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Floristic Diversity of Sandi Bird Sanctuary, Uttar Pradesh, India

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ABSTRACT

The Sandi Bird Sanctuary is a distinctive wetland system situated in Uttar Pradesh's Indo-Gangetic region that experiences significant anthropogenic impact. The present study documents the diversity of vascular plants and their threat status. Observations and occurrences of different types of flora, like herbs, shrubs, trees, and climbers, have been completed. The sampling was carried out for pre-monsoon (April to May), monsoon (June to September), and post-monsoon seasons (October to December) in 2023-2024. In each season, the survey was done with an appropriate time interval. After being observed and recognized in the field, the specimens of the various species were subsequently identified in a lab for complete description. The vascular plant diversity in all three seasons (rainy, winter, summer) was recorded as about 157 Species belonging to 119 Genera and 53 families from Sandi Bird Sanctuary. The most dominant family was Poaceae (20 species), followed by Fabaceae (17 species), Cyperaceae (16 species), Asteraceae (12 species), and Amaranthaceae (7 species). The most dominant genus was Cyperus with 8 species. The aquatic areas were largely dominated by two communities, viz., Pontederia and Azolla, whereas the terrestrial areas were by Lantana and Parthenium. For improved management, the sanctuary must strategically eradicate invasive species and native plants.

Keywords: *Bird Sanctuary, Wetland, Floristic diversity, Monsoon.*

INTRODUCTION

Biodiversity is characterized by the diversity of species inhabiting a particular region. Biodiversity is one of the significant measures to determine how healthy the environment is at a location, because it is a measure of both living and non-living present. As a functional component of the climate system, biodiversity influences the survival and extinction rates of living organisms, and it also reflects biological losses and gains. It also seems that biodiversity is decreasing at an alarming rate day by day. Hence, documentation of complete plant diversity is the immediate requirement for sustainable management and use of plants. In order to save and flourish the flora and fauna of the whole state, 23 sanctuaries and 1 national park have been announced. In Uttar Pradesh, there are 13 bird sanctuaries, significant for the conservation of biodiversity [1]. In this perception, Sandi Wetland Bird Sanctuary, situated in Hardoi District of Uttar Pradesh, under the Indo-Gangetic zone, has been selected for plant diversity documentation. India harbours four major terrestrial biodiversity hotspots, namely the Himalayas, Indo-Burma, Western Ghats, and Sundaland [2]. The majority of these areas, which are biodiversity-rich too, have been notified as protected areas in order to conserve the species, habitats, and ecosystems. Worldwide coverage of connected areas under some form of protection increased from 6.5% in 2010 to 7.7% in 2018 [3]. A region-wide floristic exploration, which should be employed as a baseline against which field investigations in the areas of photochemistry, taxonomy, ecology, ethnobotany, conservation, and management must be framed [4]. Since it is one of the most important biotic components of ecosystems [5], precise information on the flora will enable us to understand more about the microclimatic, edaphic, and topographical status in that area [6].

The Sandi Wetland Bird Sanctuary is one such wetland located in Hardoi, and its divisional headquarters are at Lucknow. Vascular plant species in all three seasons (Rainy, Winter, and Summer) were recorded, about 157 species belonging to 119 genera and 53 families from this Sanctuary.

STUDY AREA

Sandi Bird Sanctuary is located in Hardoi district of Uttar Pradesh, covering an area of 309 hectares at 26^0 53' N and 80^0 46' E near Sandi town in Bilgram tehsil under the Indo-Gangetic zone at about 19 km away from the Hardoi-Sandi road. River Garra, previously known as Garun Ganga, flows adjacent to the sanctuary (Fig.1). Sandi Bird Sanctuary was established in 1990 to conserve aquatic vegetation and natural habitats for the residents and migratory birds. The site has been accorded as a protected Ramsar site since September 2019. The source of water recharge is mainly seasonal rain, which is not enough to make this lake a perennial water body. Uttar Pradesh hosts about 13 protected bird sanctuaries distributed across four different eco-climatic zones, such as (i) Indo-Gangetic plain, (ii) Tarai region, (iii) Vindhyan region, and (iv) Semi-arid region. The Sandi Bird Sanctuary is one of these [7].

METHODOLOGY

The surveys were carried out for pre-monsoon (April to May), monsoon (July to September), and post-monsoon seasons (October to December) in 2023-2024. In each season, a survey was done with an appropriate time interval. Identification and processing of the collected specimens were done by following standard herbarium techniques [8] and literature about species [9]. The name of the recorded plant species has been enumerated, as per ICN (2018), and classified according to Bentham & Hooker`s system.

Threat categories established for each species based on present categories (IUCN 2001) for global levels [10]. A hand-held GPS was used to record the direction and coordinates readings of longitudes and latitudes of various observation points. Further, a digital camera was used for photography of plant and wetland views.

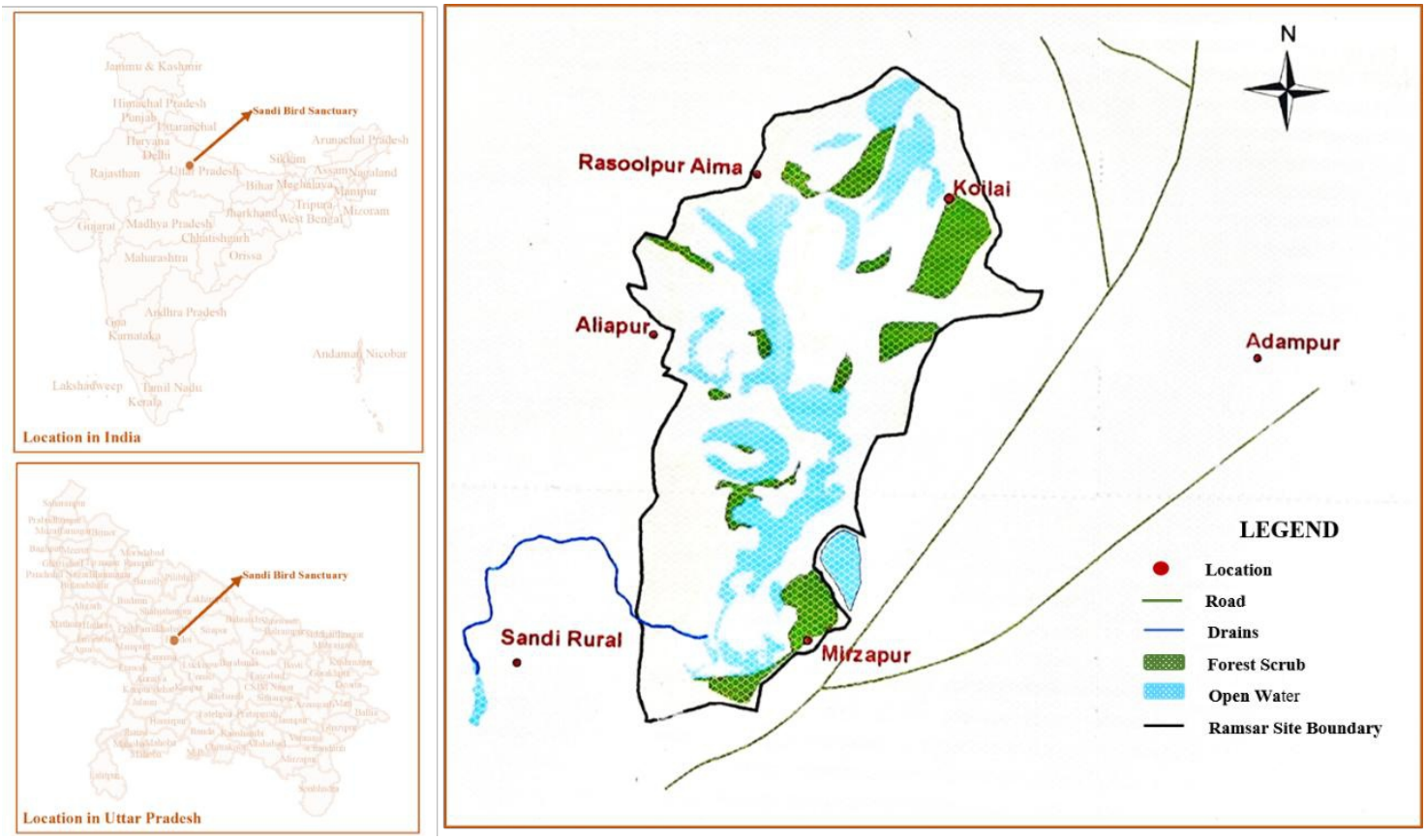

Figure 1. Map of Study Area

OBSERVATIONS

Observations and occurrence of different types of flora like herbs, shrubs, trees, and climbers has been completed and detailed observations in all three seasons (Rainy, Winter and Summer) a list of total plant diversity in study area are given below (Table 1.).

Table 1. List of vascular plants present at Sandi Bird Sanctuary

S. No.	Scientific Name	Habit	Common Name	Family	IUCN Status
1	*Abutilon indicum* (L.) Sweet	S	Kanghi	Malvaceae	NE
2	*Acacia catechu* (L.f.) Willd.	T	Khair	Fabaceae	LC
3	*Acacia nilotica* (L.) Willd.ex Delile	T	Babool	Fabaceae	LC
4	*Achyranthus aspera* L.	H	Latjeera	Amaranthaceae	NE
5	*Acmella paniculata* (Wall.ex DC.) R.K.Jansen	H	Toothache plant	Asteraceae	LC
6	*Ageratina ligustrina* (DC.) R.M.King & H.Rob.	S	Privet-leaved ageratina	Asteraceae	LC
7	*Ageratum conyzoides* L.	H	White weed	Asteraceae	LC
8	*Ageratum houstonianum* Mill.	H	Bluemink	Asteraceae	NE
9	*Albizzia lebbeck* (L.) Benth.	T	Siris	Fabaceae	NE
10	*Alternanthera sessilis* (L.) DC.	H	Carpet weed	Amaranthaceae	LC
11	*Amaranthus spinosus* L.	H	Spiny pigweed	Amaranthaceae	NE
12	*Amaranthus viridis* L.	H	Lal sak	Amaranthaceae	NE
13	*Anthocephalus cadamba* (Roxb.) Miq.	T	Kadam	Rubiaceae	NE
14	*Azadirachta indica* A.Juss.	T	Neem	Meliaceae	LC
15	*Azolla pinnata* R.Br.	H	Water fern	Salviniaceae	LC
16	*Bacopa monnieri* (L.) Wettst.	H	Brahmi	Scrophulariaceae	LC
17	*Bambusa vulgaris* Schrad. Ex J.C.Wendl.	T	Baans	Poaceae	NE
18	*Butea monosperma* (Lam.) Kuntze	T	Palash	Fabaceae	LC
19	*Caesulia axillaris* Roxb.	H	Pink node flower	Asteraceae	LC
20	*Calotropis procera* (Aiton) W.T.Aiton	S	Madar	Asclepiadaceae	LC
21	*Cannabis sativa* L.	H	Ganja/Bhang	Cannabinaceae	NE
22	*Cassia fistula* L.	T	Amaltas	Fabaceae	LC
23	*Cassia occidentalis* L.	T	Mogdad coffee	Fabaceae	LC
24	*Cassia tora* L.	T	Panwar	Fabaceae	NE
25	*Celosia argentea* L.	H	Cockscomb	Amaranthaceae	LC
26	*Ceratophyllum demersum* L.	H	Rigid hornwort	Ceratophyllaceae	LC
27	*Chenopodium album* L.	H	Pigweed	Amaranthaceae	NE
28	*Chenopodium murale* L.	H	Sowbane	Amaranthaceae	LC
29	*Chloris dolichostachya* Lag.	H	Finger grass	Poaceae	NE
30	*Cirsium arvense* (L.) Scop.	H	Creeping thistle	Asteraceae	LC
31	*Cleome viscosa* L.	H	Hur- hur	Cleomaceae	NE

32	*Coccinea grandis* (L.) Voigt	C	Ivy gourd	Cucurbitaceae	NE
33	*Commelina benghalensis* L.	H	Kanchara	Commelinaceae	LC
34	*Corbichonia decumbens* (Forssk.) Exell	H	Patthar chatta	Aizoaceae	NE
35	*Cordia obliqua* Willd.	T	Clammy cherry	Boraginaceae	NE
36	*Cyanthillium cinereum* (L.) H.Rob.	H	Little ironweed	Asteraceae	NE
37	*Cynodon dactylon* (L.) Pers	H	Doob ghas	Poaceae	NE
38	*Cyperus alopecuroides* J.Koenig ex Roxb.	H	Cyperus	Cyperaceae	LC
39	*Cyperus alulatus* J.Kern	H	Motha patera	Cyperaceae	LC
40	*Cyperus corymbosus* Steud.	H	Gudu tunga kadu	Cyperaceae	LC
41	*Cyperus difformis* L.	H	Rice sedge	Cyperaceae	LC
42	*Cyperus exaltatus* Retz.	H	Tall flat sedge	Cyperaceae	LC
43	*Cyperus imbricatus* Retz.	H	Shingle flatsedge	Cyperaceae	LC
44	*Cyperus nutans* Vahl	H	Drooping Sedge	Cyperaceae	LC
45	*Cyperus rotundus* L.	H	Nutgrass roots	Cyperaceae	LC
46	*Dalbergia sissoo* Roxb. ex DC.	T	Shisham	Fabaceae	LC
47	*Datura innoxia* Mill.	S	Dhatura	Solanaceae	NE
48	*Datura metel* L.	S	Dhatura	Solanaceae	NE
49	*Delonix regia* (Bojer ex Hook.) Raf.	T	Gulmohar	Fabaceae	LC
50	*Dichanthium annulatum* (Forssk.) Stapf	H	Marvel grass	Poaceae	NE
51	*Digitaria ciliaris* (Retz.) Koeler	H	Tropical crabgrass	Poaceae	NE
52	*Echinochloa colona* (L.) Link	H	Jungle rice	Poaceae	LC
53	*Echinochloa crus-galli* (L.) P.Beauv.	H	Barnyard grass	Poaceae	LC
54	*Echinochloa stagnina* (Retz.) P.Beauv.	H	Burgu millet	Poaceae	LC
55	*Eclipta prostrate* (L.) L.	H	Bhringraj	Asteraceae	LC
56	*Pontederia crassipes* (Mart.) Solms	H	Jalkumbhi	Pontederiaceae	NE
57	*Eleocharis acutangula* (Roxb.) Schult.	H	Acute spikerush	Cyperaceae	LC
58	*Eleocharis atropurpurea* (Retz.) J.Presl &C.Presl	H	Purple spikerush	Cyperaceae	LC
59	*Eleocharis dulcis* (Burm.f.) Trin. ex Hensch	H	Pola Cyperaceae	Cyperaceae	LC
60	*Eragrostis gangetica* (Roxb.) Steud.	H	Lovegrass	Poaceae	LC
61	*Euphorbia hirta* L.	H	Asthma weed	Euphorbiaceae	NE
62	*Ficus benghalensis* L.	T	Bargad	Moraceae	NE
63	*Ficus carica* L.	T	Common fig	Moraceae	LC
64	*Ficus glomerata* Roxb.	T	Gular	Moraceae	NE
65	*Ficus religiosa* L.	T	Peepal	Moraceae	LC
66	*Fimbristylis dichotoma* (L.) Vahl	H	Forked fimbry	Cyperaceae	LC
67	*Fimbristylis littoralis* Gaudich.	H	Grass-like fimbry	Cyperaceae	LC
68	*Fimbristylis ovata* (Burm.f.) J.Kern	H	One-spike fimbry	Cyperaceae	LC
69	*Fimbristylis squarrosa* Vahl	H	Curved- fimbristylis	Cyperaceae	LC
70	*Heliotropium indicum* L.	H	Indian heliotrope	Boraginaceae	NE
71	*Holoptelia integrifolia* (Roxb.) Planch.	T	Chilbil	Ulmaceae	LC
72	*Hydrilla verticillata* (L.f.) Royle	H	Hydrilla	Hydrocharitaceae	LC
73	*Hydrolea zeylanica* (L.) Vahl	H	Blue water leaf	Hydroleaceae	LC
74	*Hygrophila auriculata* (Schumach.) Heine	H	Gokulakanta	Acanthaceae	LC
75	*Hygroryza aristata* (Retz.) Nees ex Wight & Arn.	H	Asian watergrass	Poaceae	NE
76	*Imperata cylindrica* (L.) Raeusch.	H	Cogongrass	Poaceae	LC
77	*Ipomoea aquatica* Forssk.	H	Water spinach	Convolvulaceae	LC
78	*Ipomoea carnea* G.Forst.	S	Pink morning Glory	Convolvulaceae	NE
79	*Jussiaea repens* L.	H	Jussiaea	Onagraceae	LC
80	*Kigelia africana* (Lam.) Benth.	T	Sausage tree	Bignoniaceae	LC
81	*Lantana camara* L.	S	Lantana	Verbenaceae	NE
82	*Launea procumbens* (Roxb.) Ramayya&Rajagopal	H	Jungi gobi	Asteraceae	NE
83	*Lemna minor* L.	H	Duckweed	Lemnaceae	LC
84	*Limnophila indica* (L.) Druce	H	Indian marshweed	Scrophulariaceae	LC
85	*Lindernia ciliata* (Colsm.) Pennell	H	Fringed pimpernel	Scrophulariaceae	LC
86	*Lindernia procumbens* (Krock.) Philcox	H	Creeping siltwort	Scrophulariaceae	LC
87	*Madhuca indica* J.F.Gmel.	T	Mahua	Sapotaceae	NE
88	*Mangifera indica* L.	T	Mango	Anacardiaceae	DD
89	*Marsilea quadrifolia* L.	H	Marsilea	Marsileaceae	LC
90	*Mimosa pudica* L	H	Shameplant	Fabaceae	LC
91	*Momordica charantia* L	C	Bitter melon	Cucurbitaceae	NE
92	*Monochoria vaginalis* (Burm.f.) C.Presl exKunth	H	Pickerel weed	Pontederiaceae	LC
93	*Morus alba* L.	T	Mulberry	Moraceae	LC
94	*Najas graminea* Delile	H	Water-nymph	Hydrocharitaceae	LC
95	*Najas minor* All.	H	Bushy pond weed	Hydrocharitaceae	LC
96	*Nelumbo nucifera* Gaertn.	H	Lotus	Nelumbonaceae	DD
97	*Neptunia oleracea* Lour.	T	Lajalu	Fabaceae	LC
98	*Nerium oleander* L.	S	Oleander	Apocynaceae	LC
99	*Nicotiana plumbaginifolia* Willd.	H	Tex-Mex Tobacco	Solanaceae	NE
100	*Nymphaea nouchali* Burm.f.	H	Water lily	Nymphaeaceae	LC
101	*Nymphoides indica* (L.) Kuntze	H	Jalrani	Menyanthaceae	LC
102	*Ocimum basilicum* L.	H	Van tulsi	Lamiaceae	NE
103	*Ocimum tenuiflorum* L.	H	Tulsi	Lamiaceae	NE
104	*Oryza rufipogon* Griff.	H	Wild rice	Poaceae	LC
105	*Oxalis corniculata* L.	H	Indian sorrel	Oxalidaceae	NE
106	*Panicum paludosum* Hochst. Ex Steud.	H	Marsh panic grass	Poaceae	NE
107	*Parthenium hysterophorus* L.	H	Congress grass	Asteraceae	NE
108	*Paspalidium punctatum* (Burm.f.) A.Camus	H	Watercrown grass	Poaceae	LC
109	*Paspalum scrobiculatum* L.	H	Kodo millet	Poaceae	LC
110	*Paspalum vaginatum* Elliott	H	Silt grass	Poaceae	LC

111	*Peristrophe paniculata* (Forssk.) Brummitt	H	Panicled foldwing	Acanthaceae	NE
112	*Persicaria barbata* (L.) H.Hara	H	Joint weed	Polygonaceae	LC
113	*Persicaria glabra* (Willd.) M.Gomez	H	Knotweed	Polygonaceae	LC
114	*Phoenix sylvestris* (L.) Roxb.	T	Khajoor	Palmae	NE
115	*Phyllanthus emblica* L.	T	Indian gooseberry	Phyllanthaceae	LC
116	*Pistia stratiotes* L.	H	Water lettuce	Araceae	LC
117	*Pithecellobium dulce* (Roxb.) Benth.	T	Jungle jalebi	Fabaceae	LC
118	*Polygonum limbatum* Meisn.	H	Sment weed	Polygonaceae	LC
119	*Pongamia pinnata* (L.) Pierre	T	Kanji	Fabaceae	LC
120	*Potamogeton natans* L.	H	Pond weed	Potamogetonaceae	LC
121	*Potamogeton nodosus* Poir.	H	Pond weed	Potamogetonaceae	LC
122	*Potamogeton pectinatus* L.	H	Pond weed	Potamogetonaceae	LC
123	*Prosopis juliflora* (Sw.) DC.	T	Vilayati babool	Fabaceae	LC
124	*Psidium guajava* L.	T	Common guava	Myrtaceae	LC
125	*Ricinus communis* L.	S	Castor	Euphorbiaceae	LC
126	*Rumex dentatus* L.	H	Toothed dock	Polygonaceae	LC
127	*Rungia pectinata* (L.) Nees	H	Comb rungia	Acanthaceae	NE
128	*Saccharum bengalense* Retz.	H	Munj sweetcane	Poaceae	NE
129	*Saccharum munja* Roxb.	H	Moonj	Poaceae	NE
130	*Sagittaria guayanensis* Kunth	H	Guayanese arrowhead	Alismataceae	LC
131	*Sagittaria sagittifolia* L.	H	Arrowhead	Alismataceae	LC
132	*Scirpus tuberosus* Desf.	H	Motha	Cyperaceae	NE
133	*Sesbania aculeata* Pers.	H	Dhaincha	Fabaceae	NE
134	*Setaria verticillata* (L.) P.Beauv.	H	Bristly foxtail	Poaceae	NE
135	*Shorea robusta* C.F. Gaertn.	T	Sal	Dipterocarpaceae	LC
136	*Sida acuta* Burm.f.	H	Wire weed	Malvaceae	NE
137	*Sida cordifolia* L.	H	Sida	Malvaceae	NE
138	*Sida rhombifolia* L.	H	Angled sida	Malvaceae	NE
139	*Solanum nigrum* L.	H	Common Nightshade	Solanaceae	NE
140	*Sonchus asper* (L.) Hill	H	Spiny sowthistle	Asteraceae	NE
141	*Spirodela polyrhiza* (L.) Schleid.	H	Big duck weed	Lemnaceae	LC
142	*Syzygium cumini* (L.) Skeels	T	Jaamun	Myrtaceae	LC
143	*Tamarindus indica* L.	T	Tamarind	Fabaceae	LC
144	*Tectona grandis* L.f.	T	Sagaun/ Teak	Verbenaceae	EN
145	*Terminalia arjuna* (Roxb. Ex DC.) Wight & Arn.	T	Arjun tree	Combretaceae	LC
146	*Thevetia peruviana* (Pers.)	S	Yellow oleander	Apocynaceae	VU
147	*Trapa natans* L.	H	Water nut	Trapaceae	LC
148	*Tridax procumbens* L.	H	Coat buttons	Asteraceae	NE
149	*Trifolium alexandrium* L.	H	Berseem clover	Fabaceae	NE
150	*Typha angustata* Bory & Chaub.	H	Typha	Typhaceae	LC
151	*Typha elephantina* Roxb.	H	Elephant grass	Typhaceae	LC
152	*Utricularia stellaris* L.f.	H	Star bladderwort	Lentibulariaceae	VU
153	*Vallisneria americana* Michx.	H	Wild celery	Hydrocharitaceae	LC
154	*Vallisneria spiralis* L.	H	Tape grass	Hydrocharitaceae	LC
155	*Vetiveria lawsonii* (Hook.f.) Veldkamp	H	Khus	Poaceae	NE
156	*Wolffia globosa* (Roxb.) Hartog & Plas	H	Water meal	Lemnaceae	LC
157	*Ziziphus jujube* Mill.	T	Beri	Rhamnaceae	LC

H= Herb; S= Shrub; T= Tree; C= Climber; NE= Not Evaluated; DD= Data Deficient; LC= Least Concern; VU= Vulnerable; & EN= Endangered

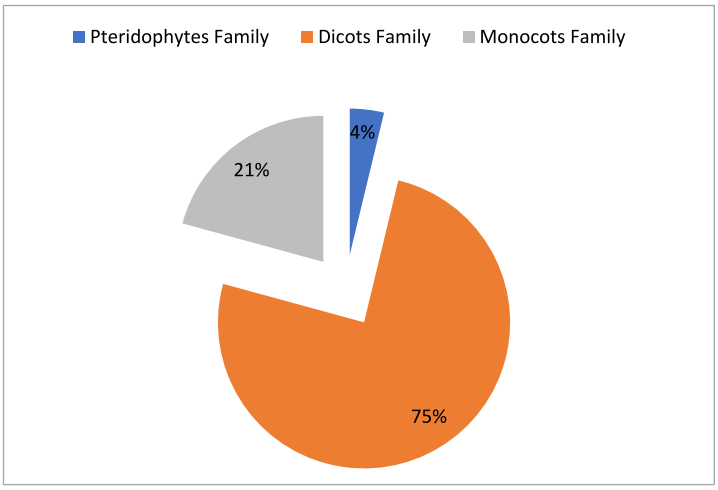

Figure 2. Percentage distribution of plant families

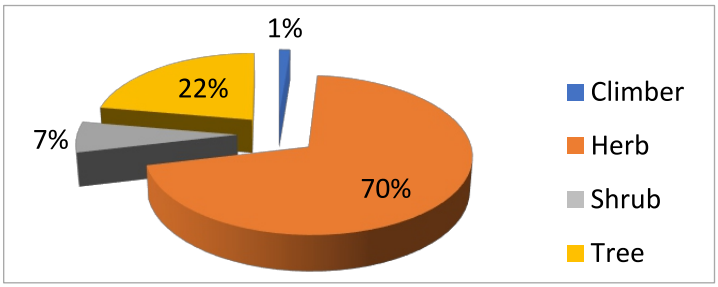

Figure 3. Plants Habit diversity

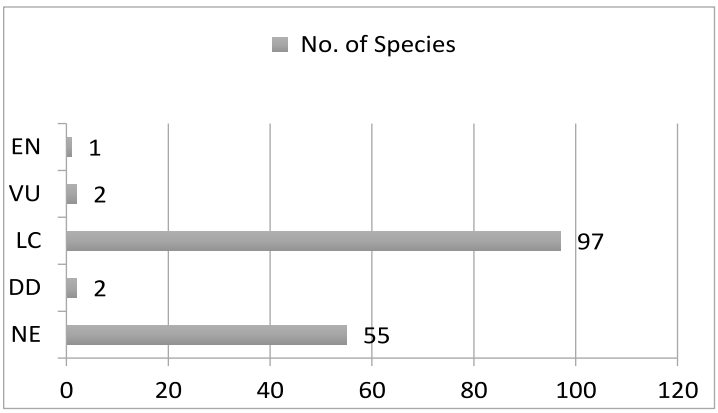

Figure 4. IUCN Status of Plant Species

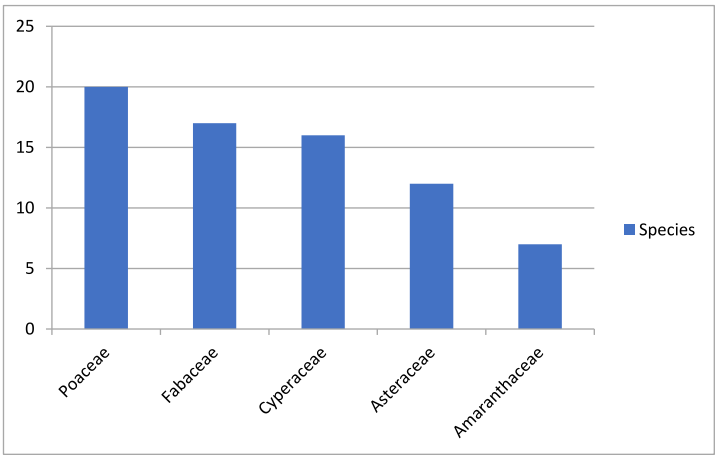

Figure 5. Dominant families

RESULTS AND DISCUSSION

A total of 157 species belonging to 119 Genera and 53 families were recorded from the study area in all three seasons (Rainy, winter, and summer) in 2023-2024 (Table 1). Out of 53 identified plant families, angiosperms account for 51, whereas pteridophytes are represented by 2 families. From the 51 families of angiosperms, 41 families are dicots and 10 are monocots (Fig. 2). Poaceae was the most dominant family with 20 species, followed by Fabaceae with 17 species, Cyperaceae with 16 species, Asteraceae with 12 species, and 7 species from the Amaranthaceae family (Fig. 5).

There is around a 1:4 ratio between the monocot and dicot families. With eight species, Cyperus was the most prevalent genus. There are 157 species total, with 100 dicot species, 55 monocot species, and 2 pteridophyte species. With 70% of the entire flora, herbaceous species were the dominant group, according to the distribution analysis of living forms. The next most common taxonomic group was trees (22%), followed by shrubs (7%). Only 1% of the entire floristic makeup was made up of climbers, making them the least significant contributor (Fig.3). Wetlands are threatened by pollution, urbanisation, and unsustainable farming practices despite their significance. Development has resulted in the loss of a significant amount of wetlands in India. Therefore, we also identified species in this study based on their IUCN threat status on a global scale. *Utricularia stellaris* and *Thevetia peruviana* are two plant species that exhibit a vulnerable status. One plant, *Tectona grandis* exhibits endangered status, and two plants are data deficient, namely *Nelumbo nucifera* and *Mangifera indica.* There are 97 plant species, which have the least concerning status, and 55 plant species are not evaluated by IUCN (Fig.4). The Sandi Bird Sanctuary is a wetland that is home to an incredible diversity of species, from tall grasses to small, fragile, watery herbs, and also are critical habitat for fauna, supporting numerous species. Thus, the plants, the life they sustain, and the benefits they offer to humans, such as food supplies, medications, and natural environmental purifiers, all depend on the maintenance of these ecosystems, like the strategic eradication of invasive species and native plants.

Figure 6. Terrestrial Plant Diversity A. Oxalis corniculata, B. Alternanthera sessilis, C. Launea procumbens, D. Peristrophe paniculata, E. Rungia pectinata, F. Hygrophila auriculata

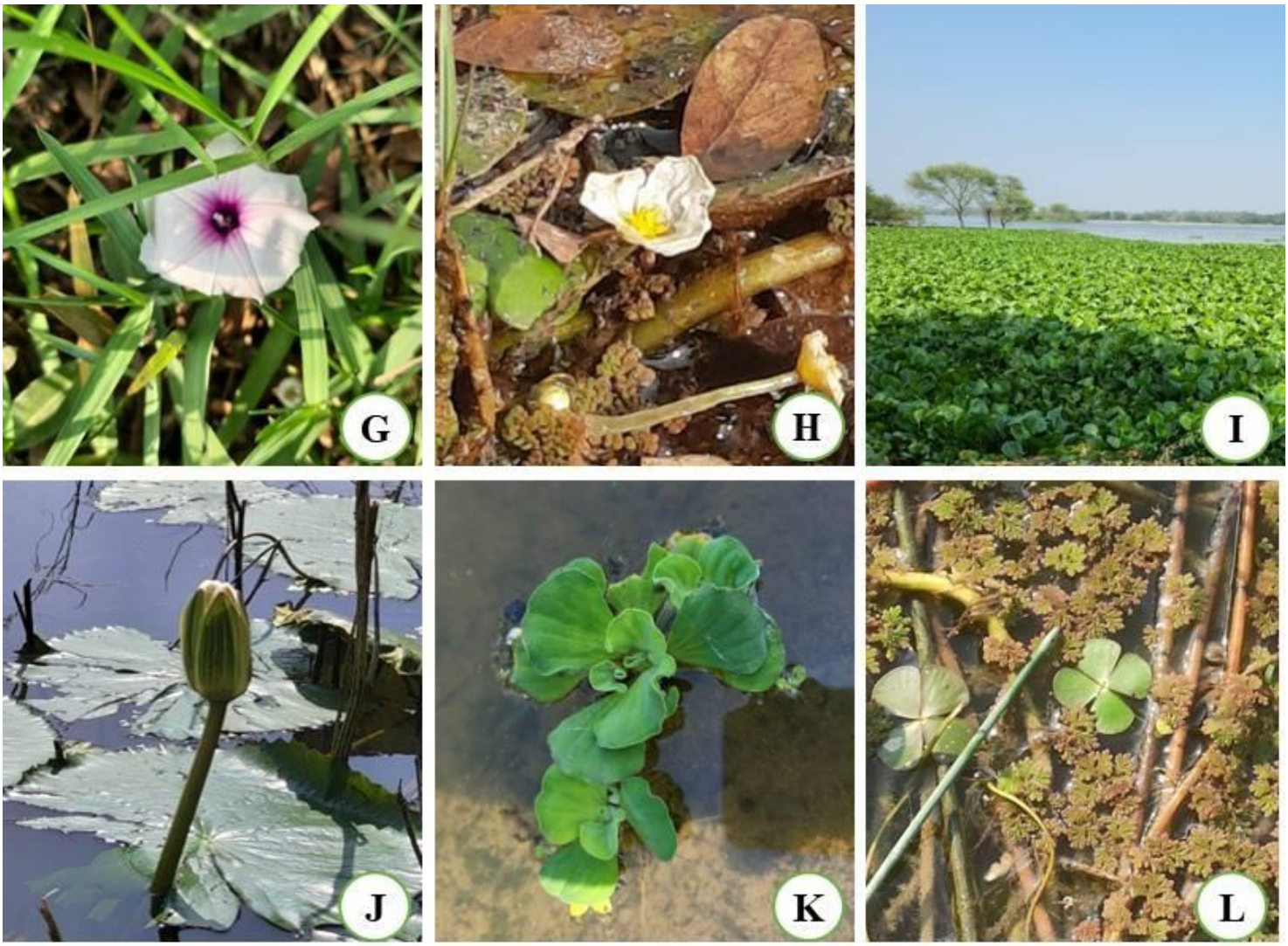

Figure 7. Aquatic Plant Diversity G. Ipomoea aquatica, H. Nymphoides indica, I. Pontederia crassipes, J. Nymphaea nouchali, K. Pistia stratiotes, L. Azolla pinnata

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