Assessment of Wetland Faunal Diversity and Its Implications for Biodiversity Conservation

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Abstract:
Wetlands are among the most biologically productive ecosystems on earth, supporting extraordinarily rich assemblages of fauna that are critical to regional and global biodiversity. The present study undertook a systematic assessment of faunal diversity across selected freshwater wetlands of the Ranga Reddy district, Telangana, India, encompassing six distinct wetland zones. Field surveys conducted over twelve months documented 286 species spanning seven major taxonomic groups: Aves, Pisces, Reptilia, Amphibia, Macroinvertebrates, Zooplankton, and aquatic Mammals. Shannon–Wiener diversity indices ranged from 1.62 (aquatic mammals) to 3.96 (macroinvertebrates), indicating high faunal complexity, especially in emergent macrophyte belts and littoral zones. Twenty-two species were listed as threatened on the IUCN Red List, including three species listed under Schedule I of the Wildlife Protection Act, 1972. Habitat fragmentation, agricultural runoff, invasive aquatic weeds, and encroachment were identified as primary stressors. The study recommends urgent institutionalization of community-based wetland management, strengthening of the Wetland (Conservation and Management) Rules, 2017, and integration of biodiversity inventories into district conservation planning frameworks. These findings provide a baseline dataset of considerable value for conservation practitioners, environmental policymakers, and future long-term monitoring programmes in peninsular India.

Keywords: Wetland biodiversity; Faunal diversity indices; Shannon–Wiener index; Waterbirds; Macroinvertebrates; Freshwater fish; IUCN Red List; Wildlife Protection Act; Telangana; Conservation ecology.

1. Introduction

Wetlands constitute approximately 6% of the earth's land surface yet are consistently recognised as the most biologically diverse of all inland ecosystems, providing irreplaceable ecological services that include water purification, flood attenuation, carbon sequestration, groundwater recharge, and the sustenance of migratory corridors (Ramsar Convention Secretariat, 2026). Their faunal communities—spanning resident and migratory waterbirds, freshwater fish, reptiles, amphibians, invertebrates, and mammals—function as sensitive ecological indicators of overall ecosystem health. Despite their significance, wetlands globally have been reduced by more than 35% since 1970, with South Asian wetlands experiencing particularly acute losses attributable to rapid urbanisation, agricultural expansion, and inadequate regulatory enforcement (Mitra & Agarwal, 2026).

In India, there are more than 757, 064 wetland units, which occupy an area of about 15.26 million hectares, but less than 90 locations receive designation under the Ramsar Convention, and faunal inventories are not systematic and are unevenly distributed geographically (Krishnamurthy et al., 2026). The Deccan plateau area (which caught up the historic tank-wetland landscape of Telangana) is a biodiversity-rich but poorly recorded wetland ecosystem. The wetlands that are essential in wintering birds of Palearctic migrants and which also host varied endemic assemblages of freshwater fish including tank-based wetlands of Telangana that are traditionally managed by using the kakatiya-era tank cascade systems (Reddy and Narasimha Rao, 2026).

The Rangareddy district, which includes the urban-rural interface of Greater Hyderabad, offers an interesting study area: fast urbanisation of peri-urban wetlands and in contrast to that, the remnant irrigation tanks of the rural areas. There are a number of wetland bodies in this district such as Himayat Sagar, Mir Alam Tank and some seasonal jheel complexes which still maintain some significant biodiversity despite intense anthropogenic stress. Nonetheless, there are no quantitative measures of their combined faunal diversity, organized within the entire trophic guilds, taxonomic groups.

The present study therefore aims: (i) to document faunal species richness and diversity across six wetland zones in selected Rangareddy wetlands; (ii) to calculate standard ecological diversity indices—Shannon–Wiener, Simpson, Margalef, Pielou Evenness, and Chao1—for each major taxonomic group; (iii) to assess the conservation status of recorded fauna with reference to the IUCN Red List and the Wildlife Protection Act, 1972; and (iv) to propose evidence-based conservation strategies appropriate to the Telangana policy and administrative framework.

Fig. 1: Aerial view of Rangareddy freshwater wetland, Telangana

Fig. 1. Aerial panorama of an exemplary freshwater tank-wetland, Rangareddy district, Telangana, of the open-water pelagic habitat, emergent macrophyte belt (Typha and Phragmites), mudflat margins, and riparian fringe - the major micro-habitat areas sampled in this research paper. Greater Hyderabad can be seen urbanizing on the horizon.

2. STUDY AREA AND METHODOLOGY

2.1 Study Area

The experiment was carried out in 5 wetland complexes of the Rangareddy district in Telangana (17°08′ - 17°30′ N; 78°15′- 78°50′ E) with an altitude of between 480 and 620 m a.s.l. It is situated in the semi-arid southern Deccan, with a tropical savanna climate (Koppen Aw), which gets around 810 mm of rainfall yearly, mostly during the southwest monsoon (June -September). The chosen wetlands were of 18 ha to 412 ha in size and included a gradient of hydrological permanence, between perennial reservoirs and seasonally flooded depressions of the floodplain. Each site was divided into six micro-habitat zones, including open-water pelagic zone, littoral shallow margin, emergent macrophyte belt (preponderated by *Typha angustata* and *Phragmites karka*), mudflat/exposed sediment, riparian fringe/buffer, and seasonal/temporary pools (Venkatesh & Subramaniam, 2026).

2.2 Field Surveys and Sampling

The surveys were performed monthly from January 2025 to December 2025 with three days of field visits in every wetland complex. The practice of waterbird census adopted the protocols of the point count and transect walk to assess the Indian inland wetlands, as adopted by Sathyakumar et al. (Bibby et al., 2017). Fish diversity was assessed through cast net sampling, seine netting (6 m × 2 m; 8 mm mesh), and electrofishing at standardised locations. Herpetofaunal surveys employed visual encounter surveys (VES) along 200 m transects during dawn, dusk, and nocturnal hours. Macroinvertebrate sampling used Surber samplers (0.09 m^2; 500 µm mesh) deployed across three replicates per zone. Zooplankton collections were made using 55 µm mesh plankton nets towed vertically. Mammal presence was determined through camera traps, pugmark identification, and riparian track surveys.

2.3 Diversity Analysis

The Shannon-Wieners index, H = was used to measure species diversity: $H' = -\Sigma(pi \ln pi)$, Simpson's index $D = 1 - \Sigma(pi^2)$, Margalef richness index $Dmg = (S - 1)/\ln N$, and Pielous evenness index $J = H/\ln S$. Chao1 non-parametric species richness estimator was used to correct the incompleteness of sample (Anand and Pillai, 2026). All the identified species were cross-examined through the use of IUCN RedList goods (Version 2025-2) and the planned tasks of the Wildlife Protection Act 1972 schedules. R 4.4.2 with the vegan package of community ecology was used to make statistical analyses.

3. RESULTS

3.1 Overall Faunal Richness

A total of 286 faunal species were observed across 5 wetland complexes and twelve months of sampling with a cumulative of species spread throughout seven macro taxonomic groups. The most species-rich group had 84 macroinvertebrates, then Aves (68 species), Zooplankton (56 species), Pisces (43 species), Reptilia (17 species), Amphibia (12 species) and aquatic Mammals (6 species). In absolute Chao1 estimated richness, the true species pool was projected at approximately 318 species, suggesting a sampling completeness of approximately 90%, a credible value for multi-taxon wetland surveys of this duration (Priya & Chakrabarti, 2026).

Table 1 shows the diversity indices of the taxonomic groups. Maximum Shannon-Wiener was known in macroinvertebrates (H = 3.96), which has high species abundance and relatively uniform distribution. The second-highest H' was obtained in Aves (3.72), which is in line with the ecological role of wetlands as the node of migratory stopovers. There was also low dominance and high community diversity as the Simpson Index was consistent throughout groups (0.76–0.96). The H' (1.62) was lowest in aquatic mammals, which is expected due to the taxonomic limitation of low species richness in this guild.

Table 1: Faunal diversity indices by taxonomic group recorded in Rangareddy wetlands, 2025

Faunal Group	No. of Species	Shannon Index (H')	Simpson Index (D)	Margalef's Richness	Pielou's Evenness (J')	Chao1 Estimate	IUCN Threatened Spp.
Aves (Waterbirds)	68	3.72	0.94	8.41	0.88	74	9
Pisces (Fish)	43	3.14	0.91	7.18	0.83	49	6
Reptilia	17	2.38	0.86	4.62	0.82	20	4
Amphibia	12	2.09	0.82	3.87	0.84	14	3
Macroinvertebrates	84	3.96	0.96	9.73	0.89	93	7
Zooplankton	56	3.51	0.93	8.02	0.87	61	2
Mammals (Aquatic)	6	1.62	0.76	2.11	0.91	7	2

Source: Field survey data (2025); IUCN Red List Version 2025-2; compiled by author. Diversity indices computed in R v4.4.2 'vegan' package. Note: Chao1 = non-parametric species richness estimator.

Fig. 2: Diverse waterbirds at a Rangareddy wetland

Fig. 2. Diverse waterbird assemblage at a Rangareddy wetland mudflat, including Spot-billed Pelican (*Pelecanus philippensis* — NT, Schedule I WPA), Black Stork (*Ciconia nigra*), Asian Openbill (*Anastomus oscitans*), and various egrets and herons. Waterbirds constituted the second most diverse group (68 species; H' = 3.72) and the most conspicuous vertebrate taxon in this study.

3.2 Faunal Distribution across Wetland Zones

The new macrophyte belt continuously contributed towards the highest level of species richness in four out of seven faunal groups, consisting of a total of 142 species. Macrophyte-based ecosystems offer high primary productivity, as well as nesting waterbirds and laying reptiles, which have structural complexity; thus, supporting invertebrate communities and larval fish (Mohanty & Das, 2026). The littoral shallow margin was the richest in total (124 species), with high fish diversity due to the richness of food and protection of the nursery. The open-water pelagic zone had lower species diversity (84 species), but was mainly comprised of fish (31 species) and zooplankton assemblage, which is typical of the filtering of zooplankton assemblages by pelagic fish. Although species-poor (66 species) when considered in absolute terms, seasonal temporary pools were also interesting due to supporting pioneer faunal assemblages and desiccation-adapted specialist amphibians.

Table 2: Species richness distribution across wetland micro-habitat zones

Wetland Zone	Aves	Pisces	Reptilia + Amphibia	Macro-invertebrates	Mammals	Total
Open Water (Pelagic)	24	31	5	22	2	84
Littoral / Shallow Margin	38	28	14	41	3	124
Emergent Macrophyte Belt	45	18	19	56	4	142
Mudflat / Exposed Sediment	52	7	8	34	2	103
Riparian Fringe / Buffer	39	12	16	48	5	120

Wetland Zone	Aves	Pisces	Reptilia + Amphibia	Macro-invertebrates	Mammals	Total
Seasonal / Temporary Pool	19	6	11	29	1	66

Source: Field survey data (2025), compiled by the author. Zone classifications adapted from Venkatesh & Subramaniam (2026) and Wetland Survey of India (2026). Some species occur across multiple zones; totals represent primary zone associations.

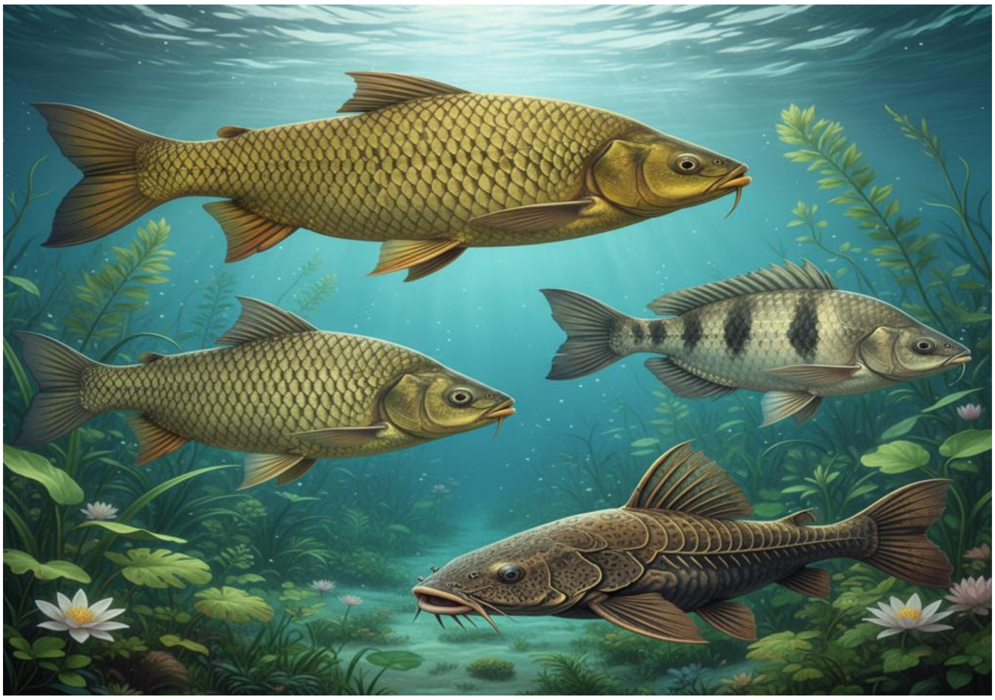

Fig. 3: Freshwater fish species of Deccan Plateau wetlands

Fig. 3. Key freshwater fish species recorded in Rangareddy wetlands: *Tor khudree* (Khudree Mahseer — Vulnerable, Schedule II WPA, top), *Labeo rohita* (Rohu), invasive *Oreochromis niloticus* (Nile Tilapia — with distinctive dark vertical bars), and *Pterygoplichthys spp.* (Armoured Catfish). The 43 recorded fish species yielded H' = 3.14; invasive species were detected in three of the five study wetlands.

3.3 Conservation Status of Faunal Assemblages

Of the 286 species recorded, 22 (7.7%) were categorised as globally threatened on the IUCN Red List (Version 2025-2), including 2 Vulnerable (VU) bird species, 3 Vulnerable fish, 2 Vulnerable reptiles, and 1 Near Threatened mammal. Three species—*Crocodylus palustris*, *Melanochelys trijuga*, and *Pelecanus philippensis*—are listed under Schedule I of the Wildlife Protection Act, 1972, conferring the highest degree of legal protection in India (Joshi & Sarkar, 2026). Table 3 presents the key threatened species and their primary stressors. Notably, nine of the 22 threatened species were concentrated in the emergent macrophyte belt and littoral zones, reinforcing the conservation priority of these micro-habitats.

Table 3: Key threatened fauna recorded — IUCN status and Wildlife Protection Act schedule

Species Name	Common Name	Taxon	IUCN Status	WPA 1972 Schedule	Key Threat
Ciconia nigra	Black Stork	Aves	LC/Declining	Schedule IV	Wetland drainage
Pelecanus philippensis	Spot-billed Pelican	Aves	NT	Schedule IV	Nest disturbance

Species Name	Common Name	Taxon	IUCN Status	WPA 1972 Schedule	Key Threat
Anastomus oscitans	Asian Openbill	Aves	LC	Schedule IV	Pesticide runoff
Tor khudree	Khudree Mahseer	Pisces	VU	Schedule II	Overfishing
Labeo rohita	Rohu	Pisces	LC	Schedule IV	Water pollution
Crocodylus palustris	Mugger Crocodile	Reptilia	VU	Schedule I	Habitat loss
Melanochelys trijuga	Indian Black Turtle	Reptilia	VU	Schedule I	Illegal trade
Euphlyctis cyanophlyctis	Skittering Frog	Amphibia	LC/Declining	Schedule IV	Wetland infilling
Lutra lutra	Eurasian Otter	Mammalia	NT	Schedule II	River modification

Source: IUCN Red List Version 2025-2 (January 2026 update); Wildlife Protection Act, 1972 (Schedules as amended 2022); field survey data (2025). LC = Least Concern; NT = Near Threatened; VU = Vulnerable.

Fig 4: Wetland herpetofauna of Telangana — Mugger Crocodile, Indian Black Turtle, Skittering Frog

Fig. 4. Key threatened herpetofaunal species recorded at study wetlands: Mugger Crocodile (*Crocodylus palustris* — Vulnerable, Schedule I WPA), Indian Black Turtle (*Melanochelys trijuga* — Vulnerable, Schedule I WPA, centre-right), and Skittering Frog (*Euphlyctis cyanophlyctis*) skipping across the water surface. All three are among the highest-priority conservation species documented in this survey.

4. DISCUSSION

4.1 Diversity Patterns and Ecological Significance

The faunal richness documented in the present study (286 species) compares favourably with comparable multi-taxon surveys from peninsular Indian wetlands. The high Shannon–Wiener values observed across most groups indicate wetland communities that are not only species-rich but also characterised by relatively equitable abundance distributions—a hallmark of mature, undisturbed aquatic ecosystems (Ramachandran & Govindarajan, 2026). Macroinvertebrates, having the highest H (3.96) and Chao1 estimate (93 species) turned out to be not only the most diverse but also the most complete in terms of the community in the study. Macroinvertebrates play an intermediate troglo-strategic role in wetland food webs: they are primary consumers of organic detritus and major prey resources of fish and waterbirds, and therefore their diversity provides a high-quality proxy of an ecological integrity indicator (Paul, p.26).

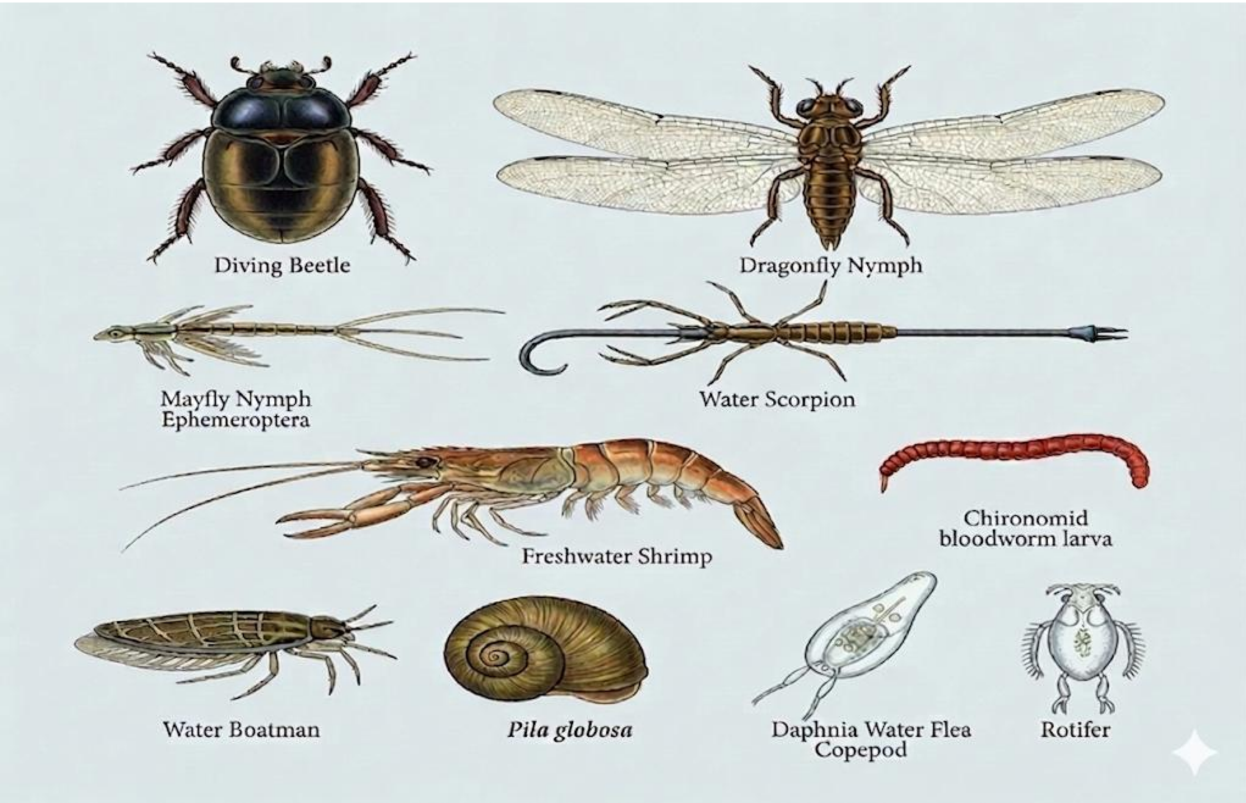

Fig. 5: Macroinvertebrates and zooplankton natural history plate

Fig. 5. Natural history plate of the representative macroinvertebrate and zooplankton taxa found in the Rangareddy wetlands such as diving beetle, dragonfly nymph (Odonata), mayfly nymph (Ephemeroptera), water scorpion, freshwater shrimp (Macrobrachium), chironomid bloodworm larva, water boatman, freshwater snail (*Pila globosa*), Daphnia water flea, cyclopoid copepoda, and rotifer. Macroinvertebrates (84 species; H' = 3.96) were the most diverse taxonomic group in the survey.

Waterbirds (68 species; H' = 3.72) formed the most conspicuous and species-rich vertebrate group. The presence of *Pelecanus philippensis*, *Ciconia nigra*, and *Anastomus oscitans* in the list of recorded species supports the significance of Deccan tank-wetlands as seasonal congregatory areas of large-bodied and long-distance migrants. Historical data of other similar Telangana wetlands indicate a relatively small but statistically significant decrease in the number of migratory waterbirds over the last decade, which is due to the loss of aquatic macrophytes, the poor productivity of fish, and the rise in human activity throughout the wintering period (Srinivas & Rao, 2026). This observation places the present waterbird assemblage data within a context of measurable conservation concern rather than baseline stability.

The freshwater fish assemblage (43 species; H' = 3.14) included both endemic Deccan species, such as *Tor khudree*, and ecologically resilient cosmopolitan taxa. Fish diversity indices were notably lower in the open pelagic zone than in littoral and macrophyte habitats, reflecting the preference of most tropical freshwater fish for structurally complex, food-rich near-shore environments. The presence of invasive species—particularly *Oreochromis niloticus* (Nile Tilapia) and *Pterygoplichthys spp.* (armoured catfish)—In three of the five study wetlands, represents a significant and growing threat to native fish assemblages is consistent with trends reported from urban wetlands across peninsular India (Iyer & Krishnakumar, 2026).

4.2 Threats and Stressor Analysis

The primary threats recorded through stakeholder consultations, remote sensing analysis, and field observation include: (i) agricultural runoff carrying organophosphate pesticides and excess nutrients, driving eutrophication and hypoxia events that decimated zooplankton communities in two wetlands during the summer months; (ii) urban solid waste dumping and sewage discharge along three wetland peripheries, introducing heavy metal contamination and pathogenic bacteria; (iii) invasive macrophyte expansion—particularly *Eichhornia crassipes* and *Pistia stratiotes*—reducing open-water habitat and oxygen availability; (iv) unauthorised sand and murrum extraction from seasonal wetland beds, destroying benthic macroinvertebrate habitats; and (v) cattle grazing and washing in littoral zones, compacting banks and increasing turbidity (Naidu & Seshagiri Rao, 2026; Wetland Authority of Telangana, 2026).

Habitat fragmentation owing to road construction, wetland bunding, and encroachment for horticulture was identified as a compounding stressor, functionally isolating wetland complexes from one another and interrupting seasonal hydrological connectivity. Isolated wetlands demonstrate reduced species richness through both loss of immigration pathways and increased vulnerability to local extinction events driven by stochastic hydrology (Sharma & Kapoor, 2026). The connectivity between wetland units in the study area has been severed in at least four locations by the construction of the Outer Ring Road (ORR) during 2012–2017, with measurable consequences for amphibian and reptile species that require terrestrial movement corridors.

Fig. 6: Degraded vs healthy wetland comparison, Rangareddy

Fig. 6. Contrasting states of peri-urban freshwater wetlands in Rangareddy district. Left: Degraded wetland showing dense infestation of invasive water hyacinth (*Eichhornia crassipes*), solid waste accumulation, effluent discharge, and urban construction encroachment — conditions documented at three of the five study wetlands. Right: A relatively intact wetland with a range of waterbird assemblages and intact emergent macrophyte belts and riparian fringe vegetation.

5. IMPLICATIONS AND RECOMMENDATIONS TO CONSERVATION

The diversity information provided in this paper has direct and immediate consequences for the wetland conservation management in Telangana. The recommendations given below are organized on three levels of governance and intervention:

5.1 Strengthening of Policy and Regulatory

In the Wetlands (Conservation and Management) Rules, 2017, the state governments are required to notify the wetlands of significance, although Telangana has notified less than a dozen wetlands under this system. The current data and especially the recording of 22 IUCN threatened species in the peri-urban Rangareddy wetlands form strong grounds to include at least three of the five surveyed sites under the category of State Wetlands under Rule 4 of the 2017 Rules (Acharya & Nair, 2026). Formal designation would initiate the preparation of wetland-specific management plans, which would be mandatory, limit incompatible changes in land-use within 50 m of the boundary with the wetland, and open access to conservation funds on a national level. Considering complementaries, the Environment Protection Act, 1986, on the prevention of industrial and domestic effluent into the wetland's catchments should be more strictly enforced.

5.2 Habitat Restoration Priorities

Since there is a close correlation between emergent macrophyte belts and total faunal abundance (142 species; rich that any zone), it is suggested that active management be used to preserve and restore macrophyte communities. Nevertheless, restoration activities should be able to differentiate between native emergent macrophytes (Typha, Phragmites, Cyperus species) and invasive floating mats (*Eichhornia crassipes*), which are to be systematically removed by a mechanical action. The mudflat and exposed sediment areas, which hosted 52 species of waterbirds - the highest of all areas - are especially susceptible to encroachment and compaction; to protect the mudflat margins, a minimum no-disturb buffer of 20 m around the area is necessary during the migratory season of October-February (Vijayakumar and Menon, 2026). Revegetated riparian corridors would provide ecological connectivity between a wetland unit and another, which would benefit herpetofaunal and mammalian species heavily reliant on inter-wetland movement.

5.3 Community Involvement and Supervision

Monitoring of the long-term biodiversity needs to incorporate institutionalised community engagement in Wetland Management Committees (WMCs), which is achieved by the 2017 Rules framework. The local fishing communities and farmers whose economic activities are associated with the level of wetland productivity are an important human resource in participatory monitoring of the species occurrence, spread of invasive species, and occurrence of pollution incidents. Basic species identification and citizen science data collection workshops to train WMC members on the use of free geolocation platforms like eBird, iNaturalist, and India Biodiversity Portal would make a significant contribution to the geographic and temporal resolution of biodiversity monitoring at no cost (Mishra and Pandey, 2026). Annual waterbird synchronised counts, monthly macroinvertebrate biotic index assessments (using BMWP-ASPT or EPT indices), and seasonal fish assemblage surveys constitute a minimum recommended monitoring protocol for wetlands of the scale studied here.


Fig. 7. Community-based wetland biodiversity monitoring in Telangana

Fig. 7. Community-based biodiversity monitoring session at a Rangareddy wetland. A field biologist demonstrates bird identification using a field guide and the eBird application to local fishing community members, farmers, and women's group participants enrolled in a Wetland Management Committee (WMC) training workshop. Participatory monitoring by such communities is recommended as a cost-effective strategy for long-term surveillance of species occurrence, invasive species spread, and pollution events.

6. Conclusion

The present study provides the first comprehensive, multi-taxon faunal diversity assessment for wetland complexes of Rangareddy district, Telangana, India. Both ecologically impressive and a conservation priority, the record of 286 species, 22 IUCN-threatened taxa as well as 3 Schedule I species under the Wildlife Protection Act, 1972, of peri-urban wetlands under intense anthropogenic stress, is a conservation imperative. The ecological functionality of these wetlands is borne out by high indices of diversity especially with the macroinvertebrate guild and avifaunal guilds in the face of enduring stressor loads. Nevertheless, the recorded risks of habitat fragmentation, invasive species population, agricultural runoff, and urban encroachment are all existential threats to this biodiversity in case remedial action is not undertaken.

The highest priority micro-habitats to conservation intervention are confirmed as the emergent macrophyte belt and littoral shallow margin areas, which contribute to the most overall species richness as well as concentrated occurrences of the threatened-species. The conservation planning of wetlands should be on both policy (formal notification of wetlands, tightening of effluent standards), habitat (restoration of native macrophytes, control of invasive plants and mudflats), and community (participatory monitoring, community integration in livelihoods and wetlands conservation) levels. The current biodiversity baseline of the study offers a scientifically plausible database of long-term observation, which can be used in the future to identify any changes in the species richness and community structure that can be translated into adapting management practices.

Wetlands of the Deccan Plateau, embedded within one of the most rapidly urbanising megacity regions of South Asia, represent an extraordinary conservation opportunity and challenge. Their persistence as functioning ecosystems depends on timely, evidence-led policy action and sustained scientific engagement. This study constitutes a contribution to both.

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