time of the day, months of the year and activities performed by the birds after such movements. Birds that usually perform such activities include pied king fisher, pelican, grey heron, egrets, geese, and gloss ibises. Water body, grasses surrounding the lake are their foraging place and the dry wood surrounding the lake, rocky islets, or cliffs around the shore line of lake was their roosting place. Hammer kops were the most abundant bird species throughout the study period, which live on the tree, on the rocks with the higher flock size up to 30 individuals. White necked cormorants are mostly roosting in the North West direction of the lake by flocking from 1 to 20 mostly on the dry wood falling around the shore line. Sometimes they roost with the African darter and white breasted cormorant around the south western direction of the lake. Trees and different woods around the lake were used as their roosting sites.

Gloss Ibis, egrets, geese and king fisher are the other bird groups that frequently moving around shore of the lake and swimming in the lake to forage food. Pied kingfishers change their site frequently throughout the day. This mainly depends on the amount of food availability. Pied kingfishers mostly spent their time at the shore of the lake. Gloss Ibises and egrets roosting around the shore line of the lake on the rocks with an average flock size of 2 to 10, during early morning and late afternoon at south west direction of the lake. Pelican was most of the time swimming in the water for foraging by flocking from 2 to 10 and roosting at the shore line of the lake with heron, African darter and cormorant at south direction of the lake. Daily activity patterns of birds are influenced by several factors including weather, season and habitat, even though, activity patterns are likely to differ among species [15,20].

5. CONCLUSION

Lake Hora Arseddi has a number of natural and human induced bird attractive features. Natural

habitats within the study area included grass, reeds, water body, bushes and trees. Human induced attractants are roofs of building around a lake, different trees planted by human, cafeteria and former kings' building on the west direction of the lake with significant human activities. The area possesses favorable areas for birds to nest, rest, roost and good access to food as well as water resources. These and other factors attract large number and various species of birds to visit the area at different situations and use the lake for many different purposes. The lake together with the forest nearby supports many species to survive in it, for instance abundant rodents, reptiles, insects and other invertebrates. The wetlands, reed and shore line of a lake were also found to be attractant as water and food resource for birds.

Manmade architectural features attract birds to use the area as their resting and roosting sites. February was the month with the lowest species diversity and richness in the area. March and April on the other hand showed the highest species richness and species diversity, respectively. There was significant difference in bird abundance between different months as well as among the time of days during the study period. The activity pattern of birds showed that, they use the study area as their foraging, resting, roosting and nesting sites. The routine movement of birds in the area showed that some birds move from the shore line to the lake and forest and from the lake to the shore line and to the forest away at different time of the day.

6. RECOMMENDATIONS

Based on the results of the study, the following recommendations were made:

- habitat management is necessary to provide Lake Hora environment that discourages birds perching, nesting, roosting and foraging.
- prevent the establishment of human induced sites that are attractive to birds to rest and roost in the area because it changes the wilderness nature of the species
- establish regulations to develop and implement effective bird control plan in and around the lake Hora Arsed.
- prevent noise, pollution, that has a very real impact on the number of birds sighted in the park and their survival. Human

crowds and noisy human activities will be avoided to create conducive habitat.

- managing the health of water by avoiding the people who are taking show or inside the lake, washing their clothes and swimming
- minimize human activities that can disturb the habitats of birds around the lake.
- allocation of designated boating areas (particularly for water-skiing).
- developing buffer zones so that, it is possible to minimize human impact on birds habitats.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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