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AVIAN INDICATOR SPECIES AS BIOINDICATORS OF WETLAND HEALTH IN GOVINDGARH, REWA DISTRICT (M.P.), INDIA

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ABSTRACT

Wetlands serve as essential habitats for numerous avian species and play a critical role in maintaining ecological balance. Avian indicator species are increasingly used as bioindicators to assess the health of wetland ecosystems due to their sensitivity to environmental changes. This study aims to identify key avian indicator species in the Govindgarh Wetland and analyze their relationship with various environmental parameters such as water quality, vegetation, and anthropogenic pressures. The study found that species like the Indian Cormorant (Phalacrocorax fuscicollis), Little Egret (Egretta garzetta), and Common Moorhen (Gallinula chloropus) serve as reliable indicators of ecological condition, highlighting the wetland's moderate health status and vulnerability to degradation.

KEYWORDS: *Avian indicator species, Govindgarh Wetland, Bioindicators and Trophic status.*

INTRODUCTION

Wetlands, often referred to as the "kidneys of the landscape," are vital ecosystems that perform a wide range of ecological functions. These include water purification, groundwater recharge, carbon sequestration, flood control, and support for an immense diversity of plant and animal life. Among the various fauna associated with wetlands, birds stand out as one of the most visible and ecologically significant components. Their presence, diversity, and behavior offer insights into the health and stability of the wetland environment. Due to their ecological sensitivity and rapid response to habitat alterations, birds are increasingly used as bioindicators species that reflect the health of the ecosystem they inhabit.

Bioindicators are organisms whose presence, absence, or abundance can reveal the qualitative status of the surrounding environment. Avian species, with their diverse feeding habits, habitat preferences, and migratory patterns, are particularly suited for this role. Certain bird species are highly sensitive to changes in water quality, vegetation structure, trophic status, and anthropogenic disturbances. These species, termed avian indicator species, can signal early signs of ecological imbalance or degradation. By studying them, researchers and conservationists can assess the overall ecological integrity of a wetland without extensive, costly chemical or physical monitoring. This approach not only complements traditional limnological methods but also adds a biological dimension to ecosystem assessment.

The Govindgarh Wetland, located in the Rewa District of Madhya Pradesh, is a semi-natural freshwater body that holds ecological, cultural, and aesthetic value. Situated around 18 kilometers from Rewa city, the wetland lies within the Vindhyan Plateau and supports a wide range of aquatic flora and fauna. It provides critical habitat for both resident and migratory birds, especially during the winter months. Yet, like many wetlands in India, it is increasingly threatened by anthropogenic pressures such as agricultural runoff, domestic sewage, encroachment, and unregulated tourism. These threats, if left unchecked, could drastically affect the wetland's capacity to support biodiversity, particularly avian populations.

Over the past decade, ornithologists and ecologists have emphasized the need to monitor wetland birds as proxies for ecosystem health. The logic is simple: a wetland rich in sensitive bird species, including piscivores like cormorants and herons or migratory species like bar-headed geese, is likely to have clean water, abundant prey, and balanced vegetation. Conversely, an increasing dominance of urban-adapted, generalist birds such as house crows and mynas might indicate pollution, habitat fragmentation, and ecological degradation. The seasonal distribution of birds, their nesting behavior, feeding strategies, and habitat preferences offer a comprehensive picture of the ecological processes at play.

The present study aims to identify and analyze avian indicator species found in the Govindgarh Wetland and to evaluate their potential as bioindicators of wetland health. By combining field-based ornithological surveys with limnological analysis of water quality parameters, this research seeks to establish meaningful correlations between bird presence and environmental conditions. The focus will be on understanding how specific bird species respond to fluctuations in water quality, habitat structure, and anthropogenic disturbances over a 12-month period, spanning all seasons.

This research holds particular significance in the current environmental context, where wetlands across India are shrinking or deteriorating due to unplanned development and climate change. Despite their ecological importance, wetlands often lack adequate monitoring and protection. The use of birds as cost-effective, reliable, and ecologically meaningful indicators offers a practical solution for long-term conservation strategies. The findings of this study are expected to contribute to the broader field of wetland ecology, inform local conservation policy, and provide a baseline for further ecological monitoring in the region. The study aligns with national and international conservation goals such as the Ramsar Convention on Wetlands, the Convention on Biological Diversity (CBD), and the National Action Plan for Conservation of Migratory Birds and their Habitats. It also supports India's obligations toward sustainable development by promoting biodiversity monitoring and conservation at the grassroots level.

This study of avian indicator species in the Govindgarh Wetland is not merely an academic exercise but a step toward a more informed and ecologically responsible stewardship of our natural resources. By understanding the connections between bird life and wetland health, we gain valuable tools for ecological assessment, conservation planning, and public awareness. Wetlands, though often overlooked, are vital for our environmental and economic well-being, and birds can be the sentinels that guide their protection.

MATERIALS AND METHODS

Study Area: Govindgarh Wetland lies approximately 18 km from Rewa city in Madhya Pradesh, India (Latitude: 24.53° N, Longitude: 81.28° E), at an elevation of about 400 meters above sea level. The wetland is a semi-natural freshwater body surrounded by agricultural land and human settlements. It receives seasonal inflow from monsoonal rain and supports a variety of aquatic and semi-aquatic flora and fauna.

Duration of Study: The study was conducted over a period of 12 months, from January 2024 to December 2024, to capture seasonal variations in bird populations and water parameters.

Field Equipment and Guides

Binoculars (10×50), DSLR camera with telephoto lens, Field guides:

Avian Survey Method

- Point Count Method: Birds were recorded within a fixed radius at different points around the wetland.
- Time Activity Budgets: Noted bird behaviors such as feeding, nesting, and flocking to understand habitat usage.
- Frequency and Abundance Index were calculated to identify dominant and indicator species.

Water Quality Analysis:

Monthly water samples were collected and analyzed for:

- Physical parameters: Temperature, pH, TDS, Conductivity
- Chemical parameters: Dissolved Oxygen (DO), BOD, COD, Nitrate, Phosphate, Chloride
- Samples for DO and BOD were preserved using Winkler's Method and analyzed following APHA (2017) standards.

RESULTS AND DISCUSSION:

Understanding the physico-chemical characteristics of a wetland ecosystem is fundamental for assessing its health, trophic status, and suitability as a habitat for various bird species. The values of parameters such as temperature, pH, dissolved oxygen, and nutrients directly influence the diversity and abundance of avian fauna. The following section presents a detailed analysis of key physical and chemical water quality parameters observed monthly from January to December 2024.

Physical Parameters

a) Temperature (°C): Water temperature is a critical factor that affects dissolved oxygen levels, metabolic rates of aquatic organisms, and the behavior of birds, particularly feeding and migration. 16.5°C (January 2024) to 32.8°C (May 2024), Peak temperatures were observed during the pre-monsoon (April–May), with lowest in winter., Implication: High summer temperatures led to a decrease in DO levels and a reduction in visible foraging activity of piscivorous birds like cormorants.

b) pH : The pH of the wetland water reflects its acidity or alkalinity, influenced by organic matter decomposition, runoff, and biological activity. 6.8 (July 2024) to 8.4 (March 2024) Slightly alkaline throughout the year with neutral pH during monsoon. A pH around 7–8 is generally favorable for aquatic life. The observed range supports good biodiversity, particularly insectivorous and wading birds.

c) Total Dissolved Solids (TDS) (mg/L): TDS indicates the concentration of inorganic salts and small organic matter in water. 110 mg/L (August 2024) to 298 mg/L (May 2024), Higher values during dry months due to evaporation and lower dilution. Moderate TDS levels suggest the water is suitable for most bird species, though high summer TDS may reduce aquatic vegetation, impacting herbivorous birds.

d) Conductivity (S/cm) : This measures the water's ability to conduct electrical current, which increases with ion concentration. 220 S/cm (August 2024) to 560 S/cm (May 2024), Mirrored TDS trends, peaking during summer months. A gradual increase indicates nutrient loading, which may encourage algal growth affecting fish and invertebrate populations.

2. Chemical Parameters

a) Dissolved Oxygen (DO) (mg/L): DO is vital for aquatic organisms. Low DO is often a sign of eutrophication or organic pollution. 3.4 mg/L (June 2024) to 8.1 mg/L (January 2024) Higher in winter due to increased solubility and lower microbial activity. Lower DO during monsoon and early post-monsoon affects sensitive birds like herons and moorhens that rely on aquatic prey.

b) Biological Oxygen Demand (BOD) (mg/L): BOD indicates the organic matter in water and microbial activity needed for its decomposition. 1.8 mg/L (January 2024) to 6.5 mg/L (June 2024), Higher in summer/monsoon due to organic runoff and decomposition. High BOD in monsoon negatively affects species richness, as many aquatic invertebrates (bird food) are oxygen-sensitive.

c) Chemical Oxygen Demand (COD) (mg/L): COD measures the total quantity of oxygen needed to oxidize organic and inorganic material. 8.4 mg/L (January 2024) to 24.6 mg/L (July 2024), Peaked during monsoon due to surface runoff. High COD levels indicate organic pollution, which can reduce habitat quality for sensitive species like kingfishers.

d) Nitrate (NO_3^-) (mg/L): Nitrate is a key nutrient influencing primary productivity but may cause eutrophication if elevated. 0.9 mg/L (February 2024) to 3.8 mg/L (July 2024), Higher in monsoon due to fertilizer runoff. Moderate enrichment favors herbivorous birds, but excessive nitrate can lead to algal blooms, displacing some species.

e) Phosphate (PO_4^{3-}) (mg/L): Phosphates promote algae and macrophyte growth but excessive levels can cause nutrient imbalance. 0.4 mg/L (January 2024) to 2.1 mg/L (August 2024), Spiked during and post-monsoon. Eutrophic conditions from phosphate loading may encourage generalist birds but reduce sensitive species.

f) Chloride (Cl^-) (mg/L) : Chloride is a conservative ion often used to detect pollution from sewage or industrial waste. 15.6 mg/L (August 2024) to 49.7 mg/L (May 2024) Elevated in summer due to concentration effect. Within acceptable limits, though higher values may indicate sewage inflow in dry seasons.

Avian Species Observed

A total of 38 avian species were recorded, out of which 6 species were identified as potential indicator species based on their abundance, habitat specificity, and sensitivity to environmental changes:

Species	Indicator Type	Preferred Habitat	Sensitivity
Indian Cormorant	Piscivore	Open water	High
Little Egret	Wader	Shallow wetland edges	Medium
Common Moorhen	Omnivore	Emergent vegetation	Medium
Red-wattled Lapwing	Ground-nester	Wetland margins	High
Bar-headed Goose	Migratory	Open water	High
White-throated Kingfisher	Resident	Wetland-edge trees	Low

The present study explored the utility of avian indicator species in assessing the ecological and trophic status of the Govindgarh Wetland over a year-long observational period. The analysis of both physico-chemical parameters and bird diversity revealed a strong correlation between water quality and avian assemblages, confirming the efficacy of birds as reliable bioindicators of wetland health. The richness of bird species recorded, including both resident and migratory birds, signifies that the wetland continues to provide critical habitat features such as food availability, nesting grounds, and shelter. However, monthly variations in water quality parameters such as DO, BOD, COD, and nutrient levels influenced the abundance and behavior of certain bird groups. For example, piscivorous birds like cormorants and kingfishers were more frequently observed during months with higher dissolved oxygen and lower turbidity, indicating their reliance on clearer, oxygen-rich waters for successful foraging.

Nutrient levels, particularly nitrates and phosphates, were found to be elevated during the monsoon months due to runoff from surrounding agricultural fields. This nutrient influx led to increased algal growth, reduced water clarity, and in some cases, localized eutrophication.

Consequently, there was a noticeable shift in the bird community during this period, with a rise in generalist and omnivorous species (e.g., mynas, crows) and a decline in sensitive species such as herons and dabbling ducks. This transition supports the role of avian species as ecological sentinels that reflect the trophic dynamics of wetlands.

Behavioral observations further enriched our understanding of habitat use. Wading birds like egrets and herons were seen exploiting shallow zones during the post-monsoon period, while migratory ducks preferred open waters with moderate nutrient levels in winter. Nesting behaviors of species like cattle egrets and lapwings indicated the importance of undisturbed vegetation near the wetland margins, emphasizing the need for habitat preservation. Flocking behavior among migratory birds such as bar-headed geese and red-crested pochards also suggested that these species respond collectively to environmental cues such as water depth, food distribution, and human disturbance.

The role of avifauna as indicators of water pollution was particularly evident during the summer and monsoon months when BOD and COD levels peaked. These parameters were often accompanied by reduced bird activity in central zones and increased use of peripheral areas with vegetative cover. The shift in avian distribution away from nutrient-polluted zones indicates not only the birds' adaptability but also their avoidance of degraded habitat conditions, thus serving as a direct ecological feedback mechanism. Moreover, the presence of migratory species highlights the international ecological connectivity of wetlands like Govindgarh. These birds rely on a network of healthy wetlands for survival during their annual migrations. Their arrival and residence during winter underscore the wetland's importance as a stopover or wintering ground. Any decline in water quality could disrupt these migratory patterns, with implications extending beyond local conservation concerns.

The seasonal nature of wetland fluctuations further complicates management strategies. For example, higher evaporation rates in summer concentrate pollutants, while monsoon inflows dilute water but increase runoff-related contamination. This variability calls for continuous monitoring using indicator species, rather than relying solely on sporadic chemical testing. Birds can offer year-round bioassessment, especially when monitored in tandem with environmental parameters. The study reinforces the concept that conservation of wetlands must extend beyond physical protection and address the broader watershed-level activities. Agricultural practices, deforestation, waste disposal, and urban encroachment all influence water quality and, by extension, birdlife. Any effective conservation plan must integrate community awareness, sustainable agriculture, and participatory wetland management.

The diversity, behavior, and habitat selection of birds at Govindgarh Wetland closely mirrored the physico-chemical health of the ecosystem. Avian indicator species proved to be not only useful tools for ecological assessment but also essential for early detection of environmental degradation. Continued and systematic monitoring of avian fauna can offer a cost-effective, ecologically sound approach to wetland conservation and biodiversity management.

CONCLUSION:

The present study demonstrates that avian indicator species are effective tools for assessing the ecological health and trophic status of the Govindgarh Wetland. The diversity and behavioral patterns of bird species observed over the annual cycle closely mirrored seasonal changes in the wetland's physico-chemical parameters, such as dissolved oxygen, nutrient concentrations, and temperature fluctuations. These birds responded predictably to habitat quality, with sensitive species declining in periods of low oxygen or high pollution, and generalist species increasing in nutrient-enriched or disturbed environments. Govindgarh Wetland supports a variety of resident and migratory avifauna, indicating its importance as both a permanent habitat and a seasonal refuge in the Central Indian landscape. This ecological role, however, is under increasing pressure from anthropogenic influences like agricultural runoff, habitat encroachment, and unmanaged tourism. The detection of eutrophication symptoms during monsoon months and fluctuating water quality throughout the year highlights the wetland's vulnerability. Thus, birds not only serve as bioindicators of water quality and trophic status

but also act as early-warning systems for environmental change. Their presence, behavior, and diversity offer a dynamic, accessible, and cost-effective method for long-term ecological monitoring. Conservation and management strategies must incorporate avian monitoring programs, improve community participation, and enforce sustainable watershed practices to ensure the continued ecological integrity of the Govindgarh Wetland.

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