Wetland, Water birds and Aquatic ecosystem

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Abstract- ***Birds that live in or around water, whether in freshwater or marine environments, are known as waterbirds or aquatic birds. Wetlands are unique, complex, and sensitive habitats that link terrestrial and aquatic ecosystems while providing a wide range of ecosystem services to humans.The term "waterbirds" refers to a diverse group of species that feed in or near water. Wetlands serve as an important habitat for many of water birds species, as they offer abundant food resources supported by the enrichment of organic matter that promotes the growth of aquatic weeds and planktons. They are equally vital for bird survival, offering critical sites for foraging, roosting, nesting, chick-rearing, moulting, stopovers, and wintering of both migratory and resident waterbirds. Waterbirds are widely recognized as important bioindicators of ecosystem change. They play a key role in wetland health, as they influence the diversity of aquatic organisms and form an integral part of the food web.***

Index Terms- ***Human activities, Wetlands, Water birds, Ecosystem, Biodiversity conservation***

I. INTRODUCTION

Wetlands are among the most productive ecosystems in the world, serving as reservoirs of biodiversity by supporting numerous species across all major groups of organisms (Prakash and Verma, 2023; Singh and Prakash, 2023). Often referred to as “biological supermarkets,” wetlands produce a wide variety of food in large quantities, attracting diverse animal species. The habitat diversity within a watershed or broader landscape unit also plays a crucial role in key ecological processes such as biogeochemical cycling, the hydrologic cycle, and carbon storage, which in turn benefit fishes, birds, and other organisms (Ashok, 2016; Sharma and Kirar, 2023).

Wetlands are cradles of biodiversity, supplying water and primary productivity that sustain countless species of plants and animals, including fish, amphibians, reptiles, birds, mammals, and invertebrates (Prakash, 2020; Singh and Prakash, 2025). Birds and wetlands share a vital ecological relationship. Wetlands provide food, shelter, breeding, and stopover sites for migratory and resident birds, while birds contribute to ecosystem balance by dispersing seeds, controlling pests, and cycling nutrients. Together, they maintain biodiversity and indicate the health of wetland ecosystems.

The term waterbirds refer to a broad group of species that feed in or near water and are widely recognized as indicators of wetland health. They strongly influence the diversity of aquatic organisms and play a vital role in maintaining ecosystem balance. For instance, waterbirds such as kingfishers contribute significantly to sustaining the integrity of wetland ecosystems and are highly valuable in assessing their ecological condition. A balanced ecosystem, together with sustainable development, underpins rich biodiversity, which is essential for the survival and continuity of all living organisms, including fishes (Prakash and Verma, 2016; Verma and Prakash, 2016; Verma, 2017; Singh and Prakash, 2024).

Birds are severely affected by pollution, plastics, and other environmental threats (Verma and Prakash, 2022; Singh et al., 2023). At the same time, they hold great cultural and recreational value for humans. Bird watching provides aesthetic and recreational satisfaction, allowing people to admire these magnificent creatures in their natural habitats (Verma, 2018). Some species even symbolize eternal marital fidelity (Ashok, 2018). Such values highlight the importance of conserving rich biodiversity.

Wetland Birds: Indicators of Ecosystem Health:
Wetland birds serve as reliable bio-indicators of ecosystem health. Waterbirds act as natural indicators for both vertebrates and invertebrates and play a vital role in wetland ecosystems, being well recognized for their provisioning functions. Of the 1,340 bird species recorded in India, about 310 depend on wetlands, while globally; nearly 9,000 bird species show some degree of reliance on these habitats (Parveen *et al.,* 2023). Their abundance, diversity, and behavior reflect water quality, habitat integrity, and pollution levels. Changes in bird populations signal ecological imbalance, making them valuable

tools for monitoring wetland conservation, biodiversity management, and assessing the impacts of environmental disturbances.

Wetland birds, or waterbirds, are important bio-indicators as they exhibit clear and measurable responses to changes in wetland habitats. Such responses signal pollution and the declining health of aquatic ecosystems. Consequently, waterbirds are widely used to assess ecological problems affecting wetlands. Their responses, whether at the individual or community level, provide valuable insights into environmental stressors, since these species can track habitat changes and accumulate pollutants through the food chain. This, in turn, reflects alterations occurring at lower trophic levels (Newman *et al*., 2007).

Waterbirds, being directly or indirectly exploited by humans through hunting and fisheries, reflect the productivity of nesting areas (Miller *et al*., 1988) and can also indicate fish stock availability (Einoder, 2009). This highlights the need for effective monitoring systems using waterbird species to provide early warnings of potential threats to wetland ecosystems (Burger, 2006). For example, kingfishers play a vital role in maintaining wetland integrity, relying on these habitats for food such as fish, frogs, reptiles, caterpillars, insects, mollusks, and crabs. Thus, waterbirds continue to serve as valuable bio-indicators worldwide, helping scientists assess the ecological status and health of wetland ecosystems.

Ecological Importance of Wetlands in Sustaining Waterbird Communities

Wetlands, as key habitats supporting waterbird diversity, deliver numerous ecosystem services through their varied ecological functions.Wetlands are transitional zones between aquatic and terrestrial regions, supporting diverse flora and fauna, and are among the most biologically productive ecosystems (Wetlands International, 2010). Degradation and loss of wetland habitats disrupt the biodiversity-ecosystem functioning relationship, negatively impacting habitat quality and waterbird diversity. Wetlands are vital for waterbird communities, offering food, nesting, roosting, and breeding habitats. They sustain migratory and resident species by providing stopover sites and abundant resources. Wetlands ensure survival, ecological balance, and biodiversity, while the presence of waterbirds reflects the health and productivity of these unique ecosystems.Wetland birds play a crucial role in regulating, filtering, and maintaining water bodies, while also benefiting from the wide range of habitats wetlands provide. Species such as herons, storks, and egrets thrive in these environments, which offer abundant food resources for various organisms, including waterbirds (Verma *et al*., 2015). Waterbirds use wetlands for feeding, roosting, and breeding, and their presence indicates ecological richness. In newly created wetlands, the attraction of diverse bird communities serves as a positive sign of habitat quality (Ismail *et al*., 2012). The conservation of waterbird populations is therefore closely tied to the proper functioning of wetlands, including nutrient cycling, energy storage, and productivity. Waterbirds exhibit complex habitat preferences and sensitivities, influencing biotic interactions within these ecosystems.

Influence of Anthropogenic Disturbances on Wetland Birds:

Wetland ecosystems cover about 5–10% of the Earth's land surface and play a vital role in the global economy. However, they face multiple threats, primarily from expanding human activities that negatively impact both living and non-living components. Water quality is a key determinant of the health and abundance of aquatic ecosystems and the wildlife they support. Avifauna, in particular, are highly sensitive to fluctuations in water quality, as they depend on aquatic habitats for critical stages of their life cycle.

Anthropogenic or human activities severely impact wetland birds by degrading their habitats and reducing food availability. Anthropogenic pressures on wetlands in India are steadily increasing due to excessive use of synthetic pesticides and fertilizers in agriculture, along with untreated municipal and industrial waste discharges, pollute wetlands and deteriorate water quality andleading to irreversible changes in these ecosystems (Prakash and Verma, 2022). Declining water quality is further aggravated by urbanization, untreated waste disposal, unsustainable fishing, and other human activities.

Urbanization and land-use changes fragment habitats, while unsustainable fishing practices disturb ecological balance. Pollutants such as microplastics and heavy metals accumulate in aquatic food chains, affecting fish populations and, consequently, the survival of waterbirds. Climate change-driven temperature rise further alters water chemistry,

reducing dissolved oxygen and increasing stress on aquatic life. Collectively, these pressures threaten wetland bird populations and overall ecosystem integrity.However, aquatic ecosystems are increasingly threatened, both directly and indirectly, by anthropogenic activities, which must be minimized to ensure their sustainability (Prakash, 2021).

Long-term studies on birds are valuable for assessing habitat health and for developing effective management strategies. Rising air temperatures lead to gradual increases in water temperature, altering water quality through changes in pH, dissolved oxygen, and anthropogenic impacts such as agricultural runoff, municipal and industrial waste, microplastics, and heavy metal pollution. These factors negatively affect fish populations in water bodies, which in turn threaten the survival of waterbirds dependent on them.

Wetland Conservation: A Key to Biodiversity and Aquatic Ecosystem Health:

Despite their wide-ranging importance, wetlands are under severe threat from unplanned urbanization, agricultural expansion, pollution, and climate change (Arya, 2025). These pressures result in habitat fragmentation, deteriorating water quality, and biodiversity loss, thereby weakening the ecological and societal benefits that wetlands provide. Additional conservation challenges include weak policy enforcement, invasive species, and nutrient over-enrichment. The research highlights that integrating quantitative environmental assessments with qualitative socio-economic insights is essential, emphasizing that effective wetland conservation requires joint efforts from government agencies, local communities, and non-governmental organizations (NGOs).

As one of the most important ecosystems on the planet, wetlands require urgent protection. Preventing their degradation calls for stronger laws and regulations, along with raising public awareness to ensure their effective conservation. Birds are important indicators of a healthy ecosystem, as their diversity reflects sustainability, balance, and ecological well-being.

CONCLUSION

Wetlands serve as vital habitats for waterbirds, providing essential resources during both migratory and breeding seasons. Their biogeographic distribution plays a significant role in maintaining the ecological balance of the region. However, rapid industrialization and growing anthropogenic pressures have increased contaminant levels in wetlands, leading to shifts in the dynamics and distribution of both local and migratory waterbird populations. Although wetlands are among the most crucial habitats for waterbirds, escalating human activities have caused extensive degradation and loss. The limited availability of human and natural resources further complicates effective habitat protection, making wetland conservation an urgent priority.

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