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Studies on Determining Ecological Status and Assessment of Avifaunal Diversity at Manchar Lake, Sindh, Pakistan

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Abstract
Manchar Lake is much important wetland which is providing various Environmental services essential for avifaunal species nesting and visiting the area of lake. Ecosystem services include stabilization of shorelines, purification of water, storm protection, storage of water and support to various animal and plant species. The main objective of present research study is to assess the biodiversity of avifaunal species visiting the lake, their IUCN status, distinguish between resident and migratory species. Field visits were conducted on different intervals of every month to record the biodiversity and prevalence of birds. A total number of 140 specimens were recorded and identified into ten diverse species belonging to eight families including Ardeidae, Anatidae, Laridae, Accipitridae, Anhingidae, Laridae, Rallidae, and Glareolidae. Important findings of the proposed research are from total recorded specimens, five species (50%) were recorded as resident and five (50%) were Migratory. The feeding habits observed were predominantly carnivorous (6 species, 60%), followed by omnivorous (2 species, 20%), insectivorous (1 species, 10%), and grainivorous (1 species, 10%). Seasonal Prevalence: The highest prevalence of recorded species occurred in January, February, and March, with the lowest richness observed in June and July. The study concluded that Manchar Lake is experiencing significant pollution due to runoff from agricultural fields, residential areas, and other sources. This pollution, combined with factors such as massive hunting, climatic changes, seasonal fluctuations, and decreasing food resources, has led to a decline in bird populations at the lake.

Keywords: Avifauna, diversity, fluctuation, species, declining, shorelines.

Introduction

Wetlands provide numerous ecological services that are beneficial to people, including water storage, flood protection, water quality improvement, natural products, control of shoreline erosion, and aesthetic and recreational purposes. [1] Manchar Lake, the

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largest freshwater lake in Pakistan, is located in the district of Jamshoro, covering an area of around 200 square kilometers. This lake is known to be one of the largest freshwater lakes of Asia. Recent surveys suggest that Manchar has become migratory as well resident bird's favorite spot, which provides them a peaceful habitat, giving them life support system, plenty of food, shelter for nesting and wading on daily as well seasonal basis. Manchar has been very important wetland as a vital Livelihood source for the Local Mohana fishing community. [2] The lake has historically been an important ecological zone, home to a large population of migratory birds and over 200 different species of fish. But because of both natural and man-made factors, a number of environmental problems have surfaced. Increased salinity and pollution have resulted from the construction of drainage canals and the diversion of water from the Indus River, which has significantly decreased freshwater inflows into the lake. This has caused significant ecological degradation of the lake, including a fall in fish populations, which has an effect on the avifaunal diversity of the lake as well as the livelihoods of the surrounding communities. In addition, pollution from untreated sewage and agricultural runoff has further degraded water quality, endangering aquatic life as well as the birds that depend on the lake for food. Climate change has made matters worse by changing rainfall patterns and speeding up water evaporation [3]. Because of this, a number of bird species that were once common in the area are now endangered, and conservation efforts are desperately needed to restore the ecological balance of the lake [4]. New research emphasizes the necessity of sustainable water management and pollution control measures to protect this important habitat for birds and other wildlife while sustaining the livelihoods of the native Mohanna people [3]. Avifaunal species are among the most exquisite, noble, widespread, and prosperous land-dwelling creatures of animal kingdom. [5] Systematic observations of their habitat reveal that they are the key role indicators of healthy ecosystem. [6] Globally, birds are utilized for food, medicines, timber, ornamentals, and recreational purposes. At Manchar Lake, avifaunal species use the habitat for breeding, rearing their young, drinking water, and social interactions. Birds play a significant role in maintaining ecosystem balance, food chains, and food webs. They help sustain the population levels of their predator-prey species and, after death, provide food for scavengers and decomposers. [7] The assessment of ecological status and avifaunal diversity at Manchar Lake is critical for understanding the broader environmental challenges facing wetland ecosystems in Pakistan. Conservation strategies are urgently needed to mitigate the adverse effects of pollution, habitat degradation, and climate change to preserve the lake's biodiversity and ensure the sustainability of the avian species that depend on it. This exploratory study, conducted for the first time on this topic, documents the avifaunal diversity at Manchar Lake following a massive destructive flood. The research aims to record the emergence of avifaunal species and their association with the surrounding environment.

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This work will be valuable for the wildlife department and future researchers as a literature review.

Methods

Manchar Lake, located in the district of Jamshoro, Sindh, Pakistan, is one of South Asia's largest freshwater lakes. The geographic coordinates of the lake are 26.41° N and 67.68° E. It has a maximum length of 23.5 km and a maximum width of 12.08 km.

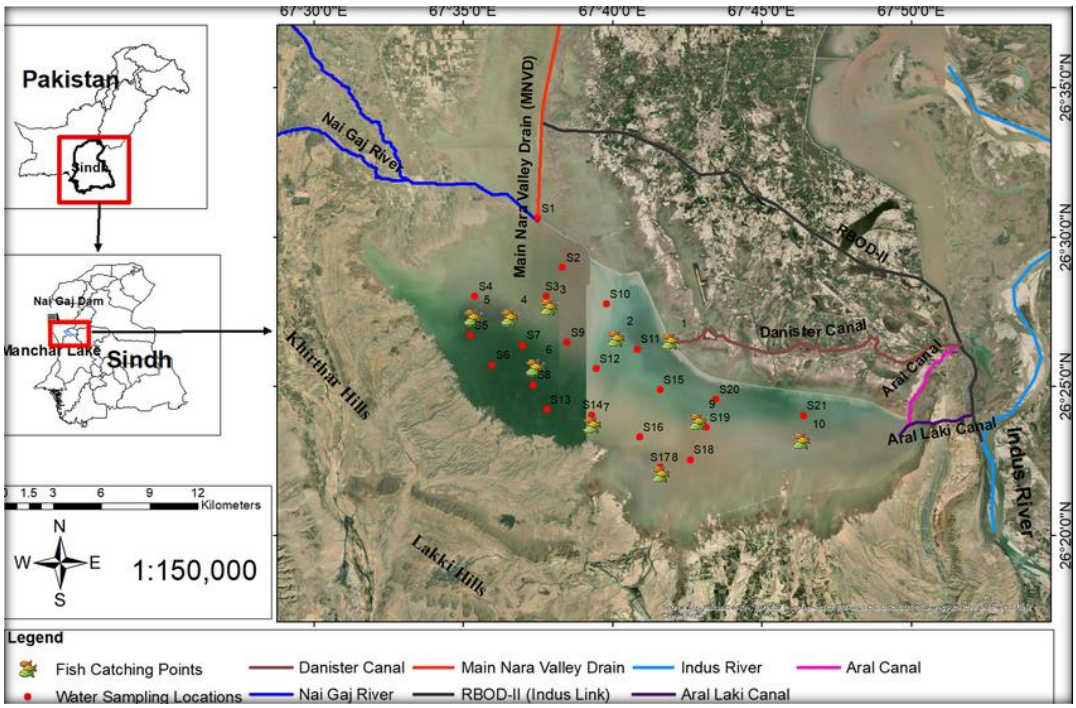

Figure 1: Map of study area (Manchar Lake and premises selected for sampling)

Study outcome variables

Avifaunal diversity metrics: primary aim of the study was to calculate species richness, species evenness, using Simpson diversity index (D) (table: 3) and abundance of individual species.

Ecological status parameters: To observe vegetation cover, water depth and proximity to anthropogenic disturbances, seasonal variation in ecological parameters and bird distribution across sampling sites, assessment of threatened or endangered species presence as per IUCN red list. The lake experiences a semi-arid climate typical of the region; summers are extremely hot exceeding 40°C (104°F) during peak months like May and June. Winters are mild with day temperature of 10 to 25°C (50°F to 77°F)

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Sampling Period: The study on the diversity of avifaunal species at Manchar Lake was conducted over a one-year period, from April 2023 to March 2024. Sample collection occurred at different intervals during this period, both at dawn (from 5:30 AM to 8:30 AM) and at dusk (from 5:00 PM to 6:30 PM). **The Bibby & Burgess (1992)** census technique was employed to count avifaunal species. Field observation was made directly using 10×50 binoculars. Additionally, birds were captured using sound trapping techniques, fishing nets, assistance from local children, and other trapping methods. **Bird Handling and Observation:** Collected birds were kept under observation for a few weeks. During this period, a few samples were taken to the laboratory of vertebrate biology for the measurement of body parameters. Detailed study was conducted to identify morphological characteristics and other related features.
Identification of species: Identification keys were prepared using international literature (**Svensson et al. (2010) that** were then compared with scientific data to accurately identify the bird species observed and captured during the study.

Data analysis
Ecological and diversity parameters were summarized using means, medians, and standard deviations for continuous data; species diversity index was analyzed using Simpson diversity index. Data was represented as mean ± SE, the spatial data has been divided into four habitat categories: Manchar Lake, lakeshores, crops and reed bed. The temporal data was divided into all four seasons, species richness, mean abundance, evenness, Simpson diversity index were calculated using ANOVA software, and diversity t-test was used in the comparison of Simpson diversities in two samples as described by Magurran (1988). GIS Mapping software was used for integrate diversity data and ecological parameters for spatial visualization and hotspot analysis. Box plots, scatterplots, for distribution and trends were used. P-value ≤ 0.05 was considered statistically significant.

Results
The study at Manchar Lake assessed the diversity of avifaunal species, their ecology, feeding habits, habitats, and status as migratory or resident birds. A total of 140 specimens were collected and identified into 10 diverse species: These species belong to 7 different families: Ardeidae, Anatidae, Laridae, Accipitridae, Anhingidae, Rallidae, Glareolidae.

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Figure 2: *Ardea cineria* (Grey Heron), *Anser anser domesticus* (Domestic Goose), *Larus ridibundus* (Common Black-headed Gull), *Anas platyrhynchos* (Mallard Duck), *Aquila chrysaetos* (Golden Eagle), *Anhinga anhinga* (Snakebird or Water Turkey), *Nycticorax nycticorax* (Black-crowned Night Heron), *Larus canus* (Common Gull or Sea Mew), *Fulica atra* (Common Coot), *Glareola lactea* (Small Pratincole) Recorded species at Manchar Lake.

Table 2: Statistical analysis of the collected specimens (length was measured in millimeters and weight was measured in grams) at Manchar Lake.

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Species	Weight of Body (g)	Length of Beak (mm)	Wingspan (mm)	Length of Limbs (mm)	Tail Feather Length (mm)	Body Length (mm)	Width of Web (mm)
Ardea cinerea	1319 ± 394.0	133.5 ± 0.943	930.0 ± 157.4	372.5 ± 1.56	185.0 ± 3.33	303.5 ± 2.23	—
Anser anser domesticus	3979 ± 285.4	102.0 ± 1.23	1370 ± 323.2	285.0 ± 10.67	157.5 ± 1.53	675.0 ± 168	114.0 ± 35.4
Larus ridibundus	212.0 ± 4.71	35.5 ± 0.85	272.5 ± 1.36	71.0 ± 91.8	133.0 ± 1.06	123.5 ± 2.23	—
Anas platyrhynchos	1060 ± 14.73	65.5 ± 1.024	367.5 ± 1.709	103.5 ± 2.51	366.0 ± 0.674	111.5 ± 0.342	36.5 ± 0.89
Aquila chrysaetos	455 ± 33.40	38.0 ± 1.38	535 ± 3.20	16.5 ± 1.05	172.5 ± 1.73	31.0 ± 1.38	—
Anhinga anhinga	1337.5 ± 250	37.5 ± 1.38	102.5 ± 2.52	355.5 ± 1.45	135.5 ± 0.843	328.0 ± 3.86	—
Nycticorax nycticorax	302 ± 1.53	72 ± 1.20	190 ± 3.22	787 ± 140.5	314 ± 3.12	21.5 ± 0.95	—
Fulica atra	835 ± 28.8	49.5 ± 7.03	70 ± 8.36	335 ± 18.3	400 ± 11.48	62.5 ± 7.9	—
Larus canus	212.0 ± 4.71	35.5 ± 0.85	272.5 ± 1.36	71.0 ± 91.8	133.0 ± 1.06	123.5 ± 2.23	22.5 ± 0.91
Glaeorela lactea	32.0±0.97	13.5±1.08	126±1.04,	26.0±1.05	47.0±6.8	56.5±7.5	----

From the recorded specimens, 50% of the specimens (5 species) were migratory and 50% of the recorded specimens (5 species) were resident birds of the lake. According to their feeding habits from the total recorded specimens 6 species (60%) were Carnivorous, Omnivorous 2 species (20%), Insectivorous 1 species (10%), and Grain eating was 1 species (10%).

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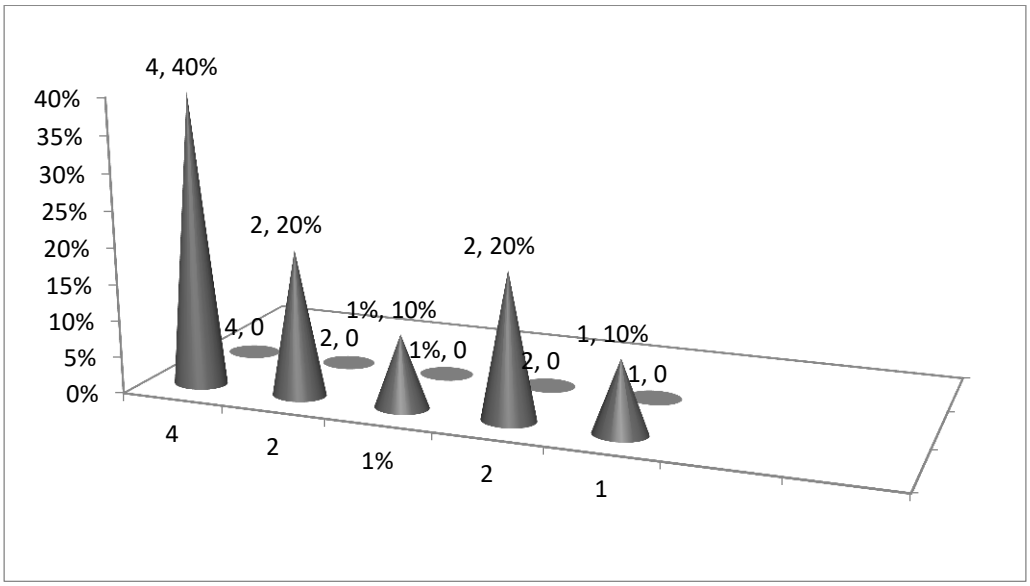

Figure 3: Trophic status of recorded species.

During a recent study, 140 bird specimens from Manchar Lake were collected and identified into ten different species across eight families. The graph is showing total number of specimens collected from April 2023 to march 2024

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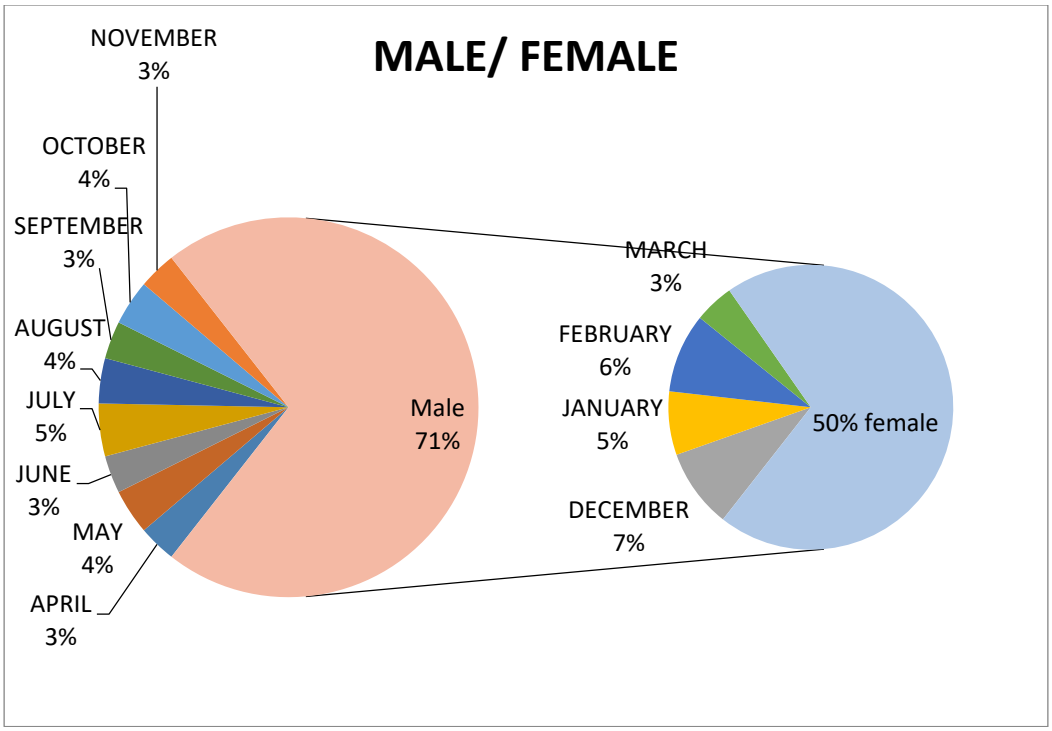

Figure 4: Prevalence of avifaunal species from April 2023 to March 2024.
In this table detailed description of recorded species is mentioned. i.e. scientific name of species, common names, belonging to which family, their IUCN status, resident or migratory birds and their trophic status.

Table 3: Distribution diagram showing abundance, prevalence, migratory/resident status, trophic status, and IUCN status (IUCN status shows least concern for recorded species but due to environmental challenges i.e. Massive flooding, massive hunting, and habitat destruction, these recorded species have started declining in population) the highest prevalence of recorded species occurred in January, February, and March, with the lowest richness observed in June and July.

Species	Percent Abundance (%)	Prevalence	Migratory/Resident Status	Trophic Status	IUCN Status

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Ardea cinerea (Grey Heron)	20%	Common	Migratory/Resident	Carnivore (Fish eater)	Least Concern (LC)
Anser anser domesticus (Domestic Goose)	20%	Common	Resident	Herbivore	Not Evaluated (NE)
Larus ridibundus (Common Black-headed Gull)	20%	Common	Migratory	Omnivore	Least Concern (LC)
Anas platyrhynchos (Mallard Duck)	25%	Common	Migratory	Omnivore	Least Concern (LC)
Aquila chrysaetos (Golden Eagle)	15%	Rare	Resident	Carnivore	Least Concern (LC)
Anhinga anhinga (Snakebird)	10%	Uncommon	Resident	Carnivore (Fish eater)	Least Concern (LC)

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Nycticorax nycticorax (Black-crowned Night Heron)	15%	Common	Migratory/Resident	Carnivore (Fish eater)	Least Concern (LC)
Fulica atra (Common Coot)	12%	Common	Migratory/Resident	Omnivore	Least Concern (LC)
Larus canus (Common Gull)	13%	Common	Migratory	Omnivore	Least Concern (LC)

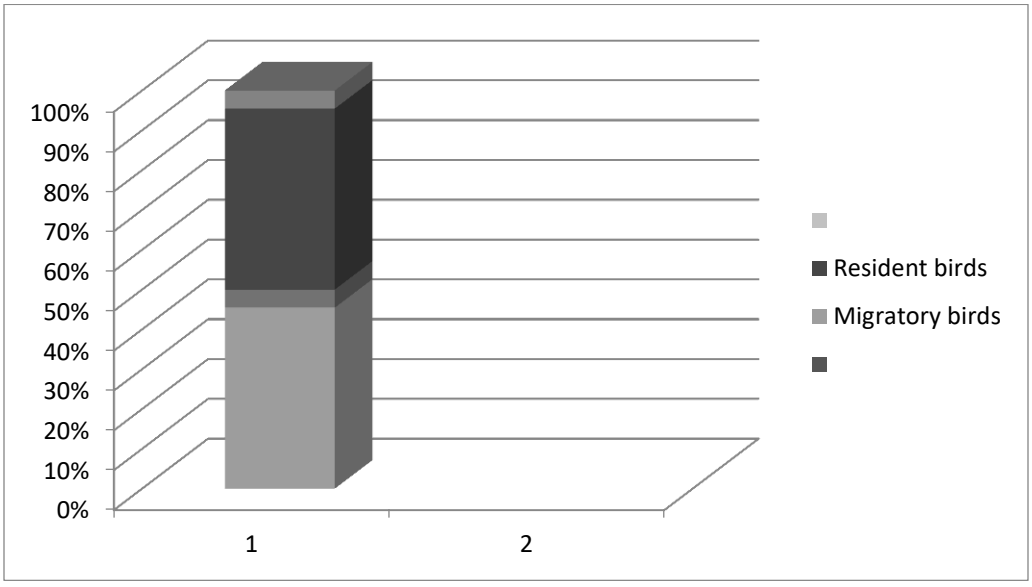

Figure 5: Status as migratory or resident birds.

Diversity of species

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The Simpson diversity index (SDI) is the measure of diversity including number of species and population size of each species.

Formula:

$D=1 -\sum ni(ni-1)N(N-1)D = 1 - \frac{\sum n_i (n_i - 1)}{N(N - 1)}D=1-N(N-1)\sum ni(ni-1)$

Where nin-ini= population size of each species

NNN= total population size

Step 1. Table Preparation:

Species	nin_ini	ni(ni−1)n_i(n_i - 1)ni(ni−1)
Ardea cinerea	15	380
Anser anser domesticus	16	380
Larus ridibundus	14	380
Anas platyrhynchos	20	600
Aquila chrysaetos	15	210
Anhinga anhinga	10	90
Nycticorax nycticorax	15	210
Fulica atra	13	132
Larus canus	12	156
Glareola lacteal	10	90

2. Calculate total population and ∑ni(ni-1)/sum n-i(n-i-1) ∑ni (ni-1)

N=∑ ni=15+16+14+20+15+10+15+13+12+10=140N=\sum n+ 15+16+14+20+15+10+15+13+12+10

∑ni(ni−1)=380+380+380+600+210+90+210+132+156+90=2628\sum n_i(n_i - 1) = 380+ 380 + 380 + 600 + 210 + 90 + 210 + 132 + 156 + 90 2628∑ni(ni−1)=380+380+380+600+210+90+210+132+156+90=2628

3. Simpson Diversity Index:

$D=1-\sum ni(ni-1)N(N-1)D = 1 - \frac{\sum n_i(n_i - 1)}{N(N - 1)}D=1-N(N-1)\sum ni(ni-1)$ $D=1-2628160(159)=1-262825440\approx1-0.1033=0.8967D = 1 - \frac{2628}{160(159)} = 1 - \frac{2628}{25440} \approx 1 - 0.1033 = 0.8967D=1-160(159)2628=1-254402628 \approx1-0.1033=0.8967$

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Table: 4 Metric and value SDI (Simpson diversity index)

Metric	Value
Total Population (NNN)	160
∑ni(ni−1)\sum n_i(n_i - 1)∑ni(ni−1)	2628
Simpson Index (DDD)	0.8967

Discussion

Wetlands play a crucial role in providing habitats for a wide variety of resident and migratory birds. This ecological importance has made the preservation and protection of wetlands a matter of significant concern. [8-9] However, human activities have led to the degradation of these vital ecosystems, threatening both biodiversity and environmental health. Wetlands, such as Manchar Lake in the Sindh province of Pakistan, are essential for supporting biodiversity. They offer shelter and breeding grounds for numerous bird species and other wildlife. [10-11] as they supply the resources required for survival and procreation, these ecosystems are essential to the life cycles of many species. Currently, a number of anthropogenic factors are endangering Manchar Lake, the largest wetland in the Right Bank of the Outfall Drain (RBOD) region: pollution and toxic runoff from agricultural and industrial runoff are introducing harmful chemicals into the lake, lowering water quality and making the environment uninhabitable for many species. [12–13] A recent study collected 140 bird specimens from Manchar Lake and classified them into ten distinct species spanning eight families. The ***Ardea cineria,*** also known as the Grey Heron, is a striking and large wading bird that is commonly found in wetlands throughout Europe, Asia, and northern Africa. With its tall and graceful build, long legs, long neck, and sharp, pointed bill for hunting and fishing, this bird is remarkable for a number of unique physical traits. Its common name comes from its predominantly grey plumage on its back and wings. The head is white, contrasted by a prominent black supercilium (a stripe running from the base of the beak above the eye). Its long, slender neck is a key feature, often seen extended while hunting or retracted during flight. Grey Herons are crucial for the health of wetland ecosystems. As apex predators, they help control fish and insect populations, maintaining ecological balance. Their presence also serves as an indicator of the health of their wetland habitats.[14-15] ***Anser anser domesticus*** (Domestic goose) is commonly known as the Domestic Goose, it vary in size depending on the breed, but they generally range from 4 to 9 kg (8.8 to 19.8 lbs) in weight, their plumage

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varies widely depending on the breed, from pure white to grey, brown, and even mixed colors, the bill is usually orange or pink, and the legs are typically orange, though coloration can vary with different breeds.[16] ***Anas platyrhynchos*** (Mallard) is a widely recognized and studied species of duck, Mallards typically range from 50 to 65 cm (20 to 26 inches) in length, and they weigh between 0.7 to 1.6 kg (1.5 to 3.5 lbs). Males (drakes) are known for their distinctive iridescent green head, white neck ring, chestnut-brown chest, and gray body. Females (hens) have mottled brown feathers, providing camouflage. [17-18] ***Larus ridibundus*** (Common gull) a common bird species found in much of Europe and Asia. Adults have a chocolate-brown head during the breeding season, which turns white with dark spots during the winter. They have white bodies, grey wings with black tips, and red legs and bills. They are medium-sized gulls, with a wingspan of 94-110 cm (37-43 inches) and a body length of 38-44 cm (15-17 inches).[19] ***Larus canus*** (Seagull or sea meow) is a species of medium-sized gull that breeds in northern Europe and Asia and migrates southward in winter. This species can often be found along coastlines, in estuaries, and near bodies of freshwater. Its plumage is mostly white with gray wings and back, and it has yellow legs and a yellow bill with a black band near the tip. In terms of behavior, it's quite adaptable, scavenging for food in various environments and also hunting small fish, crustaceans, and insects. Its body length measures up to 40-46 centimeters (16-18 inches), Wingspan: 110-125 centimeters (43-49 inches), Weight: 300-600 grams (10.5-21 ounces). These measurements can differ depending on factors such as age, sex, and geographic location. [20] ***Aquila chrysaetos*** (Golden eagle) is large bird of prey, with wingspans ranging from 1.8 to 2.34 meters (5.9 to 7.7 feet). They inhabit open and semi-open landscapes across the Northern Hemisphere, including mountains, forests, and steppes, Adults have dark brown plumage with a golden-brown nape and a distinctive golden patch on the back of the neck. They have strong, hooked beaks and talons for capturing prey. [21-22] ***Anhinga anhinga*** (Snake bird or water turkey) is a species of bird found in the Americas. It's known for its distinctive long neck, pointed bill, and slender body, which is adapted for diving and swimming. Anhinga often hunt underwater for fish, using their sharp beaks to spear their prey typically measures around 85 to 95 centimeters (33 to 37 inches) in length from the tip of the bill to the tip of the tail. Their wingspan can range from 117 to 125 centimeters (46 to 49 inches). [23-24] ***Fulica atra*** (Coot) a species of bird in the rail family. These waterbirds are recognized by their predominantly black plumage, white bill, and distinctive white frontal shield above the bill. They're found across much of Europe, Asia, Australia, and parts of Africa. Eurasian coots inhabit freshwater lakes, ponds, and marshes, where they feed on aquatic plants, insects, and small fish. Typically has a body length ranging from 36 to 42 centimeters (14 to 17 inches) and weighs between 585 and 1,100 grams (1.3 to 2.4 pounds).) [25-26] ***Nycticorax nycticorax*** (Black-crowned heron) a medium-sized wading bird found in various parts of the world. Its distinctive features include its black crown and back, gray

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wings and under parts, and red eyes. These herons are primarily nocturnal hunters, feeding on fish, insects, amphibians, and small mammals. An adult black-crowned night heron typically has a length ranging from about 58 to 66 centimeters (23 to 26 inches) from beak to tail. Their wingspan can extend from approximately 101 to 112 centimeters (40 to 44 inches). These measurements may differ slightly between males and females, with males often being slightly larger than females. [27-28] ***Glareola lactea*** (Little pratincole) It's a species of bird in the family glareolidae, which is found in parts of South and Southeast Asia, including India, Sri Lanka, Myanmar, Thailand, and Indonesia. The bird is known for its graceful flight and distinctive appearance, with long pointed wings and a short tail. Typically measures around 16 to 18 centimeters (6.3 to 7.1 inches) in length. They have a wingspan of approximately 40 to 50 centimeters (16 to 20 inches). [29] The bird species observed at Manchar Lake exhibit a range of feeding habits: Carnivorous Species: 6 species (60%), Omnivorous Species: 2 species (20%), Insectivorous Species: 1 species (10%), Granivorous Species: 1 species (10%). Regarding migratory patterns, the study found, Migratory Species: 5 species (50%), .Sedentary Species: 5 species (50%) These samples were collected across both winter and summer seasons, indicating the lake's role as a year-round habitat for both resident and migratory birds.

Conclusion

By acknowledging the lack of recent research on bird diversity at Manchar Lake and highlighting the importance of such information for conservation planning an exploratory study was conducted to document the emergence of avian fauna diversity and its association with this specific environment. This study will be very helpful for wildlife department and future researchers as literature review.

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Author's contributions

WY, YW and ZC conceived the study. The author and co. Author analyzed the data and wrote the initial manuscript.

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Availability of data and materials

All the original images of species and models, sources of work will be provided on demand.

Declarations

Ethics approval and consent to participate

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Not applicable.

Completing interests
The author and co-author declare no conflict of interest.

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