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Ecological significance of wetland grasses

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Abstract

Wetlands are dynamic ecosystems situated at the interface of terrestrial and aquatic environments, characterized by periodic or permanent inundation and water-saturated soils that support hydrophytic vegetation. Among wetland flora, grasses (Poaceae) are important primary producers that contribute significantly to ecosystem stability and functioning through soil stabilization, erosion control, nutrient cycling, carbon sequestration, and habitat provision. The present study documented 16 common wetland grass species through field surveys conducted between 2022 and 2025 in Odisha, Bihar, Chhattisgarh, West Bengal and Manipur states of India. The ecological roles of these grasses were evaluated with respect to soil stabilization, water regulation, nutrient cycling, carbon storage, habitat formation, and wildlife support. The study revealed that species such as *Chrysopogon zizanioides* and *Cymbopogon citratus* play important roles in soil conservation and fodder production. *Leersia hexandra*, *Isachne globosa*, *Polypogon monspeliensis*, *Phragmites karka*, *Phragmites australis* and *Saccharum spontaneum* provide habitats for waterbirds and other wetland species. The findings demonstrated that wetland grasses are key drivers of ecosystem resilience and biodiversity conservation and have considerable potential for wetland restoration, ecological engineering, and sustainable ecosystem management.

Keywords: Degraded wetlands restoration, ecological functions, soil binding, water filtration

Introduction

Wetlands represent ecologically dynamic ecosystems that exist at the interface between terrestrial and aquatic environments, characterized by areas that are periodically or permanently inundated and contain water-saturated soils (Grenfell *et al.*, 2022; Liu *et al.*, 2025) [14, 26]. These environments support specialized plants known as hydrophytes. Wetlands are known for their high levels of primary productivity and biogeochemical activity (Devi *et al.*, 2025; Patel and Sahoo, 2021) [10, 36]. Functionally, wetlands play vital ecological roles such as water purification, flood regulation, groundwater recharge and carbon sequestration (Song *et al.*, 2024) [48]. They naturally filter water by trapping sediments, absorbing nutrients and breaking down organic matter through microbial processes (Gosh *et al.*, 2021; Maranhão and Gomes, 2024) [27]. With their hydric soils and dense vegetation, wetlands can buffer against hydrological extremes by absorbing excess rainfall and gradually releasing stored water, thus mitigating floods and maintaining flow during dry-season flows (Hockaday *et al.*, 2024) [18]. Furthermore, wetlands act as significant global carbon sinks. Their anaerobic conditions that slow down the decomposition of organic matter, allowing carbon to be stored for long-term in sediments (Devi *et al.*, 2022) [11]. Additionally, they aid in nutrient cycling and soil stabilization (Oester *et al.*, 2025) [31]. Hence, wetlands are essential for maintaining biodiversity, regulating climatic processes, and preserving the functional integrity of landscapes (Rai and Singh 2020; Yang *et al.*, 2023) [38, 56]. The wetlands of Central, Eastern, and Northeastern India represent a remarkable diversity of freshwater ecosystems that vary in hydrology, altitude, climatic conditions and ecological functions (Table 1). These wetlands include natural lakes, floodplain wetlands, marshes, Ramsar sites, riverine systems and man-made reservoirs. Important wetlands such as Chilika Lake in Odisha, Loktak Lake in Manipur, Deepor Beel in Assam, East Kolkata Wetlands in West Bengal, Bhoj Wetland in Madhya Pradesh, and Rudrasagar Lake in Tripura. Similarly, high-altitude wetlands such as Sela Lake and Nagula Lake in Arunachal Pradesh, along with sacred and culturally important wetlands like Khecheopalri Lake in Sikkim and Tamdil Lake in Mizoram contribute

Significantly to Regional hydrological stability and biodiversity conservation. A list of representative wetlands from these regions is presented in Table 1. Despite their ecological importance, wetlands across these regions are increasingly threatened by anthropogenic disturbances such as urban expansion, pollution, eutrophication, agricultural intensification, invasive species and climate change-induced hydrological alterations (Xu *et al.*, 2019)^[55]. In this context, wetland vegetation, particularly grasses belonging to the family Poaceae, plays a crucial role in maintaining ecosystem stability and resilience. Wetland grasses are highly adaptable to fluctuating water levels, nutrient-rich sediments and oxygen-deficient conditions. Their ecological functions include shoreline stabilization, sediment trapping, nutrient retention, carbon sequestration and the provision of food and shelter for wildlife. Therefore, documenting the diversity and ecological significance of wetland grasses is essential for understanding wetland ecosystem functioning and developing sustainable conservation and restoration (Table 1). Grasses are one of the most ecologically and functionally important groups of plants, serving as the structural and nutritional foundation of numerous terrestrial and wetland ecosystems (Guo *et al.*, 2023; He *et al.*, 2023)^[16]. They display remarkable morphological and physiological adaptations that allow them to thrive in diverse climatic and edaphic conditions (Spitzer *et al.*, 2024)^[49]. Ecologically, they function as primary producers, converting solar energy into organic matter through

photosynthesis and thus supporting complex food webs (Dimri *et al.*, 2024)^[12]. Their extensive fibrous root systems enhance soil cohesion, reduce erosion, and promote soil formation and nutrient cycling through the continuous deposition of organic material (Griffiths *et al.*, 2022)^[15]. Additionally, they play a crucial role in hydrological regulation by facilitating water infiltration, minimizing surface runoff, and contributing to groundwater recharge (Shiferaw *et al.*, 2025)^[43]. They are also effective carbon sinks, assimilating atmospheric carbon dioxide and storing it in both their biomass and rhizosphere (Megan *et al.*, 2024; Behera *et al.*, 2025)^[2, 28]. Grasses also maintain ecosystem resilience by stabilizing landscapes, supporting diverse pollinator and herbivore populations, and promoting regeneration following disturbances (Charoenlertthanakit *et al.*, 2025)^[3]. Globally, approximately 780 genera and 12,000 species of grasses have been documented (Palit *et al.*, 2017)^[32]. In India, around 1,506 species of grasses are recorded, reflecting the country's significant ecological diversity (Kellogg *et al.*, 2020)^[23]. Regionally, studies have identified 65 grass species in the wetland regions of Birbhum district in West Bengal, 51 species from the Chandaka-Dampara Wildlife Sanctuary in Bhubaneswar, Odisha (Behera *et al.*, 2025)^[2], 23 species from the wetlands of Mizoram (Pathak, 2023)^[36] and 44 species from Manipur (Sharma *et al.*, 1998; Devi *et al.*, 2014; Devi *et al.*, 2016)^[8, 9, 41].

Table 1: Some wetlands of Central, Eastern and Northeast India

Name	Location	Source
Bhoj Wetland	Madhya Pradesh	Sahu and Bhawsar, (2026) ^[40]
Bolfangdisa	Nagaland	Pamai <i>et al.</i> , (2025) ^[33]
Chilika lake	Odisha	Singh <i>et al.</i> , (2021a) ^[45]
Dalpatsagar	Chhattisgarh	Pradhan <i>et al.</i> , (2025) ^[37]
Deepor Beel	Assam	Singh <i>et al.</i> , (2021b) ^[46]
Dudhawa Dams	Chhattisgarh	Pradhan <i>et al.</i> , (2025) ^[37]
East Kolkata Wetland	West Bengal	Saha <i>et al.</i> , (2021) ^[39]
Gangamunda	Chhattisgarh	Pradhan <i>et al.</i> , (2025) ^[37]
Kabar Tal	Bihar	Kaushik <i>et al.</i> , (2021) ^[22]
Khecheopalri Lake	Sikkim	Das <i>et al.</i> , (2025) ^[6]
Lamphelpat	Manipur	Singh <i>et al.</i> , (2025) ^[47]
Loktak Lake	Manipur	Devi <i>et al.</i> , (2025) ^[10]
Madladijam	Nagaland	Pamai <i>et al.</i> , (2025) ^[33]
Nagula Lake	Arunachal Pradesh	Kanwal <i>et al.</i> , (2013) ^[21]
Noune	Nagaland	Pamai <i>et al.</i> , (2025) ^[33]
Pumlenpat	Manipur	Singh <i>et al.</i> , (2025) ^[47]
Rudrasagar lake	Tripura	Taran <i>et al.</i> , (2023) ^[51]
Sela Lake	Arunachal Pradesh	Kanwal <i>et al.</i> , (2013) ^[21]
Sundarban	West Bengal	Sil, (2016) ^[44]
Sungester Lake	Arunachal Pradesh	Kanwal <i>et al.</i> , (2013) ^[21]
Tamdil Lake	Mizoram	Zothanpuia <i>et al.</i> , (2016) ^[58]
Umiam Lake	Meghalaya	Warjri <i>et al.</i> , (2024) ^[52]
Zaimeng Pat	Manipur	Singh <i>et al.</i> , (2025) ^[47]

Keeping the importance of wetlands and grass species, the present study aims to document important common wetland grass species from Odisha, Bihar, Chhattisgarh, West Bengal and Manipur and evaluate their ecological significance in wetland ecosystems.

1. Methodology

The present study was conducted to document common

wetland grasses and evaluate their ecological significance in selected wetlands of Odisha, Bihar, West Bengal, Chhattisgarh, and Manipur, India. Field surveys were carried out during 2022 - 2024. Grass species occurring within the selected habitats were recorded and identified by authors. The ecological significance of each species was noted in field.

2. Results and Discussion

Present study examined sixteen species of wetland grass, highlighting their morphological characteristics and ecological roles within study areas. Notably, tall and robust species such as *Phragmites karka*, *Phragmites australis* and *Saccharum spontaneum* demonstrated dense growth. *Phragmites karka* is frequently found as a characteristic and dominant species in Ramsar sites, including Loktak Lake in Manipur (Figure 3) and Chilika Lake in Odisha. *S. spontaneum* is widely distributed across moist, marshy and riparian zones. The threatened Indian Skimmer (*Rynchops albicollis*) has been observed nesting on triangular sandbars surrounded by water, often within dense stands of *S. spontaneum*, highlighting the species' importance as nesting cover. *Chrysopogon zizanioides* is a medium-sized perennial

grass known for its remarkable ability to tolerate various soil conditions. Field observations showed its effectiveness in slope stabilization and roadside soil restoration projects along National Highway 27 (Figure 2), where it helps reduce surface runoff and sediment loss. Several recorded plant species serve as important forage resources for large herbivores, including the Asian elephant (*Elephas maximus*), spotted deer (*Axis axis*), barking deer (*Muntiacus muntjak*), and the endangered Sangai deer (*Cervus eldi eldi*). *Cymbopogon citratus*, *Oryza rufipogon*, *Phragmites karka*, *Saccharum spontaneum* and *Urochloa mutica* are important fodder species for mega herbivores. *Paspalum scrobiculatum* produces grains that are consumed by granivorous birds. The ecological characteristics of these studied species are presented in Table 2 and Figure 1.

Table 2: Important common wetland grasses of study areas with their ecological significance

Botanical Name	Habit	Ecological significance
<i>Chrysopogon zizanioides</i> (L.) Roberty	Soft and medium-sized grass.	It is a good sand binder and fodder for wildlife.
<i>Cymbopogon citratus</i> (DC.) Stapf	Soft and medium-sized grass.	It is a common fodder plant.
<i>Echinochloa crus-galli</i> (L.) P.Beauv.	Soft and small grass.	It is a fodder for wildlife.
<i>Eragrostis unioides</i> (Retz.) Nees ex Steud.	Soft and small grass.	It is fodder for wildlife.
<i>Imperata cylindrica</i> (L.) Raeusch.	Soft and small grass.	It is also a palatable fodder for wildlife.
<i>Isachne globosa</i> (Thunb.) Kuntze	Soft and small grass.	It provides shelter for many aquatic invertebrates and helps in soil binding.
<i>Leersia hexandra</i> Sw.	Soft and small grass.	It provides shelter for small aquatic invertebrates and small birds.
<i>Oryza rufipogon</i> Griff.	Soft and small grass.	Its seed is a food for many aquatic birds.
<i>Paspalum scrobiculatum</i> L.	Soft and small grass.	It helps to restore disturbed wetland habitats. It prevents soil erosion and provides food for many wildlife species.
<i>Phragmites australis</i> (Cav.) Trin. Ex Steud.	Hard and tall grass.	It provides a habitat for waterbirds and wildlife.
<i>Phragmites karka</i> (Retz.) Trin. Ex Steud.	Hard and tall grass.	It provides critical habitat for waterbirds and wildlife.
<i>Polypogon monspeliensis</i> (L.) Desf.	Soft and small grass.	It helps to improve the water quality.
<i>Saccharum spontaneum</i> L.	Hard and tall grass.	It provides a critical habitat for waterbirds and wildlife.
<i>Sacciolepis indica</i> (L.) Chase	Soft and small grass.	Its dense vegetation helps to provide habitat for wildlife.
<i>Urochloa mutica</i> (Forssk.) T.Q.Nguyen	Soft and small grass.	It is palatable fodder for wildlife and also provides dense habitat for small fishes and other invertebrates.
<i>Zizania latifolia</i> (Griseb.) Hance ex F.Muell.	Soft and medium-sized grass.	It is an important fodder plant for <i>Cervus eldi eldi</i> on the floating vegetation.
<i>Themeda triandra</i> Forssk.	Soft and medium-sized grass.	It prevents soil erosion and improves water quality, and provides food for many wildlife species.



Fig 1: Some important wetland grasses of India: a) *Cymbopogon citratus*, b) *Phragmites karka*, c) *Phragmites australis*, d) *Leersia hexandra*, e) *Imperata cylindrica*, f) *Oryza rufipogon*, g) *Urochloa mutica*, h) *Paspalum scrobiculatum* and i) *Eragrostis unioides*



Fig 2: *Chrysopogon zizanioides*, cultivated along the National Highway 27, Odisha, to restore the soil degradation and reduce soil erosion



Fig 3: Habitat of *phragmites karka* on the floating vegetation “Phumdi”, loktak lake, manipur

3. Ecological importance of wetland grasses

Wetland grasses play a fundamental role in maintaining the structure, functioning, and resilience of wetland ecosystems (Zhang *et al.*, 2025) ^[57]. One of the most important ecological functions of wetland grasses is soil stabilization and erosion control (Meli *et al.*, 2014) ^[29]. Wetland grasses possess dense fibrous root systems and rhizomatous growth habits that effectively bind soil particles and stabilize sediments (Bansal *et al.*, 2023) ^[1]. Wetland grasses also play a crucial role in hydrological regulation and water conservation. Their dense vegetation slows water movement, enhances infiltration, and promotes groundwater recharge (Shi *et al.*, 2026) ^[42]. Another major ecological importance of wetland grasses lies in nutrient cycling and water purification (Stagg *et al.*, 2021) ^[50]. Through their roots and associated microbial communities, these grasses participate actively in biogeochemical cycling processes (Wu *et al.*, 2025) ^[54]. Wetlands are recognized globally as important carbon sinks because their waterlogged conditions slow the decomposition of organic matter (Huang *et al.*, 2024) ^[19]. Their ability to colonize disturbed habitats and improve soil quality makes them highly valuable for restoring degraded wetlands and rehabilitating polluted aquatic ecosystems (Wu *et al.*, 2023) ^[55]. Despite their immense ecological significance, wetland grasses are increasingly threatened by habitat destruction, urbanization, invasive species, pollution, hydrological modifications, and climate change (Demnati *et al.*, 2012) ^[7]. Future research should focus on understanding species-specific ecological functions, restoration potential, carbon storage capacity, and responses to environmental change (Huang *et al.*, 2026) ^[20]. Therefore, wetland grasses are indispensable ecological components of wetland ecosystems.

4. Future aspects

The study of wetland grasses in study areas highlights their immense ecological and functional importance; however, the scope for future research and application remains vast. Future research should focus on expanding both the scientific understanding and practical utilization of these species in a rapidly changing environmental landscape (Mir *et al.*, 2025) ^[30]. One of the most important future aspects lies in the ecological restoration of degraded wetlands. Wetlands across India are experiencing degradation due to encroachment, eutrophication, and hydrological alterations (Kundu *et al.*, 2026) ^[25]. Future research should focus on quantifying the efficiency of these grasses in removing specific pollutants such as nitrogen, phosphorus, arsenic, and industrial effluents (Khan *et al.*, 2022) ^[24]. Wetland grasses provide habitat, food, and breeding grounds for a wide range of fauna, including birds, fish, invertebrates, and large herbivores (Pant *et al.*, 2024) ^[34]. Many grass species serve as fodder, thatching material, and raw material for handicrafts, while some possess medicinal or aromatic properties (Chen *et al.*, 2024) ^[4]. Remote sensing and geographic information systems (GIS) can be used to map wetland vegetation, monitor changes in grass distribution, and assess ecosystem health over large spatial scales (Cheng and Dang, 2022) ^[5].

5. Conclusion

Wetland grasses are a vital part of India's wetland ecosystems. They are playing a key role in their structural integrity, ecological functioning and resilience. The present

study highlighted the diversity and ecological significance of 16 grass species. These grasses contribute in various ways, including soil stabilization, water purification, nutrient cycling, and carbon sequestration and providing habitats for a wide range of wildlife. Both tall emergent species and smaller, softer grasses collectively support trophic dynamics, enhance biodiversity and help to maintain hydrological balance. Notably, several species show great potential for ecological restoration. These grasses serve as valuable fodder for wildlife, contributing to the support of various faunal populations. Overall, wetland grasses are not just passive elements, they are active drivers of ecosystem stability and productivity. Thus, it is crucial to prioritize their conservation and strategic utilization in wetland management and restoration programs to ensure long-term ecological sustainability and biodiversity conservation in India's wetland landscapes.

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