

Assessment of Biodiversity and Conservation Status of Endangered Faunal Species in Keoladeo National Park, Rajasthan, India: Ecological Significance, Threats and Conservation Strategies

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Abstract

Keoladeo National Park (KNP), situated in Bharatpur, Rajasthan, is one of India's most significant wetland ecosystems and an internationally important site for the conservation of resident and migratory fauna. The park is recognized as a UNESCO World Heritage Site and Ramsar wetland and occupies a strategic position along the Central Asian Flyway. Despite covering only 2,873 ha, it supports an exceptionally rich assemblage of birds, fishes, reptiles, mammals, butterflies, dragonflies and other aquatic organisms. This review-based study assesses the faunal biodiversity of KNP, with particular emphasis on globally threatened species and the ecological processes supporting them. Published literature, official conservation reports, UNESCO and IUCN documents, Wildlife Institute of India information and current species assessments were synthesized. The park supports approximately 375 recorded bird species, including numerous raptors and wetland-dependent species, while 58 fish species, 71 butterfly species and more than 30 dragonfly species have also been documented. Threatened fauna associated with the park include the Critically Endangered Siberian Crane, White-rumped Vulture, Indian Vulture and Red-headed Vulture, as well as Endangered species such as the Egyptian Vulture, Steppe Eagle, Pallas's Fish Eagle, Indian Skimmer and Black-bellied Tern. Major conservation challenges include uncertain water availability, altered hydrology, invasive alien species, habitat succession, pollution risks, regional land-use change and broader threats along migratory routes. Conservation priorities should therefore integrate hydrological security, adaptive habitat management, invasive-species control, long-term population monitoring, satellite-wetland conservation and community participation. Keoladeo demonstrates that conserving a managed wetland requires ecosystem-scale interventions extending beyond protected-area boundaries.

Keywords: Keoladeo National Park, Biodiversity, Endangered Species, Wetlands, Migratory Birds, Conservation, Rajasthan, Central Asian Flyway.

Introduction

Wetlands are among the most productive ecosystems on Earth because they support complex food webs, regulate hydrological processes and provide breeding, feeding and resting habitats for large numbers of aquatic and terrestrial species. Their biological importance becomes particularly pronounced when they lie along major migratory pathways. Keoladeo National Park in Bharatpur, Rajasthan, represents one such ecosystem. Formerly known as Bharatpur Bird Sanctuary, the park developed from a natural depression whose hydrology was intensively managed, eventually producing a mosaic of

shallow wetlands, grasslands, woodland swamps, scrub and dry woodland. It was inscribed on the UNESCO World Heritage List in 1985 under criterion (x), reflecting its exceptional importance for biodiversity conservation (UNESCO World Heritage Centre, n.d.).

The ecological importance of KNP is disproportionate to its relatively small area of 28.73 km². UNESCO records approximately 375 bird species, around 115 of which breed within the park. The site is particularly important for colonial nesting waterbirds and has historically supported spectacular heronries of storks, cormorants, herons, spoonbills and ibises. Forty-two species of raptors have also been recorded, demonstrating the ecological complexity and productive trophic structure of the area (UNESCO World Heritage Centre, n.d.).

The park's position along the Central Asian Flyway gives it international significance. Migratory ducks, geese, waders, raptors and other birds use South Asian wetlands as wintering, stopover or feeding habitats. Keoladeo was historically famous as the Indian wintering site of the western/central population of the Siberian Crane (*Leucogeranus leucogeranus*). However, official conservation reporting indicates that the species has not returned since the winter of 2001–2002 (Rajasthan Forest Department, 2024). Its disappearance illustrates how protection of a wintering site alone cannot guarantee survival of a long-distance migrant when threats occur elsewhere along its international migration route.

Keoladeo therefore provides a valuable case study of biodiversity conservation in a semi-arid, heavily human-modified landscape. The present paper assesses its faunal diversity, examines the status and ecological significance of selected threatened species, identifies major environmental pressures and proposes integrated conservation strategies.

Study Area Description

Keoladeo National Park is located near Bharatpur in eastern Rajasthan, approximately 50 km west of Agra. The protected property covers 2,873 ha and is completely enclosed by a boundary wall. Its landscape includes permanent and seasonal wetlands, open grasslands, woodland, savanna, scrub, woodland swamps and elevated dry areas. Such small-scale habitat heterogeneity permits aquatic birds, raptors, reptiles, fishes, herbivorous mammals and numerous invertebrates to coexist (UNESCO World Heritage Centre, n.d.).

Unlike many naturally self-regulating wetlands, Keoladeo depends substantially on managed water delivery. Dykes, sluices and compartments allow managers to establish different water depths suitable for different ecological communities. Historically, water was supplied primarily from the Ajan Bandh system. Consequently, biodiversity within the park is closely connected to rainfall, upstream water allocation and active hydrological management (UNESCO World Heritage Centre, 2023).

This characteristic represents both an ecological strength and a vulnerability. When adequate water is supplied at appropriate times, shallow marshes provide extensive feeding habitats for waterfowl, fish-eating birds and waders, while inundated trees provide nesting sites for colonial waterbirds. When water supply is delayed or inadequate, wetland areas contract, vegetation succession accelerates and feeding and breeding opportunities decline.

Materials and Methods

The present assessment followed a review and secondary-data synthesis approach rather than primary field sampling. Information was compiled from peer-reviewed scientific literature, management-related studies, UNESCO World Heritage documentation, IUCN monitoring reports, Wildlife Institute of India resources, BirdLife International species assessments and published biodiversity records.

Data were organized into four analytical categories: (1) overall faunal diversity; (2) occurrence and conservation status of selected globally threatened species; (3) ecological pressures influencing populations and habitats; and (4) conservation interventions.

Threat categories were interpreted according to the IUCN Red List framework, with emphasis on Critically Endangered (CR), Endangered (EN) and Vulnerable (VU) taxa. Particular attention was given to birds because avifauna constitutes the principal Outstanding Universal Value for which Keoladeo is internationally recognized. However, fishes, mammals, reptiles, amphibians and invertebrates were also considered because these organisms support wetland food-web functioning.

The methodology has an important limitation: recorded species richness does not necessarily represent current abundance or recent confirmed occupancy. Historical checklists may include species that have become irregular, extremely scarce or locally absent. Consequently, presence records and current conservation status were interpreted separately wherever possible.

Biodiversity Assessment

• Avifaunal Diversity

Bird diversity represents Keoladeo's most prominent biological characteristic. UNESCO reports approximately 375 recorded species and around 115 breeding species. The park's assemblage includes ducks, geese, pelicans, coots, cranes, rails, storks, herons, ibises, spoonbills, terns, waders and numerous birds of prey (UNESCO World Heritage Centre, n.d.).

Colonial nesting waterbirds are particularly important. During years of favourable flooding, large mixed-species breeding colonies develop in inundated vegetation. UNESCO documentation notes that more than 20,000 birds may nest during well-flooded years (UNESCO World Heritage Centre, 2023). Painted Stork (*Mycteria leucocephala*), Asian Openbill (*Anastomus oscitans*), Oriental Darter (*Anhinga melanogaster*) and several species of herons, egrets, cormorants and ibises contribute to these breeding assemblages (Wildlife Institute of India, 2025).

Raptors form another notable component. The occurrence of eagles, vultures, harriers, kites, falcons and owls reflects the availability of fish, waterbirds, small mammals, reptiles, carrion and other prey. The park has historically been an important location for ecological research on raptor communities.

• Fish and Aquatic Fauna

Fish communities form a fundamental link between wetland productivity and piscivorous birds. The Wildlife Institute of India reports approximately 58 fish species from the park (Wildlife Institute of India, 2025). Seasonal flooding influences fish recruitment and availability, which in turn affects feeding opportunities for storks, pelicans, cormorants, darters, kingfishers and fish-eating raptors.

Aquatic macroinvertebrates, zooplankton, molluscs and insects provide additional trophic resources for fish, amphibians and birds. Although they receive less conservation attention than birds, these organisms are essential for nutrient cycling and energy transfer within the wetland ecosystem.

• Mammals, Reptiles and Invertebrates

Terrestrial and semi-aquatic habitats support mammals such as nilgai, spotted deer, sambar, wild boar, jackal, mongoose and smaller mammalian species. Indian rock pythons also occur within the park and use its burrows, grasslands and woodland habitats. Long-term ecological observations have indicated substantial populations of major herbivores, which can influence vegetation structure through browsing and grazing (Wildlife Institute of India, 2025).

Invertebrate diversity is also considerable. Approximately 71 butterfly species and more than 30 dragonfly species have been documented (Wildlife Institute of India, 2025). Dragonflies are particularly relevant to wetland ecological assessment because their life cycles link aquatic larval habitats with terrestrial adult environments.

Results and Discussion

The synthesis demonstrates that Keoladeo's exceptional biodiversity is primarily a product of habitat heterogeneity combined with controlled hydrology. Its biological value cannot therefore be evaluated simply by counting species. Ecological functionality depends on the simultaneous availability of shallow water, deeper pools, exposed mudflats, nesting trees, grasslands and dry refuges.

Waterbird abundance provides one of the clearest indicators of this relationship. In the 2024 State Party report to UNESCO, approximately 570 million cubic feet (mcft) of water was reported as having entered the park from the Gambhir River and Ajan Bandh, exceeding the historically identified requirement of about 550 mcft. More than 1,500 Painted Storks reportedly arrived and nested during that period, illustrating the close relationship between water availability, food production and breeding response (Rajasthan Forest Department, 2024).

Nevertheless, a single favourable hydrological year does not resolve the underlying structural problem. The 2023 IUCN Reactive Monitoring Mission emphasized that adequate water supply, invasive species, ecological monitoring and the decline or disappearance of important bird populations remain major management concerns (UNESCO World Heritage Centre, 2023). The central conservation issue is therefore the reliability, timing and quality of water rather than simply the annual total.

Another important result concerns spatial scale. Keoladeo cannot function as an isolated ecological island. Migratory birds move between the park, surrounding satellite wetlands and distant sites across Asia. UNESCO recognizes conservation efforts involving 27 satellite wetlands around the property

(UNESCO World Heritage Centre, n.d.). Such wetlands can provide alternative feeding and resting habitats during drought, high disturbance or unsuitable water conditions within the park itself.

The disappearance of the Siberian Crane provides an especially important conservation lesson. Management within KNP may preserve suitable habitat, yet species undertaking transcontinental migrations are exposed to wetland loss, hunting, infrastructure, pollution and other pressures along entire flyways. The absence of Siberian Cranes from Keoladeo since 2001–2002 therefore demonstrates the limits of strictly site-based conservation (Rajasthan Forest Department, 2024).

Conservation Status of Threatened Faunal Species

Several globally threatened species have historical or current associations with Keoladeo. Their conservation status and ecological significance are summarized below.

Species	Scientific name	IUCN category	Significance in Keoladeo
Siberian Crane	<i>Leucogeranus leucogeranus</i>	Critically Endangered	Historical winter visitor; absent since 2001–02
White-rumped Vulture	<i>Gyps bengalensis</i>	Critically Endangered	Historically recorded scavenging raptor
Indian Vulture	<i>Gyps indicus</i>	Critically Endangered	Recorded in regional and park raptor assemblages
Red-headed Vulture	<i>Sarcogyps calvus</i>	Critically Endangered	Rare scavenging raptor associated with park records
Egyptian Vulture	<i>Neophron percnopterus</i>	Endangered	Recorded vulture dependent on safe feeding landscapes
Steppe Eagle	<i>Aquila nipalensis</i>	Endangered	Migratory and wintering raptor
Pallas's Fish Eagle	<i>Haliaeetus leucoryphus</i>	Endangered	Former breeder; now much more irregular
Indian Skimmer	<i>Rynchops albicollis</i>	Endangered	Wetland-dependent species recorded in the region
Black-bellied Tern	<i>Sterna acuticauda</i>	Endangered	Scarce wetland and riverine bird

Current international assessments classify the White-rumped Vulture, Indian Vulture and Red-headed Vulture as Critically Endangered following severe population declines in South Asia, while the Egyptian Vulture remains Endangered. The Steppe Eagle is also globally Endangered. These classifications emphasize the importance of safe feeding areas, reduction of toxic veterinary-drug exposure and protection of wintering habitats across the wider landscape (BirdLife International, n.d.).

Pallas's Fish Eagle provides an example of declining habitat use. Historical information indicates that the Keoladeo–Ajan Bandh landscape once supported breeding pairs, whereas the species subsequently became an occasional winter visitor. Wetland loss, degradation, disturbance and changes in prey availability remain significant threats across its range (BirdLife International, n.d.).

Indian Skimmer and Black-bellied Tern are also globally Endangered. Their conservation requirements extend beyond KNP because both depend heavily on functioning riverine and wetland landscapes. Protection of breeding islands, open shorelines, low-disturbance feeding areas and river flows is therefore essential at a larger geographic scale (BirdLife International, n.d.).

The Siberian Crane remains Critically Endangered globally, but its importance in the Keoladeo context is now principally historical and conservation-symbolic. Official management documentation explicitly acknowledges that Siberian Cranes no longer visit the park (Rajasthan Forest Department, 2024).

Major Ecological Threats

• Water Scarcity and Altered Hydrology

Water security is the most fundamental ecological issue affecting Keoladeo. UNESCO identifies both the quantity and quality of water supply as major management concerns (UNESCO World Heritage Centre, n.d.). Because much of the wetland system depends upon externally supplied water, upstream abstraction, rainfall variability and competing human demands can directly affect habitat availability.

Insufficient or poorly timed flooding reduces fish recruitment, aquatic vegetation, benthic productivity and shallow-water feeding areas. Conversely, prolonged inundation at inappropriate depths can also disadvantage certain waders and grassland species. Hydrological management must therefore reproduce a spatial and temporal mosaic rather than simply maximize water storage.

- **Invasive Alien Species**

Invasive plants represent another major threat. *Prosopis juliflora*, water hyacinth (*Eichhornia crassipes*) and invasive grasses have been recognized as important management concerns (UNESCO World Heritage Centre, n.d.). Dense *Prosopis* stands can convert open grassland and wetland-edge habitats into woody vegetation, changing habitat suitability for birds and herbivores. Aquatic invasives may obstruct open-water habitats, influence dissolved oxygen and interfere with feeding by waterbirds.

The invasive African sharptooth catfish (*Clarias gariepinus*) has also required active removal because non-native predators can alter aquatic food webs. Wildlife Institute of India documentation records large-scale removal efforts within the park (Wildlife Institute of India, 2025).

- **Habitat Succession and Surrounding Land-use Change**

Keoladeo requires active ecological management because complete exclusion of disturbance can lead to vegetation succession. Grasslands may become scrub or woodland, and shallow wetlands may become densely vegetated. The objective should therefore be maintenance of habitat mosaics rather than uniform protection from all ecological disturbance.

Agricultural intensification and changing land use around the park may further affect hydrological flows, satellite wetlands and ecological connectivity. The absence of a conventional extensive buffer increases the importance of the formally designated Eco-Sensitive Zone and cooperation with neighbouring communities.

- **Climate Variability and Migratory-Route Threats**

Increasing climatic variability can compound water-management problems through irregular monsoon rainfall, drought and high evaporation. For migratory species, habitat loss elsewhere along the Central Asian Flyway may be equally important. Consequently, local conservation success may not translate into population recovery if breeding grounds, staging sites or other wintering habitats continue to deteriorate.

Conservation Management Strategies

- **Establish Long-Term Hydrological Security**

The highest priority should be a legally and administratively secure long-term water-allocation framework. Water requirements should be defined ecologically rather than solely volumetrically. Timing, depth, duration, quality and spatial distribution of inundation must be monitored continuously. The 2023 IUCN reactive monitoring mission specifically recommended a long-term strategic solution to the park's water supply (UNESCO World Heritage Centre, 2023).

- **Adaptive Invasive-Species Management**

Removal of *Prosopis*, water hyacinth and other invasive species should continue, but management must be followed by ecological restoration. Simply clearing invasive vegetation without restoring desired native communities can permit reinvasion. GIS-based mapping, permanent vegetation plots and repeated monitoring should therefore be integrated with removal programmes.

Recent State Party reporting indicates continued financial and physical investment in *Prosopis* removal, aquatic invasive control and grassland development (Rajasthan Forest Department, 2024). These interventions should be assessed through measurable biodiversity outcomes rather than area treated alone.

- **Strengthen Threatened-Species Monitoring**

Annual waterbird counts should be complemented by species-specific monitoring for threatened raptors, vultures, colonial nesting birds and rare waterbirds. Surveys should record abundance, breeding success, habitat use and mortality rather than simple presence or absence.

Remote sensing, GIS, camera traps, acoustic tools and standardized transects can strengthen conventional monitoring. Individual migratory birds can also be studied through satellite telemetry and colour-marking programmes, helping researchers understand connections among KNP, satellite wetlands and distant flyway sites.

- **Protect Satellite Wetlands and Landscape Connectivity**

Management should extend beyond the park boundary. The surrounding network of satellite wetlands functions as complementary habitat for migratory and resident species. Protecting these wetlands from drainage, pollution, uncontrolled development and encroachment would increase ecological resilience, particularly during years when conditions within the park are suboptimal. UNESCO has specifically recognized the importance of the 27 satellite wetlands associated with migratory-waterbird conservation (UNESCO World Heritage Centre, n.d.).

- **Community-Based Conservation**

Local communities should remain active partners in habitat restoration, invasive-species removal, ecotourism and biodiversity monitoring. Keoladeo already demonstrates an important conservation-livelihood linkage through trained local bicycle-rickshaw guides, whose low-noise transport provides employment while supporting nature-based tourism (UNESCO World Heritage Centre, n.d.).

Benefit-sharing, conservation education and participatory wetland management can reduce conflict while strengthening local stewardship. Such approaches are especially important because water allocation and land-use decisions outside the park directly influence ecological conditions within it.

- **Flyway-Scale Cooperation**

For long-distance migrants, Keoladeo's management should be linked with Central Asian Flyway conservation initiatives. International cooperation is particularly important for species such as cranes, eagles and other waterbirds whose annual cycles encompass multiple countries.

The Siberian Crane demonstrates why conservation planning must connect breeding grounds, stopover sites and wintering wetlands. Recovery of migratory populations ultimately depends on maintaining a chain of secure habitats rather than protecting individual reserves in isolation.

Conclusion

Keoladeo National Park represents one of India's most significant examples of a managed wetland supporting globally important biodiversity. Its relatively small 2,873-ha landscape sustains a complex ecological network of waterbirds, raptors, fishes, reptiles, mammals and invertebrates and occupies a critical position along the Central Asian Flyway (UNESCO World Heritage Centre, 2023).

The presence or historical occurrence of Critically Endangered and Endangered species gives the park conservation importance extending far beyond Rajasthan. However, its ecological integrity remains closely dependent on reliable water supply, appropriate habitat management and control of invasive species. The disappearance of the Siberian Crane from Keoladeo also demonstrates that protected-area management must be complemented by conservation across migratory landscapes.

Future management should prioritize scientifically determined hydrological regimes, restoration of native wetland and grassland habitats, continuous monitoring of threatened species, protection of satellite wetlands and sustained community participation. Rather than treating Keoladeo as an isolated bird sanctuary, conservation policy should recognize it as part of a larger socio-ecological wetland network. Long-term protection of this network will be essential for maintaining the ecological functions, biodiversity and Outstanding Universal Value of Keoladeo National Park.

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