



Grassland Habitat Ecology of Bengal Florican: Preferred Ecological Adaptation in Koshi Tappu Wild Life Reserve

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Abstract

This article presents an investigation into the pivotal role of ecological habitat management in the preservation of the Critically Endangered Bengal florican (*Houbaropsis bengalensis*). The study was conducted in the Koshi Tappu Wildlife Reserve and its Buffer Zone area from May 2022 to October 2023. The primary aim was to employ indigenous knowledge for the restoration of degraded grassland habitat and subsequently revive the population of the Bengal florican. Findings indicate that the grassland habitat crucial for the Bengal florican is contingent upon specific grass species, association with grazing herbivores, proximity to water bodies, availability of grains and insects for sustenance, minimal human disturbances, and a partial distribution of bushes within the grassland. This article integrates empirical data derived



from population censuses, monitoring efforts, and surveys conducted among observers and local residents within the Buffer Zone of Koshi Tappu Wildlife Reserve. The synthesis of this evidence underscores the potential for safeguarding and conserving the Bengal florican habitat to mitigate the declining population trend observed within the KTWR. This study contributes to the growing body of knowledge aimed at informing effective conservation strategies for the Bengal florican, thereby offering insights into the broader realm of endangered species management and ecological preservation.



Figure 1. Bengal florican in fly

Keywords: Bengal florican, *Houbaropsis bengalensis*, Koshi Tappu Wildlife Reserve, threatened species

Introduction

The Bengal florican (*Houbaropsis bengalensis*) (Figure 1 and 2), a critically endangered bustard species, faces significant threats to its survival within protected areas in Nepal. This majestic bird is listed as critically endangered on the IUCN Red List of Threatened Species, highlighting the urgent need for conservation efforts to protect its dwindling populations. With disjunct populations in the Tonle Sap of Cambodia and the alluvial grasslands of southern Nepal and northern India, the Bengal florican is particularly vulnerable to improper habitat management practices that have led to a loss of suitable habitats in Nepal's protected areas (Poudyal et al., 2008; Baral et al., 2013; DNPWC, 2016).

The Bengal florican is mainly found in the alluvial grasslands of the Terai region in southern Nepal and northern India, along the foothills of the Himalayas, and in the Brahmaputra plain in northeastern India. In Nepal, the species is restricted to a few lowland protected areas, with a population of fewer than 100 individuals (DNPWC, 2016). Among these areas, Koshi Tappu Wildlife Reserve is known to hold a relatively higher number of Bengal floricans, although the population within the reserve has shown fluctuations over the years.

The Bengal florican is closely associated with dry grassland habitats, preferring short grasslands for feeding and long grasslands for



Figure 2 Bengal florican in grassland



breeding. These birds establish territories in relatively open short grass areas, often within expanses of tall grass and scattered bushes. While short grasslands are ideal for foraging and displaying, the birds seek shelter in tall grass during the heat of the day, with females spending much of their time in tall grass for breeding (Inskipp & Inskipp, 1983).

Although conservation measures are in place, a robust recovery strategy is essential to simultaneously safeguard the Bengal florican and enhance the biodiversity of Nepal's vulnerable grassland ecosystems. Engaging and supporting local communities in managing grasslands to cater to their needs for cattle fodder and thatch grasses while maintaining suitable habitats for the florican and other grassland species is a critical component of such a strategy. Encouraging farmers to preserve some grassland habitats within farmlands, especially during the florican's breeding season, can help mitigate habitat loss and support conservation efforts (Baral et al., 2020).

Despite these efforts, the Bengal florican population faces ongoing challenges due to habitat degradation and human activities like ploughing and grass harvesting. There is a critical need for comprehensive research to understand the species' habitat requirements, population dynamics, and conservation needs better (Jha & Jhala 2015; Pain & Donald 2011). Efforts should focus on identifying sustainable management strategies that benefit both local communities and the long-term survival of the Bengal florican in Nepal's protected areas.

By addressing the objectives of understanding vegetation structure, environmental factors influencing habitat selection, impacts of human activities on grassland habitats, and spatial-temporal patterns of habitat use by the Bengal florican, future research can provide valuable insights for effective conservation measures. Emphasizing the importance of preserving suitable grassland habitats and strengthening community participation in conservation efforts will be crucial in ensuring the continued survival and recovery of this critically endangered species in Nepal.

Methods

Study area

The study was conducted in the Koshi Tappu Wildlife Reserve, its Buffer Zone, and adjacent private lands. Established in 1976, the Reserve spans 173 sq. km, making it Nepal's smallest wildlife reserve. It is located in the floodplains of the Sapta Koshi River in southeastern Terai and preserves the habitat of the endangered wild water buffalo (Arna). The area, including a buffer zone declared in 2004, is crucial for biodiversity, especially for aquatic and migratory bird species, making it a notable birdwatching site. Ecologically, it supports tall grasslands and plays a significant role in soil stabilization and flood control, with embankments constructed to mitigate seasonal flooding. Institutionally, it was declared a Ramsar site in 1987, highlighting its international importance as a wetland. Government conservation efforts emphasize sustainable management, balancing cultural, economic, and ecological significance to protect this unique ecosystem. The study site is divided into four blocks based on the

grassland habitat of the Bengal florican: North Block (32 sq. km), South Block (2 sq. km), East Block (34 sq. km), and West Block (106 sq. km) as explained in the Table 1 and Figure 3.

Table 1. Study site description

Site	Block	Block area (km ²)	Site area (km ²)	Remarks
Koshi Tappu Wildlife Reserve and its surrounding Area	North Block	32.00	174.00	smaller patches of Imperata grasses Elephant grass
	East Block	34.00		with a sward height of about 50cm
	West Block	106.00		grasslands with patches of young
	South Block	2.00		Saccharum and species
Total Area			174.00	



Figure 3: Study blocks set for Bengal Florican population count

Methods and tools

The methodology focused on collecting qualitative data on the habitat and conservation of the Bengal florican (*Houbaropsis bengalensis*) in the Koshi Tappu Wildlife Reserve and its buffer zone, home to approximately 80,000 people (IUCN Nepal, 2004). Given the bird’s habitat spans core and buffer areas, and public awareness is limited, ten individuals familiar with the Bengal florican were selected from each surrounding village based on recommendations from Buffer Zone User Committee members.



Data collection included a household survey of 40 households from Buffer Zone and Community Forest User Groups, comprising 30 men and 10 women. The survey provided insights into community engagement with forest resources, emphasizing gender dynamics and resource dependency. Five focus group discussions with local committees explored challenges in resource management and gathered recommendations for sustainable conservation strategies. Key informant interviews with five experts from conservation organizations, such as the National Trust for Nature Conservation and Koshi Conservation Project, helped identify causes of grassland degradation and habitat challenges.

Habitat improvement activities involved ploughing grasslands with tractors and systematically removing invasive species to support native biodiversity and restore ecological balance. An annual population census of the Bengal florican, conducted in collaboration with conservation partners, offered vital data for monitoring trends and guiding management strategies.

All qualitative data were analyzed using thematic and content analysis, which involved identifying patterns, categorizing information, and interpreting themes to understand community perspectives and conservation challenges comprehensively. This integrated approach underscores the commitment to safeguarding the Bengal florican and the biodiversity of Koshi Tappu Wildlife Reserve.

Results and Discussion

The population records from 2023 and 2024 show that Bengal florican numbers have increased in most areas, except for the East Block. This growth is evident not only in the core areas but also in buffer zones and adjacent regions. Core areas are more secure for Bengal floricans due to fewer human disturbances, whereas buffer zones and outside areas, despite showing population growth, are more exposed to human interference and habitat issues.

The distribution of Bengal floricans is influenced by several factors. Human activities such as the collection of grasses and Non-Timber Forest Products (NTFPs), feral grazing of domestic animals, the loss of biodiversity corridors and nesting areas have significantly impacted their habitats. These activities are less common in core areas, providing a safer environment for the birds. The reduction of grasslands due to agricultural expansion has led to habitat loss, making survival more challenging for the birds. Additionally, food shortages caused by habitat degradation and competition with livestock further stress the population.

This emphasizes the importance of effective conservation strategies to address these challenges and ensure the long-term survival of the Bengal Florican.

Key Habitat Features of Bengal florican

The critically endangered Bengal florican (*Houbaropsis bengalensis*) depends on the unique floodplain grasslands of the Koshi Tappu Wildlife Reserve (KTWR) and its buffer zones for survival. The Bengal florican depends on short grasslands for foraging and taller grasslands, predominantly featuring *Saccharum spontaneum* and *Imperata cylindrica*, for nesting and displaying courtship behavior. The ideal habitat combines grass heights between 50-100 cm and 60-80% vegetation cover, complemented by scattered trees and shrubs for shelter and



protection. Grazing by herbivores helps regulate grass growth, maintaining the habitat's ecological balance. Proximity to rivers and lakes is vital, as floricans favor elevated dry patches within these wetland systems, particularly during seasonal waterlogging. Avoiding heavily disturbed or intensively grazed areas, they require minimally disturbed ecosystems, where the dynamic interplay of vegetation, water, and herbivore activity ensures their survival. Table 2 presents the key habitat features of Bengal florican.

Table 2: Key Habitat Features of Bengal florican

Habitat Feature	Details	References
Preferred Grassland Composition	Short grasslands for feeding; long grasslands for breeding; <i>Saccharum-Imperata</i> assemblage	Inskipp & Inskipp (1983), Baral et al. (2013), Sundar & Kittur (2013)
Vegetation Structure	Grass height of 50-100 cm; 60-80% grass cover; scattered trees and shrubs	Current study, Baral et al. (2020)
Associated Fauna	Grazing by Wild Water Buffalo, Bluebul, and domestic buffalo; herbivore activity maintains habitat	Baral et al. (2013), Current study
Proximity to Water Bodies	Found near lakes or rivers on high, dry land	Baral et al. (2001), Current study

These findings align with global studies underscoring the critical role of intact grasslands in sustaining florican populations. Habitat fragmentation due to agricultural expansion and invasive species, such as *Mikania micrantha* in the over-storey, and *water hyacinth* in the water bodies, intensifies the decline. Effective management of these habitats requires addressing anthropogenic pressures, restoring degraded grasslands, and involving local communities in conservation efforts. Previous research (e.g., Baral et al., 2012; BirdLife International, 2021) supports such integrated approaches, emphasizing that conservation measures must prioritize long-term habitat security. Thus, safeguarding the Bengal florican's key habitats within KTWR is crucial to reversing its population decline and ensuring ecological stability in these grassland ecosystems.

Grass Species Found in Bengal florican Habitat

The Bengal florican's habitat in Koshi Tappu Wildlife Reserve is shaped by the presence of four key grass species, each playing a distinct ecological role. *Imperata cylindrica* (Cogon grass), a perennial with sharp-edged leaves and extensive rhizomes, dominates degraded grasslands, providing essential nesting cover. However, its invasive nature poses risks by suppressing native plant diversity. *Saccharum spontaneum* (Wild sugarcane), reaching 3–4 meters, stabilizes soil and regenerates rapidly in flood-prone areas, creating a preferred habitat for grassland birds. *Typha elephantina* (Elephant grass), found along wetland edges, grows up to 6 meters in height and offers critical refuge and feeding grounds near water sources, particularly during monsoons. *Casuarina sp.* (She-oak), a woody grass-like tree, enhances



habitat complexity by providing perches and improving soil fertility through nitrogen fixation. Together, these species form a dynamic and functional landscape that supports the florican's feeding, breeding, and survival needs while balancing ecosystem processes. Table 3: Grass species and their features in the Bengal florican Habitat

Table 3. Common grass species, their features and ecological significance

Scientific Name	Common Name	Features	Ecological Significance
<i>Imperata cylindrica</i>	Cogon Grass	Perennial grass with slender, erect stems up to 1.5 m tall; sharp-edged leaves; extensive rhizome system.	Dominant in degraded grasslands; provides cover and nesting sites; but can become invasive, suppressing native plant diversity.
<i>Saccharum spontaneum</i>	Wild Sugarcane	Tall perennial grass growing up to 3–4 m; lanceolate leaves; important for soil stabilization.	Preferred habitat for grassland birds; regenerates rapidly in flood-prone areas, stabilizing riverbanks.
<i>Typha elephantina</i>	Elephant Grass	Tall aquatic or semi-aquatic grass; up to 4–6 m in height; grows in wet or marshy areas.	Found in wetland edges; offers refuge and feeding ground for Bengal Florican, especially near water sources.
<i>Casuarina</i> sp.	She-Oak	Woody grass-like tree; needle-like leaves; often planted in degraded areas or used as windbreaks.	Scattered individuals provide perches; fixes nitrogen, improving soil fertility.

The Bengal florican (*Houbaropsis bengalensis*) thrives in diverse grassland habitats in Koshi Tappu Wildlife Reserve, shaped by key grass species, herbivore activity, and ecological dynamics. Rahmani (1988) outlined that *Saccharum spontaneum* and *Imperata cylindrica* dominate these habitats, offering essential cover and nesting sites. He emphasized that *Saccharum*, with its tall growth up to 4 meters, stabilizes flood-prone soils and supports florican breeding, while *Imperata* ensures grassland integrity through its dense rhizomes, though its invasiveness can suppress plant diversity. Baral et al. (2013) supported this by highlighting the role of *Typha elephantina* along wetland edges and *Casuarina* sp. in degraded areas, enhancing habitat heterogeneity by providing refuges, foraging grounds, and structural diversity.

Rahmani (1988) also detailed that moderate grazing by wild herbivores, such as wild water buffalo, blue bull, hog deer, and spotted deer, maintains grassland mosaics by preventing



overgrowth, fostering habitat heterogeneity critical for floricans. Baral et al. (2013) reinforced this, noting that grazing aligns with the florican's gender-specific preferences, where females favor shorter grasses under 50 cm for nesting, while males utilize taller grasslands for display and protection.

D'Antonio and Vitousek (1992) argued that invasive species like *Mikania micrantha*, *Ipomoea carnea*, and *Lantana camara* disrupt these ecosystems by outcompeting native grasses and reducing biodiversity. Addressing these issues holistically through herbivore management, invasive species control, and mitigation of human pressures is essential to secure the long-term viability of Bengal floricans and their grassland habitats.

Threats to Grassland Ecology

Koshi Tappu Wildlife Reserve's grasslands are severely impacted by human activities and natural stressors, jeopardizing their ecological balance. Findings indicate that agricultural encroachment, overgrazing, invasive species proliferation, and sand deposition from recurrent flooding are primary threats. Agricultural expansion, driven by increasing demand for farmland, replaces native grass species such as *Saccharum spontaneum* with crops, reducing habitat availability for the Bengal florican. Overgrazing, particularly by unmanaged livestock, leads to soil compaction and the loss of grassland structure, further degrading the ecosystem (Table 4).

Table 4: Threats to **Grassland Ecology**

Factor	Impact on Grassland Ecology	References
Feral Grazing	Depletes grass cover, leading to habitat degradation	Baral et al. (2013), Current study
Habitat Fragmentation	Reduces connectivity between grassland patches	Current study
Lack of Management	Absence of systematic mowing or removal of invasive species hampers grassland restoration	Pain & Donald, 2011; Jha & Jhala, 2015)." Current study
Deforestation	Loss of tree and shrub cover, further degrading grassland quality	Current study
Forest fire	Destroys biodiversity and promotes invasive species	Baral et al. (2013), Current study

Invasive species such as *Mikania micrantha* and *Parthenium hysterophorus* outcompete native flora, disrupting ecological balance and reducing suitable nesting and foraging habitats for the Bengal florican. Recurrent flooding further exacerbates habitat degradation by depositing sand, transforming fertile grasslands into barren patches and complicating restoration efforts.

Uncontrolled grazing by domestic and feral animals depletes grass cover and intensifies competition with wild herbivores essential for maintaining grassland ecosystems (Baral et al., 2013; Narwade et al., 2018; Sankaran, 1996). Habitat fragmentation due to human settlements and agricultural expansion disrupts connectivity between grassland patches, limiting the



movement and distribution of Bengal floricans (Karki & Upadhyaya (2014), Thakuri & Poudel (2020). Additionally, insufficient management practices such as mowing and invasive species control hinder grassland restoration. Fire mismanagement—whether uncontrolled burning or land clearing—destroys biodiversity and facilitates the spread of invasive species (Donald et al., 2013). Deforestation and the removal of scattered trees and shrubs further degrade structural diversity critical for florican nesting and breeding.

The decline in grassland quality adversely impacts biodiversity and ecosystem services like carbon sequestration and water regulation. Studies (Baral et al., 2012; BirdLife International, 2021) highlight how invasive species and human interventions render habitats unsuitable for specialist species (Table 5). A combined approach emphasizing habitat restoration, invasive species management, and sustainable land-use practices is vital for conserving grassland ecosystems in KTWR.

Table 5 Threats to Bengal florican Habitat

Threat	Impact on Habitat	References
Grassland Fires	Destruction of habitat, loss of nests and young	Baral et al. (2013), Current study
Human Activities	Deforestation, grass cutting, and pesticide use degrades habitat	Poudyal et al. (2008), Current study
Stray Livestock Grazing, and predators	Reduces suitable breeding grounds, and young are predated	Baral et al. (2013), Current study
Invasive Species	Spread of <i>Mikania micrantha</i> , <i>Ipomoea carnea</i> , and <i>Lantana camara</i> impacts grasslands	Current study
Elusive nature	Preference of open grassland, coming out early in the morning for feeding, and breeding makes poachers easily to identify its presence	Current study
Ground nesting	susceptible to disturbances and habitat degradation	Current study

Factors effecting the distribution of Bengal florican population

The Bengal Florican (*Houbaropsis bengalensis*), critically endangered, shows a population increase in the core area of Koshi Tappu Wildlife Reserve (KTWR) due to minimal human disturbance, well-maintained grasslands, and effective management practices. Core areas provide secure habitats with controlled grazing and invasive species management (Table 6). In contrast, buffer zones face challenges from human encroachment, overgrazing by feral cattle, and grassland degradation due to invasive species like *Mikania micrantha* and water bodies by *Water Hyacinth*. Outside areas are severely impacted by urbanization, agricultural expansion, and predation risks. Flooding and climate change further disrupt grassland habitats, impacting breeding cycles. Conservation strategies should focus on grassland restoration, sustainable



grazing practices, and community involvement in buffer zones. Monitoring and enforcing habitat protection, especially in degraded areas, are vital for long-term survival and population stability of the Bengal florican in KTWR.

Table 6: Bengal Florican Population and sighted sites 2023/2024

Study blocks	Bengal florican Population		Area Differentiation		
	2023	2024	Core Area (in 2023/2024)	Buffer Zone Area (in 2023/2024)	Outside Reserve (in 2023/2024)
North Block	5	6		2/0	3 /6
East Block	10	6	10/6	0/0	
West Block	7	11	5/11	2/0	2
South Block	0	2	0/4	0/5	
Total	15	32	15/21	4/5	5/6

Grassland ecosystems are critical for the survival of the Bengal florican (*Houbaropsis bengalensis*), providing essential habitats for feeding, nesting, and breeding. However, these ecosystems face significant threats such as habitat loss due to agricultural conversion (DNPWC, 2016), unsustainable agricultural practices, overgrazing, and human settlements (Bengal florican Project, n.d.). Climate change affects grassland productivity and species composition (DNPWC, 2024), while invasive species disrupt the native ecosystem (ResearchGate, 2023). Changes in fire regimes can alter grassland structure (Science, 2023). Degradation factors include soil nutrient loss and organic matter depletion due to intensive agriculture (DNPWC, 2024), changes in water availability (DNPWC, 2024), and a reduction in biodiversity due to habitat degradation (DNPWC, 2016). These issues significantly impact the Bengal florican and its habitat.

Comeback of Bengal florican Population

The 15-30% revival of the Bengal florican population in Koshi Tappu Wildlife Reserve from 2017 to 2021 (Table 7 and Figure 4) showcases the success of collaborative conservation efforts, driven by effective habitat management and strong community engagement. However, sustaining this recovery remains challenging due to ongoing threats like habitat degradation, invasive species, climate change, and human-wildlife conflict. Ensuring long-term success will require sustained multi-stakeholder collaboration, adaptive strategies, and dedicated funding. While the progress is encouraging, maintaining it demands continuous vigilance and innovative solutions.

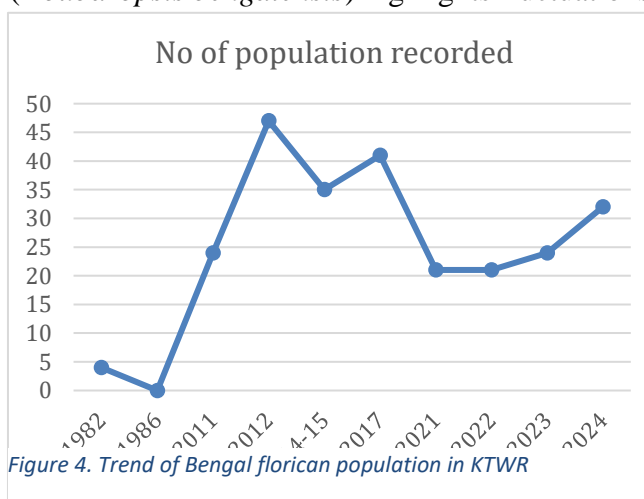
Table 7: Bengal Florican Population Surveys in Koshi Tappu Wildlife Reserve and Surrounding Areas

Year	Survey Organization	Survey Area	Number of Individuals	Reference
1982	-	KTWR	4	Inskipp & Inskipp (1991)



1986	-	KTWR	0	Inskipp & Inskipp (1991)
2011	Baral et al.	KTWR and surrounding grasslands	~12 pairs (24 individuals)	Baral et al. (2013)
2012	Baral et al.	KTWR and surrounding grasslands	47	Baral et al. (2013)
2014-2015	Bird Conservation Nepal (BCN)	KTWR and surrounding grasslands	35	BCN (2014; 2015)
2017	Baral et al.	KTWR and surrounding grasslands	41	Baral et al. (2020)
2021	Bird Conservation Nepal (BCN)	KTWR and surrounding regions (Sunsari, Saptari, Udayapur)	21	BCN (2021)
2022	NTNC, KTWR, Koshi Bird Society, Pokhara Bird Society, Himalayan Nature, BCCN, Army	KTWR and surrounding regions (Sunsari, Saptari, Udayapur)	21	NTNC (2022)
2023	NTNC, KTWR, Koshi Bird Society, Bird Society, Himalayan Nature, BCCN, Army	KTWR and surrounding regions (Sunsari, Saptari, Udayapur)	24	NTNC (2023)
2024	NTNC, KTWR, Koshi Bird Society, Bird Society, Himalayan Nature, BCCN, Army	KTWR and surrounding regions (Sunsari, Saptari, Udayapur)	32	NTNC (2024)

The population trend of the Bengal florican (*Houbaropsis bengalensis*) highlights fluctuations that reflect both conservation successes and ongoing challenges. Based on studies, the initial survey in 1982 recorded just four individuals in KTWR, with no sightings by 1986, indicating a severe decline (Inskipp & Inskipp, 1991). However, by 2011 and 2012, there was a notable resurgence, with populations rising to approximately 47 individuals (Baral et al., 2013), suggesting effective conservation measures and increased





survey efforts. Subsequent studies in 2014-2015 showed a slight decline to 35 individuals (BCN), which then increased to 41 in 2017 (Baral et al., 2020). Yet, a significant drop to 21 individuals in 2021 pointed to habitat degradation or other pressures (BCN). Collaborative surveys in 2022, 2023, and 2024 consistently estimated populations around 21-24 individuals, covering larger areas including Sunsari, Saptari, and Udayapur districts (NTNC et al.). Supported by these studies, this trend underscores the importance of ongoing habitat improvement efforts, such as controlling invasive species, managing fire regimes, and promoting sustainable agricultural practices, to stabilize and enhance the Bengal florican population.

Conclusion

The Bengal florican (*Houbaropsis bengalensis*), a critically endangered species, faces an alarming risk of extinction due to habitat loss, human activities, and insufficient conservation measures. This study highlights the importance of adopting a multifaceted approach to grassland conservation that integrates ecological needs with socio-economic considerations. Effective conservation strategies include improved fire management, targeted control of invasive species, sustainable grazing practices, and community involvement ((Baral et al., 2013; Rahmani, 2016). Implementing controlled burns and monitoring systems can prevent accidental fires that often devastate nesting areas. Simultaneously, restoring native grass species through the removal of invasive plants is essential to maintaining a suitable habitat for the florican. Engaging local communities in adopting sustainable practices, such as regulated grazing and responsible grass collection during the breeding season, is vital for long-term success.

Policy interventions, including the expansion of buffer zones and the inclusion of critical habitats outside protected areas, are key to mitigating habitat fragmentation. Achieving this requires strong collaboration among local stakeholders, conservation organizations, and government agencies.

Direct measures to safeguard the species, such as protecting nesting sites, implementing anti-poaching programs, and restoring degraded habitats, are critical for population recovery. Restricting uncontrolled cattle grazing and minimizing human intrusion into sensitive areas are also necessary to preserve the integrity of their environment. Local initiatives, such as reducing pesticide use and preventing indiscriminate burning, further contribute to maintaining a healthy grassland ecosystem.

Adopting these measures can foster the recovery of Bengal florican populations and bolster the ecological integrity of grassland habitats. The conservation of this iconic species serves as a barometer for sustainable grassland management and offers a model for protecting other at-risk species globally. This holistic framework bridges the gap between ecological preservation and community well-being, demonstrating the interconnected nature of biodiversity conservation.



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