

Assessment of Avian Diversity and Water Parameters of Narsinh Mehta Lake, Junagadh City, Gujarat, India: A Case Study of Revamping Habitat

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(Received 12 November, 2023; Accepted 13 January, 2024)

ABSTRACT

Landscape changes due to habitat alteration and fragmentation can result in complex changes in biodiversity. In the present study, Narsinh Mehta Lake located on the center of Junagadh city was studied for avian diversity during March 2021 to December 2022. The lake, a vital ecosystem within an urban setting, presents a unique opportunity to investigate how avian species composition and abundance are influenced by various water quality parameters. A total of 85 avian species belongs to 14 orders and 36 families and 69 genera are recorded including 5 near threatened and 3 vulnerable species. Amongst the recorded species, 22 were migratory and 63 resident birds. The carnivorous feeding habit was shown by the maximum number of species while nectarivores and frugivorous bird species were in the least numbers. The rich avifaunal diversity of Narsinh Mehta Lake confirms it as a suitable habitat for both migrant and resident bird species. Furthermore, variations in water parameters appear to influence the distribution and behavior of avian species, highlighting the importance of maintaining suitable water conditions for avian populations. Such insights are critical for effective conservation and management strategies aimed at preserving both avian diversity and the integrity of Narsinh Mehta Lake ecosystem. It is worth to mention that the lake is selected for beautification to attract tourists which may affect the biodiversity of the lake.

Key words: *Avian diversity, Water parameters, Narsinh Mehta Lake, Feeding Habit, Junagadh City*

Introduction

Biodiversity is threatened worldwide by land-use change and urbanization, which results in the loss, fragmentation and degradation of primary habitats (Spotswood *et al.*, 2021). Global avian diversity estimated as far as 9700 extant species (Callaghan *et al.*, 2021). India, which has a tropical climate and a variety of habitats, has 1358 different species of birds (<http://www.indianbirds.in/india/> Accessed 22 August, 2023) or about 13% of the world's bird species, demonstrating its high diversity and richness. This richness in the form of diversity comes natural

to areas that are rich in ecosystem diversity as observed in Junagadh city. This is clearly reflected from its geographic location in Gujarat, which has four bio-geographic zone and five biotic provinces all over the state. These diverse habitats in Gujarat have provided abode for a total of 609 bird species (Ibis, 2021), including terrestrial and aquatic species (predominantly migratory), with majority of them found to occupy forest of South Gujarat, Aravali foothills of NE Gujarat, Little Rann of Kachchh and the Gir forest of Southern Saurashtra. Narsinh Mehta Lake, nestled in the heart of Junagadh City, Gujarat, India, stands as a remarkable example of an

urban aquatic ecosystem that plays a pivotal role in supporting a diverse array of avian species. Urbanization and its associated alterations to natural habitats have raised concerns about the impact of environmental changes on avian communities. The interdependence between avian diversity and water parameters within such an ecosystem warrants comprehensive scientific investigation to clarify the complex relationships at play. Due to urbanization, excess sewage water is often dumped into water bodies as a result the physicochemical characteristics of the water and the aquatic flora and organisms are affected (Bhat *et al.*, 2009). This research aims to bridge the gap in understanding by conducting a comprehensive assessment of avian diversity in relation to water parameters within Narsinh Mehta Lake. By examining the interplay between avian communities and the physicochemical attributes of the lake's water, we can shed light on the mechanisms driving avian species distribution, behavior, and potential adaptations to changing environmental conditions. The findings of this study will not only contribute to the scientific understanding of urban aquatic ecosystems but also provide practical guidance for the sustainable management and conservation of avian diversity of lake.

Materials and Methods

Study Area

The Narsinh Mehta Lake (21.518394 °N, 70.455270 °E) selected for this study is situated on the middle outskirts of Junagadh. Total area of the lake is 156131 m² (Figure 1) and an average depth of 8

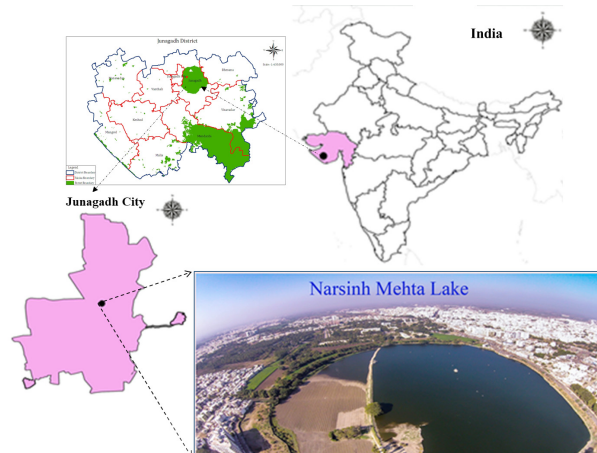


Fig. 1. Sampling site and study area (Narsinh Mehta Lake).

meter. The Kalwa River is main source of the lake water. The river water reaches the lake when the Wellington dam overflows during the monsoon which is built at the foot of the hill from where the river originates. Narsinh Mehta Lake is perennial water body into which the external drainage stream mixes and overflow occurs due to heavy rainfall. Three very small mounds has been built between the lake water bodies. There is agricultural landscape on one side which is devoid of human population. A huge number of aquatic zooplankton are supported by aquatic weed in the lake. Fish and other aquatic animals are used as a source of food by many carnivorous birds, while a variety of birds find habitats in the nearby trees and shrubs.

Avifaunal Data: Bird surveys were carried out seasonally (summer, winter, and monsoon) during March 2021 to December 2022. Regular weekly surveys were conducted in the morning (from 7:00 AM to 9:00AM) and evening (5:00PM to 7:00PM). The number of bird species and individuals present in and around the lake were determined using the direct observation approach using binocular Nikon 8265 ACULON and photographs were captured by Nikon COOLPIX B500 Digital Camera and DSLR Nikon D3300 with Nikon 70-300mm lens. Birds were identified using the books Birds of Indian Subcontinent (Grimmett *et al.*, 2011). Each species was assessed according to its IUCN classification from the electronic version 2.0 (IUCN 2021) and its migration status, and it was divided into four categories: Common, Uncommon, Very Common, and Rare.

Water quality analysis: Physico-chemical analysis of water was conducted to determine the water quality of the lake. Surface water samples were collected from Narsinh Mehta Lake in clean container. Temperature and pH were measured in the collection point, using mercury in glass Thermometer and portable hand pH meter. The depth of lake was also measured in all the seasons. The collected water samples are immediately brought to laboratory for estimation of BOD and COD (Food Testing Laboratory, Junagadh Agriculture University).

Data Analysis: The major feeding guilds of birds categorized as Carrnivore (CV), Frugivore (FV), Graminivore (GV), Herbivore (HV), Insectivore (IV), Nectarivore (NV), and Omnivore (OM) while migratory status of birds categorized as Resident (R), Wintermigrant (WM) and Summer Migrant (SM). Bird species are also classified as very Common (VC), Common (C), Uncommon (UC) and Rare (RA)

species of study site. Each identified species was cross referenced with the latest IUCN status and were categorized into least concern (LC), near threatened (NT) and vulnerable (VC) category (IUCN 2022).

Results

A total 85 avian species of 69 genera belonging to 36 families and 14 orders were reported from the study area (Table 1). Order Passeriformes represents 13 families followed by Charadriiformes with five families (Figure 2).

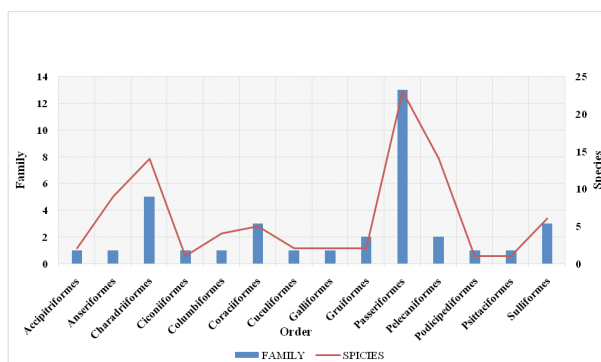


Fig. 2. Order wise distribution of avian fauna.

According to the migratory status, a total of 63 resident birds (RA), 21 winter migrants (WM), and one summer migrant (SM) species have been reported (Figure 3).

The major feeding preferences of the bird species that have been observed are: Carnivore 42% (36 species), Omnivore 32% (27 species), Insectivore 13% (11 species), Granivore 6% (Five species), Herbivorous 5% (Four species), Frugivore and Nectarivore 1% (One species) (Figure 4).

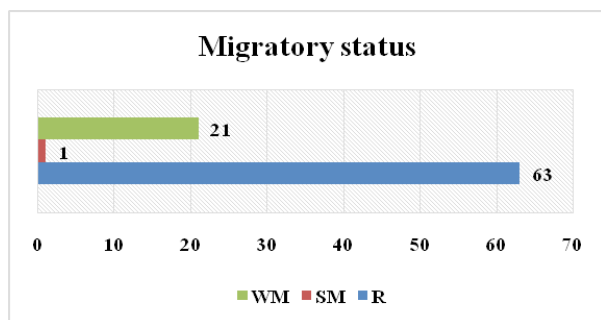


Fig. 3. Migratory status of Avifauna (WM-Winter migrant, SM-Summer migrant, R- Resident)

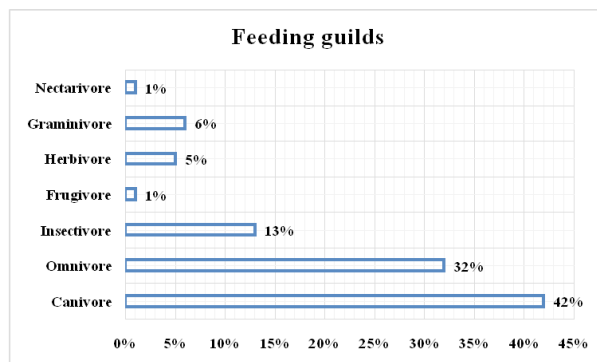


Fig. 4. Feeding guilds of reported avian species.

According to the abundance status, 41 species were classified as Very Common (VC), 25 as Common, 15 as Uncommon, and 4 as Rare (RA) (Figure 5).

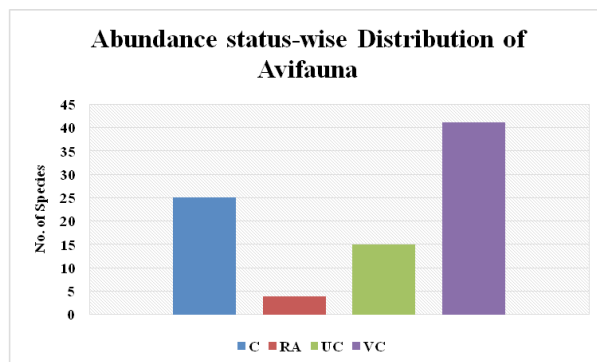


Fig. 5. Abundance status of avifauna at study site.

According to the IUCN status, the avifauna categorized as: 77 species were Least Concern (LC), six species Near threatened (NT) and three species Vulnerable (VU) (Figure 6).

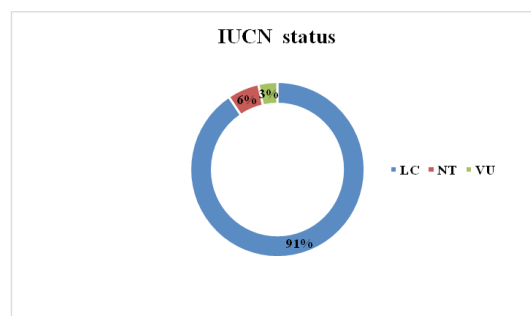


Fig. 6. The IUCN status of reported avifauna

The maximum abundance of birds was recorded in November & December months of winter season and the lowest was recorded in May & June months of summer (Figure 7).

Table 1. Systematic list of Birds recorded form Narsinh Mehta Lake of Junagadh City, Gujarat

Common Name	Scientific Name	Abundance	Residential Status	IUCN Status	Feeding Habit
Order:Accipitriformes					
Family: Accipitridae					
1 Black Kite	<i>Milvus migrans</i>	VC	R	LC	CV
2 Shikra	<i>Accipiter badius</i>	VC	R	LC	CV
Order:Anseriformes					
Family: Anatidae					
3 Common Teal	<i>Anas aita</i>	RA	WM	LC	HV
4 Indian Spotbilled Duck	<i>Anas poecilohynchos</i>	VC	R	LC	OV
5 Lesser whistling Duck	<i>Dendrocygna jamaica</i>	C	R	LC	OV
6 Common pochard	<i>Aythya faya</i>	UC	WM	VU	OV
7 Northern Pintail	<i>Anas platyrhynchos</i>	UC	WM	LC	HV
8 Knob-billed Duck	<i>Sarkidiornis melanotos</i>	VC	R	LC	OV
9 Northern shoveler	<i>Spatula clypeata</i>	C	WM	LC	HV
10 Gadwall	<i>Mareca strepera</i>	UC	WM	LC	HV
11 Garganey	<i>Spatula querquedula</i>	UC	WM	LC	OV
Order: Charadriiformes					
Family : Charadriidae					
12 Red wattle lapwing	<i>Vanellus indicus</i>	VC	R	LC	OV
13 Little-ring plover	<i>Charadrius dubius</i>	VC	WM	LC	OV
Family: Jacanidae					
14 Pheasant-tailed jacana	<i>Hydrophasianus chirurgus</i>	UC	R	LC	OV
Family: Laridae					
15 River Tern	<i>Sterna auantia</i>	VC	R	VU	CV
16 Whiskered Tern	<i>Chlidonias hybrida</i>	C	WM	LC	CV
Family: Recurvirostridae					
17 Black winged stilt	<i>Himantopus himantopus</i>	VC	R	LC	OV
18 Pied avocet	<i>Recurvirostra avosella</i>	C	WM	LC	OV
Family: Scolopacidae					
19 Common sandpiper	<i>Actitis hypoleucos</i>	VC	WM	LC	CV
20 Common snipe	<i>Gallinago gallinago</i>	C	R	LC	CV
21 Common Red shank	<i>Tringa totanus</i>	C	WM	LC	CV
22 Little stint	<i>Calidris minuta</i>	C	WM	LC	CV
23 Black tailed Godwit	<i>Limosa limosa</i>	C	WM	NT	OV
24 Green sandpiper	<i>Tringa ochropus</i>	C	WM	LC	CV
25 wood sandpiper	<i>Tringa glareola</i>	UC	R	LC	CV
Order: Ciconiiformes					
Family: Ciconiidae					
26 Painted Stork	<i>Mycteria leucocephala</i>	VC	R	NT	CV
Order: Columbiformes					
Family: Columbidae					
27 Eurasian-collared Dove	<i>Streptopelia decaocto</i>	VC	R	LC	GV
28 Laughing Dove	<i>Spilopelia senegalensis</i>	C	R	LC	GV
29 Rock Pigeon	<i>Columba livia</i>	VC	R	LC	GV
30 Spotted Dove	<i>Spilopelia chinensis</i>	VC	R	LC	GV
Order: Coraciiformes					
Family: Alcedinidae					
31 Common kingfisher	<i>Alcedo atthis</i>	C	R	LC	CV
32 Pied Kingfisher	<i>Ceryle rudis</i>	C	R	LC	CV
33 Whith-throated kingfisher	<i>Halcyon smytnensis</i>	VC	R	LC	CV
Family: Coraciidae					
34 Indian roller	<i>Coracias benghalensis</i>	UC	R	LC	CV

Table 1. Continued..

	Common Name	Scientific Name	Abundance	Residential Status	IUCN Status	Feeding Habit
Family: Meropidae						
35	Green bee-eater	<i>Meropsorientalis</i>	VC	R	LC	IV
Order: Cuculiformes						
Family: Cuculidae						
36	Greater coucal	<i>Centropus sinensisparroti</i>	VC	R	LC	OV
37	Asian koel	<i>Eudynamysscolopacea</i>	VC	R	LC	OV
Order: Galliformes						
Family: Phasianidae						
38	Indian peafowl	<i>Pavocristatus</i>	VC	R	LC	OV
39	Grey francolin	<i>Francolinus pondicerianus</i>	VC	R	LC	OV
Order: Gruiformes						
Family: Gruidae						
40	Saras Crane	<i>Antigone antigone</i>	UC	R	VU	OV
Family: Rallidae						
41	Purple swampphen	<i>Porphyrioporphyrio</i>	UC	R	LC	OV
Order: Passeriformes						
Family: Cisticollidae						
42	Common tailorbird	<i>Orthotomus sutorius</i>	VC	R	LC	OV
Family: Corvidae						
43	House crow	<i>Corvussplendens</i>	VC	R	LC	OV
44	Jungle crow	<i>Corvusmacrorhynchos</i>	C	R	LC	OV
Family: Dicruridae						
45	Black drongo	<i>Dicrurusmacroceus</i>	VC	R	LC	IV
Family: Estrildidae						
46	Indian silverbill	<i>Lonchuramalabarica</i>	VC	R	LC	OV
47	Scally - breasted munia	<i>Lonchuapunctulata</i>	C	R	LC	OV
Family: Hirundinidae						
48	Wire tailed swallow	<i>Hirundosmithii</i>	C	SM	LC	IV
Family: Lelothrichidae						
49	Common babbler	<i>Turdoides caudatus</i>	VC	R	LC	IV
50	Jungle babbler	<i>Turdoides striatus</i>	VC	R	LC	IV
Family: Motacillidae						
51	White wagtail	<i>Motacilla alba</i>	VC	WM	LC	IV
52	Yellow wagtail	<i>Motacillaflava</i>	C	WM	LC	IV
53	Grey wagtail	<i>Motacillacinerea</i>	UC	WM	LC	IV
Family: Muscicapidae						
54	Indian robin	<i>Saxicoloidesfulcatus</i>	VC	R	LC	IV
55	Oriental Megpie robin	<i>Copsychussaulari</i>	VC	R	LC	OV
56	Tickellsbule flycatcher	<i>Cyornistickelliae</i>	C	R	LC	IV
Family: Nectariniidae						
57	Purple sunbird	<i>Nectariniaasiatica</i>	VC	R	LC	NV
Family: Passeridae						
58	House sparrow	<i>Passer domesticus</i>	VC	R	LC	GV
Family: Ploceidae						
59	Baya weaver	<i>Ploceusphilippinus</i>	VC	R	LC	IV
Family: Pycnonotidae						
60	Red-vented bulbul	<i>Pycnonotuscafer</i>	VC	R	LC	OV
Family: Sturnidae						
61	Common myna	<i>Acridotherestrictis</i>	VC	R	LC	OV
62	Bank myna	<i>Acridotheresginginianus</i>	C	R	LC	OV
63	Brahminy starling	<i>Sturniapagodaum</i>	C	R	LC	OV

Table 1. Continued..

	Common Name	Scientific Name	Abundance	Residential Status	IUCN Status	Feeding Habit
Order: Pelecaniformes						
Family: Ardeidae						
64	Black crowned night-heron	<i>Nycticorax nycticorax</i>	UC	R	LC	CV
65	Cattle egret	<i>Bubulcus ibis</i>	VC	R	LC	CV
66	Great egret	<i>Casmeodius albus</i>	UC	R	LC	CV
67	Little egret	<i>Egretta gazetta</i>	VC	R	LC	CV
68	Indian pond heron	<i>Ardeola grayii</i>	VC	R	LC	CV
69	Grey heron	<i>Ardeacinerea</i>	C	R	LC	CV
70	Western reef heron	<i>Egretta alula</i>	C	WM	LC	CV
71	Purple heron	<i>Ardea purpurea</i>	RA	R	LC	CV
72	Intermediate egret	<i>Ardea intermedia</i>	VC	R	LC	CV
73	Yellow bittern	<i>Ixobrychus sinensis</i>	RA	R	LC	CV
Family: Threskiornithidae						
74	Black-headed ibis	<i>Threskiornis melanocephalus</i>	C	R	NT	CV
75	Red-naped ibis	<i>Pseudibis papillosa</i>	VC	R	LC	CV
76	Glossy ibis	<i>Plegadis falcinellus</i>	UC	R	LC	CV
77	Eurasian spoonbill	<i>Platalea leucorodia</i>	C	WM	LC	CV
Order: Podicipediformes						
Family: Podicipedidae						
78	Little grebe	<i>Tachybaptus ruficollis</i>	VC	R	LC	CV
Order: Psittaciformes						
Family: Psittacidae						
79	Rose-ringed parakeet	<i>Psittacula kramera</i>	VC	R	LC	FV
Order: Sulliformes						
Family: Phalacrocoracidae						
80	Indian cormorant	<i>Phalacrocorax fuscicollis</i>	C	R	LC	CV
81	Great cormorant	<i>Phalacrocorax carbo</i>	UC	R	LC	CV
82	Little cormorant	<i>Microcarbo nigripes</i>	VC	R	LC	CV
Family: Anhingidae						
83	Orinoco stork	<i>Anhinga melanogaster</i>	C	R	NT	CV
Family: Pelecanidae						
84	Great white pelican	<i>Pelecanus onocrotalus</i>	RA	WM	LC	CV
85	Dalmatian pelican	<i>Pelecanus crispus</i>	UC	WM	NT	CV

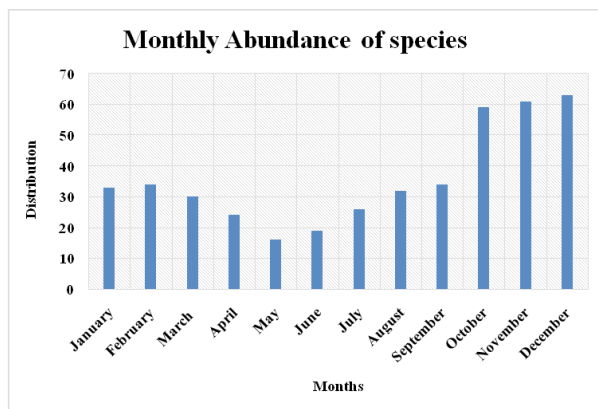


Fig. 7. Monthly variation in the avifaunal population in terms of abundance during the study period.

The results of water parameters (Table 2) indicate an ideal aquatic environment for faunal and floral diversity. The variations in water parameters may only have a seasonal effect. Average depth of water level was 8.5 meter, it was lowest reported during the peak of summer. High pH and BOD level was observed during the winter months. Major fluctua-

Table 2. Water parameters of Narsinh Mehta Lake.

	Winter	Summer	Monsoon
pH	6.8 - 7.1	6.1 - 6.8	7.8 - 8.1
Temperature	22.2 - 27.8°C	29.8 - 32.1°C	28.1 - 29.4°C
BOD	16-17 mg/l	17-22 mg/l	10-12 mg/l
COD	40 - 47 mg/l	46 - 54 mg/l	34 - 36 mg/l
Depth	9m - 10m	4m - 6m	11m - 13m



Fig. 8. Bird diversity of Lake. a- Purple swamphen, b- Little grebe, c- Great cormorant, d- Black-winged stilt, e- Cattle egret, f- Brahminy starling, g- Eurasian coot, h- Indian pond heron, i- Indian spot-billed duck, j- Wood sandpiper, k- Great white pelican

tion was observed in COD values where it was highest in summer months due to decreasing water depth and effluents from surrounding area. The monsoon season showed a rise in pH levels due to rain water and water flow from surroundings. The BOD and COD values increased during the summer which clearly indicated somewhat higher amount of eutrophication in this water.

Discussion

In recent decades, protecting of the planet's biodiversity has risen to the top of the priority list (Ehrlich and Wilson, 1991). Nearly all habitat types are occupied by birds, and the diversity of these species frequently provides a reliable indicator of the total diversity of a region (Furness and Greenwood, 1993). Birds are also known to be highly responsive to changes in their environment, therefore they can be employed as bioindicators (Padoa-Schioppa *et al.*, 2006). Preparing checklists of birds on a larger scale has been given significant relevance in the context of the increasing popularity of biodiversity assessment using short-term research (Roy *et al.*, 2011). The current study provides a checklist of 85 bird species documented from Narsinh Mehta Lake. Migratory status of avifauna indicates 74% of the species in the study region are resident, whereas 26% are migratory. The Narsinh Mehta Lake ecosystem is not only a focal point of urban biodiversity but also a recreational area for local residents. It has very small islands, agricultural land, and peripheral

waterlogged region that provide heterogeneous habitats that sustain a rich diversity of birds. The dynamic environment of lake also provides a unique opportunity to explore the nexus between avian presence, abundance, and the physicochemical attributes of the water. Water temperature, pH, BOD and COD are the key parameters that can influence avian behaviors, habitat preferences, and ultimately, the composition of avian communities (Dey *et al.*, 2021). There are fewer species of birds in the lake when the temperature, BOD, and COD are high and the pH and depth are low. Additionally, the prevalence of some bird species increases with moderate pH, temperature, BOD, COD, and lake depth. The results of this study provide insights into how environmental factors shape avian habitat preferences and contribute to the overall biodiversity within the lake. Our findings reveal significant associations between specific avian species and certain water quality indicators. It is noteworthy to mention that presently the Narsinh Mehta Lake is under beautification program to attract tourists. The present study will be useful for comparison of biodiversity data after the modification and restoration of lake water bodies.

Acknowledgements

Authors are thankful to Bhakta Kavi Narsinh Mehta University, Junagadh and Principal, Dr. R. P. Bhatt, Bahauddin Science College, Junagadh for the support and help during study. Food testing laboratory of Junagadh Agriculture University is also acknowledged for the results of water quality parameters.

Conflict of Interest

The authors declare that they have no known conflict of interests or personal relationships that could have appeared to influence the work reported in this paper.

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