



Impact of Habitat Degradation on Migratory and Resident Bird Species in Keoladeo National Park, Rajasthan, India

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Abstract

Keoladeo National Park, Rajasthan, India, is a globally important wetland ecosystem supporting diverse migratory and resident bird species. Recognized as a Ramsar Wetland and UNESCO World Heritage Site, the park serves as an important wintering and stopover habitat along the Central Asian Flyway. However, increasing habitat degradation caused by hydrological changes, invasive vegetation, agricultural pressure, tourism disturbance, and climate variability threatens its ecological stability. This study examines the impacts of habitat degradation on migratory and resident bird species by assessing changes in avian diversity, habitat use, and ecological responses. A mixed ecological approach integrating field observations and secondary data analysis was used to evaluate the influence of wetland degradation on bird communities. The study highlights that migratory birds are more sensitive to habitat alterations due to their dependence on seasonal wetland conditions, whereas resident species show greater adaptability but remain affected by long-term habitat changes. The findings emphasize the need for integrated conservation strategies involving hydrological restoration, invasive species management, biodiversity monitoring, and sustainable tourism practices to maintain the ecological integrity of Keoladeo National Park.

Keywords

Keoladeo National Park, wetland degradation, migratory birds, resident birds, avian diversity, Central Asian Flyway, conservation

1. INTRODUCTION

Wetlands represent some of the most productive and biologically diverse ecosystems on Earth. These transitional ecosystems between terrestrial and aquatic environments provide essential ecological services, including water regulation, nutrient cycling, flood control, carbon storage, groundwater recharge, and biodiversity conservation. Among the various organisms dependent on wetlands, birds represent one of the most visible and ecologically

significant groups because they occupy multiple trophic levels and respond rapidly to environmental changes.

Wetland ecosystems provide critical habitats for birds by offering feeding grounds, nesting sites, breeding areas, and migratory stopover locations. The availability of water, vegetation structure, food resources, and suitable nesting habitats determines the distribution and abundance of avian communities. Consequently, changes in wetland

conditions can directly influence bird population dynamics and ecological interactions.

Keoladeo National Park, formerly known as Bharatpur Bird Sanctuary, is one of India's most important wetland ecosystems. Located in Bharatpur district of Rajasthan, the park covers approximately 29 square kilometres and was designated as a Ramsar Wetland of International Importance in 1981 and a UNESCO World Heritage Site in 1985. The park represents a unique mosaic of shallow wetlands, seasonal marshes, grasslands, woodland patches, and artificial water bodies that support diverse biological communities.

The strategic location of Keoladeo National Park along the Central Asian Flyway makes it an important wintering and staging site for migratory birds travelling from Central Asia, Siberia, Mongolia, China, and other northern regions. Historically, the park supported globally significant populations of migratory waterbirds, including ducks, geese, cranes, storks, herons, and waders. Resident bird species also depend on the park's habitat complexity for breeding, feeding, and shelter.

Despite its international conservation importance, Keoladeo National Park has experienced increasing ecological pressures over recent decades. One of the most significant challenges is hydrological instability. The wetland ecosystem depends heavily on seasonal water availability from rainfall and managed water inflows. Reduction in freshwater supply, irregular flooding patterns, and prolonged dry periods have altered habitat conditions and reduced the availability of shallow water habitats required by many aquatic bird species.

Water scarcity affects wetland productivity by influencing aquatic vegetation growth, invertebrate populations, fish availability, and overall food chain stability. Since many migratory birds depend on shallow-water habitats for feeding and resting, changes in water regimes can influence their abundance, distribution, and migration behaviour.

Another major threat is the expansion of invasive plant species. Invasive vegetation such as *Prosopis juliflora* and other aggressive plant species can transform open wetland areas into terrestrial habitats. This reduces the availability of feeding and breeding habitats for water-dependent birds and modifies ecological relationships within the wetland system.

Human activities around the park also contribute to habitat degradation. Agricultural activities near the park boundaries introduce fertilizers and pesticides into surrounding environments, potentially affecting water quality and aquatic organisms. Tourism activities, although economically important, may

create disturbance through increased human presence, noise, and habitat pressure if not properly managed.

Climate variability has further intensified ecological challenges. Changes in rainfall patterns, increasing temperatures, and prolonged drought conditions influence wetland hydrology and alter ecological signals used by migratory birds. Since migration timing depends on environmental cues such as water availability and food abundance, climate-related changes may result in altered migration routes, reduced stopover duration, and declining population stability.

Migratory and resident birds respond differently to habitat degradation. Migratory species generally have narrower ecological requirements because they depend on specific habitats during seasonal movements. Any reduction in wetland quality can affect their survival and reproductive success. Resident birds may demonstrate greater adaptability because they occupy the ecosystem throughout the year; however, continuous habitat deterioration can gradually reduce their breeding success and population stability.

Previous studies on Keoladeo National Park have examined aspects of water management, bird diversity, and wetland ecology. However, limited research has simultaneously compared the effects of habitat degradation on migratory and resident bird communities within the same ecological framework. Understanding these differences is essential for developing effective conservation strategies.

Therefore, this study focuses on assessing the impact of habitat degradation on migratory and resident bird species in Keoladeo National Park. The research integrates ecological observations and environmental assessment to understand how changing habitat conditions influence avian diversity, behaviour, and population trends.

2. RESEARCH GAP

Although several studies have investigated wetland ecology, water management, and bird diversity in Keoladeo National Park, important knowledge gaps remain.

First, previous research has often focused separately on either migratory birds or resident bird communities rather than comparing their responses to habitat degradation within the same ecosystem.

Second, limited studies have combined habitat quality assessment with behavioural and population-level responses of birds. Understanding changes in feeding behaviour, nesting patterns, and habitat preference is necessary for evaluating long-term ecological impacts.

Third, although hydrological changes and invasive species have been identified as major threats, integrated assessments linking environmental degradation with changes in avian community structure remain limited.

This study addresses these gaps by providing a comparative ecological assessment of migratory and resident bird species responses to habitat degradation in Keoladeo National Park.

3. OBJECTIVES OF THE STUDY

The main objective of this study is:

To assess the impact of habitat degradation on migratory and resident bird species in Keoladeo National Park, Rajasthan, India.

The specific objectives are:

1. To document the diversity and distribution patterns of migratory and resident bird species in Keoladeo National Park.
2. To evaluate the influence of habitat degradation factors, including water scarcity, invasive vegetation, and anthropogenic pressure, on avian communities.
3. To compare ecological responses of migratory and resident bird species under changing wetland conditions.
4. To examine changes in feeding behaviour, nesting habitat availability, and breeding success associated with habitat degradation.
5. To identify major conservation challenges affecting wetland biodiversity.
6. To recommend sustainable management strategies for conserving avian diversity in Keoladeo National Park.

4. Study Area Description

4.1 Location and Geographical Characteristics

Keoladeo National Park is located in Bharatpur district of Rajasthan, northwestern India (27°07'N–27°12'N latitude and 77°29'E–77°33'E longitude). The protected wetland covers an area of approximately 29 square kilometres and represents one of the most important managed freshwater wetlands in India.

The park was historically developed as a duck-hunting reserve by the rulers of Bharatpur and was later transformed into a protected conservation area. Due to its exceptional ecological importance, Keoladeo was declared a Ramsar Wetland of International Importance in 1981 and recognized as a UNESCO World Heritage Site in 1985.

The ecosystem consists of a complex mosaic of shallow wetlands, seasonal marshes, grasslands, woodland patches, and temporary water pools. This habitat diversity creates suitable ecological conditions for a wide range of aquatic and terrestrial organisms, particularly birds.

4.2 Climate and Hydrological Characteristics

The region experiences a semi-arid climate characterized by hot summers, moderate winters, and seasonal monsoon rainfall. The annual rainfall is approximately 650–700 mm, with most precipitation occurring between July and September.

The ecological functioning of Keoladeo National Park depends strongly on seasonal water availability. Historically, water was supplied through the Ajan Bund and surrounding river systems. The timing, duration, and extent of flooding play a major role in maintaining aquatic vegetation, invertebrate populations, fish communities, and waterbird habitats.

In recent decades, reduced freshwater availability, irregular rainfall patterns, and changing water management practices have resulted in prolonged dry periods. These hydrological changes have influenced habitat quality and affected bird populations dependent on aquatic environments.

4.3 Vegetation and Habitat Structure

The vegetation of Keoladeo National Park includes aquatic plants, grasses, shrubs, and dry deciduous woodland species. The wetland supports submerged, floating, and emergent vegetation that provides food and shelter for aquatic organisms.

Important habitat components include:

- Shallow water zones used by ducks and waders for feeding
- Wet grasslands used by terrestrial birds
- Woodland areas used for nesting by resident birds
- Marsh vegetation supporting insects and aquatic food resources

However, increasing growth of invasive plant species has altered habitat structure. Expansion of terrestrial vegetation into wetland areas reduces open water availability and affects species dependent on aquatic habitats.

5. METHODOLOGY

5.1 Research Design

The study adopted a mixed ecological assessment approach combining primary field observations and secondary data analysis to evaluate the effects of habitat degradation on migratory and resident bird species in Keoladeo National Park.

5.2 Data Collection

Primary data were collected through field-based bird surveys, habitat assessment, and behavioural observations. Bird observations focused on species diversity, abundance, habitat preference, feeding activity, and nesting behaviour. Surveys were conducted during:

Study period: 2 to 4 Weeks

Number of field visits: 4

Secondary data were obtained from published literature, biodiversity reports, Ramsar records, UNESCO documents, and previous ecological studies.

5.3 Bird and Habitat Assessment

Bird surveys were conducted using point count and transect methods across different habitat zones, including wetlands, grasslands, woodland areas, and degraded sites. Habitat conditions were assessed based on water availability, vegetation characteristics, invasive species presence, and human disturbance.

5.4 Data Analysis

Species richness, abundance patterns, and diversity indices were used to evaluate avian responses. Differences between migratory and resident bird groups were assessed using descriptive and comparative statistical approaches.

6. RESULTS

The assessment revealed that habitat degradation influences both migratory and resident bird communities in Keoladeo National Park. Bird distribution and abundance varied according to habitat conditions, particularly water availability, vegetation structure, and habitat disturbance.

Migratory birds showed greater dependence on wetland habitats, with reduced water availability affecting feeding areas, resting sites, and seasonal population patterns. Resident birds demonstrated comparatively higher adaptability; however, habitat degradation affected nesting sites, food resources, and long-term population stability.

Water scarcity emerged as a major factor influencing avian diversity by reducing suitable aquatic habitats and affecting food availability. Expansion of invasive vegetation further reduced open-water areas and altered habitat structure, leading to changes in bird distribution.

Overall, degraded habitats showed lower bird activity and reduced ecological suitability compared with well-maintained wetland areas.

Table 1: Major Impacts of Habitat Degradation on Bird Communities

S. No.	Degradation Factor	Impact on Birds
1	Reduced water availability	Loss of feeding and resting habitats
2	Invasive vegetation	Reduction of open wetland areas
3	Agricultural runoff	Decline in habitat quality
4	Tourism disturbance	Behavioural changes
5	Climate variability	Altered migration and breeding patterns

The findings indicate that migratory species are more sensitive indicators of wetland degradation, while resident species experience gradual ecological stress under prolonged habitat changes.

7. DISCUSSION

The results demonstrate that habitat degradation has significant ecological consequences for bird communities in Keoladeo National Park. Changes in hydrological conditions, vegetation structure, and human pressure influence both migratory and resident species, although their responses differ considerably.

7.1 Impact on Migratory Birds

Migratory birds are highly dependent on predictable wetland conditions during seasonal movements. The availability of shallow water habitats determines feeding success, energy accumulation, and survival during migration.

Reduction in wetland area and irregular water availability can reduce suitable habitats for ducks, geese, cranes, and waders. Similar ecological patterns have been reported in other Asian wetlands

where hydrological disturbance has resulted in declining migratory bird populations.

The decline of suitable stopover habitats may also force migratory birds to modify traditional migration routes and increase dependence on alternative wetlands.

7.2 Impact on Resident Birds

Resident birds demonstrate greater ecological flexibility because they occupy the habitat throughout the year. Species such as herons, egrets, and woodland birds can tolerate moderate environmental changes.

However, long-term degradation affects:

- Nesting tree availability
- Food resource availability
- Breeding success
- Habitat connectivity

Therefore, even adaptable resident species may experience gradual population stress if habitat quality continues to decline.

7.3 Role of Hydrological Changes

Water management remains the most important factor controlling ecological conditions in Keoladeo National Park.

Adequate flooding maintains:

- Aquatic vegetation
- Fish populations
- Invertebrate communities
- Feeding habitats

Reduced water supply leads to habitat transformation from wetland systems into terrestrial landscapes, reducing biodiversity.

7.4 Influence of Invasive Species

Invasive vegetation represents another major ecological challenge.

The expansion of invasive plants reduces:

- Open water availability
- Bird feeding zones
- Nesting opportunities

Effective invasive species management is therefore necessary to maintain wetland habitat diversity.

7.5 Climate Change and Future Risks

Climate variability is expected to increase pressure on wetland ecosystems.

Changes in:

- Rainfall timing
- Temperature patterns
- Drought frequency

may influence migration timing and breeding success.

Adaptive conservation planning is essential to maintain ecological resilience.

7.6 Overall Ecological Implications

The study indicates that habitat degradation produces cascading ecological effects:

**Habitat degradation → Reduced water availability
→ Lower food resources → Reduced bird abundance
→ Altered ecological balance**

Maintaining wetland integrity is therefore essential not only for bird conservation but also for preserving ecosystem functions.

8. Conservation Challenges in Keoladeo National Park

Despite its international conservation status, Keoladeo National Park continues to face multiple ecological challenges that threaten its long-term biodiversity stability. The interaction between natural and human-induced pressures has created complex management difficulties.

8.1 Hydrological Management Challenges

The availability of adequate water remains the most critical factor influencing wetland health. Reduced freshwater inflow, irregular rainfall, and changing water management practices have resulted in unstable wetland conditions.

Major concerns include:

- Declining availability of shallow-water habitats
- Shortening duration of wetland inundation
- Reduced aquatic productivity
- Increasing dryland vegetation expansion

Maintaining appropriate water regimes is essential for sustaining migratory waterbirds and aquatic biodiversity.

8.2 Invasive Species Management

The expansion of invasive plants has altered the ecological structure of Keoladeo National Park. Invasive vegetation reduces open water availability and modifies habitats required by many bird species.

Effective management requires:

- Regular monitoring of invasive plant spread
- Scientific removal methods
- Restoration of native vegetation
- Prevention of further invasion

8.3 Human Disturbance and Tourism Pressure

Tourism contributes significantly to conservation awareness and local economic development. However, uncontrolled visitor activities may disturb sensitive habitats.

Potential impacts include:

- Disturbance during breeding periods
- Noise pollution
- Habitat trampling
- Increased waste generation

Sustainable tourism management is therefore necessary to balance conservation and public access.

8.4 Agricultural and Pollution Pressure

Agricultural activities surrounding the park may introduce fertilizers, pesticides, and other pollutants into wetland systems.

These pollutants can:

- Reduce water quality
- Affect aquatic organisms
- Alter food chains
- Influence bird health

Establishing effective buffer zones around the park can reduce external ecological pressures.

9. Conservation and Management Strategies

Based on the ecological assessment, the following strategies are recommended for improving biodiversity conservation in Keoladeo National Park.

9.1 Restoration of Natural Hydrological Conditions

Maintaining suitable water availability should be the primary conservation priority.

Recommended actions:

- Ensure regular freshwater supply
- Develop scientifically planned water management schedules
- Monitor water depth throughout seasons
- Restore natural flooding patterns where possible

A stable hydrological regime will improve habitat suitability for migratory and resident bird species.

9.2 Integrated Invasive Species Control

Management of invasive vegetation should include:

- Periodic removal of invasive plants
- Restoration of native wetland vegetation
- Long-term vegetation monitoring
- Prevention of new invasive species introduction

9.3 Biodiversity Monitoring Programs

Long-term monitoring should be strengthened using:

- Regular bird census programs
- GIS-based habitat mapping
- Remote sensing analysis
- Automated biodiversity monitoring tools

Continuous ecological data collection will help identify population trends and conservation priorities.

9.4 Sustainable Tourism Management

Tourism activities should be regulated through:

- Controlled visitor numbers
- Designated tourism routes
- Awareness programs
- Restrictions near breeding areas

Conservation education can encourage visitors to participate in biodiversity protection.

9.5 Community Participation

Local communities should be involved through:

- Environmental awareness programs
- Conservation employment opportunities
- Sustainable resource management initiatives

Community involvement increases long-term conservation success.

10. CONCLUSION

Keoladeo National Park represents one of India's most valuable wetland ecosystems and provides essential habitat for both migratory and resident bird species. However, increasing habitat degradation caused by hydrological instability, invasive vegetation, pollution, human disturbance, and climate variability threatens its ecological integrity. This study highlights that migratory birds are particularly vulnerable to wetland degradation because they depend on specific seasonal habitat conditions for feeding, resting, and survival during migration. Resident birds demonstrate comparatively greater adaptability, but continuous habitat deterioration may gradually affect their breeding success, food availability, and population stability.

The conservation of Keoladeo National Park requires an integrated approach combining effective water management, invasive species control, habitat restoration, biodiversity monitoring, and sustainable tourism practices. Maintaining ecological

connectivity and wetland functionality is essential for conserving avian diversity and ensuring the continued ecological services provided by this internationally important ecosystem.

Future research should focus on long-term population monitoring, climate change impacts, remote sensing-based habitat assessment, and adaptive management strategies to strengthen conservation planning.

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