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Avian diversity and Physio-chemical parameters of Chhaya wetland, Porbandar, Gujarat, India

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ABSTRACT

Wetlands support a tremendous floral and faunal diversity by providing habitat along with food and water. During adverse conditions of drought and flooding they act as a natural sponge that purifies and replenishes water. Chhaya is one such wetland located at Porbandar city in the western part of Gujarat state in India. Rain water is the major source of water for Chhaya Wetland, hence environmental conditions get adverse with decreasing water levels. The present study focuses on Avian diversity and Physico-chemical parameters of water, this study will help to understand water quality of wetland that is being preferred by the birds. Birds from 19 orders and 46 families were identified. As per IUCN status, birds from 3 types of IUCN categories: vulnerable (VU), near threatened (NT) and least concern (LC) category. The Scolopacidae family contributed the highest number of species i.e., 18 species followed by Anatidae and Laridae. During the research, we observed that the Chhaya wetland, although present in the urban area and affected by various anthropogenic activities, still remains a preferred site for the winter migrants, as these winter visitors account for more than half of its Avian diversity.

Keywords: Winter migrants, Avian diversity, Physico-chemical parameters, Chhaya wetland

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INTRODUCTION

Wetlands are one of the most useful environments on the earth, offering numerous significant types of assistance to human culture but are highly ecologically sensitive [8, 27, 26]. These wetlands occur in all heights from tropical deserts to cold tundra, at all elevations from beneath the ocean level to around 6000 m high in the Himalaya [4]. Wetlands share just 0.0001% of the total fresh water assessable involving 6.45% of the world's surface. Regardless of the critical natural, hydrological and financial qualities played by them, wetlands have been confronting dangers from a varried man-made instigated factors. Among the Indian states, Gujarat positions first with an absolute wetland area of around 3.47 m ha (around 23 % of the complete Indian wetland region) [18].

Being an unloading ground of anthropogenic release, these wetlands brought about a special biological system by eutrophication and subsequently support expanding biomass of phytoplankton, gelatinous zooplankton, benthic and epiphytic algae. This unique environment likewise upholds an enormous variety of microbes, hardy fish species, crustaceans and molluscs that allure fauna particularly birds which feed upon them [12]. Nonetheless, since the start of the twentieth century, almost 60-70% of all wetlands worldwide have been lost because of rural seepage and urbanization [5], and of those remaining, many are degraded [32]. Thusly, it is proposed that the decay of wetland biodiversity is more prominent than that in terrestrial systems [6]. Among avian wetland species, around 55% are declining around the world, although large herbivorous waterbirds are on rise [31, 19]. Living organisms, plants and animals are dependent on the environment of their habitat [14].

Birds are the critical parts of these ecosystems which can indicate their ecological circumstances and assume a crucial part in improving their biodiversity [22]. Birds are excellent indicators of the state of a healthy environment and form an integral component of agricultural ecosystem [13]. Wetlands are well known to support high concentrations of birds [23] and are considered as paradise for birds [3]. They play an enormous part in ecosystem services like pollination, pest control, seed dispersal, scavenging, cycling the nutrients, and so forth [30]. Furthermore, Birds support various other taxa and act as

indicator species of various natural surroundings. There are 11,158 extant species of birds reported worldwide. Out of which 1341 species (26 orders, 113 families and 489 genera) are recorded from India [21]. 14 of which 612 species are recorded from Gujarat [7]. The diversity of these organisms is one of the most important ecological indicators to evaluate the quality of habitats [16].

The quality of water is vital for the evaluation of waterbird habitat, as numerous physical and chemical factors interacting can influence the primary productivity of the aquatic environment and thus affect overall biomass across the water food web [29], Physicochemical parameters of water showed significant variations with water bird density, diversity, richness, and evenness [1].

Several author such as [20, 24, 25, 1] have studied Bird Diversity and Physico-chemical parameters of the selected wetlands and have observed that these wetlands provide an excellent habitat for these magnificent winged-creatures. They also observed that it is very important to understand avian diversity along with the physico-chemical parameters of these wetlands.

Our Present research work was to assess Avian diversity and Physico-chemical parameters of Chhaya wetland, as this is a very important and preferred site of winter birds. It is home to a good number of bird species therefore by conserving Chhaya wetland, we can save all floral and faunal diversity along with avian diversity. As there was no systematic data available regarding Avian diversity and Physico-chemical parameters; we attempted to fill the research gap by preparing a detailed report on diversity of aves and physico-chemical parameters of Chhaya wetland, which would be helpful in further references as well.

MATERIAL AND METHODS

Study area:

The Research was conducted on Chhaya wetland (21°37'51.72"N, 69°37'42.60"E) which is located at Porbandar city in the western part of Gujarat state in India. The wetland covers a zone of 2.17 km². It is 3.34 km long and 0.58 km wide. The major source of water is rainwater which nourishes the wetland and other secondary water sources apart from rain water were sewage water, waste water and industrial effluents from nearby households and industry respectively. The fundamental cause behind the water evaporating of this wetland is because of precipitation and surface run-off. The atmosphere of the territory is semi-arid (yearly rainfall is between 200 – 700 mm).



Figure 1: location of study site: Chhaya wetland, Porbandar, Gujarat, India (Source: <https://earth.google.com/web/>)

Data Collection:

The present research was conducted for the tenure of one year i.e., from January 2021 to December 2021. The study area was surveyed twice a month and a total of 24 visits were made during the study. The field visits were scheduled in the morning (6:00 to 9:00 hrs) and evening (16:00 to 19:00 hrs) as birds showed higher activities during these times. Birds were observed with the help of Nikon Binoculars (ACULON A211 10x50). Birds were identified using available scientific references, field guide (Grimmett et al., 2011) and other published literature. Random sampling and point-count observation methods were used for data collection of birds. Water sample for the analysis of physico-chemical parameters were also collected during the field visit.

Data Analysis:

As per the data collected during the study, we categorised residential status of birds as Resident (RE), and Winter migrant (WM). The occurrence of species in the study area was also reported based on the number of sightings during the study period as Very Common (≥ 8 sighting), Common (5-7 sighting), Uncommon (3-4 sighting), and Rare (1-2 sighting). Each identified species was cross referenced with the latest IUCN status and were categorised into vulnerable (VU), near threatened (NT) and least concern (LC) category (IUCN 2022). Diversity indices such as Simpson diversity $1/D$; $1-D$; Shannon diversity $-H'$, evenness $-e^H/S$, Margalef's species richness (d), and Fisher alpha diversity (α) were computed using software PAST (Hammer et al., 2001). pH and T.D.S. was measured using pH and TDS meter respectively. T.S, TSS, D.O., B.O.D., analysis was done as per the standard method available in [2].

RESULTS

During our research a total of 149 species from 19 orders and 46 families were recorded (Table.1). Order Passeriformes represents 17 families followed by Charadriiformes with 6 families (Figure.2). Scolopacidae family contributes 18 species which is highest among all the families, Anatidae and Laridae recorded 14 and 10 species respectively. Chhaya wetland is home to several winter migratory birds, 77 species (52% of the total Avian Diversity) are winter migrants (WM) & 72 species (48%) were residents (figure.4). This wetland provides habitat to birds from three IUCN Categories: 2 species (Common Pochard *Aythya ferina*, River Tern *Sterna aurantia*) belong to Vulnerable (VU) category, 11 species belong to Near threatened (NT) category and 136 species belong to least concern (LC) category (figure.5). As per abundance status Bird were categorised into 4 categories: 34% (50 species) were Very Common and 29% (44 species) were Common, 34% (50 species) were Uncommon and 3% (5 species) were Rare (figure.3). During the Physico-chemical analysis highest pH was recorded in the month of January (8.62) while lowest was recorded in the month of June (6.5), highest DO (mg/L) was recorded in the month of August (7.64 mg/L) while lowest was recorded in the month of May (3.45 mg/L), highest BOD (mg/L) was recorded in the month of January while lowest was recorded in the month of May, highest TS (mg/L) was recorded in the month of May (977 mg/L) while lowest was recorded in the month of September (604 mg/L), highest TDS (mg/L) was recorded in the month of May (425 mg/L) while lowest was recorded in the month of September (246 mg/L), highest TSS (mg/L) was recorded in the month of May (552 mg/L) while lowest was recorded in the month of September (358 mg/L) (table.2). Lower values of Dominance_D and Berger-Parker and Higher values of Simpson_1-D, Shannon H, Margalef and Fisher_alpha indicate a good diversity of Avian fauna is observed at Chhaya wetland (table.3).

Table.1: Checklist of Birds of Chhaya wetland Porbandar, Gujarat, India (January 2021 to December 202) showing Bird's Common name, Scientific name, Family, IUCN status, Residential status and Abundance

Common Name	Scientific Name	Order	Family	IUCN	Residential Status	Abundance
Black kite	<i>Milvus migrans</i>	Accipitriformes	Accipitridae	LC	R	VC
Black-winged Kite	<i>Elanus caeruleus</i>			LC	R	C
Brahminy Kite	<i>Haliasturindus</i>			LC	WM	UC
Eurasian Marsh-Harrier	<i>Circus aeruginosus</i>			LC	WM	C
Shikra	<i>Accipiter badius</i>			LC	R	VC
Osprey	<i>Pandion haliaetus</i>		Pandionidae	LC	WM	C
Common Pochard	<i>Aythya ferina</i>	Anseriformes	Anatidae	VU	WM	UC
Cotton Pygmy-Goose	<i>Nettapus coromandelianus</i>			LC	WM	R
Eurasian Wigeon	<i>Mareca penelope</i>			LC	WM	UC
Ferruginous Duck	<i>Aythya nyroca</i>			NT	WM	UC

Gadwall	<i>Mareca strepera</i>			LC	WM	UC
Garganey	<i>Anas querquedula</i>			LC	WM	UC
Green-winged Teal	<i>Anas carolinensis</i>			LC	WM	C
Indian Spot-billed Duck	<i>Anas poecilorhyncha</i>			LC	R	VC
Knob-billed Duck	<i>Sarkidiornis melanotos</i>			LC	R	VC
Lesser Whistling-Duck	<i>Dendrocygnajavanica</i>			LC	WM	C
Northern Pintail	<i>Anas acuta</i>			LC	WM	UC
Northern Shoveler	<i>Spatula clypeata</i>			LC	WM	C
Ruddy Shelduck	<i>Tadornaferruginea</i>			LC	WM	UC
Tufted Duck	<i>Aythya fuligula</i>			LC	WM	UC
Asian Palm-Swift	<i>Cypsiurusbalasiensis</i>	Apodiformes	Apodidae	LC	R	C
Little Swift	<i>Apus affinis</i>			LC	WM	C
Eurasian Hoopoe	<i>Upupa epops</i>	Bucerotiformes	Upupidae	LC	wm	C
Great Thick-knee	<i>Esacusrecurvirostris</i>	Charadriiformes	Burhinidae	NT	R	UC
Indian Thick-knee	<i>Burhinus indicus</i>			LC	R	C
Greater Sand Plover	<i>Charadrius leschenaultii</i>		Charadriidae	LC	WM	UC
Kentish Plover	<i>Charadrius alexandrinus</i>			LC	WM	UC
Lesser Sand-Plover	<i>Charadrius mongolus</i>			LC	WM	C
Little Ringed Plover	<i>Charadrius dubius</i>			LC	WM	VC
Pacific Golden-Plover	<i>Pluvialis fulva</i>			LC	WM	UC
Red-wattled Lapwing	<i>Vanellus indicus</i>			LC	R	VC
Pheasant-tailed Jacana	<i>Hydrophasianuschirurgus</i>		Jacanidae	LC	WM	UC
Black-headed Gull	<i>Chroicocephalus ridibundus</i>		Laridae	LC	R	VC
Bridled Tern	<i>Onychoprionanaethetus</i>			LC	WM	UC
Brown-headed Gull	<i>Chroicocephalusbrunnicephalus</i>			LC	R	C
Caspian Tern	<i>Hydroprognecaspia</i>			LC	WM	UC
Gull-billed Tern	<i>Gelochelidonnilotica</i>			LC	WM	UC
Lesser Black-backed Gull	<i>Larus fuscus</i>			LC	WM	UC
Pallas's Gull	<i>Ichthyiaetichthyiaetus</i>			LC	WM	C
River Tern	<i>Sterna aurantia</i>			VU	R	VC
Slender-billed Gull	<i>Chroicocephalusgenei</i>			LC	WM	UC
Whiskered Tern	<i>Chlidoniashybrida</i>			LC	WM	C
Black-winged Stilt	<i>Himantopus himantopus</i>		Recurvirostridae	LC	R	VC
Pied Avocet	<i>Recurvirostraavosetta</i>			LC	WM	C
Bar-tailed Godwit	<i>Limosalapponica</i>		Scolopacidae	NT	WM	UC
Black-tailed Godwit	<i>Limosalimosa</i>			NT	WM	C
Common Greenshank	<i>Tringanebularia</i>			LC	WM	UC
Common Redshank	<i>Tringatotanus</i>			LC	WM	C
Common Sandpiper	<i>Actitishypoleucos</i>			LC	WM	VC
Common Snipe	<i>Gallinagogallinago</i>			LC	WM	C
Curlew Sandpiper	<i>Calidris ferruginea</i>			NT	WM	UC
Eurasian Curlew	<i>Numenius arquata</i>			NT	WM	UC
Green Sandpiper	<i>Tringaochropus</i>			LC	WM	C
Little Stint	<i>Calidris minuta</i>			LC	WM	C
Marsh Sandpiper	<i>Tringastagnatilis</i>			LC	WM	C
Red-necked Phalarope	<i>Phalaropuslobatus</i>			LC	WM	R
Ruddy Turnstone	<i>Arenaria interpres</i>			LC	WM	UC
Ruff	<i>Calidris pugnax</i>			LC	WM	UC
Spotted Redshank	<i>Tringaerythropus</i>			LC	WM	UC
Temminck's Stint	<i>Calidris temminckii</i>			LC	WM	UC
Terek Sandpiper	<i>Xenus cinereus</i>			LC	WM	UC
Wood Sandpiper	<i>Tringaglareola</i>			LC	WM	UC
Asian Openbill	<i>Anastomusoscitans</i>	Ciconiiformes	Ciconiidae	LC	WM	UC

Painted Stork	<i>Mycteria leucocephala</i>			NT	R	VC
Eurasian Collared-Dove	<i>Streptopeliadeocto</i>	Columbiformes	Columbidae	LC	R	VC
Laughing Dove	<i>Spilopelia senegalensis</i>			LC	R	C
Rock Pigeon	<i>Columba livia</i>			LC	R	VC
Pied Kingfisher	<i>Cerylerudis</i>			LC	R	C
White-throated Kingfisher	<i>Halcyon smyrnensis</i>	Coraciiformes	Alcedinidae	LC	R	VC
Green Bee-eater	<i>Meropsorientalis</i>		Meropidae	LC	R	VC
Asian Koel	<i>Eudynamysscolopaceus</i>	Cuculiformes	Cuculidae	LC	R	VC
Greater Coucal	<i>Centropus sinensis</i>			LC	R	VC
Peregrine Falcon	<i>Falco peregrinus</i>	Falconiformes	Falconidae	LC	WM	UC
Gray Francolin	<i>Ortygornispondicerianus</i>	Galliformes	Phasianidae	LC	R	VC
Indian Peafowl	<i>Pavocristatus</i>			LC	R	VC
Common Crane	<i>Grus grus</i>	Gruiformes	Gruidae	LC	WM	R
Demoiselle Crane	<i>Grus virgo</i>			LC	WM	C
Baillon's Crake	<i>Porzana pusilla</i>		Rallidae	LC	WM	UC
Brown Crake	<i>Zaporniaakool</i>			LC	WM	UC
Eurasian Coot	<i>Fulicaatra</i>			LC	WM	VC
Eurasian Moorhen	<i>Gallinula chloropus</i>			LC	R	VC
Gray-headed Swampphen	<i>Porphyriopolioccephalus</i>			LC	R	C
Little Crake	<i>Porzana parva</i>			LC	WM	R
White-breasted Waterhen	<i>Amaurornisphoenicurus</i>			LC	R	VC
Clamorous Reed Warbler	<i>Acrocephalusstentoreus</i>		Acrocephalidae	LC	WM	VC
Paddyfield Warbler	<i>Acrocephalusagricola</i>			LC	WM	C
Common Iora	<i>Aegithina tiphia</i>		Aegithinidae	LC	R	C
Ashy-crowned Sparrow-Lark	<i>Eremopterix griseus</i>		Alaudidae	LC	R	VC
Crested Lark	<i>Galerida cristata</i>			LC	R	C
Rufous-tailed Lark	<i>Ammomanesphoenicura</i>			LC	R	VC
Sand Lark	<i>Calandrellaraytal</i>			LC	R	UC
Common Tailorbird	<i>Orthotomussutorius</i>			LC	R	VC
Plain Prinia	<i>Prinia inornata</i>	Passeriformes	Cisticolidae	LC	R	VC
House Crow	<i>Corvus splendens</i>			LC	R	VC
Large-billed crow	<i>Corvus macrorhynchos</i>		Corvidae	LC	R	C
Rufous Treepie	<i>Dendrocittavagabunda</i>			LC	R	VC
Ashy Drongo	<i>Dicrurusleucophaeus</i>			LC	R	UC
Black Drongo	<i>Dicrurusmacrocerus</i>		Dicruridae	LC	R	VC
Indian Silverbill	<i>Euodicalabarica</i>			LC	R	VC
Bank Swallow	<i>Riparia riparia</i>		Estrildidae	LC	R	VC
Barn Swallow	<i>Hirundorustica</i>			LC	WM	UC
Dusky Crag-Martin	<i>Ptyonoprogne concolor</i>		Hirundinidae	LC	WM	UC
Gray-throated Martin	<i>Riparia chinensis</i>			LC	WM	UC
Red-rumped Swallow	<i>Cecropisdaurica</i>			LC	R	C
Wire-tailed Swallow	<i>Hirundosmithii</i>			LC	R	C
Isabelline Shrike	<i>Laniusisabellinus</i>			LC	WM	UC
Common Babbler	<i>Argyacaudata</i>		Laniidae	LC	R	VC
Jungle Babbler	<i>Argya striata</i>			LC	R	VC
Paddyfield Pipit	<i>Anthusrufulus</i>		Leiothrichidae	LC	WM	UC
Tawny Pipit	<i>Anthus campestris</i>			LC	WM	UC
Western Yellow Wagtail	<i>Motacilla flava</i>			LC	WM	C
White Wagtail	<i>Motacilla alba</i>			LC	WM	VC
White-browed Wagtail	<i>Motacillamaderaspatensis</i>			LC	R	C
Bluethroat	<i>Luscinia svecica</i>		Muscicapidae	LC	WM	UC
Indian Robin	<i>Saxicoloidesfulicatus</i>			LC	R	VC
Oriental Magpie-Robin	<i>Copsychussaularis</i>			LC	R	VC

Siberian Stonechat	<i>Saxicola maurus</i>	Pelecaniformes		LC	WM	C
Purple Sunbird	<i>Cinnyris asiaticus</i>		Nectariniidae	LC	R	VC
House Sparrow	<i>Passer domesticus</i>		Passeridae	LC	R	VC
Yellow-throated Sparrow	<i>Gymnorisxanthocolis</i>			LC	R	C
Common Chiffchaff	<i>Phylloscopuscollybita</i>		Phylloscopidae	LC	WM	UC
Red-vented Bulbul	<i>Pycnonotuscafer</i>		Pycnonotidae	LC	R	VC
Bank Myna	<i>Acridotheresginginianus</i>		Sturnidae	LC	R	C
Common Myna	<i>Acridotheres tristis</i>			LC	R	VC
Rosy Starling	<i>Pastor roseus</i>			LC	R	VC
Cattle Egret	<i>Bubulcus ibis</i>	Pelecaniformes	Ardeidae	LC	R	VC
Gray Heron	<i>Ardea cinerea</i>			LC	R	C
Great Egret	<i>Ardea alba</i>			LC	R	UC
Indian Pond-Heron	<i>ArdeolaGreyii</i>			LC	R	VC
Intermediate Egret	<i>Ardea intermedia</i>			LC	R	VC
Little Egret	<i>Egrettaarazetta</i>			LC	R	VC
Purple Heron	<i>Ardea purpurea</i>			LC	R	C
Western Reef-Heron	<i>Egrettaularis</i>			LC	R	C
Dalmatian Pelican	<i>Pelecanus crispus</i>		Pelecanidae	NT	WM	UC
Great White Pelican	<i>Pelecanusonocrotalus</i>			LC	WM	UC
Black-headed ibis	<i>Threskiornism elanocephalus</i>		Threskiornithidae	NT	R	C
Eurasian Spoonbill	<i>Platalealeucorodia</i>			LC	R	C
Glossy Ibis	<i>Plegadisfalcinellus</i>			LC	WM	UC
Red-naped Ibis	<i>Pseudibispapillosa</i>			LC	R	VC
Greater Flamingo	<i>Phoenicopterus roseus</i>	Phoenicopteriformes	Phoenicopteridae	LC	WM	UC
Lesser Flamingo	<i>Phoeniconaias minor</i>			NT	R	VC
Eared Grebe	<i>Podiceps nigricollis</i>	Podicipediformes	Podicipedidae	LC	WM	R
Great Crested Grebe	<i>Podiceps cristatus</i>			LC	WM	UC
Little Grebe	<i>Tachybaptus ruficollis</i>			LC	R	VC
Rose-ringed Parakeet	<i>Psittaculakrameri</i>	Psittaciformes	Psittaculidae	LC	R	VC
Chestnut-bellied Sandgrouse	<i>Pteroclessexustus</i>	Pterocliiformes	Pteroclididae	LC	R	UC
Oriental Darter	<i>Anhinga melanogaster</i>	Suliformes	Anhingidae	NT	R	C
Indian Cormorant	<i>Phalacrocorax fuscicollis</i>		Phalacrocoracidae	LC	WM	C
Little Cormorant	<i>Microcarboniger</i>			LC	R	VC

IUCN status: vulnerable (VU), near threatened (NT) and least concern (LC) category (Source: <https://www.iucnredlist.org/>).

Residential status: Resident (RE) and Winter migrant (WM).

Abundance status: Very common (VC), Common (C), Uncommon (UC) & Rare (R).

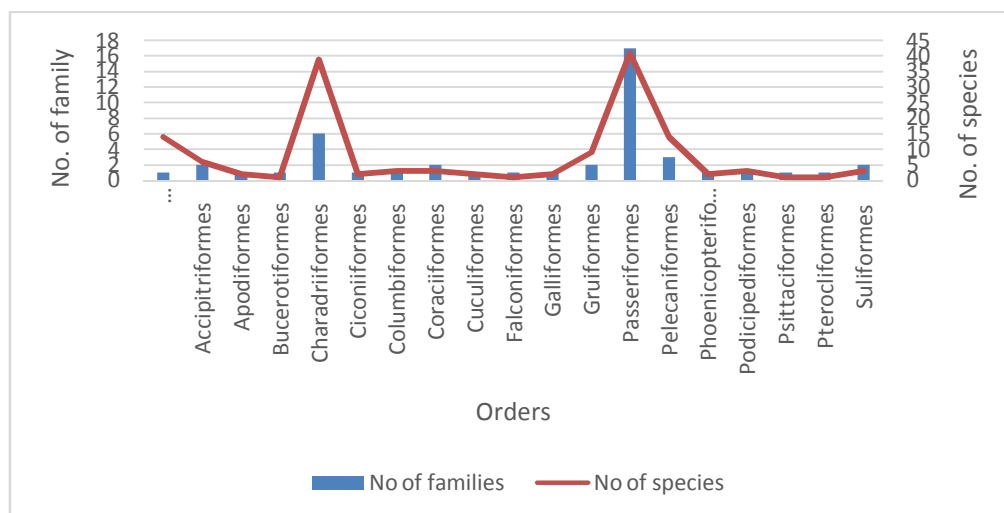


Figure 2: Order wise distribution of Avian fauna

Order Passeriformes represents highest no. of families (17) and species (41) of total Avian families followed by Charadriiformes with (6) families and (39) species. (Figure 2).

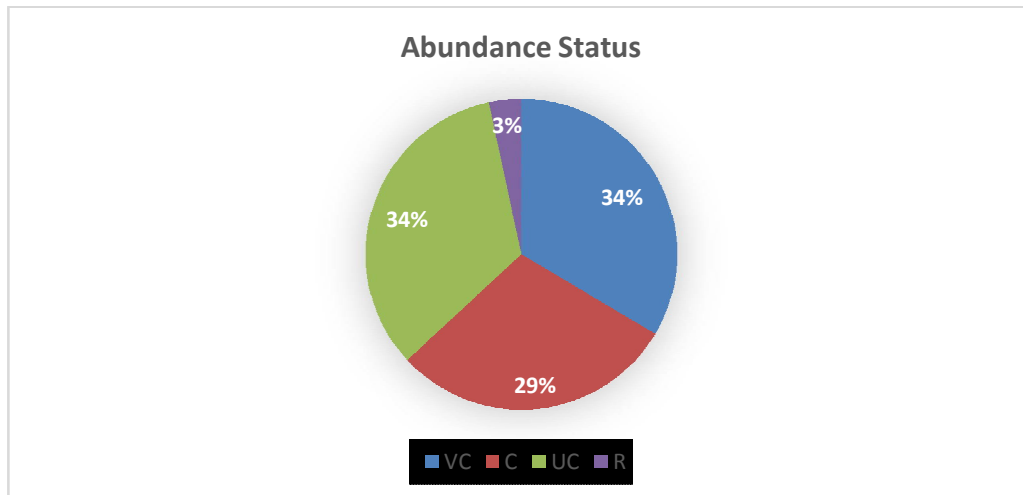


Figure.3:Abundance status

As per the abundance status of Avian diversity, (34%)species were Categorised as Very Common (VC), (29%) species as Common (C), (34%) species as Uncommon (UC) and (3%) species were Rare (R) (Figure 3)

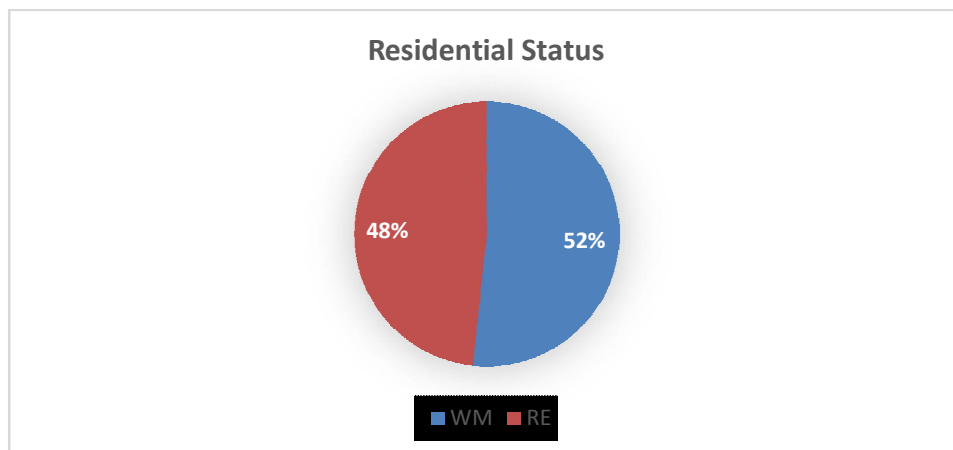


Figure.4:Residential status

As per the residential status of Avian diversity,(52%) species were winter migrant (WM),while (48%) species were resident (RE) (Figure 4)

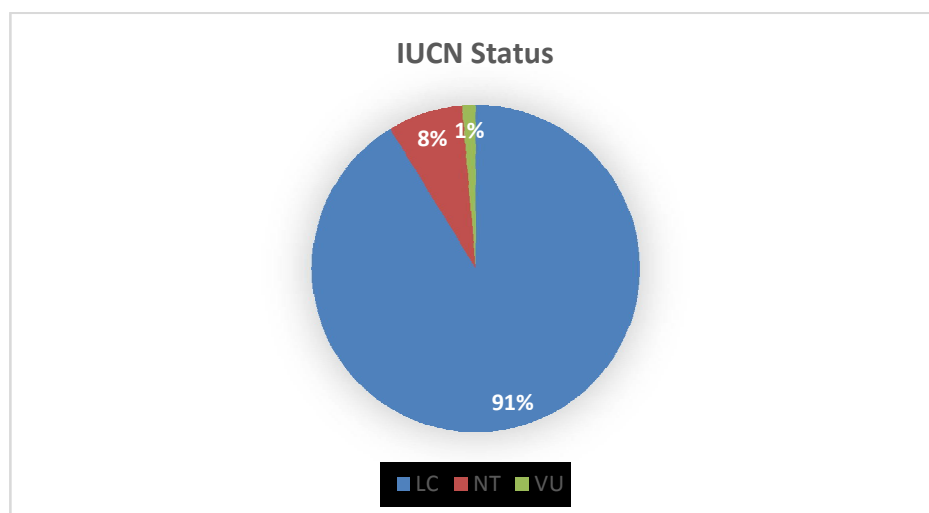


Figure.5:IUCN Status

As per the IUCN status (91%) species belongs to Least concern category, (8%) species belongs to Near threatened and (1%) species belongs to Vulnerable category (Figure 5)

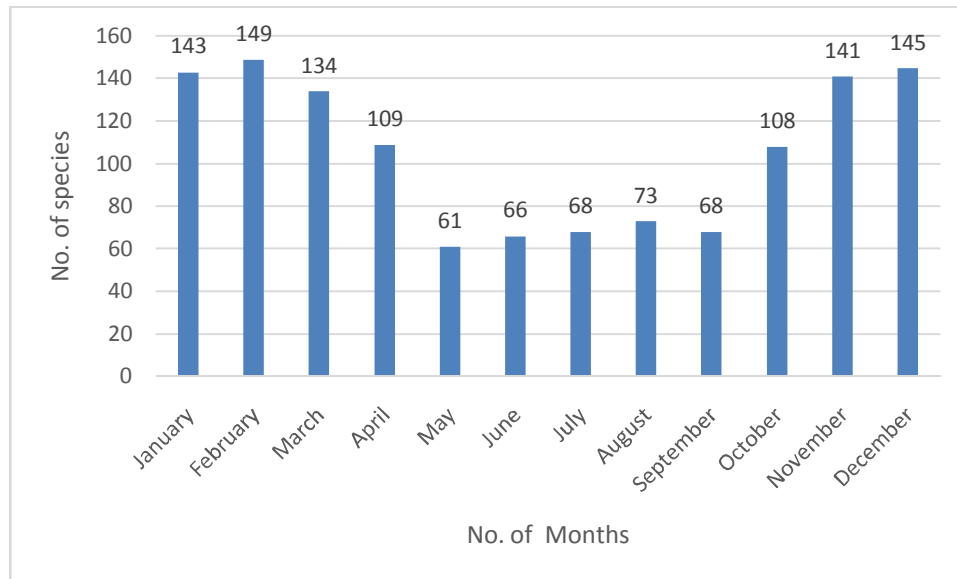


Figure 6: No of species (January 2021 to December 2021)

Maximum no of species was recorded in the month of February (149 species) and lowest no of species were recorded in the month of May (61 species) (Figure 6)

Table.2: Physico-chemical parameters of Chhaya wetland, Porbandar, Gujarat, India (January 2021 to December 2021)

Physico-chemical Parameters	pH (mg/L)	DO (mg/L)	BOD (mg/L)	TS (mg/L)	TDS (mg/L)	TSS (mg/L)
January	8.62	5.8	3.86	868	358	510
February	8.15	5.6	3.7	888	365	523
March	7.62	4.66	3.5	927	387	540
April	7.16	3.9	2.89	957	412	545
May	6.73	3.45	1.9	977	425	552
June	6.5	4.12	2.68	956	415	541
July	6.87	6.1	2.83	864	371	493
August	7.12	7.64	3.23	737	310	427
September	7.86	7.6	3.11	604	246	358
October	7.79	6.89	3.38	651	275	376
November	8.12	6.45	3.25	728	316	412
December	8.36	6.2	3.48	765	328	437

Table.3: Diversity indices	
Dominance_D	0.03683
Simpson_1-D	0.9632
Shannon_H	3.526
Evenness_e^H/S	0.7228
Brillouin	3.458
Menhinick	1.321
Margalef	6.44
Equitability_J	0.9157
Fisher_alpha	9.618
Berger-Parker	0.08933

DISCUSSION

During the study we recorded 149 species of birds (January 2021 to December 2021). 77 species were winter migrants Accounting to 52% species of total avian fauna at Chhaya wetland. This habitat attracts a good number of winter migrants. Highest species richness was observed during winter season, making Chhaya wetland a preferred site for winter visitors. Kushwaha et al., 2021 studied that the wetlands in Suhelwa Wildlife Sanctuary have strong potential to support the rich diversity of wetland birds, including the important migratory species.

Worldwide destruction of wetland is being experienced by many countries as reported by Davidson [5]. Similarly, Chhaya wetland is also under great pressure due to anthropogenic activities going around it.

Order Passeriformes were more abundant followed by Charadriiformes and Pelecaniformes. Gibru and Mengesha [9] recorded higher abundance of Charadriiformes next to order Passeriformes during their study on Species composition, seasonal abundance and distribution of avifauna in the Eastern Wetland habitats.

During December, January and February, bird diversity as well as winter migrants observed abundantly. Meena *et al.*, [17] reported the highest population of the migratory birds during the month of December January and February.

Two species (Common Pochard *Aythya farina*, River Tern *Sterna aurantia*) belong to Vulnerable (VU) category were reported at Chhaya Wetland making it an important site along with 11 species (Lesser Flamingo *Phoeniconaias minor*, Dalmatian Pelican *Pelecanus crispus*, Oriental Darter *Anhinga melanogaster*, Black-headed ibis *Threskiornis melanocephalus*, Eurasian Curlew *Numenius arquata*, Curlew Sandpiper *Calidris ferruginea*, Black-tailed Godwit *Limosalimosa*, Bar-tailed Godwit *Limosalapponica*, Painted Stork *Mycteria leucocephala*, Great Thick-knee *Esacus recurvirostris*, Ferruginous Duck *Aythya nyroca*) belonging to Near threatened (NT) category. And 136 species belong to least concern (LC). Vargiya & Chakraborty, [28] recorded one (1.4% of all species) Vulnerable species (Common Pochard *Aythya ferina*), six (8.5%) Near Threatened species (Lesser Flamingo, Oriental Darter *Anhinga melanogaster*, Dalmatian Pelican *Pelecanus crispus*, Black-headed Ibis *Threskiornis melanocephalus*, Black-tailed Godwit *Limosalimosa*, and River Tern *Sterna aurantia*), and 63 (82.9%) species listed as of Least Concern from Chhaya wetland.

Chhaya wetland has a good potential to become a Ramsar site due to high number of Waterbirds and winter migrants. As per the current situation the wetland is under the huge anthropogenic pressure, such as household construction and acquisition of land in the name of urbanization around the wetland. Vargiya & Chakraborty, [28] observed that The Chhaya Rann wetland complex has been influenced by salt and soda ash from the past salt production. In recent years, the main source of water has been domestic sewage and rain water. As it appears that these conditions are still conducive to attract the flamingos and other waterbirds and in internationally important numbers (>20,000 individuals) as per Criterion five of the Ramsar Convention on Wetlands, it is important for the state and national authorities to propose formal designation of the area as a Ramsar site.

Lower pH level in May and June maybe is an indication of high microbial activity due to increase in environmental temperature. Sonowal & Baruah, [25] reported the lower pH during monsoon is caused due to high turbidity, and in summers, the high temperature enhances microbial activity, causing excessive production of CO₂ and reduced pH.

Lower levels of DO (Dissolved oxygen) was observed in the month of May and highest in the month of August. BOD (Biological oxygen demand) was highest in January and lowest in the month of May. As the birds of wetland depend majorly on the micro fauna, good amount of micro faunal activity may have been the reason for increased BOD, as both Bird diversity and BOD levels both are highest in the January and February. Similarly lower BOD levels and bird diversity was observed in the month of May.

CONCLUSION

This study on Chhaya wetland helped us understand the importance of Chhaya wetland as a decent habitat for Avian Fauna. A total of 149 species of birds were recorded during the study (January – December 2021) out of which 77 (52%) were winter migrants. Although the wetland is surrounded by housing colonies and industry, it still remains a preferred site for these winter birds. Thus, conservation of such habitat is highly recommended. Conservation of such wetland can help preserve the Avian diversity of the Chhaya wetland and other organism which are directly or indirectly related to the Avian diversity.

CONFLICT OF INTEREST:

The authors have no conflicts of interest to declare.

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