BUSTARD FLORICAN PROGRAM STATUS REPORT

2026

BNHS INDIA CONSERVING NATURE SINCE 1883

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Disclaimer

- **Since the distribution areas of the Great Indian Bustard and the Lesser Florican overlap in Rajasthan, Gujarat, Maharashtra, Karnataka, and Andhra Pradesh, we have combined the sections for these two species in this report. In contrast, the Bengal Florican, which is found in the wet grasslands of the Northeast, has been placed in a separate section.**
- **While general methods are provided, more detailed information regarding the surveys and results is included in the site-specific sections.**
- **The maps included in this report are for illustrative purposes only and do not represent the Bombay Natural History Society's opinion on boundary delineation. These maps should be regarded as illustrative, and the borders are neither verified nor accurate.**
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Back cover – A Great Indian Bustard at the backdrop of the BNHS base camp at Khetolai – Tarkik verma

In Report - To the respective photographers

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Purpose of the Report

The purpose of this report is to provide a thorough and detailed review of the BNHS's extensive conservation efforts focused on the Great Indian Bustard, Lesser Florican, and Bengal Florican. This document traces the Society's pioneering initiatives that began in the 1980s, charting their evolution from foundational ecological studies to comprehensive landscape-level conservation planning that integrates multiple environmental factors and stakeholders. This report particularly emphasises the consolidated details of the various initiatives implemented since 2019 across several key landscapes, including the arid regions of Rajasthan, the diverse ecosystems of Karnataka, the agricultural landscapes of Maharashtra, and the varied habitats of North-East India. It also addresses the recently initiated conservation activities in western Madhya Pradesh and Vidarbha in Maharashtra, and mentions occasional field visits to Andhra Pradesh, highlighting the broad geographic scope of the BNHS's work.

By weaving together significant historical milestones and recent field actions into a cohesive narrative, the report seeks to underscore BNHS's long-term commitment to conserving these critically endangered grassland species. It illustrates the impact of successfully employed collaborative conservation strategies, especially in regions outside designated Protected Areas, showcasing the positive outcomes of such efforts. Additionally, this report lays the groundwork for future conservation planning, aiming to secure the survival of the Great Indian Bustard, Lesser Florican, and Bengal Florican in landscapes increasingly dominated by human activity. By documenting both achievements and ongoing challenges, it serves as a valuable resource for stakeholders engaged in conservation work and contributes to broader awareness and action to protect these unique and vulnerable avian species.

BNHS Mission: Conservation of nature, primarily biological diversity, through action based on research, education, and public awareness

BNHS Vision: Premier independent scientific organization with a broad-based constituency, excelling in conserving threatened species and habitats.

BNHS is a national conservation organisation with a mandate for environmental conservation. It has been actively involved in bustard conservation for decades and has been developing conservation strategies for grassland birds since the 1970s.

Published on the occasion of BNHS ARS 2026

11 July 2026

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Summary

BNHS's Conservation Work on Bustards and Floricans

Since the 1980s, the Bombay Natural History Society (BNHS) has been at the forefront of conservation research and action for India's three critically endangered bustards—the Great Indian Bustard (GIB), Lesser Florican (LF), and Bengal Florican (BF). Over the decades, its work has evolved from pioneering ecological studies to integrated landscape-level conservation planning, combining science, policy, community engagement, and habitat restoration.

Great Indian Bustard

BNHS has implemented a suite of conservation measures in the Deccan and Thar Deserts, focusing on habitat restoration and water security. Recent significant activities in Pokhran tehsil, Rajasthan, have focused on rejuvenating traditional water bodies, such as Nadis and Khadins, to provide essential water for wildlife and local communities. Parallel efforts have targeted the removal of the exotic invasive *Prosopis juliflora*, whose spread degraded grasslands and increased risks for native species. In partnership with the ICICI Foundation, the Indian Army, and Gram Panchayats, in the year 2025-26, BNHS restored over 1,100 hectares of land, directly benefiting nine villages around the Pokhran Field Firing Range (PFFR). These actions improved fodder availability, enhanced access to water, and created safer habitats for the GIB while strengthening ecological monitoring with the Army. Remarkably, the GIB population in the Pokhran area of Jaisalmer has shown signs of recovery, rising from 25–30 individuals in 2020 to 40–45 by 2025.

BNHS and Canine Control and Care (CCC) implemented a humane Dog ABC program in Pokhran (July 2025–April 2026), sterilising and vaccinating 1,000 dogs. CCC's trust-based model in five Thar villages used twice-daily milk feeding and cues to raise approachability to 80%. Direct handling replaced nets, with surgeries under India's 5-day ABC Rules, 2023. Complications were under 1%, with no mortality or bites reported. The project shows how food security and positive human–dog interactions stabilise free-ranging populations. Apart from wildlife killed by free-ranging dogs, the issue of roadkill has been highlighted in the Pokhran area, particularly due to the deaths of animals along two stretches: one from Dholiya to Khetolai and the other near Khara. Additionally, important power lines in the Pokhran area have been identified, with 35 km designated as high priority and 200 km as medium priority, and mapped. In 2021-2022, year-round nature education programs were implemented in ten villages of Pokhran, featuring multiple educational modules.

BNHS established four blocks of 35-ha, 28-ha, 12-ha, and 8-ha grassland reserves on Bishnoi land in Pokhran. Community partnerships have been central, with the Bishnoi community in Khetolai and Dholiya villages playing a key role. Education programs, including a one-year nature education initiative, and networks of "Godawan Mitra" (friends of GIB) have strengthened grassroots conservation. In a series of comprehensive landscape surveys

conducted across Maharashtra, Karnataka, and Andhra Pradesh, BNHS researchers documented a significant finding: only a single female Great Indian Bustard (GIB) was observed in the Gangewadi-Boramani area of Solapur district in July 2022. This solitary sighting underscores the critical status of the GIB population in the region and the ongoing conservation challenges this endangered species faces. The surveys aimed to assess the habitat and population dynamics of the GIB, emphasising the need for targeted conservation efforts to protect this iconic bird.

With the help of BirdLife International, BNHS developed an innovative tool for avian sensitivity mapping to assess the impacts of new renewable energy projects and land-use changes on threatened birds. This tool is helping protect vulnerable populations while supporting the development of sustainable energy and responsible land management. BNHS has also worked with investment banks, CSR agencies and government bodies to address threats to energy infrastructure in bustard landscapes. It guided the realignment of a power line in Solapur, Maharashtra, to protect GIB habitat.

Lesser Florican

BNHS's work on the Lesser Florican began in 2017, when the Rajasthan Forest Department requested surveys in the Shokaliya area. Joint surveys with WII, TCF, NGOs, volunteers, and the Forest Department during the breeding seasons of 2017 and 2018 recorded 30–40 males in Ajmer and surrounding landscapes, suggesting a population of 100–125 birds. These surveys confirmed the species' distribution across seven states, with Velavadar National Park in Gujarat and Shokaliya in Rajasthan emerging as strongholds.

While Velavadar benefits from protected status, Shokaliya faces intense pressures from mining and agriculture. BNHS initiated micro-level conservation planning, and its report helped the Rajasthan Government halt mining in 40 villages through the National Green Tribunal. It assisted in mapping LF sites in Ajmer and surrounding areas, which supported the declaration of a Conservation Reserve across the villages of Arwar, Goyala, and Kheeriya. Between 2021 and 2025, the BNHS conducted extensive landscape-level surveys in Rajasthan and Karnataka, including some dry wetlands in the backwaters of large water reservoirs, such as the TB Dam backwaters. These surveys aimed to identify critical grassland clusters, assess threats, and provide a scientific basis for habitat protection and restoration. In October 2022, two male lesser floricans were observed at Rollapadu Wildlife Sanctuary. Additionally, seven sightings of the lesser florican in Bidar, Karnataka, during 2021-2022 underscore the significance of this habitat across the Deccan region during the non-breeding season.

In 2025, the BNHS partnered with the Maharashtra Forest Department to conduct avifaunal studies in the Tadoba Andhari Tiger Reserve (TATR). This collaboration aimed to evaluate the impact of village rehabilitation and grassland development on local wildlife, with a particular focus on conserving the lesser florican. Additionally, BNHS started working with the Rajasthan Biodiversity Board (RSBB) to propose the lesser florican as a Biodiversity Heritage Site, emphasising the importance of protecting its unique habitat. That same year, BNHS received

support from the Madhya Pradesh Forest Department to assess the lesser florican population in western Madhya Pradesh, particularly in the Sardar Wildlife Sanctuary (WLS) and the Sailana WLS, and to develop effective conservation strategies. One lesser florican was sighted in Sailana WSL in September 2025, giving hope for conservation. Networks of “Kahrmor mitra” (friends of floricans) have strengthened grassroots conservation.

Lesser Florican records span Telangana, Maharashtra, Karnataka, and Andhra Pradesh, showing use of dry waterbodies, agriculture, plantations, open areas, and grasslands. Key reports include Osmansagar Lake (2016), Tadoba buffer (2021, female), multiple WII PTT-tagged birds in Chatrapati Sambhaji Nagar, Solapur, Vijayapura, Gadag, and Warangal (2022), Himayat Bagh (Oct 2022), Chamorshi (female, 2022), and Rollapadu WLS (Oct 2022). Together, they highlight wide distribution across landscapes, documented by field teams, trap cameras, and telemetry.

Bengal Florican

BNHS has played a pioneering role in Bengal Florican conservation, with work spanning more than four decades. In the 1980s and 1990s, it conducted foundational ecological studies in Assam and Uttar Pradesh, contributing to the first population estimates in the Brahmaputra floodplains and advising on early wildlife policies. In the 2000s, BNHS intensified research, documenting breeding ecology in Manas National Park and Dudhwa Tiger Reserve, and refining distribution maps. From 2010 to 2017, the focus of research shifted towards active conservation efforts. This period saw the implementation of satellite-transmitter studies to track and map the movements of the Bengal Florican, providing valuable data on their movement patterns and habitat use. Additionally, experiments were conducted in the Dudhwa Tiger Reserve to assess the impact of habitat restoration initiatives. These experiments aimed to understand how restoring natural environments could benefit both wildlife and ecosystems, ultimately contributing to more effective conservation strategies in the region. Due to certain constraints, systematic surveys could not be conducted, particularly on community-owned land, during 2020-2025.

During 2022-2025, BNHS launched the Brahmaputra Grassland Bird Project in Assam and Arunachal Pradesh, with support from BirdLife International and local forest departments. Occasional surveys in Manas, Orang, Kaziranga, Baghjan, and surrounding agro-pastoral landscapes assessed habitat occupancy and sightings. Community perception surveys explored socio-ecological factors, while outreach programs in schools and colleges produced illustrated handbooks in regional languages. Policy advocacy promoted habitat restoration, grazing regulation, and invasive species control. A key finding in May 2025 documented 21 Bengal Floricans, including one female, at Koklabari Agricultural Farm, underscoring its importance as a conservation priority.

Visit to Important grassland sites

To gain a comprehensive understanding of the issues affecting grassland ecosystems, a series of additional sites was occasionally visited. These locations included the Jorbeer Conservation

Reserve in Bikaner, which is known for its unique biodiversity and conservation efforts. The Sorsan grassland, located in the Baran district of Rajasthan, was visited to understand the challenges it faces. Further visits were conducted at Rollapadu Wildlife Sanctuary, which is crucial for the conservation of several endangered species, including the Great Indian Bustard (GIB) and Lesser Florican. In Maharashtra, the Solapur-Ahilyanagar region was examined to assess the effectiveness of grassland management practices. Additionally, the Sardarpur and Sailana Wildlife Sanctuaries in Madhya Pradesh were visited to document their conservation status and habitat quality. The renowned Kaziranga National Park and Manas National Park were also included in this assessment, given their significance in preserving grassland and wetland habitats. This report includes detailed briefs on these sites, highlighting the specific issues encountered and the measures taken to conserve them. A visit to Ranebennur WLS, which was one of the bustard sites and became unsuitable because of an Eucalyptus plantation, helped us understand how people have lost sight of grassland habitats over the decades.

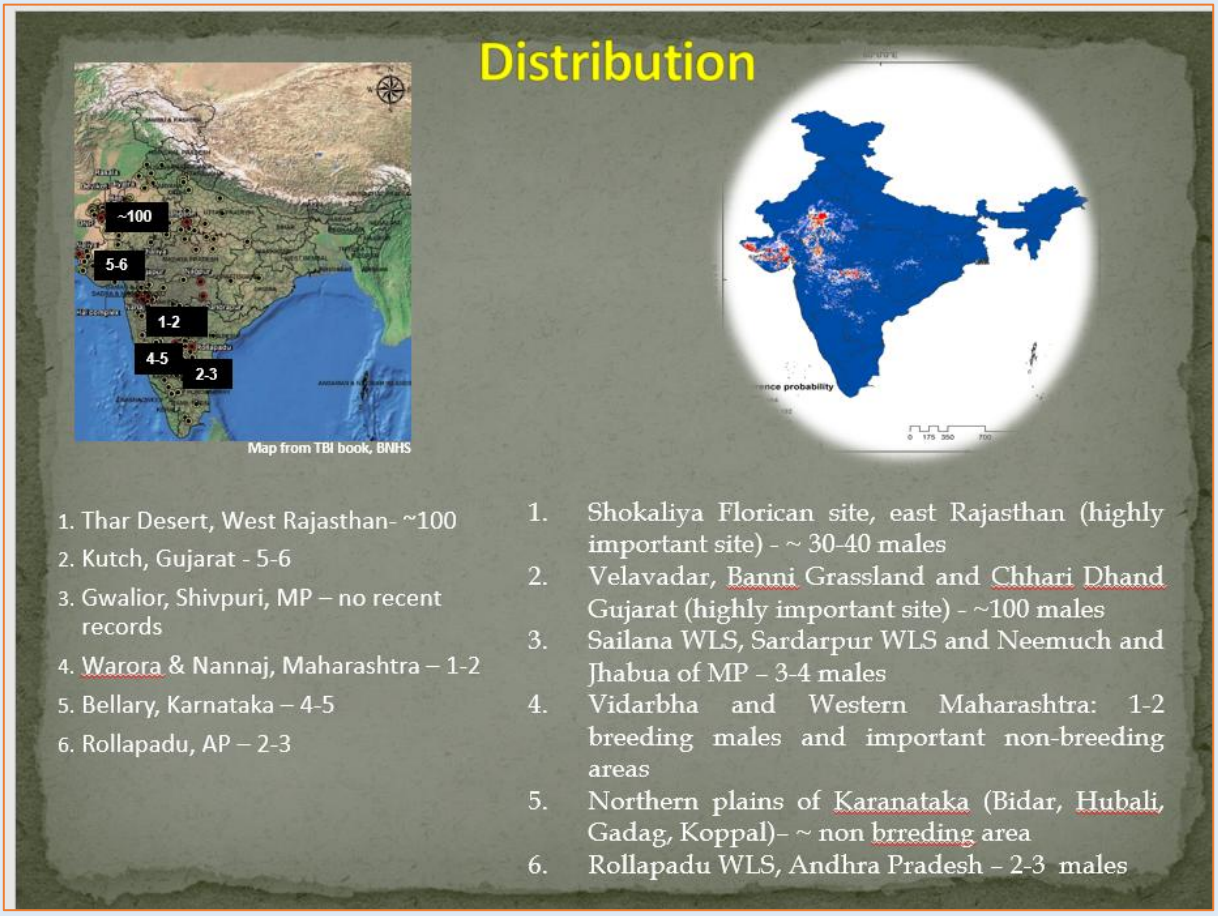
Discussion

The condition of India's grasslands is becoming increasingly alarming, with many areas experiencing significant degradation. While the monsoon season presents a facade of vibrant green, this is often misleading, as invasive plant species have taken over native flora, disrupting the ecosystem. The sharp decline in populations of crucial species such as bustards and floricans, often seen only as solitary individuals across vast areas, serves as a wake-up call for urgent conservation efforts. The BNHS is spearheading a comprehensive approach that combines research, field surveys, habitat restoration, breeding initiatives, community engagement and policy advocacy to protect India’s vanishing grasslands.

BNHS is actively restoring traditional water-harvesting systems, known as Nadis, in Pokhran, and working to halt harmful mining activities in Shokaliya. They are also documenting Bengal Floricans in Assam to gain insights for their conservation. Emphasising the link between ecological rarity and cultural significance, BNHS aims to build trust with local communities while safeguarding species such as bustards and floricans. The organization calls on governments to implement inclusive conservation measures and has proposed guidelines to enhance grassland management and protect these vital ecosystems for the future.

About Bustards and Floricans – In brief

Bustards are one of the most threatened groups of birds, and the situation in Asia is particularly critical (Collar *et al.*, 2017). Four species of globally threatened Bustards are found in India: Great Indian Bustard *Ardeotis nigriceps*, Bengal Florican *Houbaropsis bengalensis*, Lesser Florican *Sypheotides indicus and* MacQueen's Bustard *Chlamydotis macqueeni*. In India, three of these species are residents of a significant global population, and one is a winter migrant.
(**Please refer to the distribution map)**



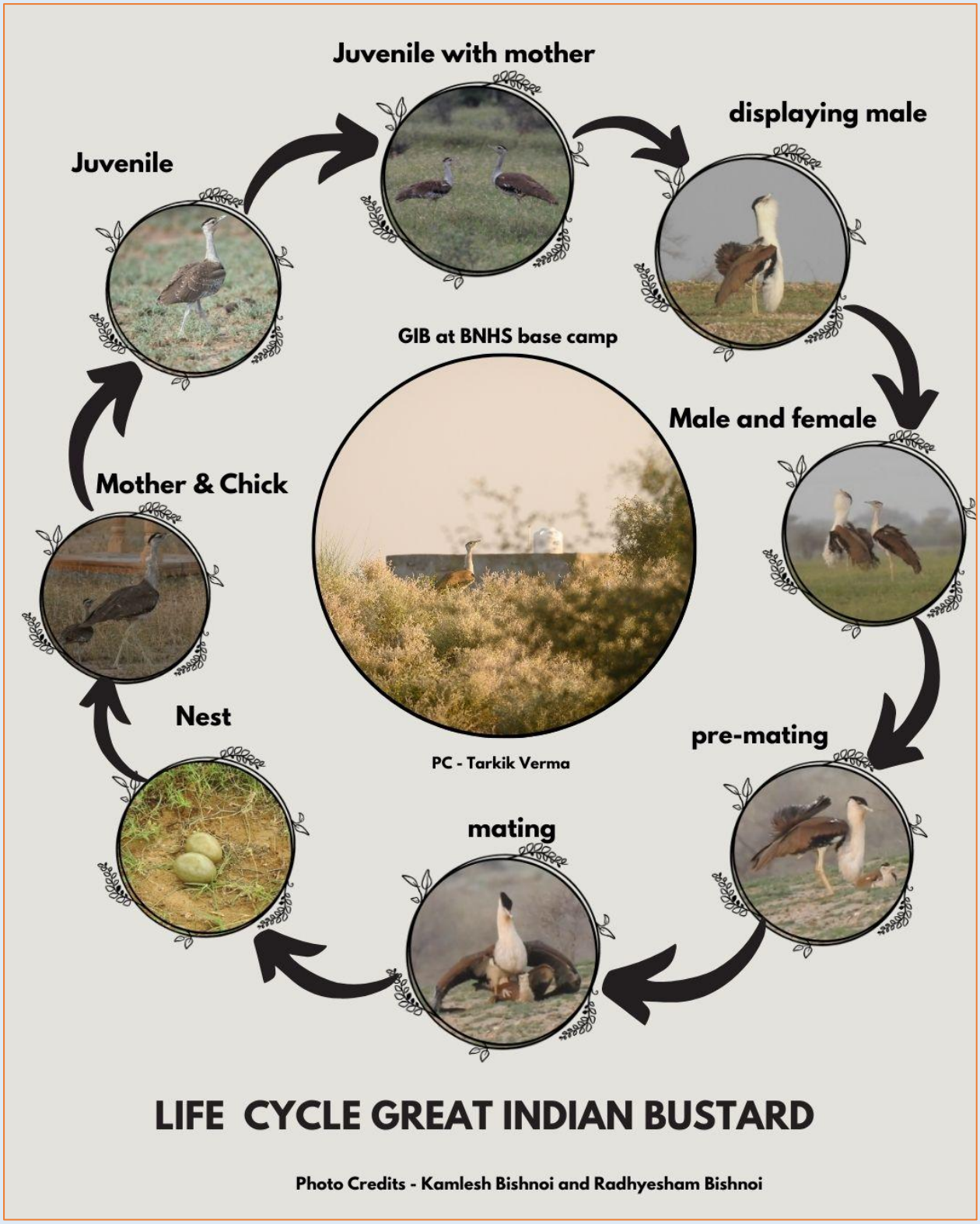
A map illustrating the current distribution of Bustards and Floricans throughout India, accompanied by estimated population numbers for each species in different regions. This detailed representation highlights key habitats and areas where these birds can be found, providing insight into their geographical spread and conservation status across the country.

About Great Indian Bustard *Ardeotis nigriceps*

The Great Indian Bustard (GIB) is considered 'extinction-prone' due to its slow life history traits. The GIB is endemic to the Indian subcontinent, but its population is limited to the grasslands of Rajasthan and Gujarat. The last census in 2018 counted fewer than 150 individuals in the wild, of which 122 were in Jaisalmer. (Jhala 2022). Several issues plague the GIB in the last remaining grasslands of the Thar Desert, especially in the unprotected areas.

1. **Scientific Name**: - *Ardeotis nigriceps*
2. **Local Name**: - Godawan (Marwari)/ Son Chiriya (Hindi)/ Maldhok (Marathi)

3. **IUCN Red List Status**: - Critically Endangered
4. **Estimated Global Population**: - 100 –150 (BirdLife International 2020)
5. **Wildlife Protection Act**: - Schedule 1
6. **Distribution**: - Once spread across the length and breadth of the Indian Subcontinent from the eastern Sindh province in Pakistan in the West to the Chhota Nagpur Plateau in the East, from the Plains of Punjab in the North to Tamil Nadu in the South. Currently, the only viable population survives in the Thar Desert of Rajasthan, specifically in the Jaisalmer District. The Great Indian Bustard is the state bird of Rajasthan, India.
7. **Diet**: - This species is an omnivore; its diet ranges from small invertebrates such as grasshoppers and locusts to small mammals such as Indian Desert Jirds *Meriones hurrianae*, reptiles such as geckos, spiny-tailed lizards *Saara hardwickii*, and a variety of plant parts such as berries of Ber *Zizyphus nummularia*, Jhaal *Salvadora persica*, to the pods of Khimp *Leptadenia pyrotechnica*. It also feeds upon Millet (Bajra), Jowar, Sunflower, Chana (Bengal gram) and Groundnut cultivation.
8. **Morphology**: - It is one of the largest flying birds in India. The male can grow up to 1 to 1.2 metres tall and weigh about 15 to 18 kg, whereas the female is smaller, weighing up to 11 Kg. The males have been observed through satellite telemetry moving as far as 140 kilometres from their breeding grounds in the non-breeding season. GIB can fly to a height of 15-20 metres. They can live up to 25 years in the wild. The species has a distinctive plumage, as the nape is covered with pitch-black feathers, which may extend to the back of the head in males. Females have a slightly streaked appearance on the neck, whereas males have a white neck. The dorsal feathers are brownish. The Legs are slim and pale in colour. The absence of a hind toe prevents it from clutching objects and, hence, it is unable to perch, making it a ground-dwelling bird. The Great Indian Bustard is a good runner. In males, the lower neck portion is extended, with an air sac called the Gular Pouch. The GIB has laterally placed eyes as an evolutionary benefit, giving it a better view in open grasslands. In the wild, the estimated demographic ratio is two females per male.
9. **Breeding**: - The GIB shows a classical Lek-Mating system where different males compete to attract females through courtship display. These displays are performed year after year by individuals at the very same site, as these birds show high sight fidelity. During Display (courtship display), males often move to a vantage point and inflate their Gullar Pouch, which extends and nearly touches the ground. It makes the tail feathers curve towards the median, producing a loud, booming sound through vibrations in its larynx. Parental care is exclusively provided by the mother. The chick has been observed following its mother for more than a year, giving the impression that they are a couple as the chick grows. These birds are mostly solitary, coming together only during the breeding season. Males and females have been seen forming groups in winter **(Please refer to the Image below).**
10. **Nesting**: The GIB is a grassland obligate species with a slow life history. The clutch size is usually one egg per year, which may increase to two during a good monsoon. It may abort egg laying in dry or drought seasons. The female lays eggs on the ground, creating a small, clean space over flat ground. The eggs are olive green in colour with a checkered black appearance. The incubation period is approximately 28 days. The chicks of GIB are precocial.
11. **Major threats**: The major threats facing bustards are the menace of free-range dogs, land use changes leading to habitat loss, habitat degradation, mushrooming of the Renewable Energy sector, and the threat from the High-Tension Transmission Lines (HTTL).



The life cycle of the Great Indian Bustard (GIB) is a remarkable journey, showcasing the resilience and beauty of this endangered species. Witnessing the transformation of a GIB from a fragile egg to a fully grown adult in its natural habitat is both inspiring and rewarding. Over the years, spanning from 2019 to 2025, with the help of local Bishnoi conservationists, we have captured various phases of this incredible life cycle through a series of photographs.

Glorious past of GIB in the Deccan Plateau

In Maharashtra, the Great Indian Bustard (GIB) is found in the grasslands of the Nannaj Sanctuary in Solapur, Latur, Ahmednagar and Osmanabad districts. The population GIB was 50–60 in the 1980s (Kulkarni, 1981; Rahmani & Manakadan, 1990; Kumar *et al*., 1997), and 30–40 during 2000–2006 (Rahmani & Kalra, 2005). This population declined to 13 in 2010, to 5 in 2015, and then to a single bird in 2016 within the Sanctuary (366.73 sq. km, located in the districts of Solapur and Ahmednagar). During the 1980s and 1990s, after its initial success, Bustard conservation efforts failed in many areas due to poor habitat management in protected areas by the forest department and changes in land use in non-protected areas (Ali *et al*., 1984; Rahmani, 1989; Rahmani *et al*., 2014). Extensive infrastructure developments, such as heavy-duty overhead wires, roads, industries, and canals, have entirely changed the landscape on a habitat level. For example, during our study, an adult male GIB collided with a power line in the Nannaj area in September 2015 (Bhagwat Mhaske from Great Indian Bustard (GIB) Sanctuary, Nannaj, pers. comm., September 2015).

Around half a century ago, Great Indian Bustards were spotted throughout Karnataka, except for the Western Ghats. However, now they are restricted to only Ballari and Koppal. Rahmani and Manakadan (1990) reported the occurrence of the Bustard as unconfirmed, based on personal communication with many researchers in Bijapur, Raichur, Dharwad, Ballari, Chitradurga, Tumkur, Hassan, and Mysore. These researchers further stated the presence of the Bustard in Dharwad. Rahmani and Manakadan also estimated the Bustard number as 30 to 40 for the state. Neginhal (1997) also reported a Bustard nest and egg from Ranibennur. Ghorpade (1996) reported the bird from Hagedal in the Gadag district (Bhat *et al.* 2005) based on secondary sources compiled for the Bustard status from 1981 to 2005 in Ranibennur Blackbuck Sanctuary, which showed regular sightings of five birds from 1981 to 1997 and the highest of 14 birds in 1990; since 1998 the number of birds has drastically reduced in the Sanctuary; however, one bird was reported in 2003 (Kumara and Raj, 2007). Nevertheless, the last sighting of Bustards at the Ranibennur Blackbuck Sanctuary was in 1998, and since then there have been neither reports nor sightings of Great Indian Bustards elsewhere in Karnataka. However, a group of naturalists from Hospet and Ballari, under the banner of the Society for Wildlife and Nature (SWAN), rediscovered Great Indian Bustards in the remote corners of the Siruguppa taluk of the Ballari district in 2006. Ever since, the NGO has been recording and documenting the sightings with little publicity among the local villagers (Samad, Mistnet 2006, WWF Special Issue 2012). In Karnataka, it has been reported in the north in Vijapura district, adjacent to the Maharashtra border (Bilal *et al*., 2016).

About Lesser Florican *Sypheotides indicus*

The Lesser Florican (LF) is the smallest member of the bustard family (Otididae) under the order Otidiformes. The species name *Sypheotides indicus* was designated by Collar and Andrew (1988). Locally known as *Karinavilu* in Karnataka, *Nelanemili* in Telugu states (Telangana and Andhra Pradesh), *Tanmor* in Maharashtra, *Kharmor* in Hindi. It is endemic to this country (Ali, 1981). It is one of the four bustard species of India, all of which are threatened (IUCN). Though the Lesser Florican has been accorded the highest degree of protection under Schedule I of the Wildlife (Protection) Act, 1972, its numbers have declined, necessitating its designation as an Endangered species in the IUCN Red List. Subsequently, it has been included as a priority species in the Species Recovery plan by the Ministry of Environment, Forest and Climate Change, Government of India (Dutta, 2013).

1. **Scientific Name**: - *Sypheotides indicus*
2. **Local Name**: - Kharmor (Hindi/Gujarati)/Tanmore (Marathi)/Khar Titar (by Bhills)

3. **IUCN Red List Status**: - Critically Endangered
4. **Estimated Global Population**: - Less than 1000 individuals (IUCN Red Data List)
5. **Wildlife Protection Act**: - Schedule 1
6. **Distribution**: - The Lesser Florican is endemic to the Indian subcontinent. It is a local monsoon breeder. Once widespread, it now breeds in the Velavadar sanctuary in Gujarat, south-east Rajasthan, and western Madhya Pradesh. There is dispersal to central and southern India in the non-breeding season. (**Please refer to Figure 06**). It was once abundant in Nepal's Terai region, but there have been no recent sightings.

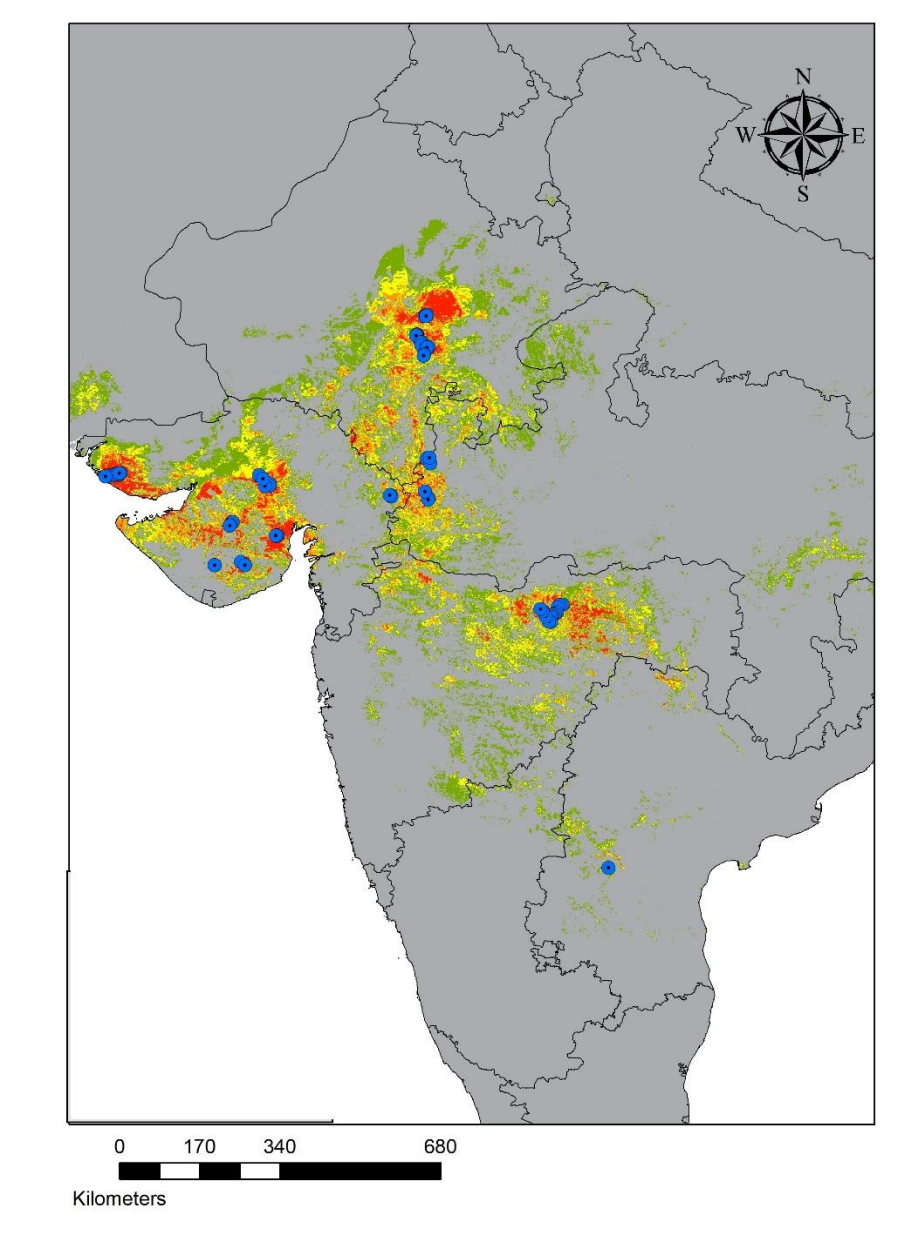


Figure 06: The Lesser Florican, a small and elusive bird species, is known to inhabit a range of habitats across India. The current distribution of this bird is highlighted by blue dots on the map, indicating its presence in specific regions. These areas typically include grasslands, open fields, and scrublands, which provide the necessary conditions for their survival and breeding. Understanding both the potential habitats and the actual distribution of the Lesser Florican is crucial for conservation efforts to protect this vulnerable species.

7. **Diet**: - The LF is an omnivore, and the diet varies from locusts, caterpillars, flying ants, worms, lizards, and frogs to herbs, berries and plant shoots. A typical foraging characteristic is that it walks for 5 to 10 meters, stops to look for any threats, and then dashes up or snaps up the prey. It feasts on caterpillar outbreaks in Butea bushes. The abundance of orthopteran insects plays a crucial role in the food supply for females and young. It can be seen in dry grasslands and scrublands, mainly in the crop fields of Moong and Jowar.
8. **Morphology**: - The size of the male and female is 46 and 52 cm, respectively. During the breeding season, males display a striking appearance with glossy black plumage covering their heads, necks, and underparts. This is contrasted by white wings with black flight feathers. The legs are dusky yellow coloured, the upper mandible is brown, and the lower mandible is yellow. One of the most distinguishing features of the male is the presence of four long, black, ribbon-like crest feathers on its head, along with elongated white plumes on the sides of its neck. Females are sand-coloured. The average height is 52 cm, larger than that of the male, and she has a more camouflaged appearance, which helps her nest and avoid predators. The female has a mottled brown-and-buff colouration that blends well with dry grasslands. The female has a sandy-brown head and neck with faint streaks, a slender body, and a long tail, while her wings are brown with a pale, spotted pattern. Additionally, females have more robust yellowish legs. This cryptic colouration enables females to remain hidden while nesting.
9. **Breeding**: - Historically, the principal breeding grounds were in eastern Haryana, Nasik and Kathiawar peninsula, which have now shifted to south-eastern Rajasthan, western MP and Velavadar Blackbuck Sanctuary in Bhavnagar, Gujarat. It follows the Lek-Mating System, in which males compete, and females have the chance to select the best among them. While performing the display, the male folds his legs and shoots vertically upwards, attaining a height of about 2 to 3 meters. The wings are partly open and flutter rapidly, producing a croak-like sound (Lad, 2016). It was observed that the voice box did not emit the sound produced by the displaying male, but rather came from bits of sound produced by the rotation of the primary feathers around the carpel joint during the wingbeat. The male jumps from a height of 2-3 meters at a selected spot; it may make as many as 600 jumps in a day, and its sound can be heard from 300 to 400 meters away. The area regularly used by the male for display tends to become a bare spot as the grass is trampled, so these display plots can be easily identified by the bird's excrement. LF tends to hide by lying low in the grass and flies off if the threat is nearby; birds produce short whistles when flushed, fly with rhythmic strokes of broad wings, have an outstretched neck, and tuck their feet under their bodies.
10. **Ecology**: The bird is a local migrant. It acts nomadic in the SW monsoon and is confined to plains and open areas. After the breeding period, most birds from Rajasthan, Gujarat, and MP migrate to peninsular India.
11. **Nesting**: The Lesser Florican selects the area near the bunds for nesting, which takes place on the ground. The nest is prepared by removing twigs and cleaning the surface before the eggs are laid. The clutch size may vary from 3 to 4 eggs. The Lesser Florican may be polyandrous. The eggs are dark olive green in colour (**Please refer to the Image below**).
12. **Threats**: The major threats this species currently faces are intensified agriculture, habitat loss due to changes in land use, unsustainable industrialisation, and the menace of Free-Ranging Dogs, along with High-Tension Transmission Lines (HTTL).

In 2022, the survey team from the BNHS discovered a Lesser Florican (LF) nest situated within the expansive farm fields of the Shokaliya landscape. This finding highlights the area's importance as a habitat for nesting birds and provides valuable information for ongoing conservation efforts. © Arindam Sinha.

The Lesser Florican is distributed in the lowland open plains. (Goriup, 1982). Historically, it occurred from Gujarat and Rajasthan in the west-to-West Bengal and Orissa in the east, as well as in the Saharanpur and Mainpuri districts. (Gopi Sundar, 2006) From Uttar Pradesh in the north to Thiruvananthapuram (Kerala) in the south (Ganguli Lachungpa, 1990). It also occurred in the Terai region of Nepal and Pakistan, and sporadically in Bangladesh and Myanmar. The main breeding areas were probably in the districts of Nashik, Ahmednagar and Solapur of Maharashtra, eastern Haryana, and the Kathiawar Peninsula of Gujarat (Anon, 1908). As per the surveys in 1999, the estimated population of the Lesser Florican was ~ 3530 birds (Sankaran, 2000), which came down to 500-600 individuals in the year 2018 during a joint Pan-India survey conducted by BNHS, WII, TCF and all range states (Dutta *et al*, 2018). The breeding success of the Lesser Florican depends on the distribution of monsoon, which is highly uncertain across all its breeding ranges (Sankaran, 1994) and the availability of sufficient grass cover (Ali and Ripley 1983). Undisturbed grasslands with mixed vegetation cover appear to be of the greatest importance in habitat selection during the breeding season of the Lesser Florican (Sankaran, 1997a).

Several studies (Jerdon 1864, Baker 1921; Dharmakumarsinhji, 1950; Ali & Ripley, 1969; Sankaran *et al.* 1992, Sankaran 1997a and b, Sankaran 2000) have been carried out to gather information on habitat use, population status and breeding behaviour of this species during the breeding season. Loss of breeding sites is believed to be a major cause for the decline of this endangered species. More than 620 sites have been brought under the protected area networks in India, but grasslands are very poorly represented (Rahmani and Manakadan, 1988; Rodgers and Panwar, 1988). There has been a considerable loss of privately-owned grasslands and grass patches between crop fields (Rahmani, 1987; Sankaran, 1994).

LF uses semi-arid grasslands during the breeding and non-breeding seasons, with scattered bushes and scrub, and, to a lesser extent, agro-pastoral landscapes with tall crops. The species does not use closed-canopy forests with large trees (Magrath *et al.*, 1985; Sankaran & Manakadan, 1990). The birds feed in open grassy patches at dawn and dusk and retire to thicker bushes as temperatures rise (Sankaran, 1991). In areas where grasslands are overgrazed, the birds find the habitat unsuitable and move into croplands (Sankaran, 1997). LF is also regularly found in agricultural fields where millet, cotton, and cereals are cultivated (Sankaran, 1991). According to Sankaran and Rahmani (1986), the male can be seen in waterlogged areas and typically confined to *beads* (unused private lands or common grazing pastures or grasslands) during the breeding season in the monsoon, as this obligatory grassland species is unable to find any suitable grassland for its breeding in the Shokaliya landscape and currently settles itself in the crop fields. Hence, it is essential to study crop heights, time of settlement, and other relevant factors. Its population fluctuations appear to correlate with rainfall patterns, making the species highly susceptible to extinction during severe, prolonged droughts (Sankaran, 1997).

Extensive surveys were conducted by the BNHS and later by the Salim Ali Centre for Ornithology and Natural History (SACON) in the 1980s and early 1990s (Sankaran 1991, 1994, 1996, 2000, Sankaran *et al.* 1992). These surveys documented a sharp population decline from an estimated 2187 males in 1982 to 836 in 1989 (a 60% decline), attributed to grassland loss and high anthropogenic pressure (e.g., overgrazing). In 2010, a sharp decline of almost 65% since 2008 in the population was seen in parts of Rajasthan, Gujarat, and MP (Bharadwaj *et al.* 2011).

Lesser Florican reported in the Deccan Plateau (2016-2022)

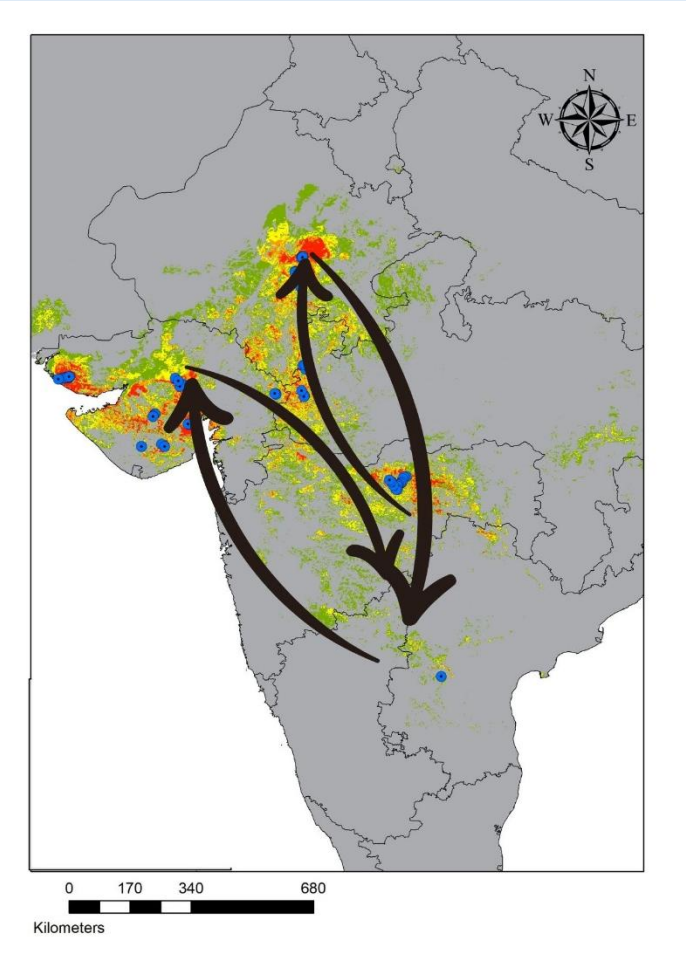
SN	Place	Lat.	Long.	Number and Sex	Date	Habitat	Reference
1.	Osmansagar lake, Ranga Reddy Telangana	17.38961	78.24782	1	2016	In the dry part of a waterbody	Deccan Chronicle, March 2022
2.	Tadoba-Andhari TR buffer area, Chandrapur, Maharashtra	20.44188	79.34638	1 (Female)	May-21	Captured in trap cameras	The Times of India, Aug 2021.
3.	Near Shivta, Chatrapati Sambhaji Nagar, Maharashtra	20.160866	75.567033	1	11-Apr-22	Agriculture	WII PTT tagged bird
4.	Near Jalgaon Mete, Chatrapati Sambhaji Nagar, Maharashtra	20.143093	75.582966	1	11-Apr-22	Agriculture	WII PTT tagged bird

SN	Place	Lat.	Long.	Number and Sex	Date	Habitat	Reference
5.	Near Ghodeshwar, Solapur, Maharashtra	17.534688	75.536933	1	11-Apr-22	Agriculture	WII PTT tagged bird
6.	Near Mullal, Vijayapura, Karnataka	16.742348	75.944333	1	11-Apr-22	Agricultre	WII PTT tagged bird
7.	Near Mullal, Vijayapura, Karnataka	16.7418	75.95196	1	11-Apr-22	Agriculture	WII PTT tagged bird
8.	Jigalur, Gadag, Karnataka	15.669106	75.788566	1	11-Apr-22	Agriculture	WII PTT tagged bird
9.	Jigalur, Gadag, Karnataka	15.66206	75.799233	1	11-Apr-22	Agriculture	WII PTT tagged bird
10.	Rollapadu Wildlife Sanctuary, Kurnool, Andhra Pradesh	15.75916	78.36759	1	11-Oct-22	Grassland	BNHS team, observations
11.	Himayat Bagh, Chatrapati Sambhaji Nagar, Maharashtra	19.902325	75.331841	1	27-Oct-22	Open area	Dr Kishor Pathak, Chatrapati Sambhaji Nagar
12.	Nellutla, Warangal, Telangana	17.074645	79.207412	1	22-Dec-22	Agriculture	WII PTT tagged bird
13.	Seetarampur, Ranga Reddy, Telangana	17.559617	79.23793	1	22-Dec-22	Agriculture	WII PTT tagged bird
14.	Chamorshi, Gadchiroli, Maharashtra	19.925445	79.890105	1 (Female)		Agriculture and Plantation	Mohan Ram et al. 2022

Table 02: Recent observations of the Lesser Florican, a critically endangered bird species, have been reported in the Deccan Plateau, which encompasses Maharashtra, Telangana, Karnataka, and Andhra Pradesh.

Movement of Lesser Florican

The study of the dispersal patterns and site fidelity of the Lesser Florican involved the ringing of 489 males in the erstwhile Bhavnagar district of Gujarat state (Dharamkumarsinhji 1957). The recent report of long-distance dispersal of the males from Rajasthan to Telangana showed they covered approximately 1000 km (Dutta 2021 in litt.), Another telemetry study showed that the tagged female (RSD-2) utilised non-breeding habitats in Maharashtra, Karnataka, and Telangana and dispersed as far as 776 km from its breeding grounds (Mohan Ram et *al.* 2022). Lesser Florican occur in good numbers in north-west India (Manakadan and Rahmani, 1999), where it is an indicator of a healthy semi-arid grassland ecosystem and monsoon. Due to agricultural expansion and other developmental activities, grassland habitats underwent rapid degradation. Consequently, the Florican population declined sharply and became rare (Sankaran 1991, 1994 b). Threats to semi-arid grasslands in western India are due to the lack of a national policy on grasslands, habitat degradation and loss, plantation and spread of invasive species, use of pesticides, indiscriminate developmental activities, poaching, and inadequate protected area coverage (Jhala 2022). Males have a short black tail and long, slender, pale-yellow legs. Outside the breeding season, males lose their vibrant black colouration and take on a more cryptic brown and buff appearance, resembling that of females. The species is known to migrate to southern India for breeding during the monsoons (Ram *et al.*, 2022).



The movement of the lesser florican between the Deccan region and northwest India was observed by the late Dr Ravi Sankaran and later confirmed by satellite telemetry studies conducted by the forest departments of Rajasthan and Gujarat, which focused on rainfall patterns during breeding and non-breeding seasons. Blue dots show recent locations of the birds, and the coloured region is the distribution range

Can we consider granting these magnificent creatures some much-needed breathing space, allowing them the freedom to thrive in their natural habitats without the pressures of human encroachment? © Nayan Khanolkar

About Bengal Florican *Houbaropsis bengalensis*

The Bengal Florican *Houbaropsis bengalensis* is one of the world's most globally threatened bustards. Other bustards are also considered globally threatened or Near Threatened (BirdLife International, 2018). The Bengal Florican *Houbaropsis bengalensis* has two subspecies: *Houbaropsis bengalensis bengalensis* is restricted to the floodplains of north and northeast India and the southern part of Nepal, and *H. b. blandini* is now found only in the Tonle Sap floodplain of Cambodia (Collar *et al.* 2018; Mahood *et al.* 2019) **(Please refer to the Image below)**. Populations of both subspecies are fragmented and declining.

The species is categorised as critically endangered in the IUCN Red List (BirdLife International 2020) due to the loss of the species grassland habitats to agriculture, grassland degradation due to poor management and overgrazing, and maybe hunting and collisions with power lines (Inskipp & Collar, 1984; Baral *et al.*, 2003; Poudyal *et al.*, 2008a, b; Grey *et al.*, 2009; Packman *et al.*, 2013, 2014; Mahood *et al.*, 2018). The population of Bengal Floricans in India is highly fragmented, and their status remains unknown. Protected areas in the floodplains of Assam and Arunachal Pradesh are strongholds for the Bengal Florican in India. However, a small, fragmented population is also found in non-protected areas of Assam and Arunachal Pradesh.

The present distribution of the Bengal Florican in India is restricted to grasslands within a human-dominated landscape and is thus highly vulnerable to anthropogenic disturbances. In India, the grasslands of the Brahmaputra floodplains and the Terai in Northeast India house the majority of the Bengal Florican population. However, the species' distribution is shrinking in this region due to anthropogenic threats and poor grassland management. Only a handful of studies have been conducted on the islands of the Brahmaputra River and its tributaries regarding the Bengal Florican.

BNHS has been working on the long-term conservation of Bengal Floricans in India for many years. Aaranyak, a local NGO, works on this species in Manas National Park, Assam. Several studies have been conducted on the ecology, behaviour, and distribution of Bengal Floricans in India since the 1980s. The ecology and behaviour of the Bengal Florican have been studied in Manas in Assam (Narayan and Rosalind 1990, Narayan 1992) and in Dudhwa in Uttar Pradesh (Sankaran 1991, 1996; Sankaran and Rahmani 1990). Rahmani *et al.* (2017) recently studied movement patterns and dispersal in Uttar Pradesh. Northeast India is the last remaining range for the survival of Bengal Floricans.

A male Bengal florican in its breeding plumage, photo capture in summer, 2022, © Biswajit Chakdar

The Bengal Floricans in the grasslands of Assam and Arunachal Pradesh are under tremendous pressure from invasive plant species, cattle grazing, hunting, conversion to agriculture and forestry plantations and uncontrolled fire. There is a potential threat to the low-lying grassland habitats posed by the construction of hydroelectric dams on the rivers of Arunachal Pradesh. Most of the grasslands in northeast India are under threat from the spread of trees viz. *Bombax ceiba*, *Zizyphus* spp. etc. and invasive alien plant species viz. *Chromolaena odorata*, *Lantana camara*, *Mimosa* spp., *Mikenia* spp. etc. The non-protected grasslands are mainly used for cattle grazing by local communities. Overgrazing and hunting are major threats to the birds in non-protected grasslands. Extensive surveys have yet to be conducted in the non-protected grassland patches, which are primarily distributed in small chaporis (river islands) along the Brahmaputra River and its tributaries in Assam and Arunachal Pradesh. The goal of this project was the long-term Conservation of the Bengal Florican in Northeast India by generating more information about its current status, distribution, and habitat use. The assessment of threats of this species will help in formulating better conservation actions in this landscape. The project will document all potential threats to the Bengal Florican at specific sites and at the landscape level in northeast India, and provide future solutions.

Local Names

Charas, Charg (Urdu, Hindi); Ulu Moira/Ulumora (Assamese); Dao Triling (Bodo); Khermenjur (Tea Tribe); Dahar (Bengali).

Distribution of Bengal Florican

The Bengal Florican (*Houbaropsis bengalensis*) is distributed across two isolated populations. *Houbaropsis bengalensis bengalensis* is found in South Asia, particularly in the Terai region of Nepal and India. The second subspecies, *Houbaropsis bengalensis blandini*, is in Southeast Asia,

with its primary habitat in Cambodia. Historically, the species was also found in Bangladesh, though it is possibly extinct there now (**Please refer to Figure 07).**

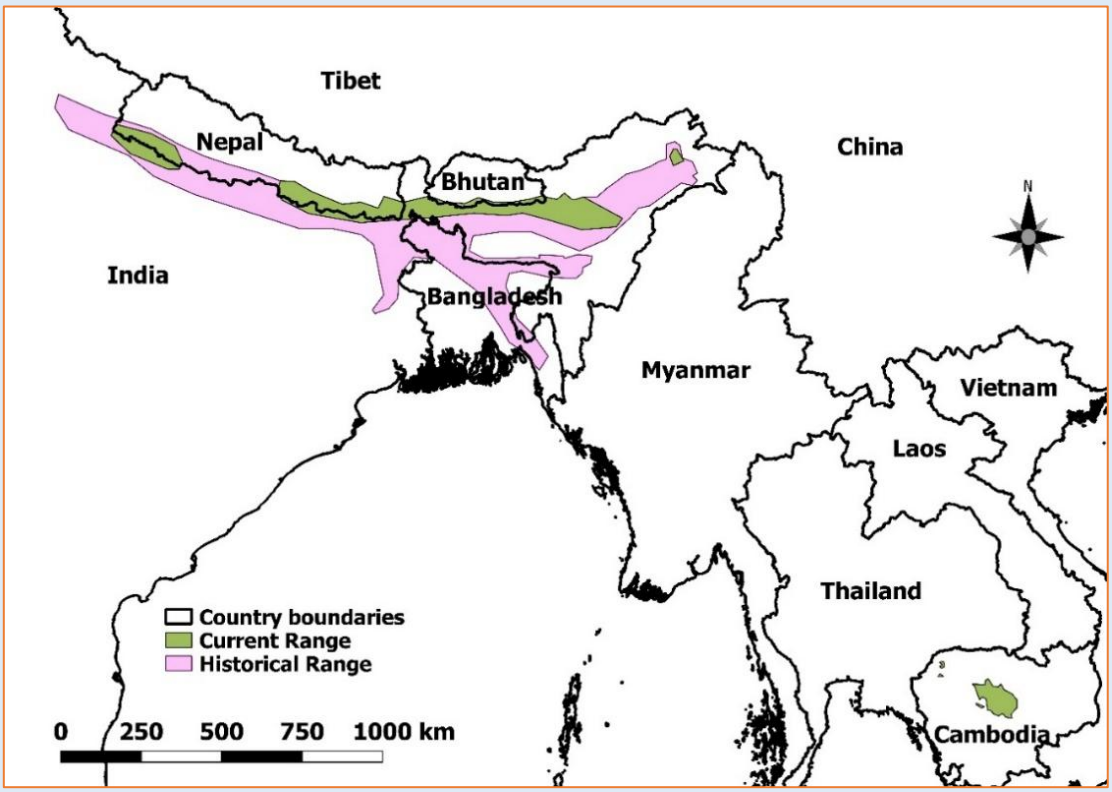


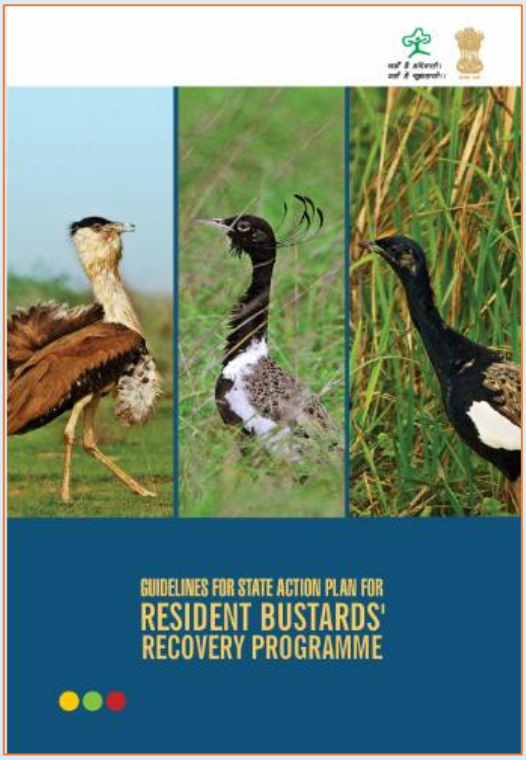
Figure 07: The distribution range of the Bengal Florican, both in its current habitat and throughout its historical range, is documented in detail in the 2017 BNHS report. This report provides valuable insights into the geographic areas where the Bengal Florican has been observed, highlighting changes in its population over time and illustrating the ecosystems it inhabits worldwide.

The Bengal Florican is primarily distributed in the Terai and floodplain grasslands of Assam, Arunachal Pradesh, and Uttar Pradesh in India. The Brahmaputra floodplains in Assam and Arunachal Pradesh are among the most significant strongholds for the Bengal Florican. The species is currently found in the protected grasslands of Kaziranga National Park and Tiger Reserve (which includes Laokhowa and Burachapori Wildlife Sanctuaries), Manas National Park, Dibru-Saikhowa National Park, *Orang* National Park, and D'Ering Memorial Wildlife Sanctuary. Small, isolated populations of Bengal Floricans also inhabit non-protected grasslands in Assam and Arunachal Pradesh. These areas are typically located in the Brahmaputra River's capris (river islands) and its tributaries. Amarpur, Koklabari Agriculture Farm, Nizamghat, and other sites in non-protected areas are important. In Uttar Pradesh, the distribution of Bengal Florican is now confined to Dudhwa National Park and Pilibhit Tiger Reserve.

Overview of BNHS's work on Bustard and Florican

1980-2013

The GIB was the subject of in-depth research under a conservation-oriented project on endangered species led by Dr Salim Ali at BNHS in the 1980s, with financial aid from the US Fish and Wildlife Service routed through the Indian Government (Rahmani, 1989). Under this project, GIB habitats were extensively surveyed throughout their known range, and in-depth knowledge of the species' population, distribution, ecology, behaviour, and other aspects was obtained. Many protected areas for the GIB were declared or established based on the project's findings and recommendations. The species was subject to monitoring studies at some sites under the BNHS Grassland Ecology Project (1991-1995), again funded by the US Fish and Wildlife Service (Rahmani, 1997). In addition to the BNHS, recent studies on bustards were also conducted by the Wildlife Institute of India (Dutta *et al.*, 2010, 2013). The advocacy work by the BNHS helped update the status of the GIB and Lesser Florican to Critically Endangered in the IUCN Red List (BirdLife International, 2011). Under the guidance of Dr Asad Rahamni, former Director, BNHS, the Species Recovery Plan was developed through a collaborative effort involving the BNHS, the Wildlife Institute of India (WII), and other subject-matter experts in conservation in 2013 (**Please refer to the following image & Table 01**).



Citation:
Dutta, S., Rahmani, A., Gautam, P., Kasambe, R., Narwade, S., Narayan, G., and Jhala. Y. 2013. Guidelines for State Action Plan for Resident Bustards' Recovery Programme. The Ministry of Environment and Forests, Government of India. New Delhi.

In 2013, a comprehensive Species Recovery Plan for bustards was developed through the collaborative efforts of a diverse group of stakeholders. This group included conservation organisations, governmental agencies, researchers, and local communities, all dedicated to the protection and recovery of bustard populations. The plan outlined specific strategies and action steps to address the key threats to bustards, enhance their habitats, and ensure the long-term viability of these magnificent birds in their natural ecosystems.

Actions	Center	State	List of Potential NGOs & Research organizations					
			Gujarat	Madhya Pradesh	Rajasthan	Maha-rashtra	Andhra Pradesh	Karnataka
Preparation of Action Plan	MoEF	Forest Dept	WII BNHS WWF KERC GEER	WII BNHS WWF	WII BNHS WWF TWSI	WII BNHS WWF GIBF	WII BNHS WWF	WII BNHS WWF SACON
Execution	MoEF	Forest Dept Revenue Dept Panchayat	WII BNHS KERC GEER GUIDE	WII BNHS WWF	WII BNHS WWF TWSI	WII BNHS WWF GIBF	WII BNHS WWF ASHRAM	WII BNHS WWF SWaN SACON
Monitoring & Evalua-tion	MoEF	Forest Dept	WII	WII	WII	BNHS	BNHS	WII
		Revenue Dept	BNHS WWF	FES BNHS WWF	TWSI BNHS WWF	WWF WII GIBF	WWF WII	BNHS WWF CES, SACON

Table 01: The Species Recovery Plan for the bustard and florican must be implemented comprehensively by all organisations mentioned above. This entails a coordinated effort that includes habitat restoration, protection of nesting sites, population monitoring, and community engagement to raise awareness of the importance of these species. Each organisation is contributing to the plan's objectives through specific actions tailored to its capabilities and resources, ensuring effective measures to facilitate the recovery of these threatened species in their natural habitats.

2017-2018

This National Recovery Plan advocated a multi-pronged landscape-level approach for saving GIB that involves a) stringent protection and informed management of breeding enclosures, b) mitigation of threats and compatible livelihoods in adjoining non-breeding habitats, and c) establishment of a captive population as insurance against extinction. Later, under the CAMPA scheme, as a government agency, the Wildlife Institute of India (WII), Dehradun, was made responsible for the Conservation breeding program and received funding to collaborate with the Rajasthan Forest Department (FD) to establish breeding centres in 2018. It was intended as a collaborative conservation activity involving all GIB and Florican-range states and agencies; however, it was ultimately confined to the Thar Desert in Rajasthan.

2018 onwards

The GIB roams in extensive areas in search of food, mates, suitable habitats, and breeding sites. This species primarily inhabits arid and semi-arid grasslands but also moves across various landscapes, including agricultural fields and scrublands. Therefore, the constantly changing landscape in India poses significant challenges for conservation efforts. Furthermore, the current laws and regulations, primarily designed to protect forests and forest animals, do not adequately address the legislative, administrative, and social requirements crucial for the effective conservation of grassland habitat and bustards. Despite repeated attempts, it has become evident that the traditional approach of establishing protected areas has failed to safeguard species like the GIB, and this pattern is likely to continue, exacerbating existing problems.

As a result, there is an urgent need for new paradigms to preserve species that inhabit large, human-dominated, multi-use landscapes. This necessitates the development of a comprehensive

landscape conservation strategy incorporating the concept of Conservation and Community Reserves, enabling controlled traditional land uses while facilitating the development of GIB-friendly infrastructure (**Please refer to Figure 01**).

The current viable population of GIB is ~ 100 individuals, primarily residing in the Thar Desert of Rajasthan. Apart from this, there are an estimated ~6-7 birds in Gujarat, 2-3 in Maharashtra, 10 in Karnataka, and ~3-4 in Andhra Pradesh. It is extinct in almost 90% of its former range, and if present trends continue, the GIB could become locally extinct. As a step towards its conservation, the BNHS has initiated a programme in the Thar Desert. The goal of the BNHS GIB program is to conduct landscape-level research and garner local support to conserve GIB in non-protected areas through village-wise action plans that involve villagers.

A substantial area of 16,463 hectares in the Thar Desert of Rajasthan, with minimal infrastructure, has been identified and recognised as a relatively undisturbed bustard habitat, with a population of 40-45 individuals. Situated near an important site managed by the Indian Army in Pokhran, this area is home to a significant global population of the GIB, emphasising its ecological importance. In response to this, the BNHS has devised a plan to establish four to five designated zones, each spanning between 100 and 150 hectares. These zones will be meticulously managed as GIB habitats, with active involvement from local communities to ensure sustainable practices and strengthen conservation efforts.

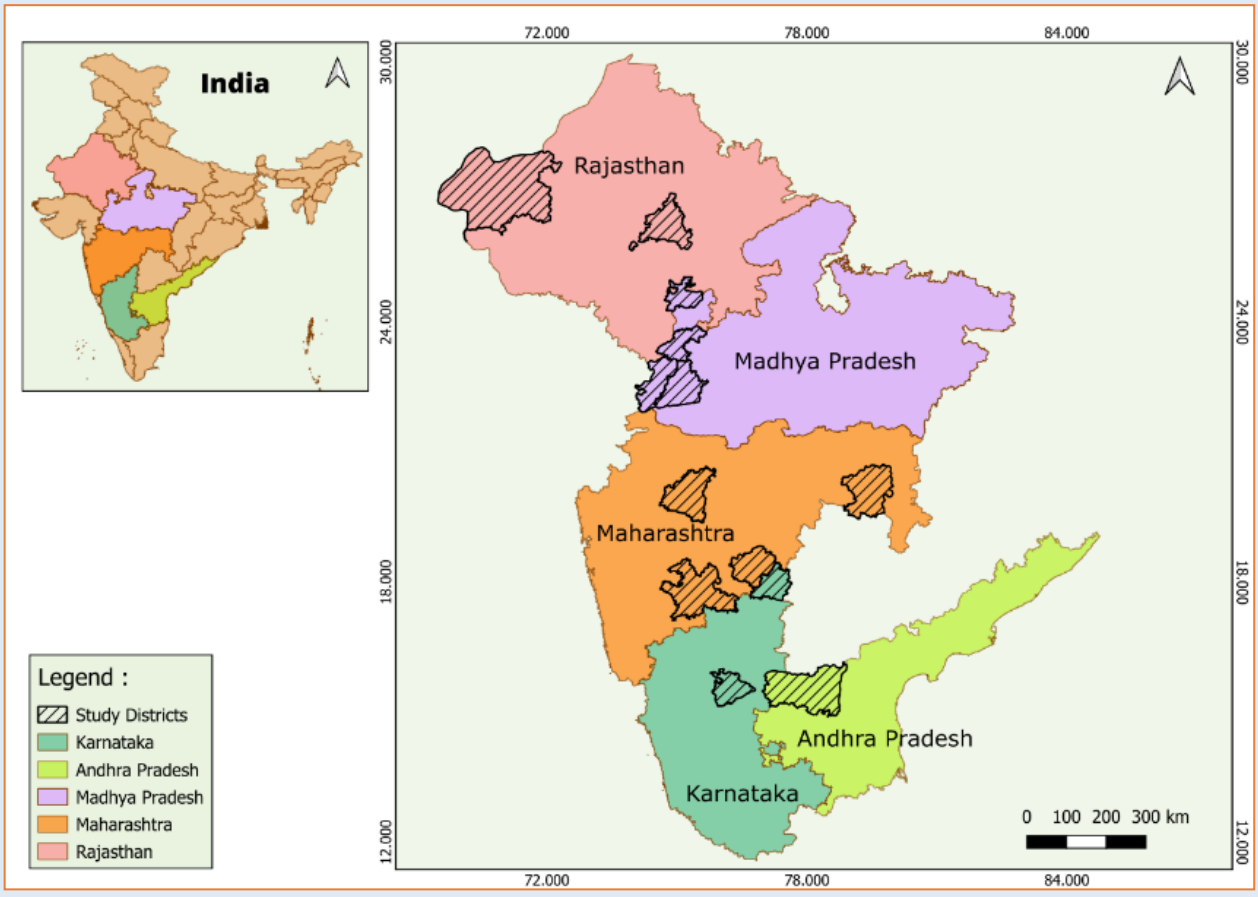


Figure 01: Regular and systematic study and analysis of the BNHS across various dryland states in India. This ongoing research aims to assess the impacts of habitat degradation and human activities on bustards and floricans and to develop conservation strategies tailored to the specific needs of each state.

Currently, the BNHS has successfully secured two plots, one of 35 ha and the other 8.74 ha, within this vital habitat, which the GIB utilises sporadically during its non-breeding season. These plots have been transformed into a secure grassland enclosure, providing a haven for the GIB and facilitating their survival and reproduction.

Thar Desert, Rajasthan (2019-2025)

BNHS is actively implementing various conservation actions necessary for the long-term conservation of the species. Some of the important actions implemented are **(Please refer to the Image below**):

Nadi Rejuvenation

In the Thar Desert, particularly within the Jaisalmer district, natural water sources are severely limited. The primary water supply originates from a few inland rivers that collect rainwater during the monsoon season. Notably, the region relies on artificial water bodies, such as Nadis and Khadin, which are crucial for both local communities and the wildlife that inhabit the area. During the hot summer months, the Thar Desert is prone to frequent sandstorms, which accelerate silt accumulation in these water bodies. Consequently, revitalising these water sources is essential, as they provide crucial hydration for wildlife in an otherwise arid landscape.

Habitat restoration - the ultimate way to save wildlife.

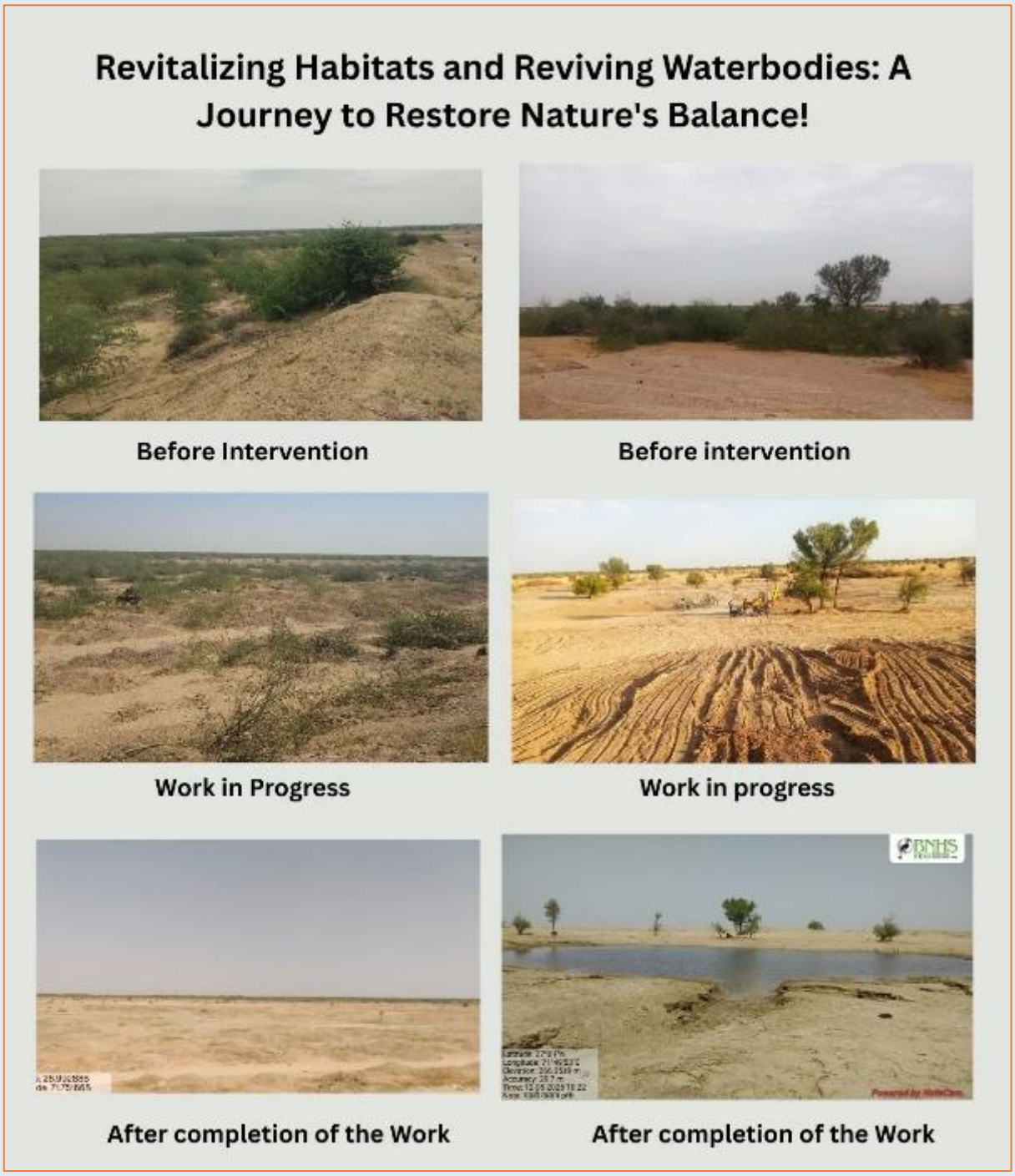
The Thar Desert experiences extremely high temperatures during the summer, with minimal rainfall from March to June. This challenging environment fosters a unique amalgamation of grasslands, fallow land, and dunes. However, recent developments pose significant threats to this ecosystem. A notable concern is the proliferation of the invasive species *Prosopis juliflora*, which encroaches on the land and disrupts the habitats required by native wildlife (**Please refer to the image on the next page**). The dense growth of this plant creates hazardous conditions for indigenous animals, such as the Chinkara, which become vulnerable to predation by roaming dogs as they attempt to evade danger. Furthermore, the expansion of this invasive species hurts regions critical to the survival of endangered species, such as the Great Indian Bustard.

In acknowledgement of the urgent need to protect and rehabilitate this delicate habitat, BNHS has recently partnered with the ICICI Foundation, the Indian Army, and local village gram panchayats. Together, they have initiated a habitat restoration project to restore the region to its natural state and ensure a protective environment for the distinctive wildlife of the Thar Desert. The ICICI Foundation contributed 6,000 hours of machinery operation to eliminate invasive plants, specifically *Prosopis juliflora*, and rejuvenate water bodies.

Major impact made

1. This initiative has successfully transformed approximately 1,100 hectares of land into a suitable habitat for the endangered Great Indian Bustard and other wildlife, benefiting nine villages surrounding the Pokhran Field Firing Range (PFFR).
2. It has significantly increased the availability of fodder, thereby supporting the substantial cattle population prevalent in the area.
3. Moreover, the enhanced landscape has improved visibility, facilitating more effective monitoring and vigilance for the Indian Army.

Additionally, the project has increased water availability, benefiting livestock and wildlife (**Please refer to Figure 02**).



The waterbody rejuvenation project carried out in the Pokhran tehsil, located within the Thar Landscape, focused on revitalising local water resources. This initiative aimed to restore and enhance water quality and availability, addressing issues such as water scarcity and ecological degradation.

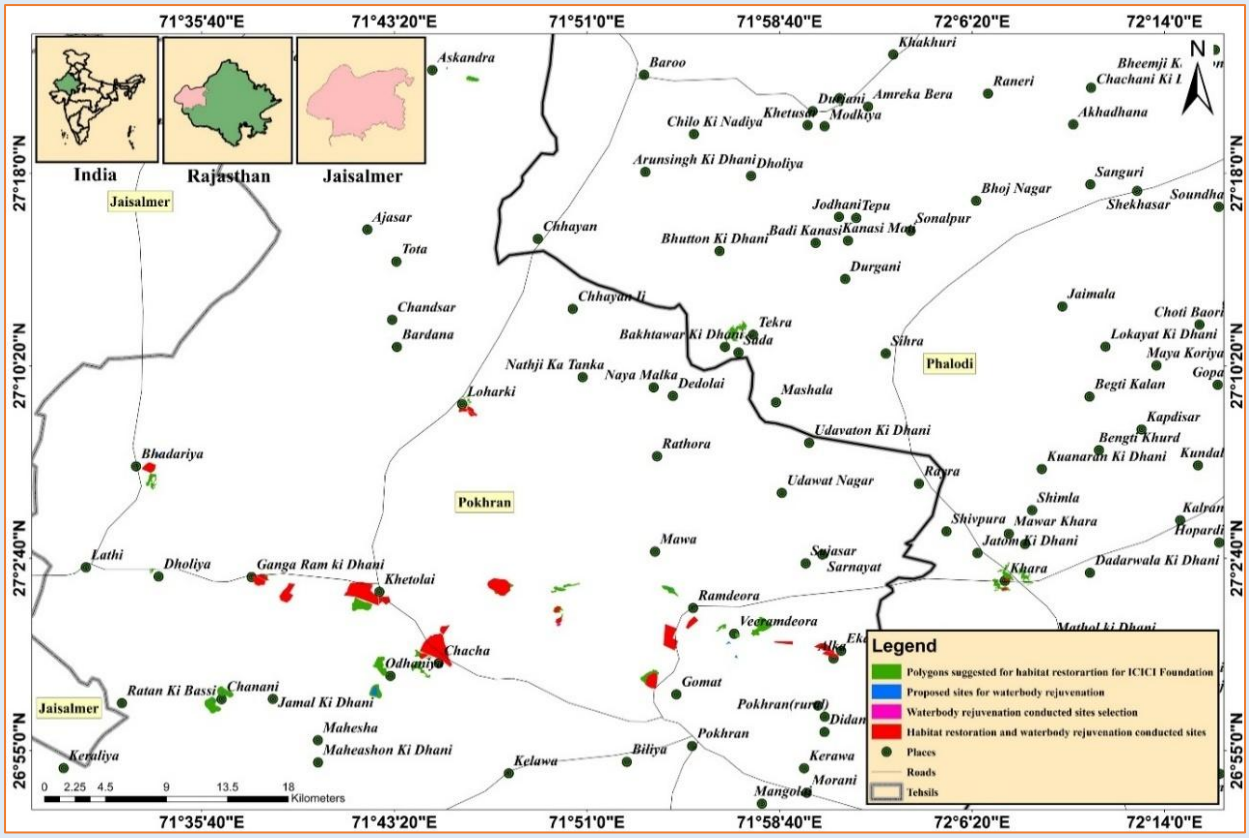


Figure 02: This map illustrates the specific regions where habitat restoration and waterbody rejuvenation efforts have been carried out with support from the ICICI Foundation. These initiatives aim to revitalise local ecosystems and improve the quality of water bodies, enhancing biodiversity and promoting sustainable environmental practices. The highlighted areas represent crucial sites of intervention and conservation efforts made possible through the foundation's support.

Ajmer, Rajasthan (2019-2025).

On the suggestion of the Office of the Additional Principal Chief Conservator of Forests (APCCF) and the Chief Wildlife Warden (CWLW), Rajasthan, the Office of the DyCF (DyCF) Ajmer approached the Bombay Natural History Society (BNHS) to conduct a survey of the Lesser Florican (LF) in the Shokaliya area with a focus on conservation. BNHS submitted a project proposal on May 4, 2017. In reply, we received a sanctioned letter from the office of the Chief Wildlife Warden, number F4(T)/vividh/CWLW/2017-18/3989, dated 25 July 2017.

Initial status and distribution data of the Florican were assessed through the joint surveys conducted in collaboration with WII, TCF, local NGOs, volunteers, and the State Forest Department during the breeding season of LF (July–August 2017 and 2018). The region where the species was previously recorded was initially monitored using vehicle occupancy, followed by a foot transect. During two consecutive breeding seasons, 2017 and 2018, around 30–40 males (based on direct sightings) were observed in and around Ajmer. Therefore, considering the 1:2 male-female ratio of this bird species and accounting for individuals that may have been missed during the survey, there may be around 100–125 Lesser Floricans in the Shokaliya area and adjoining regions (Dutta *et al.*, 2018).

The bird species was found across seven states: Rajasthan, Madhya Pradesh, Gujarat, Maharashtra, Karnataka, Telangana and Andhra Pradesh. Velavadar Blackbuck National Park in the Bhavnagar district of Gujarat and the Shokaliya landscape of Rajasthan (Nasirabad, Bhinai, Tantoti, Kekri, Sarwar, Arai; Malpura Gulabpura, Shahpura area) emerged as the strongholds of the species (Dutta et al 2018). Since Velavadar Blackbuck National Park is a Protected Area, there are comparatively fewer threats to the species than in the Shokaliya landscape, where it survives in a human-dominated landscape. Therefore, BNHS initiated micro-level planning to conserve the Lesser Florican and its habitats, which are under immense pressure from mining and intensive agricultural activities. An inception report and a brief report on the distribution of Lesser Florican, based on a breeding bird survey in 2017-2019, were submitted to the Rajasthan Government in November 2020 (Narwade et al., 2020).

Maharashtra (2012-2017)

BNHS undertook various activities to conserve GIB in collaboration with the Pune Wildlife Division, Government of Maharashtra, in accordance with the guidelines of the MoEF&CC's Species Recovery Plan (SRP) for GIB. Since 2011, intensive studies have been conducted in the Great Indian Bustard Sanctuary area in Solapur and the entire Deccan Plateau of Maharashtra as follows (Narwade et al, 2016):

1. Socioeconomic surveys were conducted with the assistance of interns at the Tata Institute of Social Sciences (TISS) in Dharashiv.
2. A study on pesticide residues in birds and their food chain has also been initiated. To reduce the use of chemical fertilisers and pesticides in GIB areas, training programmes for promoting sustainable agriculture were organised for farmers in Solapur. Insect sampling was conducted to assess the indirect effects of rampant pesticide use and prey availability on GIB.
3. Newly added areas to the Great Indian Bustard Sanctuary were surveyed to identify priority areas for grassland management. Provided inputs in preparing a management plan for the GIB Sanctuary, Maharashtra (2016-2026).
4. Since there was no proper information booklet on the Great Indian Bustard (GIB) of the Great Indian Bustard Sanctuary, we developed and released a short film on grasslands and the GIB in English and Marathi as part of its awareness programme.
5. Organised workshops to promote bustard-friendly agricultural practices at Solapur. This has resulted in strong support from the local community for conservation practices and reducing chemical use in farmlands adjoining bustard areas.
6. The BNHS team conducted field surveys and stakeholder meetings to identify an Eco-Sensitive Zone (ESZ) for the Great Indian Bustard (GIB) Sanctuary. A status survey of ground-nesting birds and other grassland obligate species has been initiated in drought-prone areas of Maharashtra as part of a PhD program (Narwade, 2016).

Important grasslands in Deccan, Maharashtra

Grasslands - G1 - Achegaon-Auj, Tal South Solapur, D Solapur; G2 - Boramani-Dhotri, Tal South; Solapur, D Solapur; G3 - Dahivadi-Kati, Tal Tuljapur, D Osmanabad; G4 - Devkuruli-Katgaon, Tal Tuljapur, D Osmanabad; G5 - Jathar Bablyat, Tal Mangalvedha, D Solapur; G6 - Kamone-Khadki, Tal Karmala, D Solapur; G7 - Karkhel, Tal Mhaswad, D Satara; G8 - Masla-Pangardarwadi grassland, Tal Tuljapur, D Osmanabad; G9 - Nannaj-Vadala-Mardi grassland, Tal North Solapur, D Solapur; G10 - Rajewadi, Tal Mhaswad, D Satara; G11 - Savargao-Kemwadi, Tal Tuljapur, D Osmanabad; G12- Vadacha Tand a, Naldurga, Tal Tuljapur, D Osmanabad; G13 - Yedshi, Tal Osmanabad, D Osmanabad; G14 - Yermala, Tal Kalamb, D Osmanabad **(Please refer to Figure 03)**

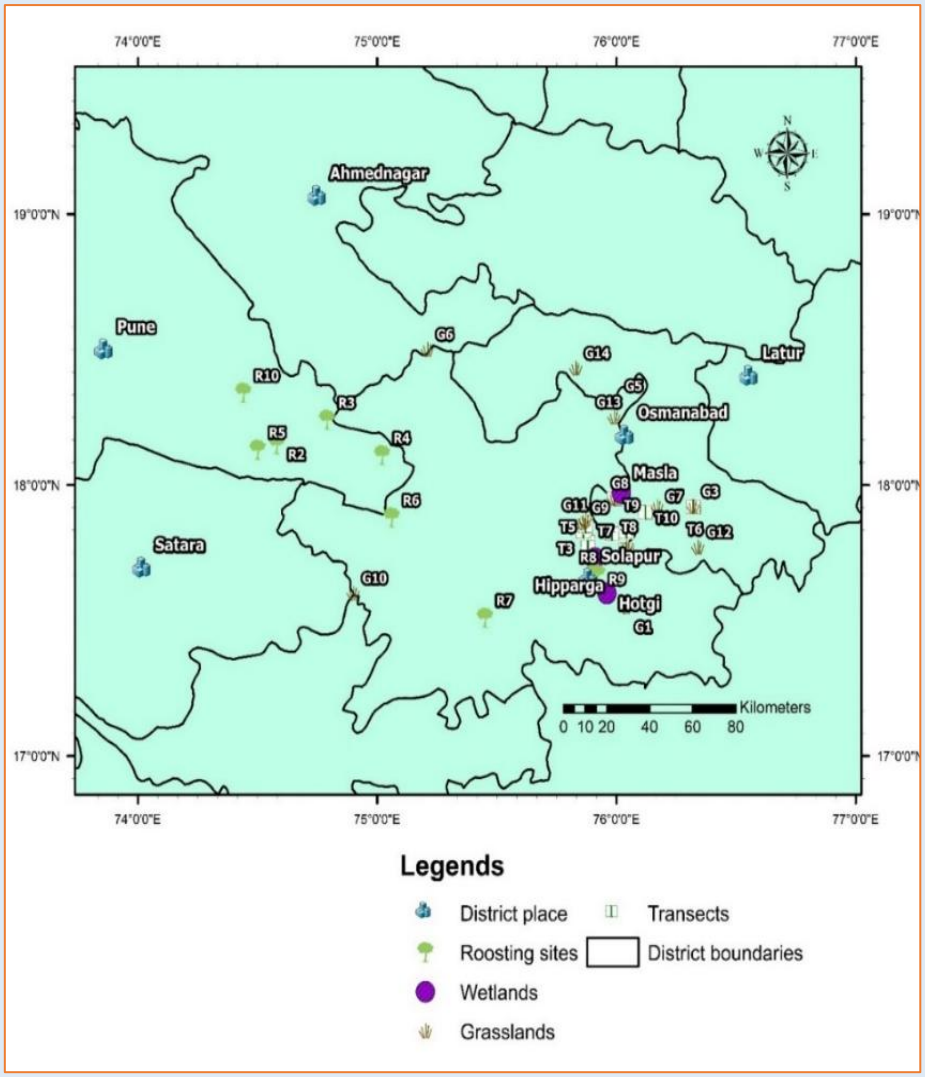


Figure 03: GIB distribution areas and developmental pressure in Deccan Maharashtra

GIB Locations - GIB1 - Boramani, Tal South Solapur, D Solapur; GIB2 - Courser hill area, Nannaj, Tal North Solapur, D Solapur; GIB3 - Dahivadi-Kati, Tal Tuljapur, D Osmanabad; GIB4 - Gangewadi, Tal South Solapur, D Solapur; GIB5 - Devkuruli-Katgaon, Tal Tuljapur, D Osmanabad; GIB6 - Karamba, Tal North Solapur, D Solapur; GIB7 - Kasegao-Gangewadi, Tal South Solapur, D Solapur; GIB8 - Katgao, Tal Tuljapur, D Osmanabad; GIB9 - Kemwadi, Tal Tuljapur, D Osmanabad; GIB10 - Masla-Pangardarwadi, Tal Tuljapur, D Osmanabad; GIB11 - Nannaj, Tal North Solapur, D Solapur; GIB12 - Plantations, Behind Rest House Nannaj, Tal North Solapur, D Solapur; GIB13 - Savargao-Kemwadi, Tal Tuljapur, D Osmanabad; GIB14 - Akolekati-Mardi road, Tal North Solapur, D Solapur; GIB15 – Shelgao, Tal Barshi, D Solapur; GIB16 - Raleras – Dhamangao Tal Barshi, D Solapur; GIB17 – Lohara, Tal Lohara, D Osmanabad; GIB18- Osmanabad, Tal Osmanabad, D Osmanabad

Existing and proposed industrial developments - 1 - Chincholi MIDC; 2- Pump house; 3 – Cement Godown; 4 – Proposed Domestic airport; 5 – Katare Spinning mill; 6 - Balajji Amines Chemical factory; 7 – Stone quarries and stone crushers; 8 – Solar power plant; 9 – poultry industry; 10 – Educational and industrial hub; 11 – Textile Industry; 12 – Siddheshwar sugar factory; 13 – NTPC thermal power plant; 14 – Zuari and Penna cement plant; 15; Jai Hind Sugar Factory; 16 – Birla Cement Factory; 17 – City expansion twin Solapur; 18 – proposed wind mills at Devkuruli, Tal Tuljapur, D Osmanabad (proposed); 19 - proposed wind mills at Naldurga, Tal Tuljapur, D Osmanabad (proposed); 20 – Solar power plant, at Naldurga, Tal Tulajpur, D Osmanabad; 21 - proposed wind mills at Lohara, D Osmanabad (proposed); 22 – GIB Sanctuary, Nananj-Mardi, D Solapur; 23- Maharashtra Industrial Development Corporation; 24 - Wind mills at Yermala; D Osmanabad

Karnataka (2021-2025)

Comprehensive landscape surveys were carried out from 2021 to 2025 to assess the population and conservation status of bustards, floricans, and their associated species across both states. In this effort, the BNHS collaborated closely with the Karnataka Forest Department. We pinpointed the vital grassland clusters that serve as crucial habitats for the Lesser Florican and blackbuck. These surveys not only aim to gather data on these iconic species but also to enhance conservation strategies by identifying key areas for habitat protection and restoration.

Andhra Pradesh (2022-23)

Landscape surveys were conducted in Rollapadu WLS and surrounding areas during July 2022 and October 2023 to assess the status of bustards and floricans.

Bengal Florican in North-East and UP (BNHS report 2017)

Using satellite telemetry data, BNHS found that Bengal Floricans prefer low-lying grass or crops. In the Terai grasslands, the population of megaherbivores has declined, resulting in tall, thick grasses at the onset of the monsoon. In turn, the habitat of Floricans becomes unsuitable, forcing them to spend most of their time in agricultural fields outside protected areas. To determine whether birds would remain in breeding sites by restoring habitat, a pilot study was conducted in 2016. The restoration pilot trial succeeded partially, in that the territorial bird was regularly seen by the research team feeding in the 'restored' short grassland patches. Nevertheless, the grass regained its height within two weeks, forcing birds to move away. Therefore, it was decided to replicate the original experiment in 2017. As it was found that birds prefer manually trimmed grass, we decided to conduct the experiment excluding the machine used at the following sites.

1. Chandan-chowki - 28°30'8.30"N 80°42'3.37"E
2. Sonaripur - 28°27'55.40"N 80°44'11.25"E
3. Nantal - 28°22'7.35"N 80°48'7.24"E

In June 2017, grass cutting was carried out on a 4-and-a-half-hectare area. Floricans were seen using the restored habitat until their departure.
Issues related to grassland restoration work

1. **Permission**—According to the Indian Wildlife Protection Act, 1972, agencies other than the forest department need permission to conduct habitat restoration work. Fortunately, BNHS got permission to conduct trial experiments in 2016 and 2017 (**Please refer to Figure 08).**
2. **Cost required in 2016**
    a. Grass cutting by machines—the amount required was around Rs. 4,000/- per ha area (including hiring a grass cutter, tractor, human resources, fuel, etc.
    b. Manual grass cutting – Considering that around 30 labourers are required to cut the grass of 4.5 ha in four days, the total cost of grass-trimming by labour works was INR 8000/Ha. The economic cost of employing labour to trim vegetation was thus almost double the cost of trimming vegetation by machine, and it was far more logistically challenging. The birds preferred the area cut by labourers because of the mosaic pattern and the greater insect abundance.
    c. Considering the issues mentioned above, we recommend cutting the grass manually

North-East India (1980s–2018)

The BNHS has played a pioneering role in the research and conservation of the critically endangered Bengal Florican across its range in the Indian subcontinent. Over the past four decades, BNHS's work has evolved from baseline ecological studies to integrated landscape-level conservation planning. Key milestones are:

1980s–1990s: Foundational Research

1. Ecological Studies: Conducted early systematic research on the Bengal Florican's ecology in Assam and Uttar Pradesh, focusing on population, breeding behaviour, and habitat preferences.
2. Population Estimates: Contributed to the first comprehensive population estimates in India, especially in the Brahmaputra floodplains.
3. Awareness and Policy Engagement: Advised on early wildlife policies for bustard conservation.

2000s: Intensified Research

1. Breeding Ecology: Documented breeding displays and nesting patterns in key areas like Manas National Park and Dudhwa Tiger Reserve.
2. Distribution Mapping: Refined the species' known distribution through field surveys and consultations.

2010s: Conservation Action

1. Threat Mapping: Identified threats like habitat loss, invasive species, and infrastructure expansion.
2. IUCN Red Listing Support: Provided data for Bengal Florican's Critically Endangered status by IUCN.

Satellite telemetry study

We obtained specific information about their movement during the breeding and post-breeding seasons through a satellite telemetry study on four birds at Pilibhit (three) and Dudhwa (one), providing valuable data from 2014-2016. Using this satellite-transmitter data, we have identified sites that are intensively used by Bengal Floricans during the breeding and non-breeding seasons (please **refer to Figure 09**).

Prescription for the recovery of species

The State action plan drafted in 2016 recommends the following conservation actions:

1. Strengthen protection in all identified natural and semi-natural grassland habitats occupied by Bengal Floricans within government land (those under the PA network and in various Forest Administrative Divisions)
2. Grassland management policy formulated for the protection of natural and semi-natural grasslands
3. Grassland habitat restoration/conservation by regular vegetation trimming throughout the year and timely rotational burning, as informed by research.
4. Ensure vigilance through various means and institutions in known non-breeding habitats, which may be on private or community land, according to available legal provisions
5. Identify suitable grassland restoration sites as potential corridors to conserve small sub-populations within various sites in the state and across the international border between India and Nepal to facilitate genetic exchange. Enhance the general awareness of the Bengal Florican and other associated threatened grassland bird species amongst targeted stakeholders.

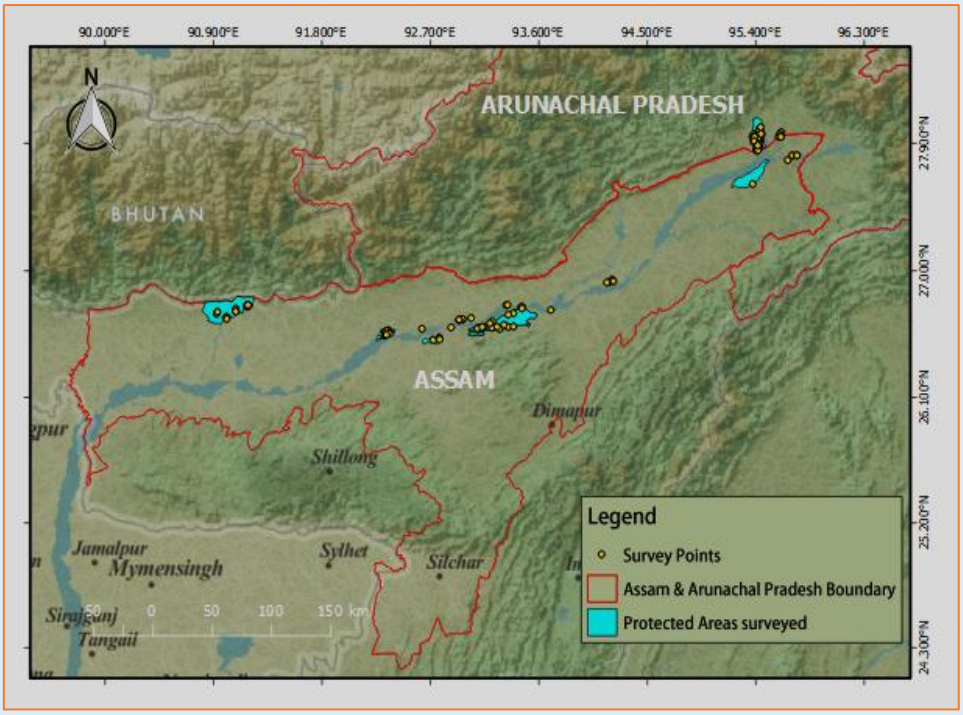


Figure 08: The Protected Area network that spans across Assam and Arunachal Pradesh has been extensively studied and documented by the team from the BNHS. The team's efforts aim to enhance conservation strategies. Through field surveys, research, and community engagement, the BNHS team is working to raise awareness about the ecological significance of the Protected Areas and the importance of preserving them for future generations.

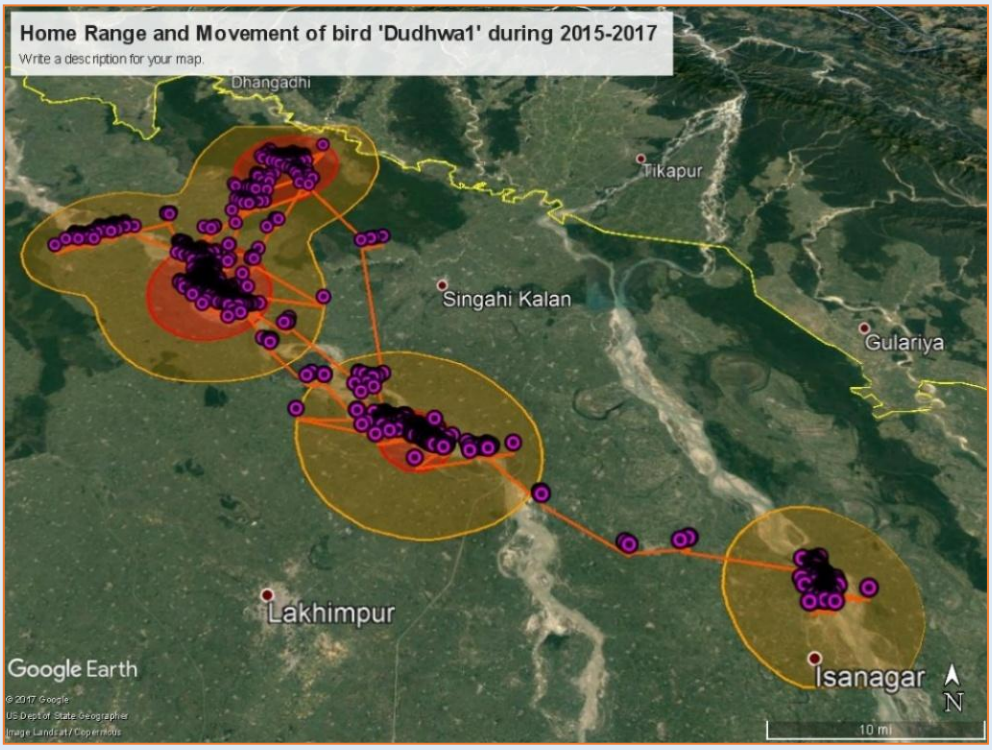


Figure 09: In the Dudhwa National Park, the movement patterns of the Bengal florican were meticulously tracked through the use of satellite telemetry. This groundbreaking research was documented in a 2016 report by the BNHS. The study aimed to gain deeper insights into the habitat preferences and movement behaviours of this bird

Significant achievements (Since the year 2019)

- **BNHS has collaborated with the Rajasthan Forest Department and the Government of Rajasthan to identify sites where the Florican resides and halt mining activities in the area through the National Green Tribunal (NGT). The BNHS report helped the government of Rajasthan to stop mining in 40 villages where the Lesser Florican is found. Except for a few reserve forests, no protected areas across the Florican range sites for the conservation of Floricans. Therefore, sites are being identified that could be managed as CCAs or OECMs as part of a long-term strategy.**
- **A sensitivity map based on GIB sightings, movement patterns, and habitat suitability was prepared to identify critical habitats for the birds.**
- **The society has also assisted in mapping Lesser Florican *(Sypheotides indicus) sites in the Ajmer-Kekri area* of Rajasthan, India. Furthermore, BNHS has helped the Rajasthan Forest Department declare a Conservation Reserve for the Lesser Florican across the villages of Arwar, Goyala, and Kheeriya.**
- **Assisted the Karnataka Forest Department in identifying clusters of grassland and preparing proposals for declaring Conservation Reserves for Blackbuck.**
- **BNHS has also achieved academic milestones in wildlife conservation, publishing several papers and notes, and students obtaining Master of Science degrees and enrolling in PhD programs (see Annexure 1).**
- **The Bishnoi community in Khetolai and Dholiya villages in the Pokhran area has been integral to BNHS's conservation efforts for the Great Indian Bustard (GIB) and associated wildlife.**
- **Significant progress has been made, including the removal of the invasive plant *P. juliflora* from much of the bustard habitat in Pokhran, Jaisalmer.**
- **Similar habitat restoration work has been initiated in Bidar by removing the exotic tree *Gliricidia* from four 25-ha plots.**
- **BNHS has established *a* 35-ha grassland reserve on Bishnoi land in the Pokhran area.**
- **With the help of Birdlife International, the team has also held consultative meetings with investment banks, the government, and the community to address large-scale energy infrastructure in the GIB-dominated landscape of Pokhran Tehsil.**
- **Additionally, the Indian Army's Southern Command established a study group to conserve the Great Indian Bustard (GIB) in Rajasthan, Maharashtra, and Goa.**
- **BNHS has supported educational programs, such as a one-year nature education program with field experience in and around Khetolai village, Pokhran.**
- **Moreover, a network of Godawan Mitra (friends of GIB), Kharmor Mitra (friends of the Lesser Florican), and Kurja Mitra (friends of cranes) was established to gather ground-level information and implement conservation work.**
- **In Maharashtra, BNHS also played a pivotal role in recommending and providing maps for the realignment of a power line traversing the core areas of the GIB Sanctuary in Solapur, thereby safeguarding the GIB's habitat within the sanctuary.**
- **BNHS is working closely with the Rajasthan Biodiversity Board (RSBB) to prepare a proposal to declare the Lesser Florican a Biodiversity Heritage Site (BHS).**
- **It was found that the northern plains of Karnataka are still being used by the Great Indian Bustard (GIB) and the Florican, and they need to be preserved from heavy land-use changes. BNHS is trying to highlight the grassland conservation in Deccan.**
- **BNHS is promoting sustainable agricultural practices.**

- Achieved the remarkable restoration of over 1,100 hectares of habitat within the Great Indian Bustard (GIB) zone in Pokhran, Jaisalmer.
- *Nadis* rejuvenated in the areas of Khetolai, Chacha, and various locations within the army premises of Pokhran, Jaisalmer.
- Remarkably, the population of the Great Indian Bustard has shown promising growth. In 2020, the population was recorded at a mere 25-30 individuals. However, by 2024, this number had increased to an estimated 40-45, reflecting the positive impact of conservation efforts in the region.

- **Brahmaputra Grassland Bird Project (2023–Present):** Under this initiative, BNHS is implementing a multi-year program focusing on Bengal Florican conservation in Assam and Arunachal Pradesh, supported by BirdLife International and local forest departments.
- **Landscape-Level Surveys:** Comprehensive seasonal surveys have been carried out in Manas NP, Orang NP, Kaziranga NP, Baghjan grasslands, and adjacent agro-pastoral landscapes to assess habitat occupancy and florican sightings.
- **Community Perception Surveys:** Conducted interviews in fringe villages to understand socio-ecological dimensions influencing Bengal Florican habitats.
- **Outreach and Education:** Organised awareness programs in local schools and colleges, including the development of educational material (e.g., illustrated handbooks for children) in regional languages.
- **Policy Advocacy:** Engaged with forest departments and conservation networks to promote habitat restoration, grazing regulation, and invasive species control.
- **Recent Key Finding:** In May 2025, BNHS and partners documented 21 Bengal Floricans (including one female) at Koklabari Agricultural Farm, highlighting the site's significance as a conservation priority.

NBT targets achieved through GIB and LF projects

1. Species conservation - NBT: 3, 6, 7, 11
2. Landscape approach - NBT: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11
3. Education - NBT: 1, 9, 11
4. Promoting effective and equitable governance of natural resources - NBT: 3,6,10,11,12.

Objectives

1. **To thoroughly assess and document the current population trends of the bustards and floricans across their respective distribution ranges, focusing on habitat conditions, threats, and conservation needs.**
2. **To undertake comprehensive research aimed at identifying and analysing the critical breeding sites of bustards and floricans, including factors such as potential disturbances affecting these areas.**
3. **To develop targeted, site-specific conservation plans that incorporate detailed field studies, ecological surveys, and mapping exercises to ensure the protection and enhancement of key habitats for these avian species.**
4. **To implement and evaluate innovative pilot experiments designed to identify the most effective conservation strategies, exploring methods such as population monitoring, habitat restoration techniques, and community engagement.**
5. **To expand and enhance conservation efforts through large-scale interventions that include habitat restoration projects, stringent protection measures for both species and their habitats, and active community awareness programs aimed at fostering long-term sustainability.**

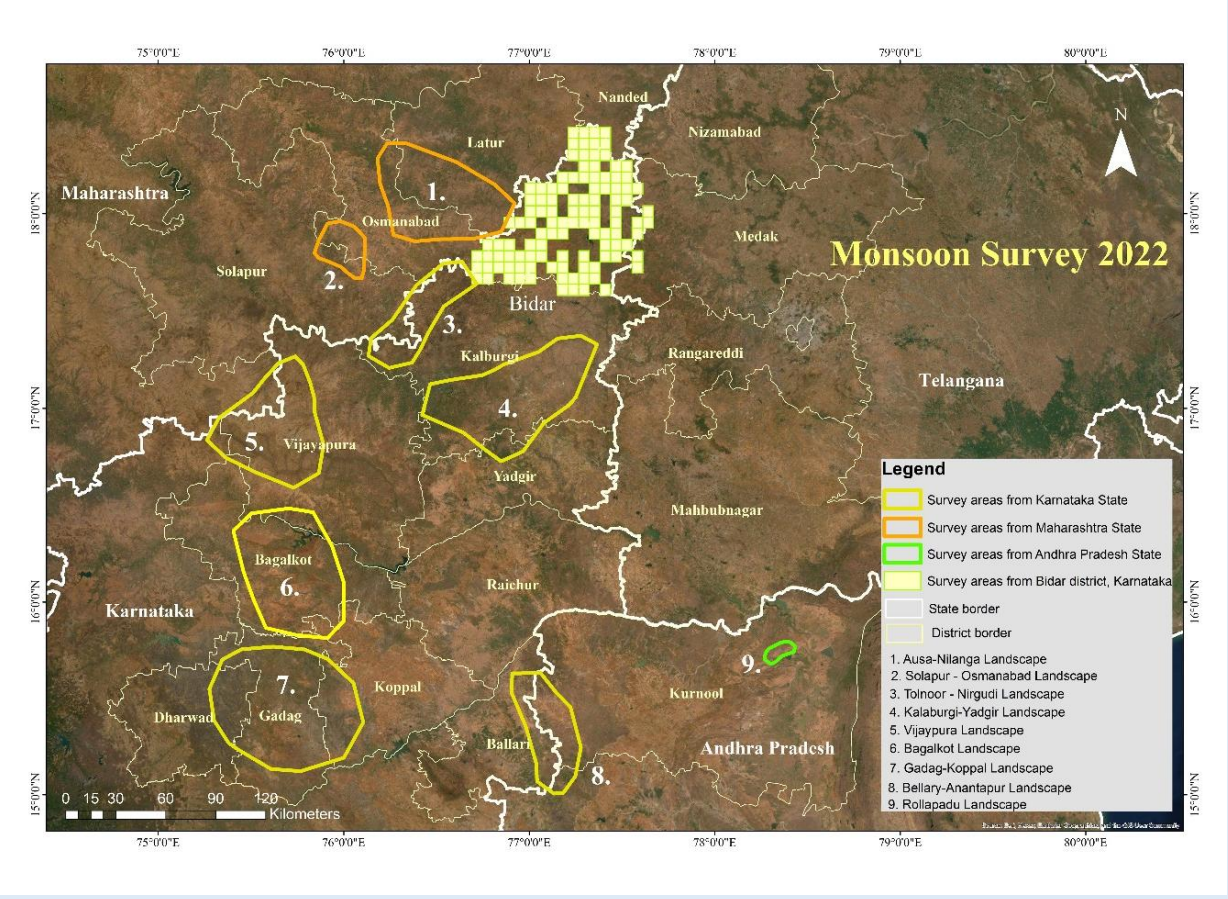
Creating safe havens where vulnerable bird species can flourish — landscapes that provide food, water, and shelter while shielding them from the pressures of urbanisation and other human-induced disturbances © Nayan Khanolkar

Methods

Disclaimer - The bird count data in the BNHS survey results are derived from the actual counts of birds observed during field studies, and no statistical tests were applied to obtain any estimated counts. This count represents the maximum number of individual birds recorded within a specific year.

Study location and types of surveys

A detailed study was conducted in the GIB and Lesser Florican landscapes from 2019 to 2025. Surveys were conducted during the birds' breeding season, whereas habitat and land-use surveys were conducted for the rest of the year through direct observation. In parallel, socio-economic surveys were conducted to understand local villagers' dependence on grazing lands and to identify potential areas for designating community reserves.



Landscape surveys carried out in the above areas by the team BNHS in 2022-2023

Monitoring lekking sites

Displaying males were monitored from a distance of 100 meters to assess how they utilised the microhabitat within a 500-meter radius and responded to other males and females during mating. For Lesser Floricans, a clustered box plot was generated using variables related to habitat preference and responses to the nearest edge/disturbance source. To identify display clusters or leks where males congregate for display, Kernel Density values were generated and mapped using ArcMap 10.6.1 software (Redland, 2011). Kernel density values highlight the nearest locations and cluster sites where male Floricans are seen together.

Understanding the threats to the birds and their habitat

To understand threats to GIB and LFs, the distance of the site from the nearest high-tension powerline, tar road, or noise source (which was assumed to influence the display sound of the male), human settlement, water source, quarry, and common grazing land (kankad) were recorded to understand their influence on the presence of birds. Disturbances such as free-ranging dogs, overgrazing, human activity in crop fields, power lines, chemical spraying, road movement, and overgrazing pressure were also recorded through direct observations.

Documenting dominant Vegetation

Data on overall habitat cover, dominant vegetation/crops, and vegetation/crop height were collected within a 100 m radius of the bird location throughout the season. The crop height was measured in the areas where GIB-LF was first observed. Subsequent measurements of vegetation and crop height were taken using direct field observations to understand the birds' preferences for selected locations that were used intensively.

Mapping land use changes

Land-use data, primarily new renewable energy projects and mining locations identified during the landscape surveys, were compiled. Additional data on existing and proposed developments were overlaid for the comparison.

Identification of Conservation/ Community Reserves

Using distribution data and Google Earth Imagery, potential areas that could be managed as Conservation/Community Reserve were identified as part of BNHS's long-term strategy. Key Informant Surveys (Marshall, 1996) were used to collect more qualitative and effective data. Key informants were identified based on their skills or societal position (Burgess, 1982).

Survey planning

During landscape surveys, five to six teams were deployed to carry out the survey, each comprising a minimum of four people: one biologist, scientist, or birdwatcher experienced in identifying species on the spot, one photographer, one data collector, and one volunteer. Survey teams conducted the ground survey in the grids using vehicle transects and point count methods in the early morning hours from 6:00 hrs to 10:00 hrs and in the late evening hours from 15:30 hrs to 18.30 hrs, depending on light availability. Thus, each team was assigned to survey one grid in the morning and one grid in the evening every day.

Survey protocol

A mix of point-count and line-transect data was collected. In each grid, 10-12 km of vehicle transects were laid. The vehicle speed was maintained between 10 and 30 km/h. From the start point to the endpoint, at 2 km intervals, a 10-minute point count was conducted 10 times. Animal and bird sightings were recorded between the point count locations as part of the line transect **(Please refer to Figure 10 on the next page).** The survey was designed to document information on the presence of grassland-obligate species such as Lesser Florican, Indian Grey Wolf, Blackbuck, Chinkara, Great Indian Bustard (GIB), raptors, Sandgrouse, Nilgai, Wild Boar, Indian Fox, and Jungle Cat.

Equipment used

Each team was equipped with a GPS device to record tracks, binoculars to observe and identify species, a rangefinder to measure the distance to the animal, and a Camera to record sightings through photographs.

Important habitat characteristics noted

Various factors, including land cover, topography, and human activities, were documented at a 2 km interval. To evaluate habitat quality, the primary land cover type, terrain type, and vegetation composition were recorded within a 100 m radius of the point.

Tracks covered

The tracks were saved using a GPS device. Habitat data and anthropogenic disturbances were recorded at 2 km intervals. If two or more trails were laid in the same grid, they were recorded separately with distinct track IDs. The tracks have been saved using GPS. The habitat data, along with anthropogenic disturbances, have been recorded at each 2 km interval.

Data Collection

- All the observations were entered in the Data Collection App, explicitly designed for landscape surveys by BNHS and The Bustard Program. All parameters, including GPS location, date and time, weather, terrain, vegetation cover, insect count, animal name, and detailed vegetation information, such as the names and characteristics of grasses, trees, shrubs, and invasive species, were entered into the app.
- The sighting of an individual animal or a group of individuals among any of the species mentioned in the survey protocol has been considered as one sighting.
- For each sighting, the number of individuals, sex (if possible), sighting angle, and sighting distance from the vehicle transect line have been recorded along with Latitude and Longitude coordinates during the vehicle line transect.
- At every point count, species sightings and habitat parameters like terrain type (flat, slope, undulating) and vegetation type (grassland, agricultural land, and forest/plantation) corresponding to each animal sighting within a 100 m radius have been recorded.
- Vegetation composition within a 100 m radius of the point was recorded as the percentage of area covered by short, medium, and tall grasses. The percentages of shrub and tree cover, along with the species name, were recorded.

Grassland mapping

Using species distribution data and ground knowledge, polygons were drawn around grassland patches in the district.

Data Analysis

The collected data, with timestamps for each activity, was subsequently subjected to thorough analysis. The primary objective was to gain a comprehensive understanding of how the Lesser Florican allocated its time within the sanctuary. The analysis involved collating the recorded data and quantifying the time spent on each activity category. The study aimed to provide valuable insights into the birds' daily time budget and activity patterns by calculating proportions and durations.

Ethical and Practical Considerations

Throughout the data collection process, ethical considerations were paramount. The observers maintained a respectful distance from the birds to minimise any potential disturbance. This approach ensured that the study would not adversely impact the Lesser Florican's natural behaviour. Furthermore, the watchtower location was carefully chosen to enable unobtrusive observation while providing a clear and safe vantage point.

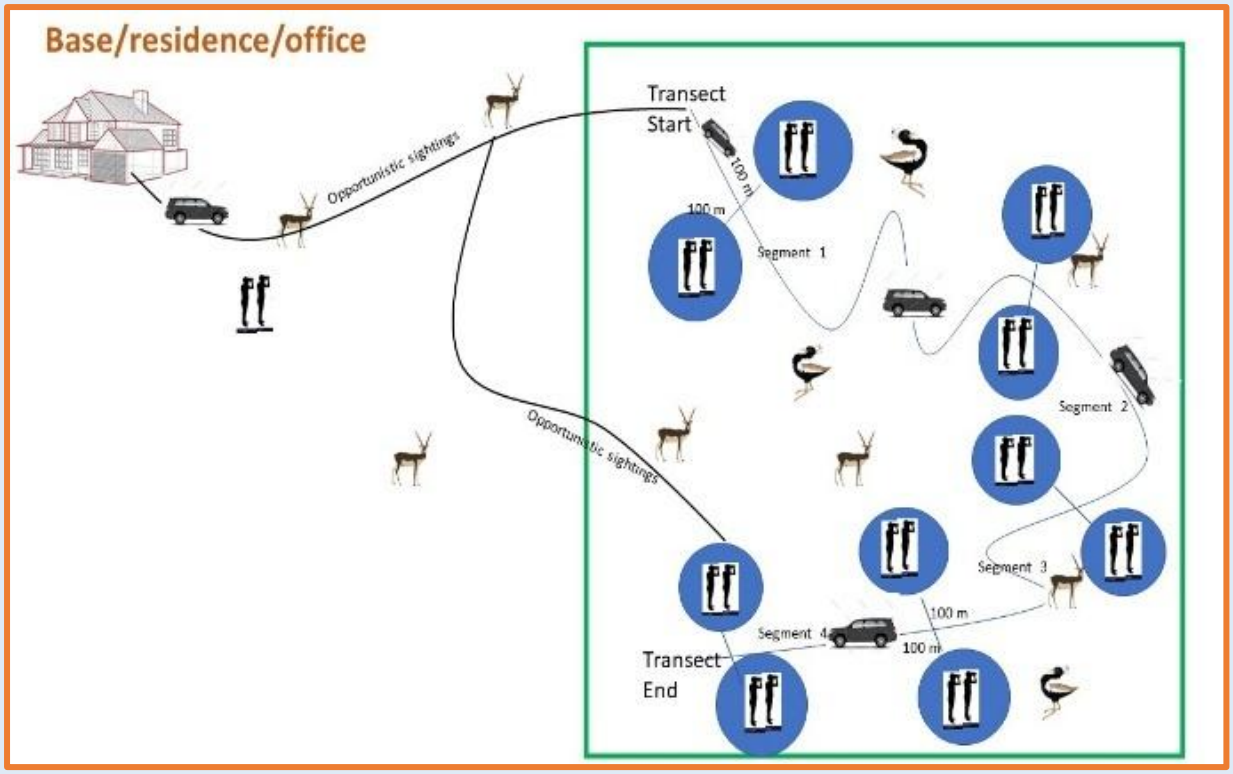


Figure 10. Multi-method survey approach for wildlife monitoring, integrating road surveys, point counts, transects, and opportunistic observations to document species presence, abundance, distribution, and habitat use, thereby enabling a comprehensive understanding of local biodiversity and supporting effective conservation planning.

The survey for the lesser Florican is conducted during the peak monsoon season, from July to September, when males are highly detectable due to their jumping display.

Chapter 1 – GIB and LF in Rajasthan

I) Lesser Florican in Rajasthan

Surveys done in the Ajmer area

Over the past years, the 3,762 km2 Shokaliya landscape, where LF was observed at 23 locations with an estimated 30-40 birds, has become a key LF conservation site for BNHS (**Please refer to Figure 11**).

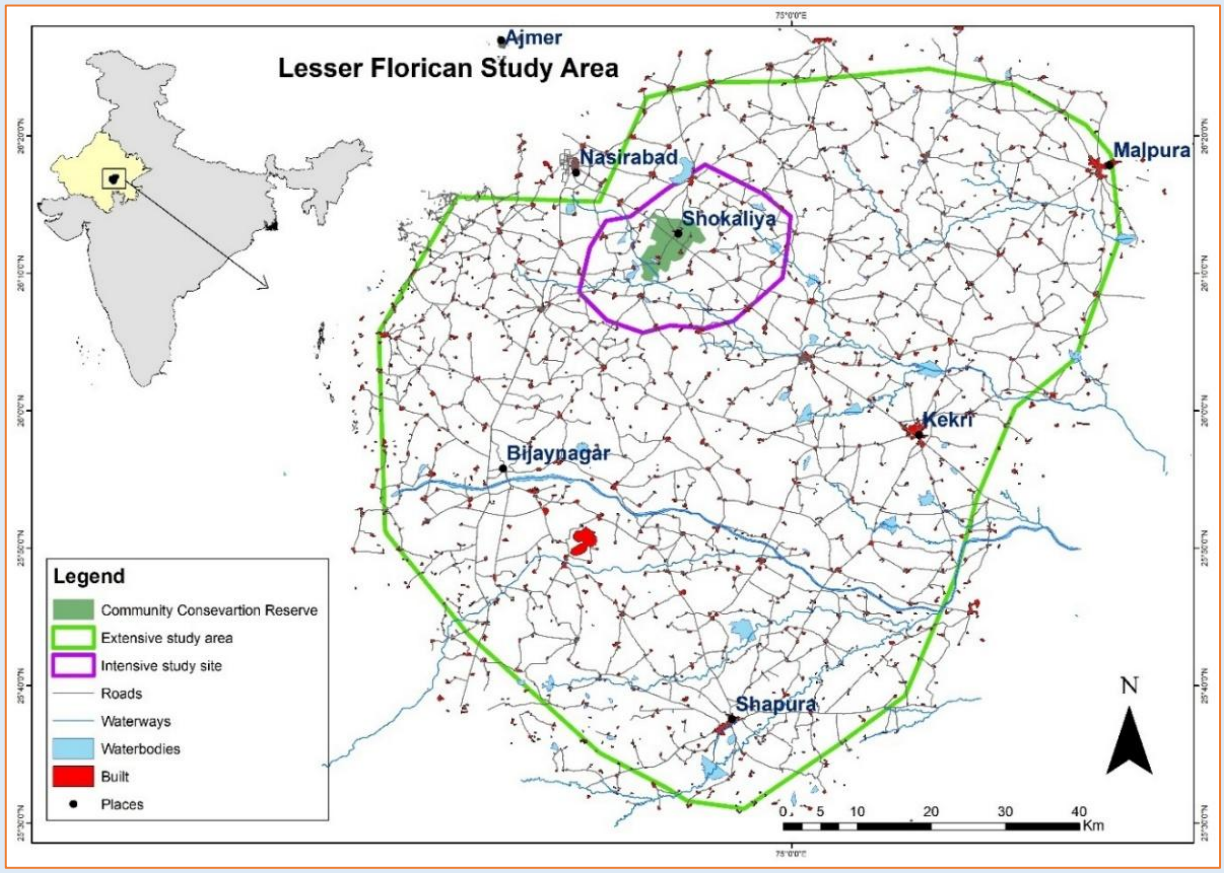


Figure 11: A comprehensive, in-depth study of the Lesser Florican population in the Ajmer region and surrounding areas. This research focuses on various aspects of the Lesser Florican's habitat, behaviour, and conservation status in this specific geographical context.

Except for a few reserve forests, there are no protected areas for conserving LFs in the Shokaliya landscape. Additionally, the site is under pressure from mining of ores such as Quartz, Feldspar, and Bauxite, as well as from intensive mechanised agricultural activities. In Rajasthan, BNHS conducted an LF population survey in 2017 on the Shokaliya landscape. This formed the basis for BNHS to develop a full-fledged conservation program in January 2019. Over the years, the Shokaliya landscape has lost its Great Indian Bustard population (~ 55 birds in the 1990s to 4 birds in 2016 and none after that). It is hoped that with support from the relevant government agencies and community engagement, the LF will have a brighter future than GIB in Shokaliya, which is one of the last remaining breeding grounds for the bird; hence, with the help of local communities and the forest department, BNHS is trying to declare the area as a community reserve to help conserve the species. According to section 36C under the Wildlife Protection Act 1972, where the community or an individual has volunteered to save

wildlife and its habitat, any private or community land not comprised within a National Park, sanctuary, or conservation reserve can be declared as a community reserve for protecting fauna, flora, and traditional or cultural conservation values and practices.

Objectives

1. Determine the distribution of LFs and their usage of the Shokaliya landscape, including identification of lek sites.
2. Identify the preference of LFs for the type and height of the crop in Shokaliya
3. Understanding threats to the LF
4. Identify potential areas that could be managed as LF Community Conserved Areas (CCAs)

Sightings of LF

LFs were detected in 73 locations, while male courtship displays were recorded in 52 locations. LF was recorded from the last week of June to the first week of November. The LF occupancy probability in the study area was 0.3173. The population declined again in 2023, with the total dropping to 20 (the male population decreased to 15 and the female population to 5), and to 13 in 2024 (5 males and 8 females). This reduction indicates that the challenges affecting the Lesser Florican population persisted (**Please refer to Figure 12**).

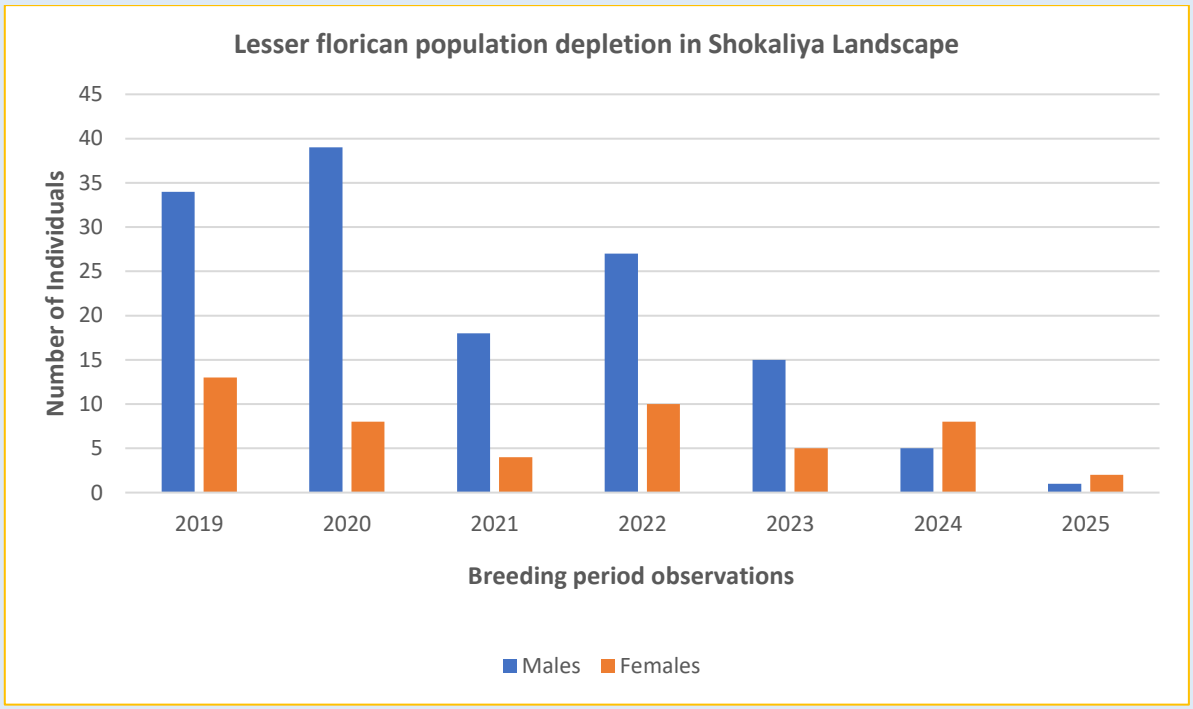


Figure 12: Since 2019, ongoing landscape surveys in the Ajmer region of Rajasthan have focused on counting the population of Lesser Floricans, including both males and females. These surveys aim to monitor and document the numbers and distribution of this unique bird species, providing valuable insights into their habitat and conservation status in the area. The male population decreased significantly, dropping from 34 males in 2019 to 1 in 2025.

Preferred display sight of LF: The display location of LF was found to be mainly covered by crops **(74%),** followed by fallow land (17%).

Observations

- **Fluctuations:** The Lesser Florican population has experienced significant fluctuations over the past five years.
- **Gender Imbalance:** A consistent imbalance exists between the male and female populations, with males generally outnumbering females.
- **Critical Declines:** The most critical decline occurred between 2020 and 2021, when the population more than halved.
- **Temporary Recovery:** A temporary recovery was observed in 2022 but was not sustained in 2023.

Habitat preferences

Overall Habitat Cover: The whole study area where the Lesser Florican was sighted had 62% crop cover, followed by 20% fallow land, 9% grass cover, 5% *Prosopis juliflora* cover, 3% *Prosopis cineraria* Khejri cover, and 1% other vegetation based on data collected over the last three years. In the landscape, only a few degraded grasslands, known as "Kankads," serve as grazing lands. LF tend to prefer these areas before settling in the crop fields. They particularly favoured crop areas with a height of less than 150 cm.

Crop pattern: The significant crops in the study area and their relative percentages were Jowar *Sorghum* spp. (47.4%)**,** Moong beans *Vigna radiata* (43%), Til or Sesame *Sesamum indicum* (5.1%), Bajra or Pearl Millet *Pennisetum glaucum* (3.3%), Gawar or Cluster beans *Cyamopsis tetragonoloba* (0.5%), Maize *Zea mays* (0.4%), Cotton (0.2%) (**Please refer to Figure 13**).

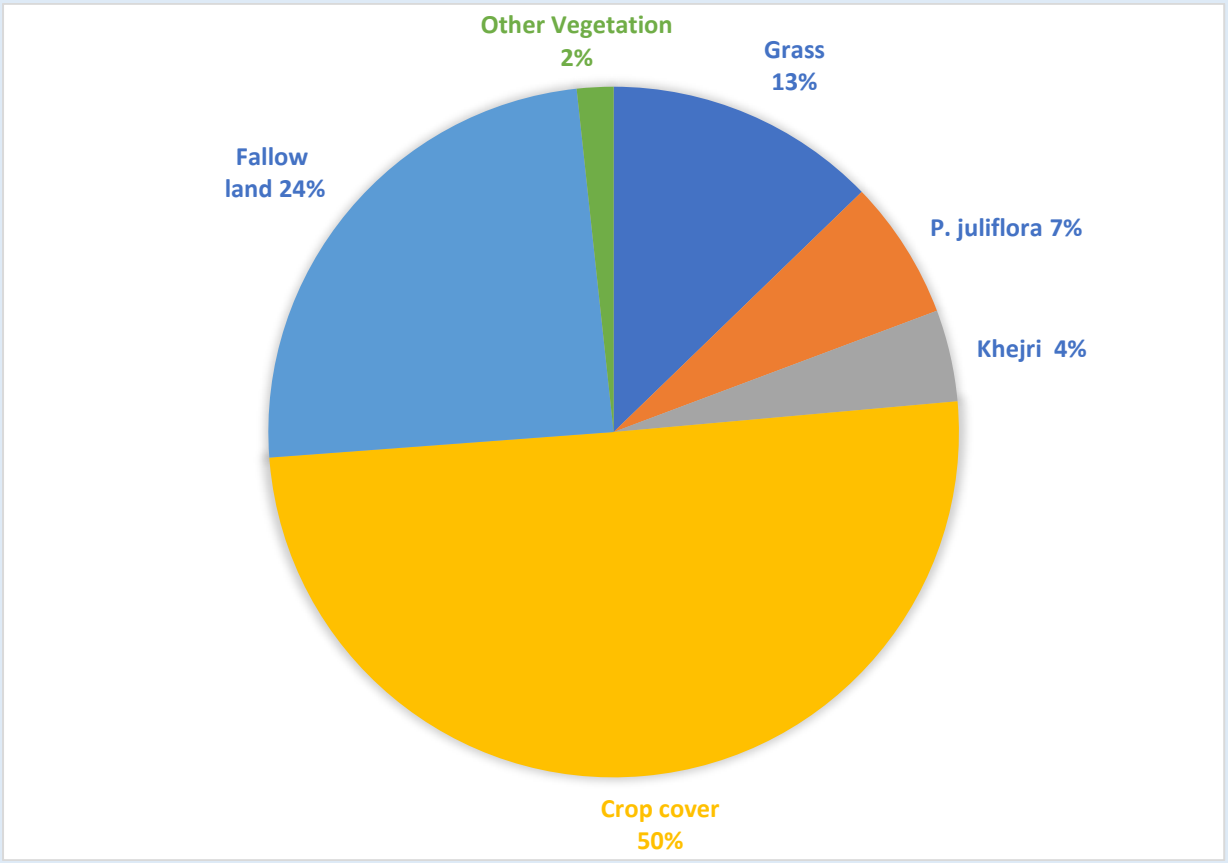


Figure 13A: The distribution of vegetation types in the habitat of the Florican species. This encompasses an analysis of the specific natural vegetation, which provides insights into the habitat requirements of the Florican.

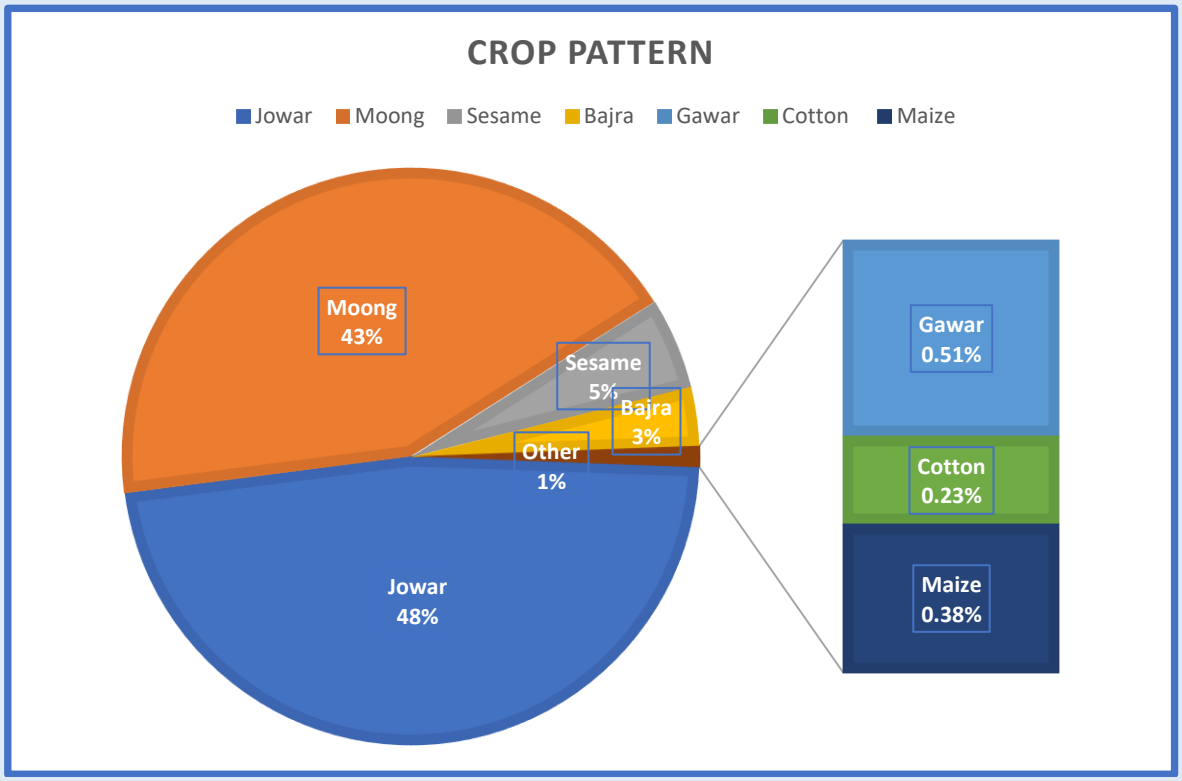


Figure 13B: The distribution of agricultural crops in the habitat of the Florican species. This encompasses an analysis of the specific crop types cultivated in the region, their seasonal growth patterns. Understanding the interaction between cultivated land and the habitat requirements of the Florican.

Response to Crop height over time: LF were observed from the third to the tenth week after crop sowing. In the third and fourth weeks, birds were observed to prefer *Sorghum* less than 75 cm tall. Later, birds began to shift toward areas with a mosaic of grains and pulses, i.e., mixed crops. The maximum pulse height was observed at 80 cm before harvesting. The grassland-obligatory species prefer grass, but hardly any grassland remains in this landscape, except for a few degraded grasslands or grazing lands.

During the monsoon period, when LF visits this area, the major crops that the farmers sow are *Sorghum* spp., *Vigna radiata*, and *Sesamum indicum*. Hence, among these crops, LF prefers *Sorghum* spp. The most suitable habitat for Vigna radiata is its own habitat, as no other habitat is available for the bird. LFs initially utilised Sorghum crops over Moong beans while the former's height was less than 100 cm (up to week four after sowing). Once Sorghum's height exceeded 100 cm, the birds moved to Moong beans, whose height was <100 cm (week five after sowing) (**Please refer to Figure 14**).

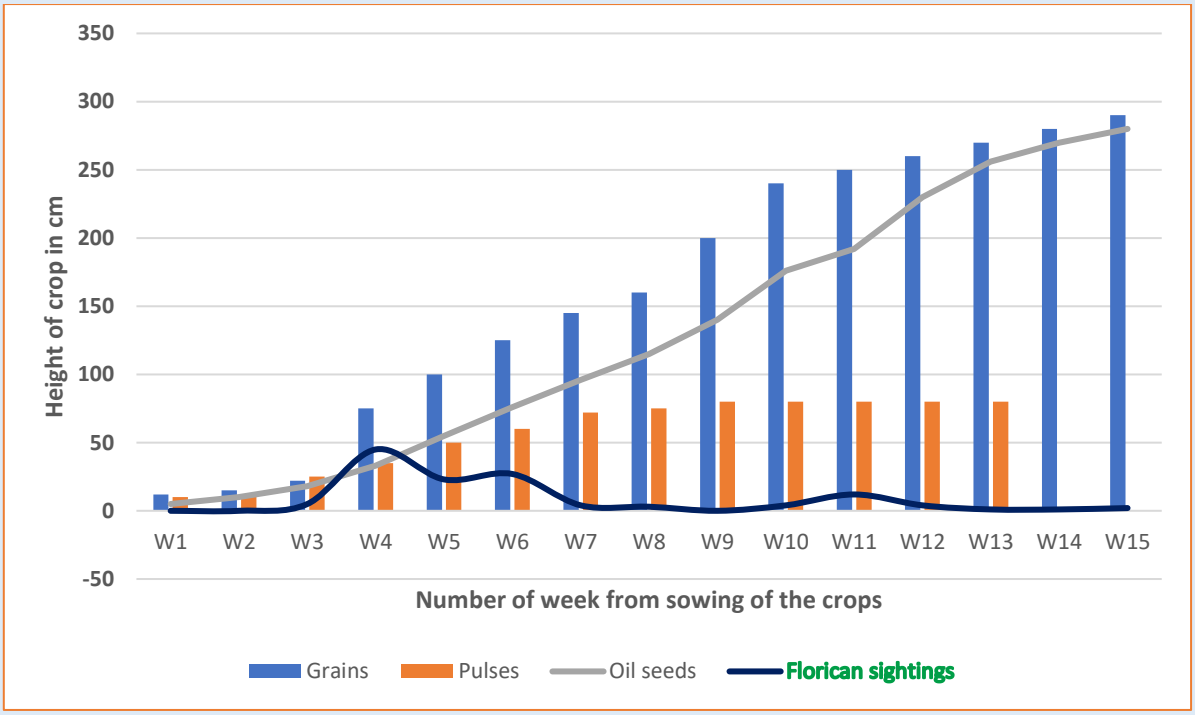


Figure 14: Floricans select their habitats based on the height of surrounding vegetation. They prefer areas where the crop height is below their line of sight, which allows them to stay vigilant. These environments support their needs for nesting, foraging, and predator protection. Understanding these preferences is essential for effective habitat management and conservation of these birds.

Display Clusters (Lek)

Spot-specific displays began in the 4th to 6th week of the monsoon (starting from 1st June) or in the 3rd to 4th week after crop sowing. The size of the male territory ranged from 50 to 100 Ha. The distance between significant display clusters ranged from 8 to 25 km, while the distance between sub-clusters ranged from 1.5 to 2 km (**Please refer to Figure 15 on the next page).**

Lesser flamingos show strong site fidelity once their territories are established. Our study identified four major display clusters and a few minor clusters, where a congregation of established male territories was recorded as follows.

1. The Shokaliya, Madhopura, Ramsar, and Bhagwantpura villages are located approximately 1.5-2 km apart.
2. Bhatiyani-Chat villages are approximately 10 km west of the Shokaliya cluster, consisting of three sub-clusters located approximately 1.5 km from each other.
3. Tantoti-Dhantol villages 15 km south of the Shokaliya cluster, consisting of two sub-clusters located approximately 1.5 km from each other.
4. Syar-Hingoniya 30 km South-East of Shokaliya cluster

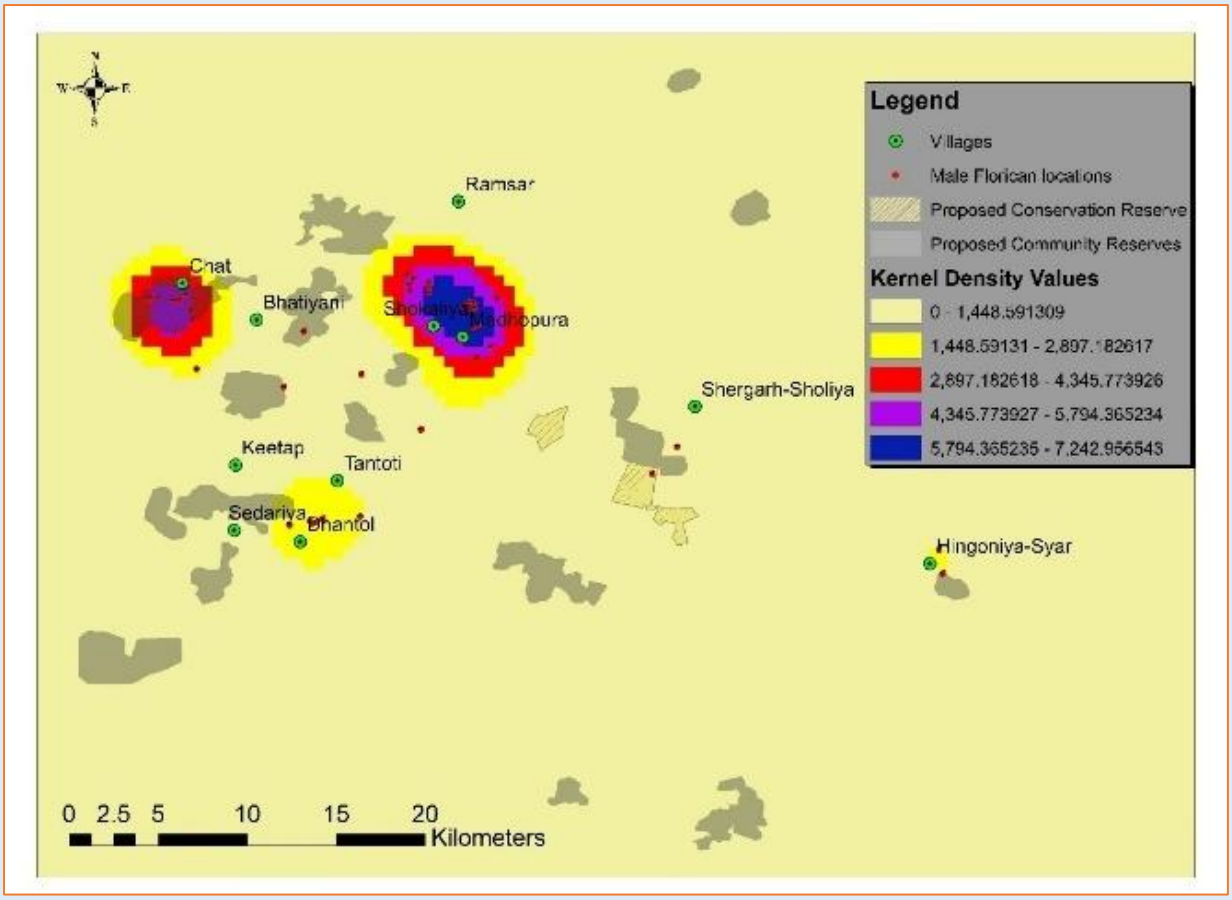


Figure 15: In order to observe the fascinating social behaviour of the Lesser Florican, one should look for its display clusters, commonly referred to as leks. These are specific areas where male Lesser Floricans gather during the breeding season to perform elaborate courtship displays in front of females. These clusters are characterised by males displaying striking plumage, engaging in distinctive ritualistic movements, and producing unique vocalisations to attract potential mates.

Potential Threats

Of the 230 surveyed locations, powerlines were recorded at 68 locations, followed by noise sources at 45 locations, tar roads at 31 locations, feral dogs at 25 locations, cattle grazing at 17 locations, humans at 9 locations, and chemical spraying at 6 locations within 200 meters of LF locations. On 12 occasions, feral dogs were recorded chasing or flushing off LFs.

i. ***Prosopis juliflora***: The area occupied by this invasive exotic species was least preferred by the birds, and it was observed that this species is chiefly responsible for the alteration and destruction of the grassland habitat.

ii. **Predators**: The LF was observed to be vigilant towards threats from predators, even at long distances; it avoided close-distance encounters by taking flight or hiding in tall vegetation.

iii. **Human**: Farmers working in crop fields did not appear to be a threat, as birds performed regular displays in their close presence. However, an unintentional direct approach towards the birds was met with walking or running away and, occasionally, a short flight.

iv. **Grazing**: Grazing in the proximity of 10 meters was treated by walking away and, on a few occasions, by flight.

v. **Dogs**: Dogs are a severe threat to displaying and incubating birds, eggs, and chicks. Dogs were avoided by birds taking flight, walking, or running away at close distances. A male lesser floater, visibly startled and visibly agitated, was observed reacting to the presence of

a free-ranging dog in its vicinity. This encounter was captured in a striking photograph by Mahesh Rajpoot, which highlights the intense moment of the male's flushed coloration. The dog's intrusion into the lesser floater's territory likely triggered a natural stress response, showcasing the delicate balance between wildlife and domestic animals in shared environments. A close encounter of a dog with LF was noticed twice (**Please refer to the Image below**).

A male LF displayed a sense of urgency as it was flushed by a nearby free-ranging dog. The moment captured by © Mahesh Rajpoot showcases the dynamic interaction between wildlife and domesticated animals in their natural habitat.

As a pilot experiment, two locals were deployed for two days to drive away the dogs from the LF location. Dogs were driven away nine times in the morning and five times in the evening during the 2-day monitoring period. The same dogs returned to the site on the same day and on consecutive days too (**Please refer to Figure 16**).

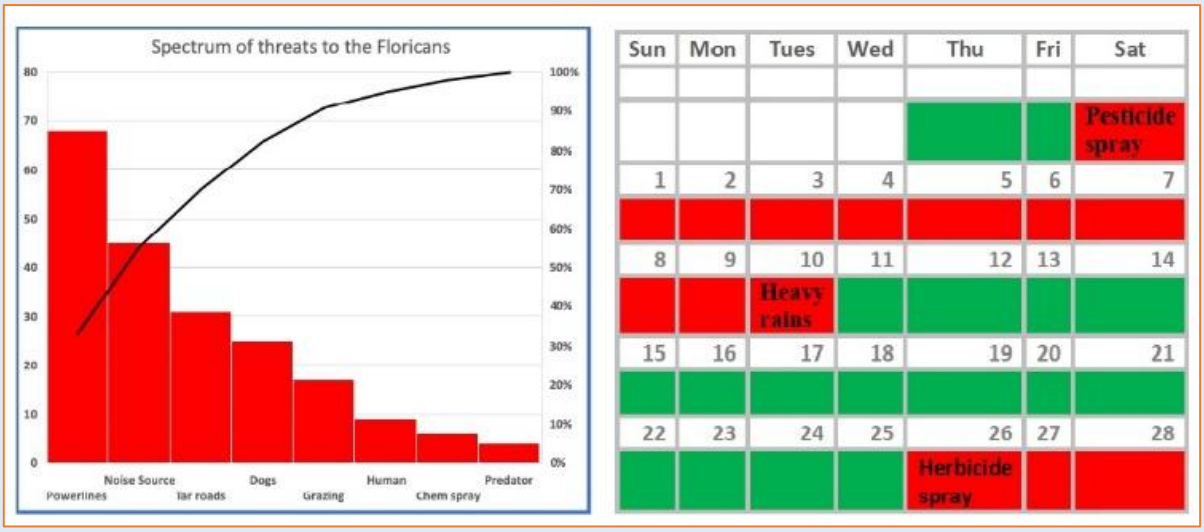


Figure 16: Left - Pareto graph showing the spectrum of threats to LFs recorded within a 100 m habitat patch; Right – presence (green) and absence (red) of male birds influenced by chemical use.

Chemical spray: The response to the chemical spray was the temporary abandonment of the site due to strong odours and a lack of insect food (**Please refer to the Image below).** On three occasions, the birds did not return to the site until the next rain shower washed off the pesticide.

Floricans all the way travelling from Deccan south to the North-Western part of India* and *facing issues of low breeding survival due to intensive agriculture, © BNHS archive

Disturbances to LF at display clusters

The distances in vegetation (or crop) height within the 100-meter habitat patch were related to various disturbances at the display clusters. Vegetation height may play a role in damping disturbances or in providing a proper hiding place for birds from disturbance (**Please refer to Figure 17**).

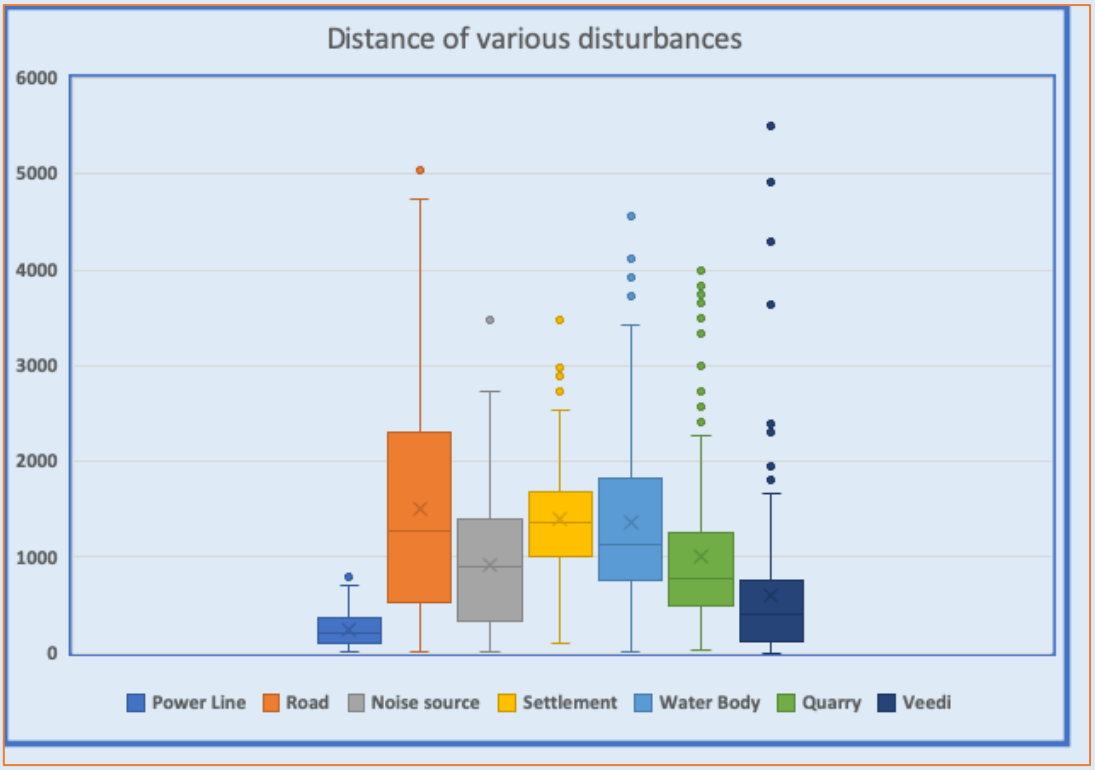
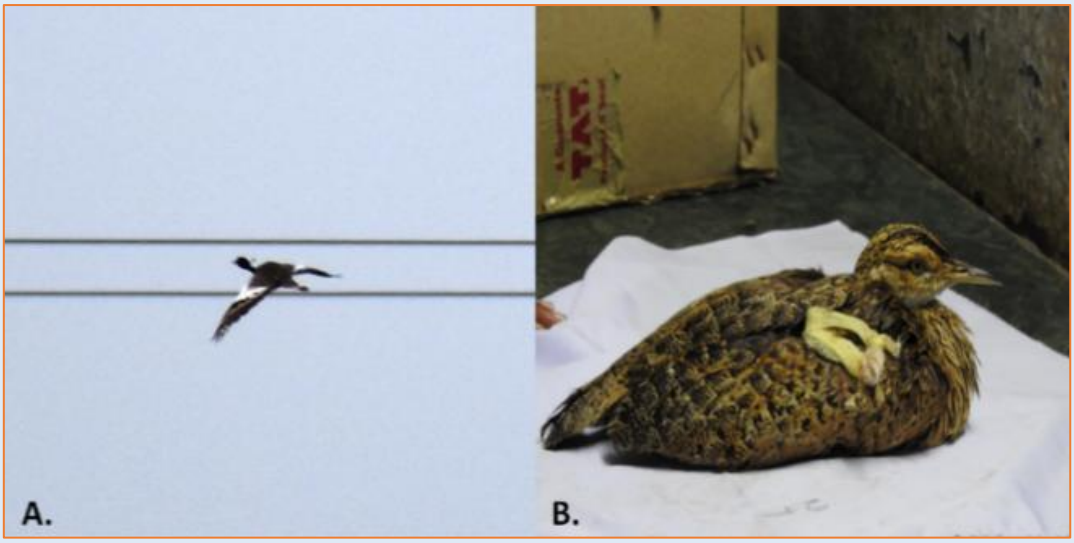


Figure 17: Proximity of Lesser LF Territory to the Closest Edge or Disturbance Source. This figure illustrates the distance between the territory of the Lesser LF and the nearest edge or source of disturbance. It highlights the spatial relationship between the Lesser LF's habitat and potential environmental stressors.

a) **Power line:** The nearest power line recorded was 5 meters, while the longest distance was 800 meters, with a median value of 200 meters. The 25-percentile value was 100 meters, and the 75-percentile value was 362 meters. (**Please refer to the image below)**
b) **Road**: The nearest tar road recorded was 10 meters, while the longest distance was 5032 meters, with a median value of 1280 meters. The 25th percentile value was 529 meters, and the 75th percentile value was 2306 meters.
c) **Noise Source**: The nearest noise source recorded was 10 meters, while the longest distance was 3470 meters, with a median of 893 meters. The 25th percentile value was 332 meters, and the 75th percentile value was 1392 meters.
d) **Settlement**: The nearest settlement recorded was 107 meters, while the longest distance was 3470 meters, with a median value of 1368 meters. The 25th percentile value was 1005 meters, and the 75th percentile value was 1676 meters.
e) **Quarry**: The nearest quarry recorded was 37 meters, while the longest distance was 3993 meters, with a median of 769 meters. The 25th percentile value was 489 meters, and the 75th percentile value was 1258 meters.
f) **Water body:** The nearest water body recorded was 10 meters, while the longest distance was 4562 meters, with a median of 1138 meters. The 25th percentile value was 753 meters, and the 75th percentile value was 1823 meters.
g) **Kaankar (grassland or common grazing land):** Nearest Kaankar recorded was 0 meters, while the longest distance was 5500 meters, with a median value of 405 meters. The 25th percentile value was 120 meters, and the 75th percentile value was 767 meters.



Male LF closely avoided collision with a power line © BNHS archive, B. Injured female due to collision with power line, which eventually succumbed to its injuries © Neelkanth Bora.

Discussion

The LF generally prefers undisturbed grasslands as habitats (Sankaran, 1997). However, the Shokaliya landscape utilises agricultural fields. This may be because of the traditional agricultural practices preferred by local farmers or strong site fidelity to breeding grounds (Dutta *et al.* 2018; Narwade *et al.* 2020). Even though the area is dominated by agriculture, the landscape is a mosaic of crops and scrublands, with approximately 20% under Kaankars (protected grazing lands characterised by dense scrub cover). Kaankars may be a crucial refuge, providing shelter to the LFs when agricultural activities peak on agricultural lands. The Kaankars have been invaded by an exotic species of *Prosopis juliflora* that has significantly impacted the habitat of these typical grasslands. Traditional agricultural patterns with minimal disturbance and a diversity of crop species are also known to benefit other LF and bustard species (Salamolard & Moreau, 1999; Bretagnole *et al.*, 2011). Regularly sighting males in established territory for a season indicates that LFs show site fidelity to their display clusters in the ongoing breeding season.

However, it is challenging to determine whether individuals exhibit inter-year site fidelity, as ring recoveries in LFs are generally low (3.48%), and recoveries at the ringed site or exact location are even lower (1.23%), as noted by Dharmakumarsinghji (1950). Once territories are established, males remain site-faithful until the end of the breeding season (Ali *et al.*, 1984). The priority criteria for display site selection are to maximise the detectability of visual and acoustic signals over large areas and to access more resources, such as food and mates (Salamolard & Moreau, 1999). The cues in display site selection to enhance detectability may include elevation, vegetation cover, and vegetation height. The shift of the display sites within territories was a response to vegetation/crop height (Sankaran, 1996). Also, at the same time, they are getting started to get food in the form of the pod borer/larva of Moong beans

LFs were observed to alter their behaviour in response to different threats. Some threats elicit the highest response to disturbance, i.e., escape (Ydenberg and Diand ll 1986). Threats from grazing animals and humans working in the field, if they were at a safe distance, did not elicit an escape response. Any unintentional movement towards the bird in its proximity was considered a moderate threat, and the bird responded by walking away or running.

Only very close encounters were responded to, short flights. In response to direct disturbances, the birds' escape movements may also expose them to additional threats, such as power lines in their flight paths, thereby increasing the probability of collision. Power lines significantly contribute to unnatural mortality in Great Bustards and the critically endangered Great Indian Bustard (Alonso *et al.*, 1994; Palacín *et al.*, 2004). Response to chemical spraying was the second highest as the bird abandoned the site for more than 15 days until the chemicals were washed away by rain. Regular disturbance resulted in quick shifting or abandonment of sites. A series of threats in an area will likely increase the time LFs spend on vigilance rather than on displays, feeding, and roosting, which may ultimately influence breeding success. Many studies have documented that birds respond to different types of human activities, depending on the specific characteristics of the approaching disturbance sources, such as speed or noise, or the potential danger they imply (Riddington *et al.*, 1996; Sastre *et al.*, 2009). Additionally, they treat different habitat types and non-habitat edges differently.

Depleting Population of Lesser Florican in Rajasthan – an alarming situation

In 2019, a total of 47 Lesser Floricans (34 males and 13 females) were recorded across all potential breeding sites, including the Shokliya, Bandanwada, Kalyanpura, Dhantol, Arwar, and Bhagwantpura areas, which were once considered strongholds for the species. In 2020, the count remained at 47 individuals (39 males and 8 females), but by 2021, it had fallen sharply to just 22 (18 males and 4 females). A slight recovery was noted in 2022 with 37 individuals (27 males and 10 females), yet the trend again turned downward in the following years 20 in 2023 (15 males and 5 females), 13 in 2024 (5 males and 8 females), and by 2025 just 3 individuals were sighted (1 male and 2 females), the species was seen only at two sites, Kalyanpura and Dhantol. The lone male was sighted in *Kalyanpura village* between 14 July and 7 August 2025 by the BNHS team, but was not seen again after August 7. Meanwhile, two females were documented only twice in Dhantol during the intensive survey conducted between 19 and 24 August 2025. This sharp decline is linked to several factors, including changes in cropping patterns, extensive use of chemical fertilizers and pesticides, collisions with power lines, grazing by cattle, and disturbances caused by unethical photography, directly observed by the survey team with this an important on ground observation by the team was that of change in landscape as intensive chain linked fencing has been introduced in the region which is adversely impacting the free movement of the floricans even creating hurdles for selecting the display sited an important step in lek formation. The introduction of threshers for mechanised crop cultivation has been lethal to females and young ones, and multiple instances have been noted in which they have been killed by these power machines, negatively impacting the recruitment of the CR Lesser Floricans. The situation highlights the fragile survival of the Lesser Florican and calls for urgent, coordinated, and stronger conservation measures to protect this critically endangered species.

Implications of conservation interventions

The data analysis indicates that the Lesser Florican population experiences significant periods of stress followed by recovery, pointing to the species' susceptibility to external factors. Effective conservation initiatives should prioritise addressing the root causes of these fluctuations, including habitat degradation, climate change, and human activities. Furthermore, the persistent gender imbalance in the population necessitates targeted strategies to achieve a more balanced and sustainable population. The insights gleaned from the graph depicting the Lesser Florican population dynamics over the past five years underscore the urgency for sustained and intensified conservation efforts **(Please refer to the image below).** Given the substantial fluctuations and gender imbalances observed, a comprehensive understanding of the underlying causes of these trends is crucial. This understanding will be instrumental in devising well-informed strategies to safeguard and maintain the Lesser Florican population over the long term (**Please refer to the image below**).

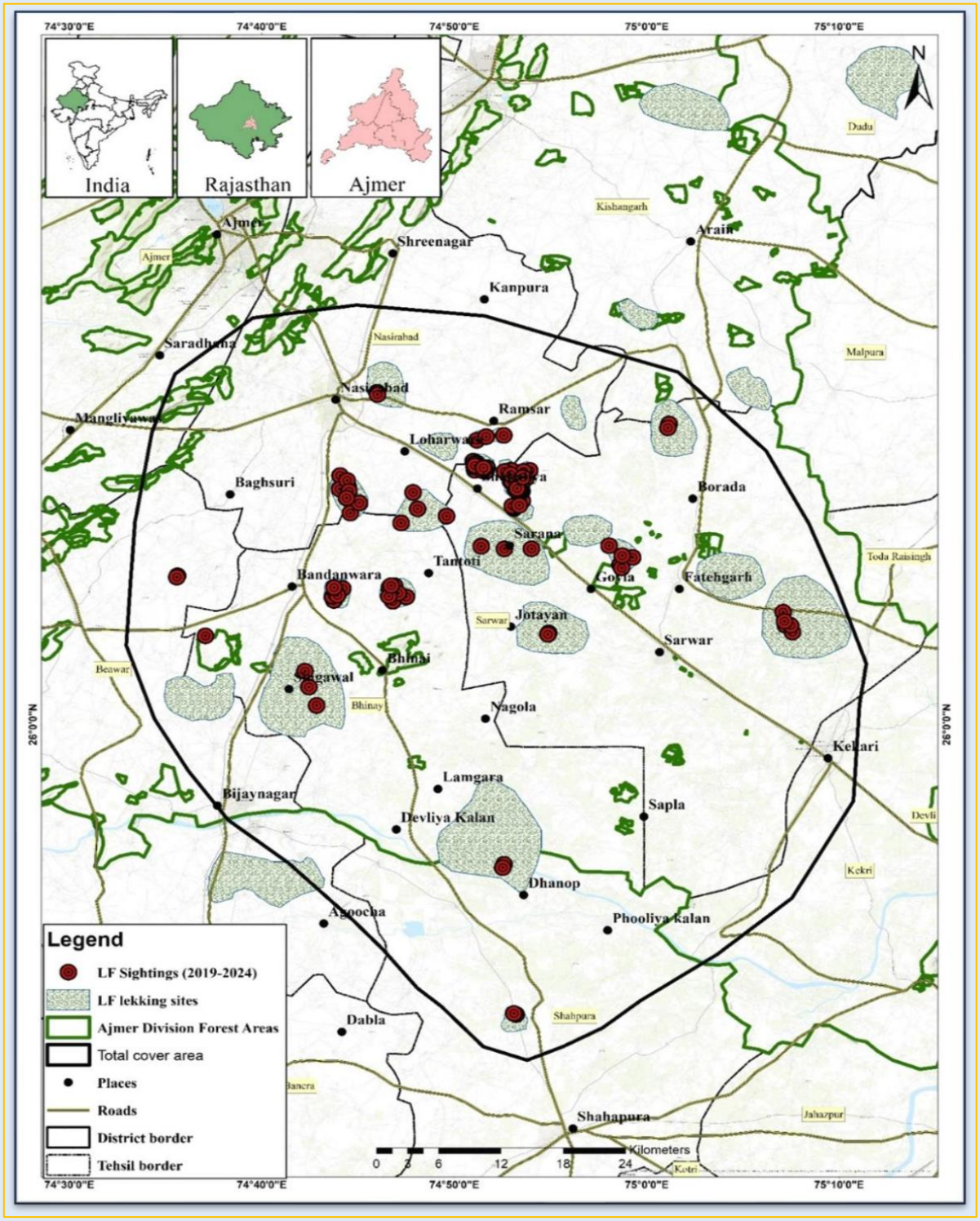
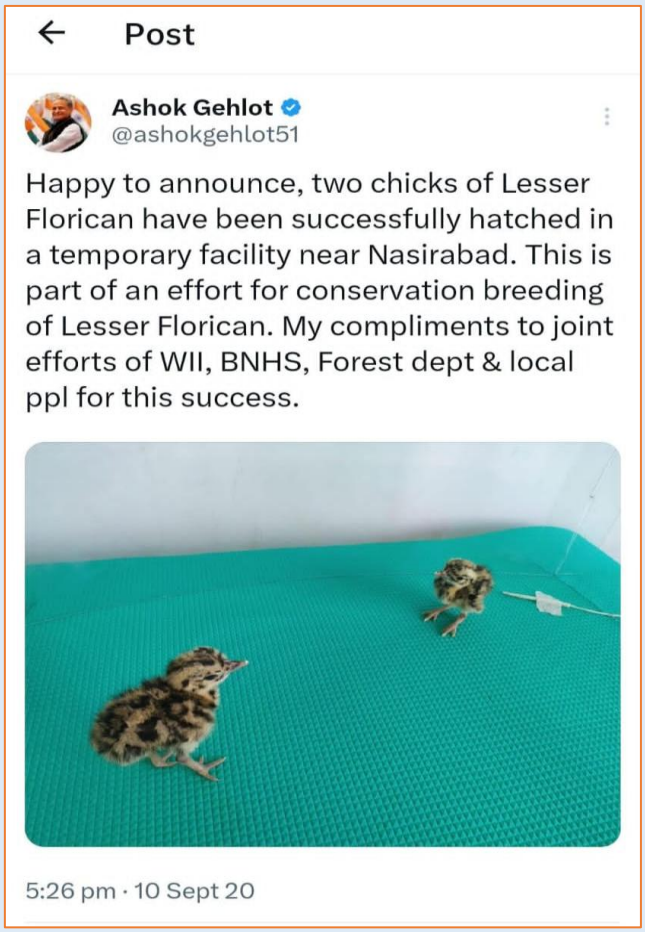


Figure 18: LF sighting locations from 2019 to 2024, focusing on specific polygons identified as potential habitats for protection. These areas are vital, as birds consistently return to them, demonstrating strong site fidelity. By prioritising these habitats, we can effectively support the well-being of these species and their ecosystems.

Shri Arindam Tomar, the former Chief Wildlife Warden, formed a team led by Shri SVR Murthy, Chief Conservator of Forests (right), Shri CR Meena, the then Conservator of Forests in Ajmer (middle), and Mr Rohit Gangwal from the Raksha NGO (left). Mr Gangwal requested assistance from the Bombay Natural History Society (BNHS), which resulted in the discovery of the first two eggs in September 2020. These eggs were subsequently handed over to the Rajasthan Forest Department for a conservation breeding program.



In the first week of September, the nest and eggs of the lesser florican were shared with the Forest Department and WII for initiating the conservation breeding program. Shri Ashok Gehlot, former Chief Minister of Rajasthan, tweeted about this news and BNHS's contribution.

In October 2019, based on the recommendations of a report submitted by BNHS, the National Green Tribunal (NGT), Principal Bench, New Delhi, in response to two appeals, ordered a stop to mining and the protection of the grasslands of Sivayachak (102.41 km²) and Charagah (57.47 km²). The NGT also ordered a halt to further mining at the florican sites in 43 villages of Shokaliya to conserve LF. Further, the Principal Secretary, Department of Forest and Environment, and Chief Wildlife Warden of the State of Rajasthan were directed to identify the area required for the conservation of Kharmor (LF) on an emergency basis and notify the same as Kharmor conservation area or bird sanctuary as deemed appropriate within six months from the date of the order. Mining leases found to fall within the LF conservation area can be restrained by the State Respondents under the EIA Notification, 2006.

Another benchmark decision by the National Green Tribunal (NGT), Principal Bench, New Delhi, in response to the original application, directed the Rajasthan State Forest Department on 3 March 2020 to issue a notification within six months regarding the establishment of a Community Reserve for the conservation of the Great Indian Bustard (GIB) and Lesser Florican.

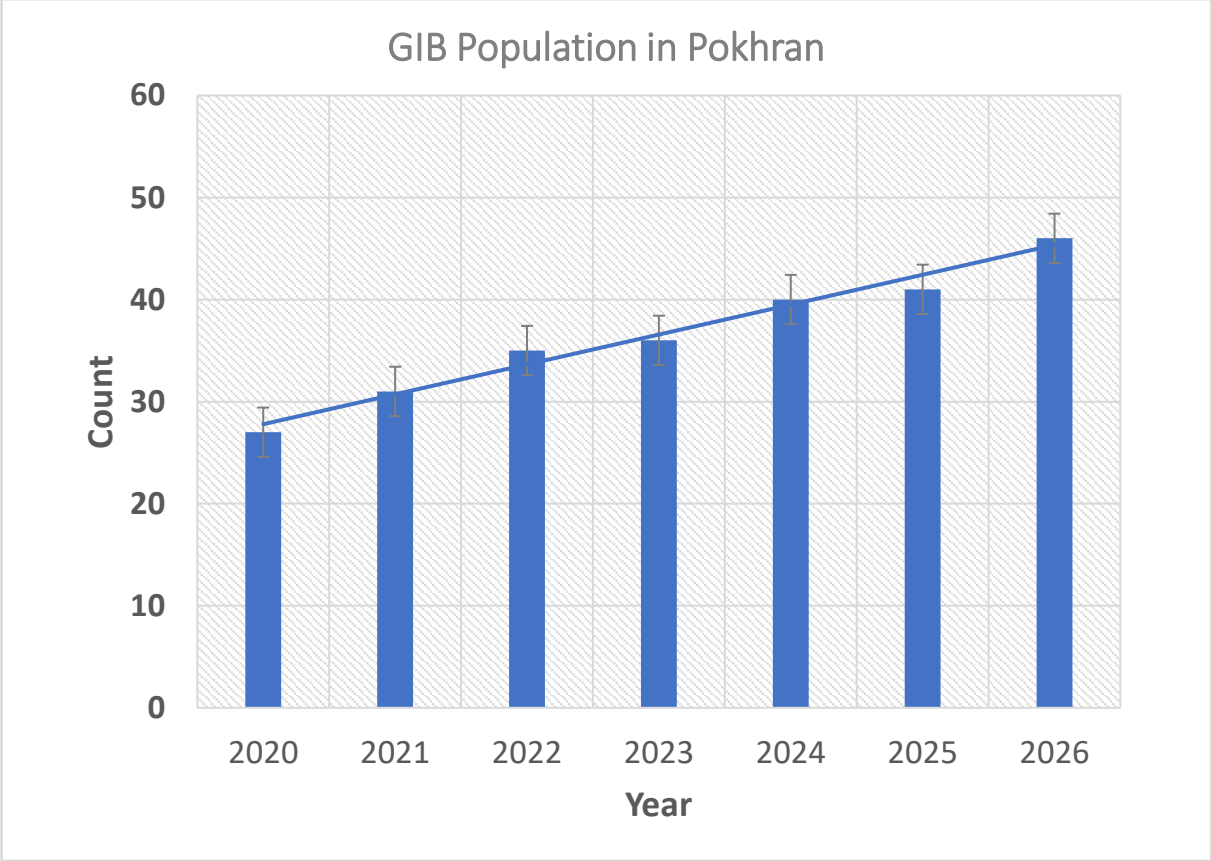
The way forward – Florican-friendly agriculture practices

1. Since most LFs breed in crop fields, promoting LF-friendly agricultural practices is necessary. An LF recovery program should include a component of a sustainable agricultural scheme. Farmers who adopt LF-friendly agricultural practices should be given training and certificates from the relevant agencies to access better market prices for their crop yields as incentives.
2. Bio-fertilisers and bio-pesticides should be promoted and incentivised to reduce the chemical load in farmlands.
3. In areas where the female LFs rest, traditional manual farming tools could be encouraged under agri-environmental schemes, such as special incentives for leaving the nesting areas on the farm untouched or ensuring minimum disturbance to the birds during their breeding season.

A constructive strategy to enhance agricultural practices to conserve the Lesser Florican in the agropastoral landscape involves sustainable farming methods, habitat management, and community engagement. Key steps include promoting crop diversification, reducing chemical inputs, and establishing buffer zones to protect critical breeding habitats. (Illustration made using AI tool MS Copilot)

II) GIB in Thar Desert, Rajasthan

The bar chart titled **"GIB Population in Pokhran"** shows a steady increase in the number of Great Indian Bustards (GIBs) between 2020 and 2026. Each year is represented by a blue bar, with the population count rising consistently from below 10 in 2020 to nearly 50 by 2026. A dotted trend line runs through the tops of the bars, highlighting the positive growth trajectory. This upward trend suggests that conservation efforts in Pokhran have been effective, leading to a gradual recovery of the species in this region.



There is a steady rise in the Great Indian Bustard population in Pokhran from 2020 to 2026, reflecting successful conservation efforts by BNHS, the Indian Army, the Bishnoi community, and local villagers.

A sensitivity map based on GIB sightings, movement patterns, and habitat suitability was prepared to identify critical habitats for the birds. The landscape was divided into high- to low-conservation-priority zones with distinct colour codes. Recommendations for each were also provided to help prepare a guideline for future landscape development activities (**Please refer to Figure 19**).

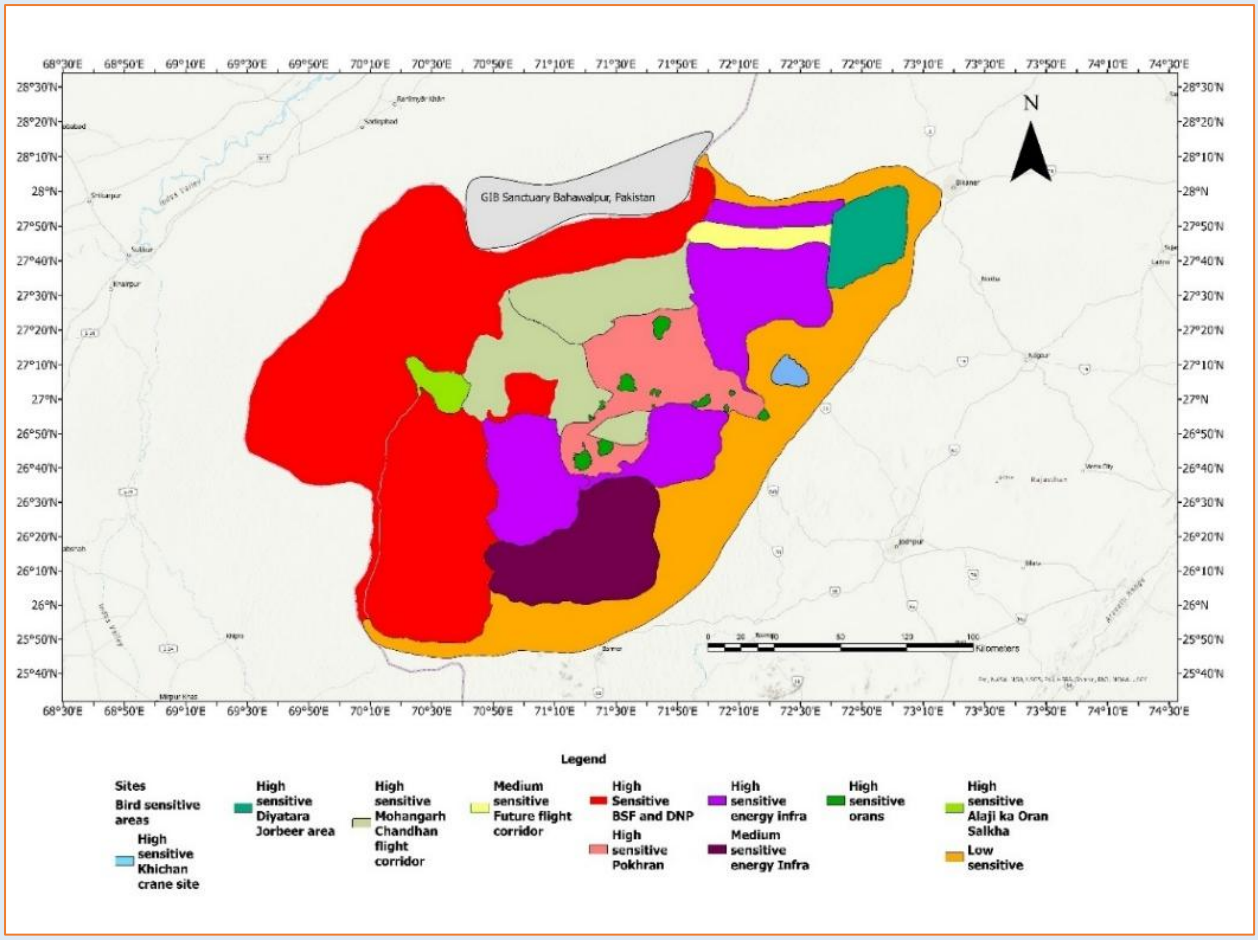


Figure 19: A sensitivity map for the Great Indian Bustard (GIB) and wildlife in the Thar Desert was developed to highlight the importance of data-driven policy-making for conservation. This map identifies critical habitats and areas vulnerable to human activities, serving as a crucial tool for policymakers and conservationists. It emphasises the need to incorporate scientific data into decision-making to effectively protect the Thar Desert's unique ecosystem and ensure the survival of the GIB and other wildlife species.

Major conservation issues

1. **Poaching** – Poaching incidents have been reported in the Pokhran area, mainly for Chinkara and Spiny-tailed Lizard, but alert Bishnois, the local community people, have been trying to curb it.
2. In summer, the rain-fed water bodies dry up; these are the primary sources of water for wildlife, which indeed face **severe water scarcity**.
3. **Free-ranging dogs** have been a significant threat to wildlife.
4. **Invasion of the tree *Prosopis juliflora* (an exotic species)** in some of the pockets.
5. **Overgrazing**, especially when there are no crops in the farmlands.

Village-wise action plans in the Pokhran area

The villages of Khetolai, Dholiya, Loharki, Askandra, Kala, Khara, Ramdevra, Chanani, Odhaniya, Chacha, Ajasar, and Bhadariya are situated within the tehsil of Pokhran, located in the Jaisalmer District of Rajasthan, India. This region, characterised by its arid landscape and rich cultural heritage, is bordered by a nearby military area defined by the geographical coordinates of 26°40' to 28°23' north latitude and 69°20' to 72°42' east longitude. These sightings typically occur during the winter season, when the GIB migrates in search of suitable

habitats. The local communities in these villages take pride in their role in conserving this remarkable bird, contributing to the region's ecological significance and drawing attention to the unique wildlife inhabiting Rajasthan's arid landscapes. **(Please refer to Figure 20).**

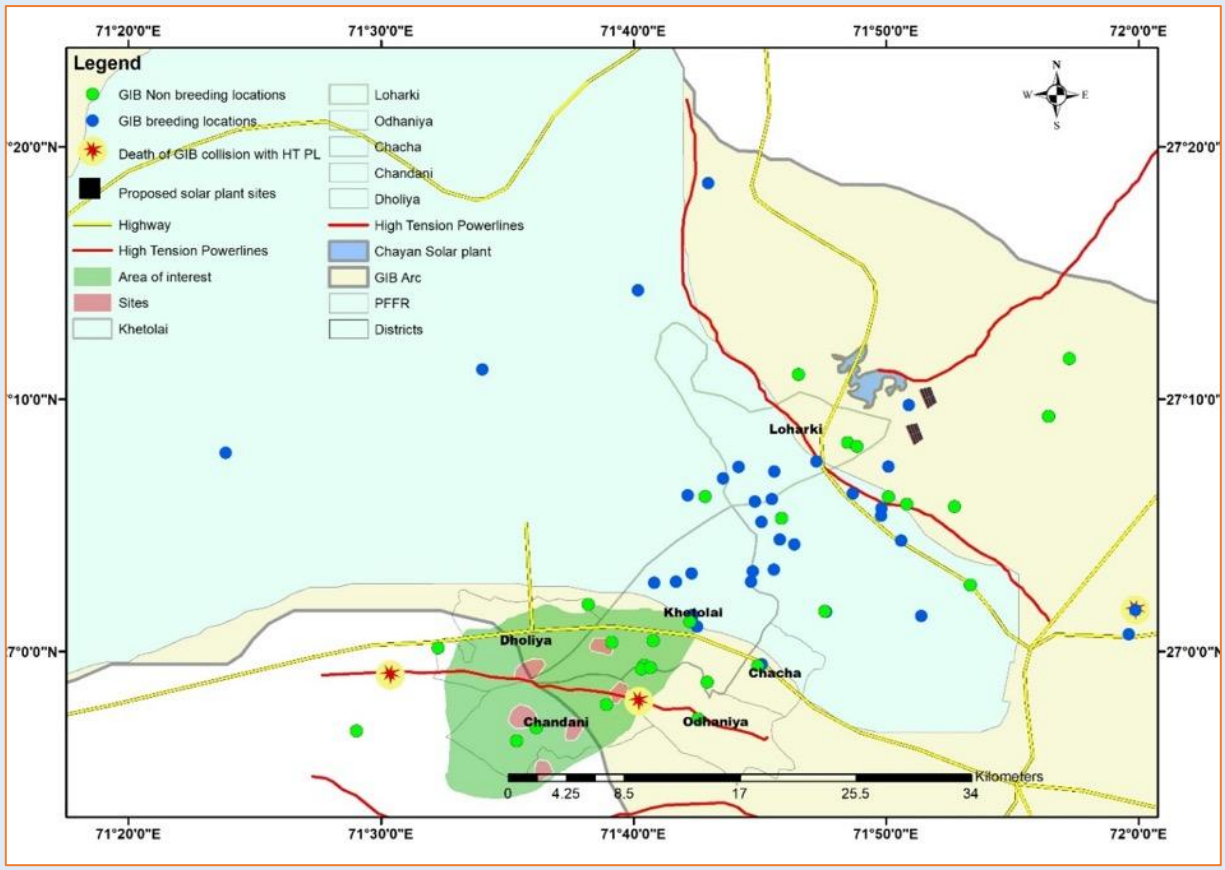


Figure 20: GIB in PFFR area, existing infrastructures, villages playing a crucial role in wildlife conservation and the proposed area to be managed through Private-Public Partnership

Village-wise wildlife conservation plans are being prepared based on the following information collated for three villages, Khetolai, Dholiya and Loharki.

Agriculture

Arable land accounts for 60 per cent of the village area; 10 per cent is grassland devoted to cattle grazing, and the rest is residential. Agriculture depends on monsoon rains, which are called *Barani* in the local language. The locals do sow in July and August, and the cropping season is known as *Kharif*. Major Kharif crops are Bajra, Jowar, Gwar, Til (sesame), Moong, and Moth. Crops sown in winter, known as *Rabi*, depend on pre-winter showers. Taramira is harvested in late spring (Feb–March). The different crops that are produced are as follows:

1. Bajra/ Pearl Millet (*Pennisetum glaucum*) – Major source of Food and Fodder
2. Gwar/Lond Bean (*Cyamopsis tetragonoloba*) – As Cash crop and Fodder
3. Jawar/Sorghum/Great Millet (*Sorghum bicolor*)- As Fodder
4. Til/Sesame (*Sesamum indicum*) – Cash crop
5. Moong/Green Gram (*Vigna radiata*) - Food and Fodder
6. Matki/Mat/Moth Beans (*Vigna aconitifolia*) - Food and Fodder
7. Taramira (*Eruca sativa*) – Cash crop and Fodder

Most of the produce is purchased by middlemen/buyers at the village level. A few farmers sell their crops in Pokhran; the nearest government-regulated agricultural produce market is in Phalodi, 70 km away.

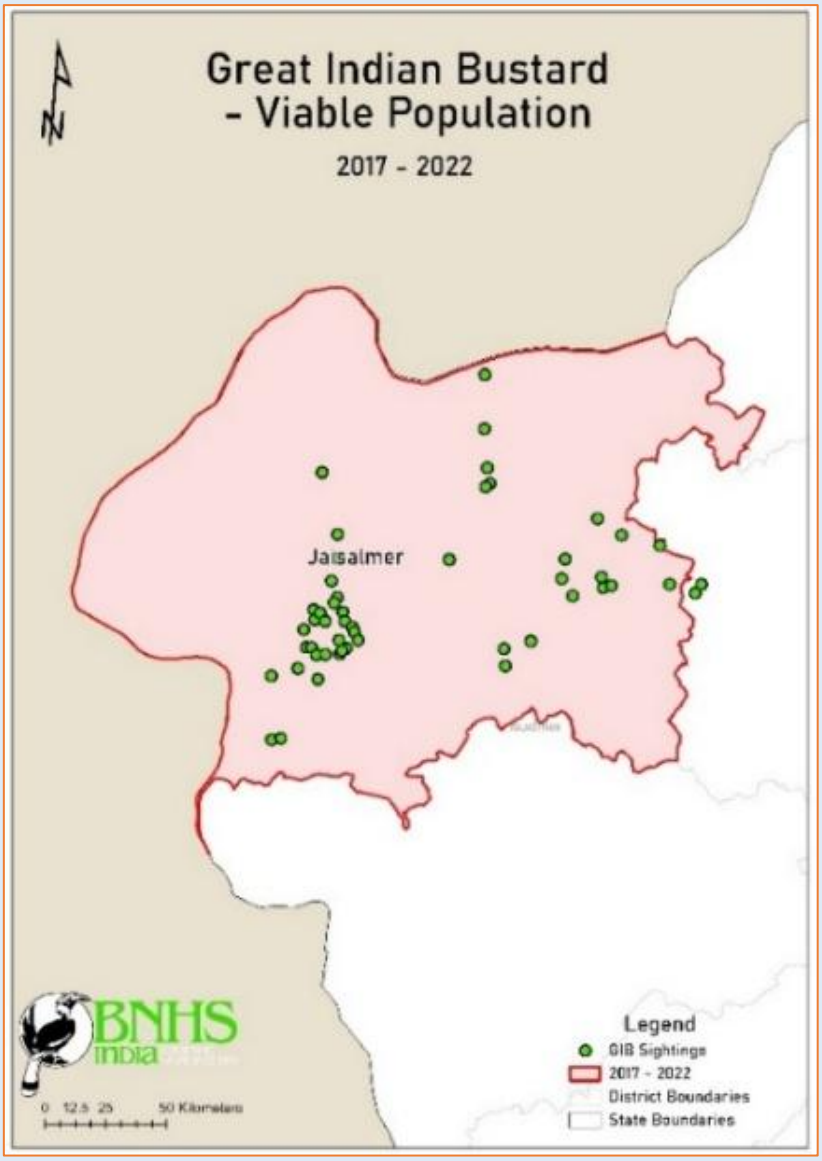


Figure 21: The map illustrates the area where the project is being implemented, highlighting various villages within the region. Additionally, it provides a comprehensive overview of the distribution of the viable population of the Great Indian Bustard (GIB) in the Jaisalmer district, highlighting key locations where this endangered species is found.

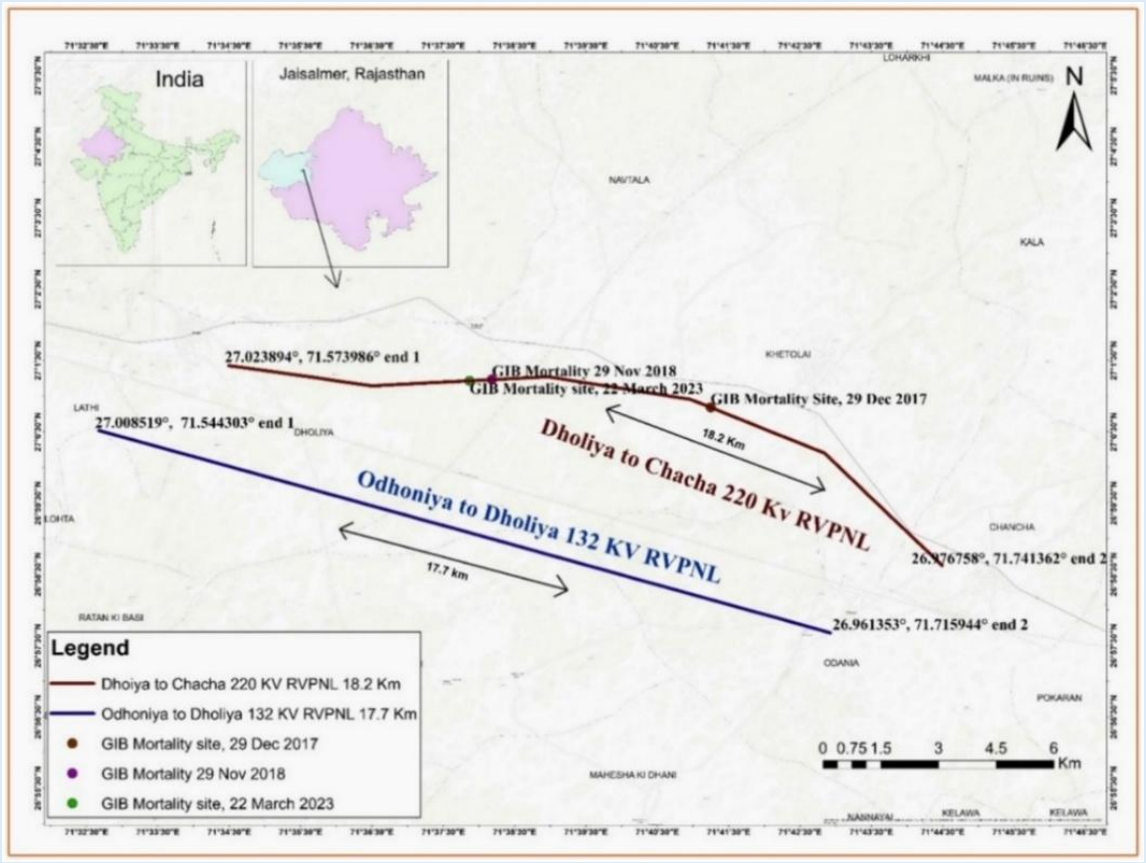


Figure 22: A detailed map shows stretches of HTTL that need to be undergrounded as a priority to save the major population of GIB using the Pokhran Field Firing Range and surrounding areas.

Around 167.66 km of underground infrastructure must be urgently implemented to save more than 50% of the global GIB population in the Pokhran area. Similarly, powerline undergrounding can be carried out in priority areas identified by the WII (please **refer to Table 03).**

SN	Name of Powerline to be undergrounded	Distance in km
	On an urgent basis (35.9 km)	
1	Dholiya to Chacha	18.2
2	Odhaniya to Dholiya	17.7
	Other important lines near PFFR (49.86 km)	
3	Ramdevra to Eka	10.5
4	Askandra	3.38
5	Ajasar to Loharki 01	11
6	Ajasar to Loharki 02	6.59

7	Ramdevra to Loharki	13
8	Dholiya to Lathi	4. 36
9	Eka to Pabupadiya	5.39
	Other important lines near DNP (81.9 km)	
10	Line Suzlon 220 kv (near DNP)	24.7
11	HT Powerline Kanoi (near DNP)	24.6
12	Powerline through Alaji Oran (near DNP)	32.6

Table no 3: showing powerlines to be undergrounded in the Pokhran area

GIB and raptors in Deg Rai Mata *Oran* and the surrounding

Deg Rai Mata *Oran* (sacred grove) is in the Fatehgarh tehsil of the Jaisalmer district, surrounding the Deg Rai Mata temple. It is approximately 50 km southeast of Jaisalmer city. It was once a preferred habitat for GIB. Asad Rahmani (pers. comm., 2020) has observed GIB on numerous occasions during his surveys conducted from the 1980s to the 2000s. One male and one female Great Indian Bustard were observed inside the enclosure in 2016 (Durga Ram, Forest Guard, per. comm). After that, no confirmed sightings of GIB were reported in this area, and it was de-notified as GIB habitat, allowing new energy projects and power lines. On 16th September 2020, A Great Indian Bustard was killed because of electrocution in Deg Rai Mata *Oran*, which validated the unconfirmed sighting records of GIB by the locals. After receiving secondary information over the phone, the spot was visited immediately, and photographs of the dead or injured birds were taken for identification, and GPS coordinates were recorded to prepare distribution data (**Please refer to the image below**).

A Gib tragically lost its life due to a collision with an electrical power line within the boundaries of Deg Rai Mata Oran. This highlights the ongoing threats facing this majestic bird, which is already struggling to survive, © Sumer Singh Bhati.

BNHS conducted a pilot study on the effects of power lines on avifauna with the help of Sumer Singh Bhati, a local of Sanwata village, and his shepherd network between December 2020 and February 2021 (**Please refer to Figure 23**).

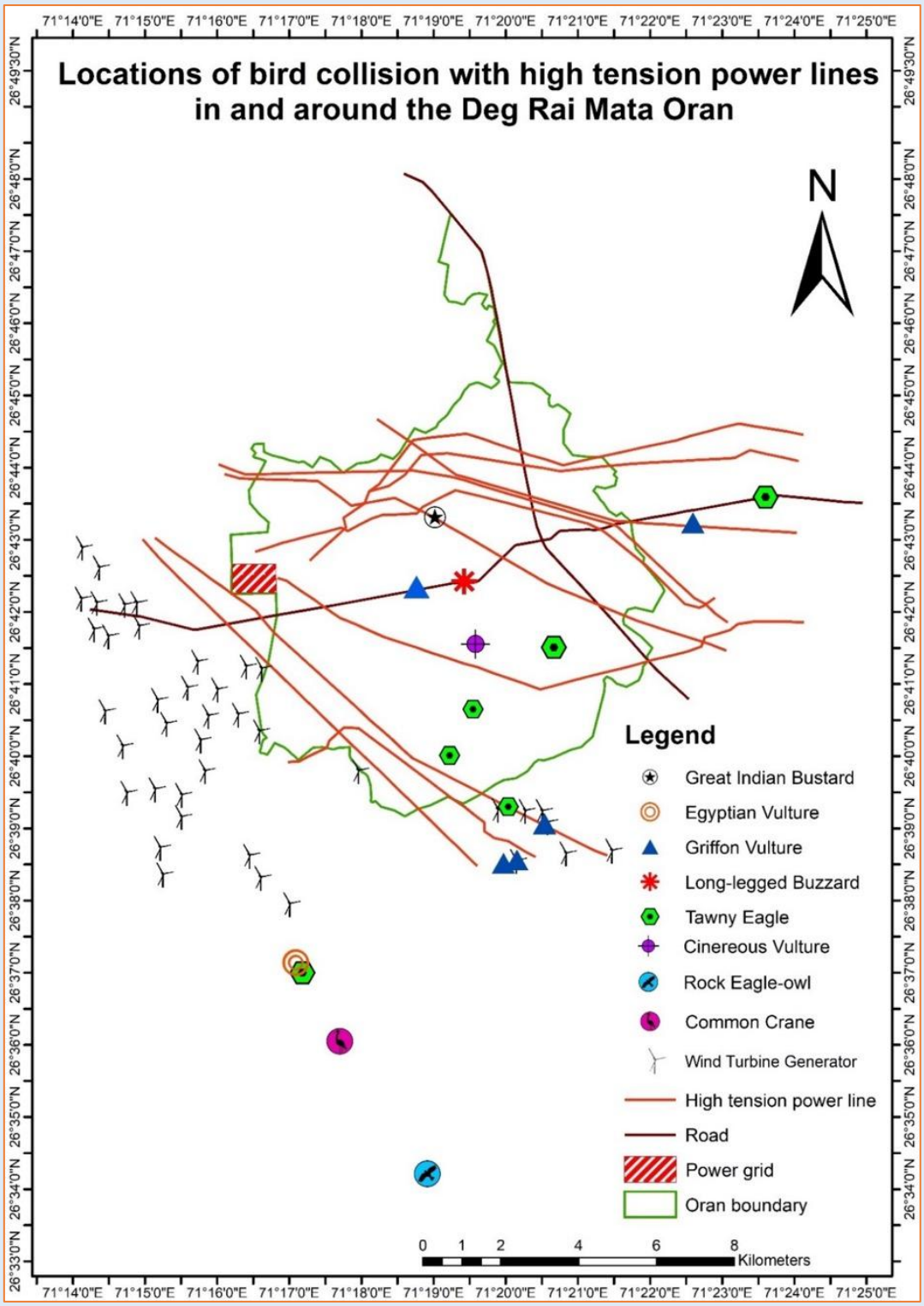


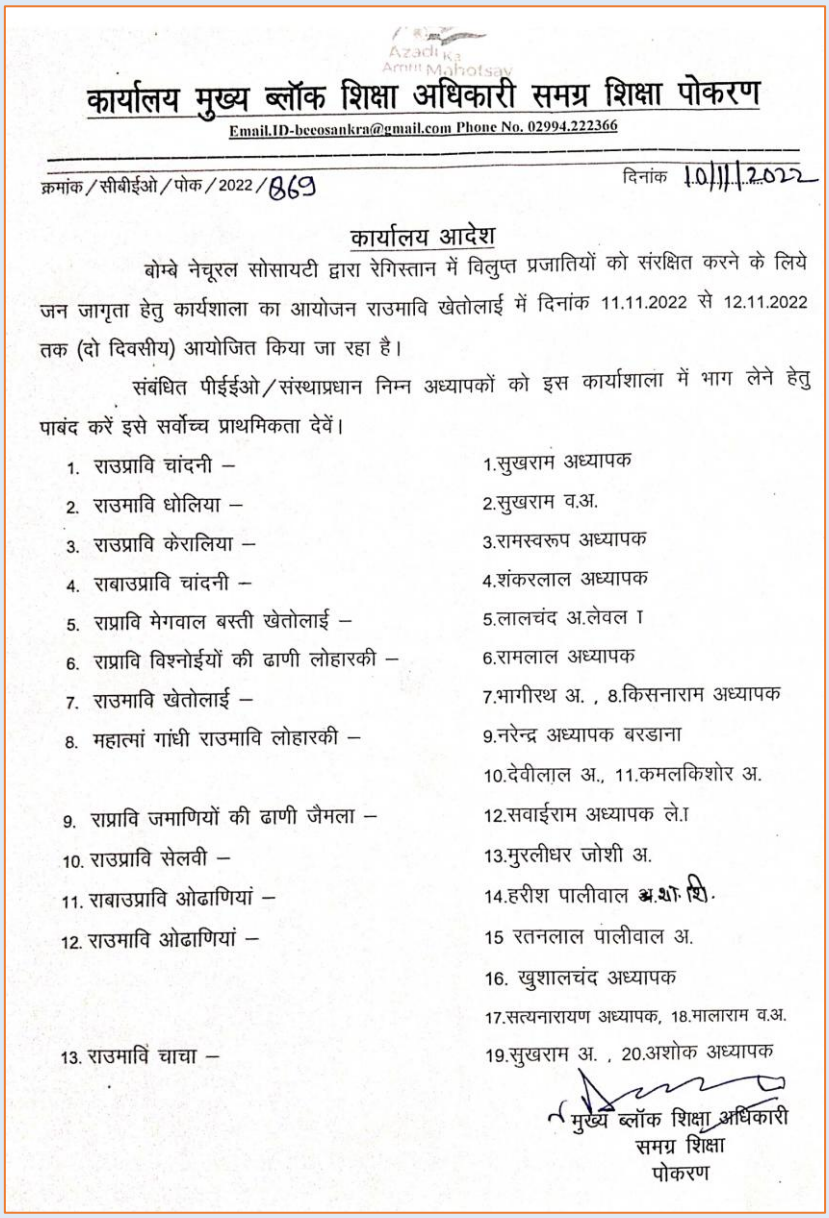
Figure 23: The impact of powerlines on bird mortality in and around Deg Rai Mata Oran has become a significant concern. The combination of the landscape and the placement of these powerlines poses a serious threat to various bird species.

Name of Bird	Scientific Name	IUCN cat	No.	Date of Mortality
Great Indian Bustard	*Ardeotis nigriceps*	CR	1	16-09-2020
Rock Eagle Owl	*Bubo bengalensis*	LC	1	17-12-2021
Common Crane	*Grus grus*	LC	1	09-01-2021
Tawny Eagle	*Aquila rapax*	VU	1	22-01-2021
Tawny Eagle	*Aquila rapax*	VU	1	23-01-2021
Griffon Vulture	*Gyps fulvus*	LC	1	25-01-2021
Long-legged Buzzard	*Buteo rufinus*	LC	1	02-02-2021
Egyptian Vulture	*Neophron percnopterus*	EN	2	05-02-2021
Tawny Eagle	*Aquila rapax*	VU	1	07-02-2021
Griffon Vulture	*Gyps fulvus*	LC	3	10-02-2021
Cinereous Vulture	*Aegypius monachus*	NT	1	19-02-2021
Demoiselle Crane	*Grus virgo*	LC	1	Undated
Tawny Eagle	*Aquila rapax*	VU	1	24-02-2021
Tawny Eagle	*Aquila rapax*	VU	2	25-02-2021
Griffon Vulture	*Gyps fulvus*	LC	1	27-02-2021

Table no 4: List of birds killed due to electrocution/ collision with powerline

Nature Education Programme in Pokhran Subdivision

1. Phase 1 - Introduction of Programme and Orientation of Concerned School Administration.
2. Phase 2 - On-Campus activity for School children, Nature Trail.
3. Phase 3 – Annual Function Programmes with school administration, felicitation of students. **(Please refer to the Image below)**



कार्यालय मुख्य ब्लॉक शिक्षा अधिकारी समग्र शिक्षा पोकरण

Email.ID-beeosankra@gmail.com Phone No. 02994.222366

क्रमांक/सीबीईओ/पोक/2022/869 दिनांक 10/11/2022

कार्यालय आदेश

बोम्बे नेचूरल सोसायटी द्वारा रेगिस्तान में विलुप्त प्रजातियों को संरक्षित करने के लिये जन जागृता हेतु कार्यशाला का आयोजन राउमावि खेतोलाई में दिनांक 11.11.2022 से 12.11.2022 तक (दो दिवसीय) आयोजित किया जा रहा है।

संबंधित पीईईओ/संस्थाप्रधान निम्न अध्यापकों को इस कार्याशाला में भाग लेने हेतु पाबंद करें इसे सर्वोच्च प्राथमिकता देवें।

1. राउप्रावि चांदनी –	1.सुखराम अध्यापक
2. राउमावि धोलिया –	2.सुखराम व.अ.
3. राउप्रावि केरालिया –	3.रामस्वरूप अध्यापक
4. राबाउप्रावि चांदनी –	4.शंकरलाल अध्यापक
5. राप्रावि मेगवाल बस्ती खेतोलाई –	5.लालचंद अ.लेवल I
6. राप्रावि विश्नोईयों की ढाणी लोहारकी –	6.रामलाल अध्यापक
7. राउमावि खेतोलाई –	7.भागीरथ अ. , 8.किसनाराम अध्यापक
8. महात्मां गांधी राउमावि लोहारकी –	9.नरेन्द्र अध्यापक बरडाना
	10.देवीलाल अ., 11.कमलकिशोर अ.
9. राप्रावि जमाणियों की ढाणी जैमला –	12.सवाईराम अध्यापक ले.I
10. राउप्रावि सेलवी –	13.मुरलीधर जोशी अ.
11. राबाउप्रावि ओढाणियां –	14.हरीश पालीवाल अ.शा. शि.
12. राउमावि ओढाणियां –	15 रतनलाल पालीवाल अ.
	16. खुशालचंद अध्यापक
	17.सत्यनारायण अध्यापक, 18.मालाराम व.अ.
13. राउमावि चाचा –	19.सुखराम अ. , 20.अशोक अध्यापक

मुख्य ब्लॉक शिक्षा अधिकारी
समग्र शिक्षा
पोकरण

The Letter from the Office of the Chief Block Education Officer, Sankhra, Pokhran, to various Schools in the Pokhran Subdivision to attend the Nature Education Programme Conducted by BNHS at Government Sn Sec School, Khetolai.

Grassland development

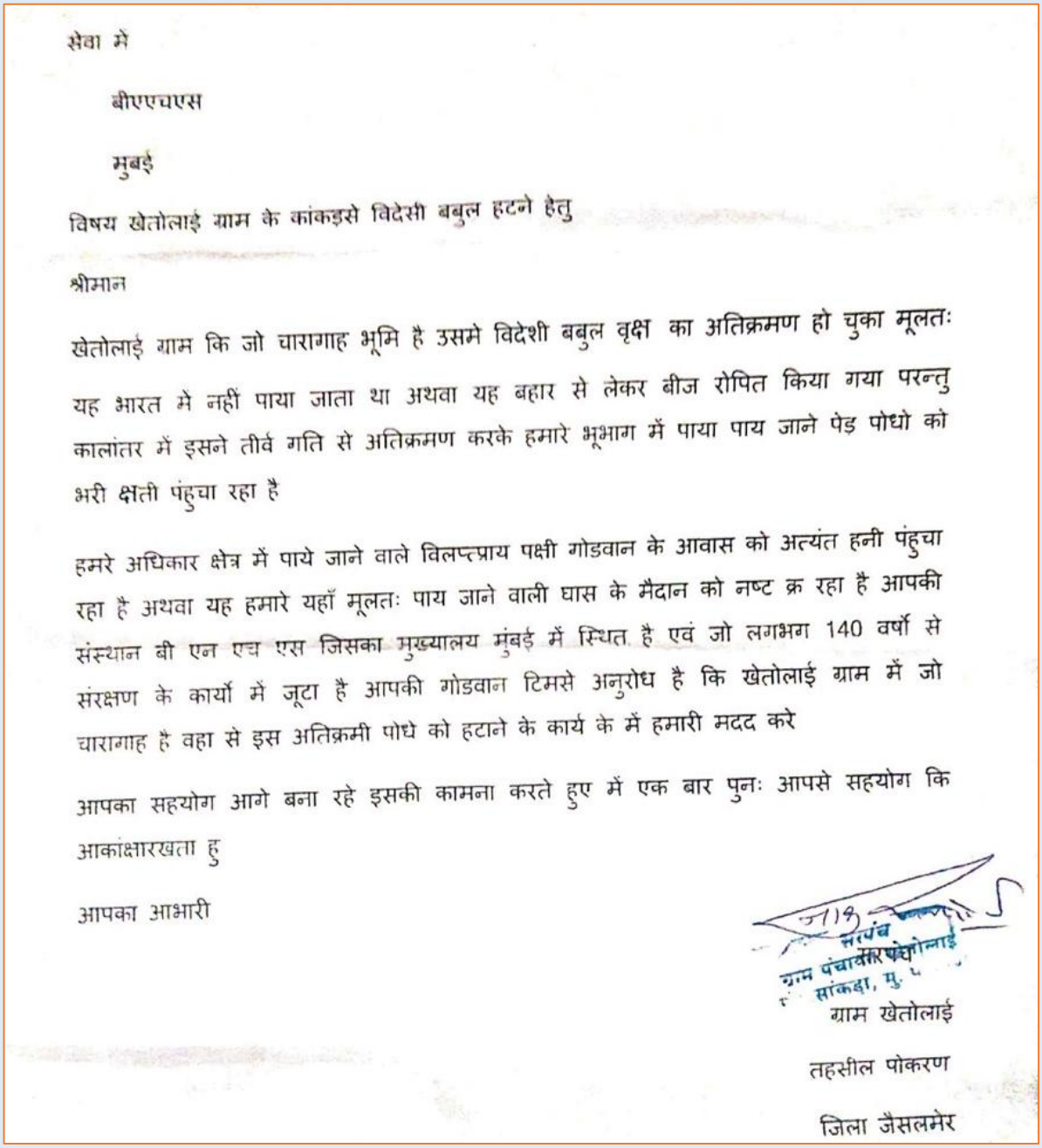
BNHS has developed two dedicated grassland reserves in Pokhran, measuring 28 hectares and 12 hectares respectively. These reserves were established in partnership with the ICICI Foundation and with strong support from local Bishnoi communities. The initiative focused on removing invasive *Prosopis juliflora* and rejuvenating native grassland vegetation, thereby creating safe and open habitats for the Great Indian Bustard and associated wildlife. The

restored grasslands now serve multiple purposes: they provide secure breeding and foraging grounds for bustards, improve fodder availability for livestock, and strengthen the ecological resilience of the Thar Desert landscape. By combining scientific restoration techniques with community participation, BNHS has ensured that these reserves function as living models of grassland conservation, linking biodiversity protection with local livelihood benefits.

The predator-proof fence features a one-foot-deep concrete foundation, ensuring durability and stability. Above ground, the fence extends an additional half foot, creating a solid barrier that effectively protects the wildlife within from various predators, including free-ranging dogs. This combination of depth and height is essential for preventing predators from digging under or jumping over the fence, thereby safeguarding the animals inside and allowing them to thrive in a secure environment. © BNHS archival.

Grass plantation

Sevan *Lasiurus scindicus* is a drought-tolerant grass species adapted to saline soil. It is a bushy, multi-branched desert grass that forms thickets in sandy grasslands. This species is important for GIB, Chinkara, and other grassland-dependent species, as well as nutritious fodder for the cattle in the Thar landscape. In Khetolai, the Gram Panchayat, with support from the BNHS team, has selected plots from which Videshi Babool has been removed, and they have decided to restore the degraded grasslands here. The *Gram Panchayat* approached our team and sought our help to create plots of Sevan Lasiurus sindicus (please **refer to the Image below**).



सेवा मे

बीएएचएस

मुबई

विषय खेतोलाई ग्राम के कांकड़से विदेशी बबुल हटने हेतु

श्रीमान

खेतोलाई ग्राम कि जो चारागाह भूमि है उसमे विदेशी बबुल वृक्ष का अतिक्रमण हो चुका मूलतः यह भारत मे नहीं पाया जाता था अथवा यह बहार से लेकर बीज रोपित किया गया परन्तु कालांतर में इसने तीव्र गति से अतिक्रमण करके हमारे भूभाग में पाया पाय जाने पेड़ पोधो को भरी क्षती पंहुचा रहा है

हमरे अधिकार क्षेत्र में पाये जाने वाले विलप्त्प्राय पक्षी गोडवान के आवास को अत्यंत हनी पंहुचा रहा है अथवा यह हमारे यहाँ मूलतः पाय जाने वाली घास के मैदान को नष्ट क्र रहा है आपकी संस्थान बी एन एच एस जिसका मुख्यालय मुंबई में स्थित है एवं जो लगभग 140 वर्षो से संरक्षण के कार्यो में जूटा है आपकी गोडवान टिमसे अनुरोध है कि खेतोलाई ग्राम में जो चारागाह है वहा से इस अतिक्रमी पोधे को हटाने के कार्य के में हमारी मदद करे

आपका सहयोग आगे बना रहे इसकी कामना करते हुए में एक बार पुनः आपसे सहयोग कि आकांक्षारखता हु

आपका आभारी

सरपंच
ग्राम पंचायत खेतोलाई
सांकड़ा, मु.

ग्राम खेतोलाई

तहसील पोकरण

जिला जैसलमेर

A request letter received from the Sarpanch of Khetolai regarding habitat restoration work, written in Hindi. (According to the letter, villagers of Khetolai are aware of the conservation of desert species and consider P. juliflora to be one of the threats to them. They request that BNHS help remove such invasive plants and provide extended support for ongoing conservation activities

A plot was selected for the development of a Sevan grassland. BNHS arranged for an experienced farmer from the Jaisalmer district to conduct a hands-on training programme for the locals (**Please refer to the Image below**).

1. Around 5 kg of seed mixture is essential to sow on 1 bigha of land.
2. Before sowing, seeds should be soaked in water overnight for some imbibition of water and an increased rate of germination.
3. A mixture of 80 % of seeds (overnight soaked in water) mixed with 10 % soil and 10 % of cow dung as seed balls
4. Identified various grasses found in the nearby areas. The ploughing in the selected plot was done, and seeds were sown at a depth of 4 to 6 centimetres.

Preparation of Sewan grass seed balls for developing a grassland plot © Neelkanth Bora

Threats- Addressing the roadkill issue in GIB areas

In our survey, we discovered a concerning development in the Thar Desert. What was once an isolated landscape now boasts some of the country's most well-connected areas, with high-quality roads crisscrossing the region. Despite its low population density, this connectivity has attracted people from all over the country eager to test their vehicles' speed. Along these well-maintained highways, the National Highways Authority of India (NHAI) has placed warning signs, but tragically, road accidents resulting in human casualties are still common (**Please refer to the Image below**).

Various wildlife succumbing to the road kill incidents, birds © Neelkanth Bora.

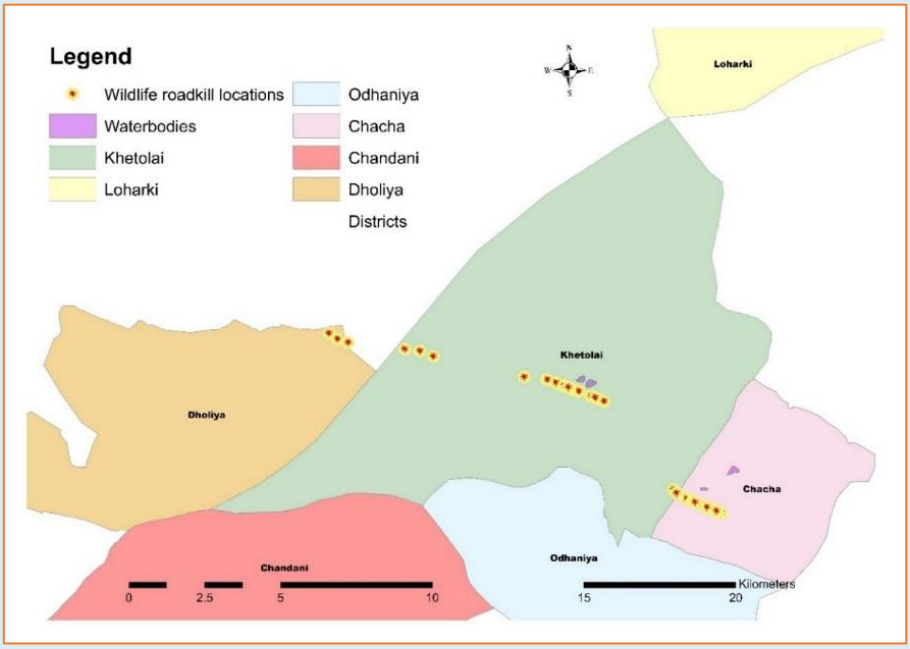
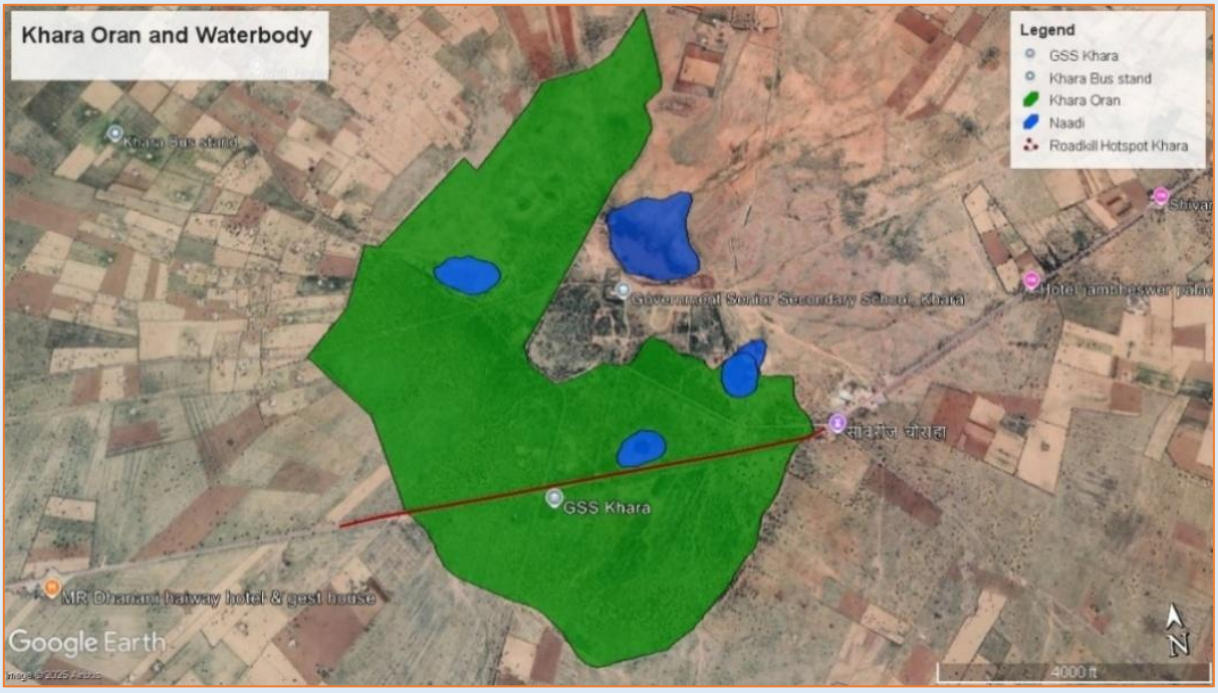


Figure 24: Map illustrating the landscape and road crossing near Khetolai, highlighting wildlife mortality due to roadkill.

It was also distressing to see animal carcasses of native animals, both diurnal and nocturnal, strewn along these roads due to collisions with speeding vehicles. Our investigation pinpointed locations with exceptionally high incidences of such tragedies, prompting us to conduct a focused case study in these areas. Based on our investigations, a case study was conducted in three distinct locations: Khetolai, Khara, and Sujasar (**Please refer to Figure 24**).

Site 1 Khara, Phalodi, Rajasthan

Situated on National Highway 11, Khara lies approximately 35 km from Phalodi, the district centre, within the stretch between Phalodi and Ramdevra (**Please refer to the Image below**).

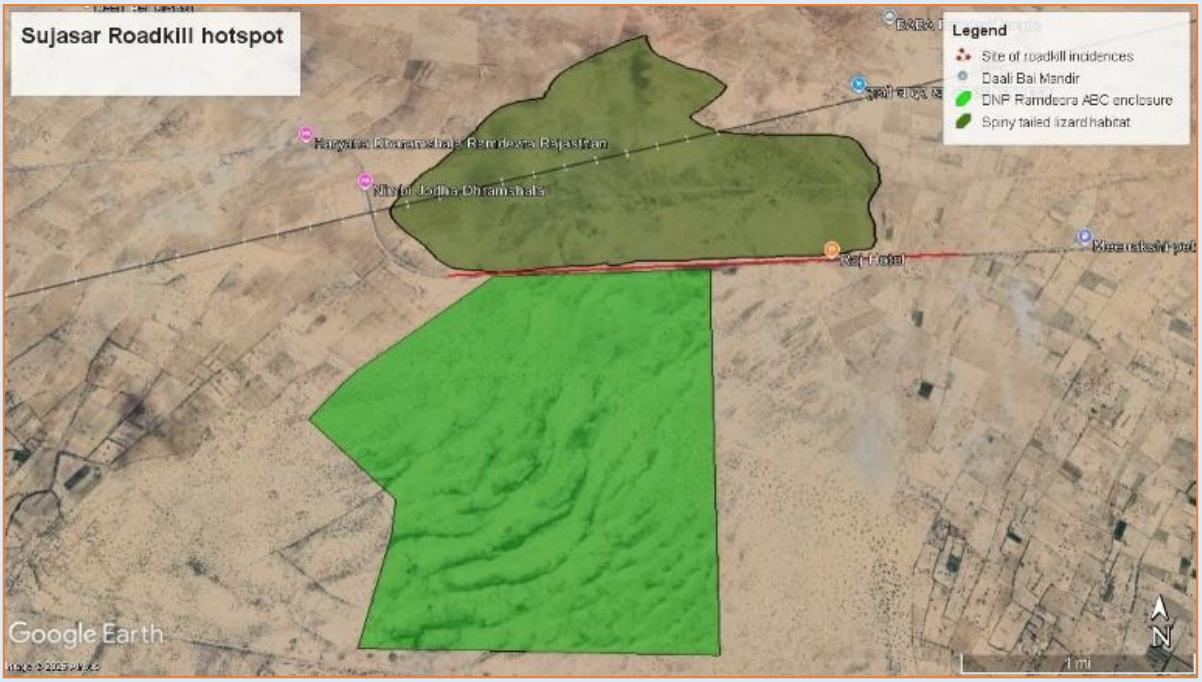


The Google Image shows the Road kill hotspot area on NH 11.

The Bishnoi community, recognised for their profound reverence for nature, populates the town. On its western perimeter, Khara houses an *Oran*, a sacred forest that boasts three rain-fed bodies of water. These ponds are a magnet for diverse wildlife and have consistently provided confirmed sightings of the critically endangered Great Indian Bustard (GIB) until 2016, making them a significant habitat for the species. Although recent sightings of the GIB remain unverified, our interest in Khara was sparked by frequent sightings of Chinkaras—a gazelle species—crossing the highway near the *Oran*. Upon examination, we found that the road divides *Oran*, severing the water bodies to the north from the greater expanse of *Oran* land to the south, which lacks a perennial water source. Consequently, these magnificent terrestrial creatures must cross the highway for water. This poses a danger, as travellers unfamiliar with the local wildlife frequently collide with these vulnerable animals, often resulting in fatal consequences for the wildlife involved.

Site 2 Sujasar

The routine survey conducted at Sujasar identified a critical area of environmental concern. Notable discolourations, including brown and red patches, were observed on the road surfaces, prompting an investigative stop to ascertain the cause (please **refer to the Image below**).



Google Imageries show the DNP enclosure and habitat of Spiny-tailed lizards nearby.

A distressing discovery was made, identifying the cause as the high mortality rate among the spiny-tailed lizard, a rare and indigenous reptile of Northwestern India, which is listed as vulnerable on the IUCN Red List due to declining populations.

Observations

Upon closer inspection of the highway, numerous smashed spiny-tailed lizard bodies were found, indicating an immediate conservation crisis. Aside from facing natural threats, these reptiles are also victim of poaching due to local myths ascribing medicinal properties to the fats in their tails. The extracted oil is a key driver in local illicit wildlife trade and trafficking. Investigative efforts revealed a substantial flat terrain adjacent to the highway, composed of rocky ground and sparse Ganthia grass, consistent with the habitat of this lizard species. The presence of thousands of small ditches, indicative of their burrowing activity, suggested a large, yet vulnerable, population in the area.

Behavioural insights

The timing of the survey, coinciding with spring, provided insight into the lizards' behaviour, as they were likely emerging from hibernation. The observed diet consisted of roadside pebbles, which the lizards licked, presumably to replace minerals lost during hibernation. However, the proximity to the road resulted in numerous fatalities due to vehicular traffic.

Discussion

The evidence points to a combination of habitat preference and seasonal behaviour resulting in this devastating mortality rate on the highway. The continued loss of the spiny-tailed lizard not only diminishes local biodiversity but also highlights issues with road safety for wildlife and the impact of poaching in the area.

Site 3 Khetolai, Pokhran, Jaisalmer

Set in the Pokhran tehsil of Jaisalmer district lies the village of Khetolai, positioned a short distance of 25 kilometres from the tehsil's headquarters and a more substantial 85 kilometres from the district centre. The Bishnoi community predominantly occupies this village and is widely recognised for its unyielding commitment to nature conservation. Khetolai village

panchayat is situated at the edge of the Pokhran Field Firing Range (PFFR), a restricted area under government control. Significantly, Khetolai plays a unique role in preserving the surrounding grasslands that envelop the village panchayat. This composite landscape, consisting of grasslands interspersed with farmland, is the natural habitat of the critically endangered Great Indian Bustard, commonly known in more humble terms as the GIB. Hence, Khetolai serves as the ideal backdrop for harmonious coexistence among society, agriculture, and wildlife conservation.

Since 2019, the BNHS has been actively involved in Khetolai. In the early stages, the team spent time understanding the local environment and landscape of Khetolai and the surrounding regions. To achieve this, we undertook small-scale landscape surveys, which helped us gain insights into the natural habitats of the surrounding areas. An interesting observation was the presence of Chinkara, desert foxes, and even hedgehogs traversing NH 11 close to Khetolai village. We also documented numerous instances of wildlife road casualties in that specific area (**Please refer to the image below**).

The area shows Khetolai Oran and water bodies situated near Khetolai village.

Water bodies such as *Naadi* serve as the sole perennial water source in this region, drawing wildlife from across the region to satisfy their hydration needs. Consequently, this activity increases the likelihood of roadkill incidents, especially after dark. To address this, we implemented a simple solution: installing signboards that alert motorists to drive vigilantly and be mindful of potential wildlife crossings (**Please refer to the Image below**).

Awareness board near Khetolai bus stop ©Unmesh Mitra

Wildlife-vehicle collisions (WVC) monitoring

The WVC monitoring study conducted in the area revealed the impact of high-speed vehicles on nocturnal species. Obligatory nocturnal mammals such as the Indian Long-eared Hedgehog *Hemiechinus collaris* were not observed during the vehicle or point count survey, but the BNHS team found many road kills during the WVC survey. It was found that the Indian Monitor Lizard, Varanus bengalensis, was a major victim of road mortality (n=27), followed by the Indian Long-eared Hedgehog (n=14) and the Rock Dove (n=7). Mammalian species like Chinkara (n=7), Desert Fox (n=4), the elusive Desert Cat (n=1), Nilgai (n=3), and Indian Grey Mongoose (n=4) were also becoming victims of vehicle collisions. Other reptiles, such as Brilliant Ground Agama (n=2), Desert Monitor Lizard (n=2), Spiny-tailed Lizard (n=4), and Red Sand Boa (n=2), were also found killed on the roads (please **refer to Figure 25**).

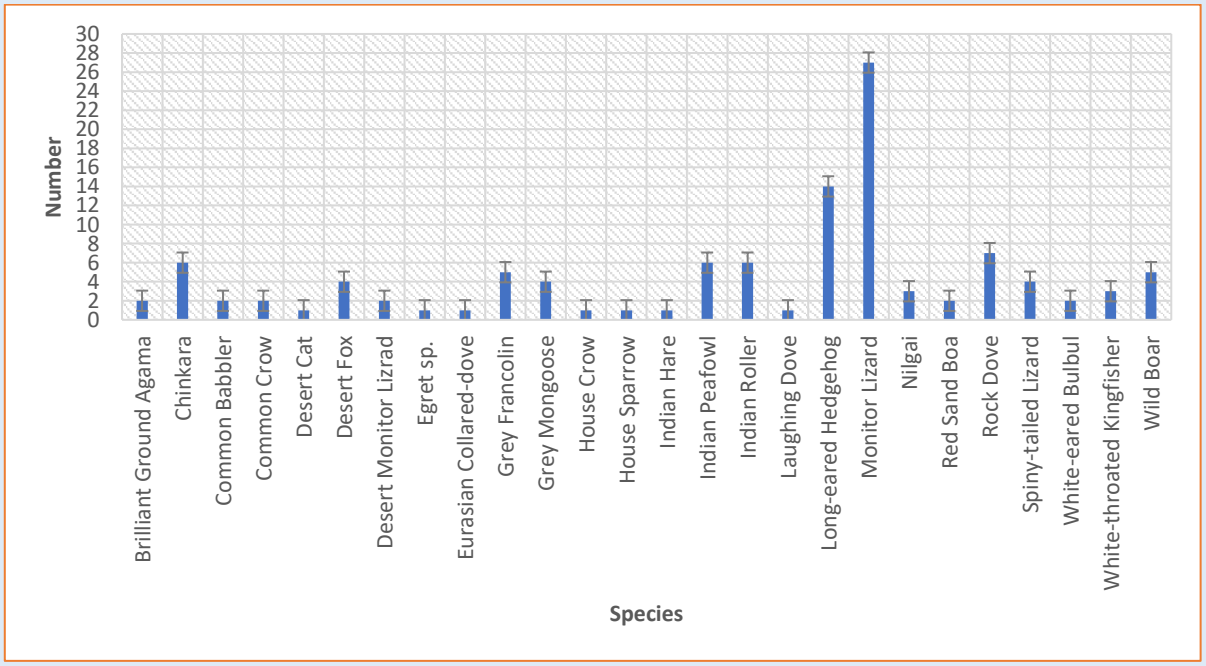


Figure 25: Graph showing species-wise mortality observed

ABC Program for Free-Ranging Dogs

Between July 2025 and April 2026, the BNHS actively contributed to the Dog Animal Birth Control (ABC) program in Pokhran, collaborating closely with Canine Control and Care (CCC), a Pune-based NGO, along with local Gram Panchayats, the Department of Education, the District Administration, and the Animal Husbandry Department of Jaisalmer. This initiative aimed to address the growing concerns surrounding free-ranging dog populations and the associated risk of rabies transmission.

BNHS provided technical leadership and established humane protocols, ensuring that sterilisation and vaccination procedures were carried out safely and effectively. The program emphasised community awareness and participation through coordinated efforts with local governance structures and schools, making the intervention socially inclusive and sustainable. As a result of this collective effort, 1,000 dogs were sterilised and vaccinated during this period, significantly reducing the risk of rabies and contributing to a more stable and healthier canine population in Pokhran. This achievement reflects BNHS's commitment to public health, animal welfare, and collaborative conservation practices.

We are sharing a brief summary of our Pokhran project as discussed with Dhanashree Ma'am. Please let us know if you need any additional details.

Trust Before Capture: ABC in the Thar Desert, implemented by Canine Control and Care (CCC), Pune. In the extreme desert villages of the Thar, CCC implemented a behaviorally conditioned Animal Birth Control (ABC) model for free-ranging dogs, where conventional force-based capture methods were unlikely to succeed. Across five villages, an estimated 1,000 dogs were identified, and 850 were sterilised over an eight-month period; 48% were female. With 95% of the dogs having body condition scores of 1–3, the project operated in a challenging survival environment for them.

The intervention was carried out in three phases:

1. **Pre-Conditioning:** Controlled, twice-daily milk feeding (approximately 1 litre of milk per dog per day, as meat or eggs are strictly banned in the region due to the religious beliefs of the Bishnoi community) and auditory cues were used to establish temporal and spatial predictability.
2. **Capture:** Direct handling methods were employed without the use of butterfly nets.
3. **Post-Operative Release:** Continued milk feeding and behavioural monitoring were conducted after the surgeries.

Local villagers were trained as feeders to ensure consistency and cultural appropriateness in the project's execution. CCC utilized predictable twice-daily milk feeding, auditory cues, and trained local feeders to build trust before capture. Within 3–4 weeks, the dogs' approachability increased from nearly zero to about 80%, enabling direct handling without butterfly nets. Surgeries adhered to India's 5-day ABC Rules, 2023, with operations scheduled in the early morning to manage the extreme heat. Complications remained below 1%, with no post-surgical mortality or bites reported from the capturing team.

The feeding program was gradually tapered off towards the end of the project and will be reinstated a month before the next phase of sterilization implementation. The findings suggest that food security, positive human-canine interactions, and environmental management play critical roles in shaping the ecology and population dynamics of free-ranging dogs.
CCC gratefully acknowledges BNHS, local wildlife wardens, and panchayat teams in 5 villages for their kind support.

To develop a bond between the free-ranging dogs and their caretakers, the dogs were fed continuously. This approach not only ensured the dogs received adequate nutrition but also encouraged positive interactions during handling. Regular and consistent feeding times helped create a routine, further enhancing the dogs' comfort and familiarity with their caretakers. © CCC Pune

A skilled dog handler effectively engages with free-ranging dogs, demonstrating excellent techniques to keep them active and well-managed. © CCC Pune.

A volunteer from CCC Pune is observed demonstrating technical proficiency in managing a free-ranging dog prior to the Animal Birth Control (ABC) procedure. © CCC Pune.

The FRDs were thoughtfully reintroduced after the successful execution of the ABC procedure. During this time, these dogs received a well-balanced and nutritious diet, which appeared to play a significant role in alleviating aggressive tendencies. © CCC Pune.

Additional important grassland sites covered in Rajasthan

1) Jorbeer

The city of Bikaner is situated in the north-west of Rajasthan. This region receives scanty rainfall, and the major water sources are the Gang Nahar, constructed in 1928, and the IGNP, constructed in 1987. Built by Rao Bika in 1486, this city has since expanded to cover 270 square kilometres and has a population of 6.44 lakhs (BMC 2021), making it the fifth-largest city in the state. It generates 150 tonnes of solid waste every day. In the Southeast of the city, on the outskirts, is situated a dumping site for disposing of dead cattle and other dead animals from the city, which attracts various predatory birds, including scavengers (Acharya *et al.* 2022). The dump site was traditionally known as Jorbeer, meaning "well" and "scrubland" in Marwari. Jorbeer provides an optimal habitat for migratory birds (Kumawat et al., 2018) and is therefore an important stopover site on their migratory route to the Indian subcontinent.

The place is home to seven species of vultures (Khatri, 2013), of which 4 are resident. The resident vultures are the Indian Vulture *Gyps indicus*, White-backed Vulture *Gyps bengalensis*, Red-headed Vulture *Sarcogyps calves* and Egyptian vulture *Neophron percnopterus*, in Bikaner both the subspecies of Egyptian Vultures *Neophron percnopterus ginginianus* and *Neophron percnopterus percnopterus* are found year-round (Bohra and Vyas 2022), and the three migratory species are the Himalayan Griffon *Gyps himalayensis*, Griffon Vulture *Gyps fulvus*, and the Cinereous Vulture *Aegypius monachus*. The area is now a conservation reserve administered by the Bikaner. Large flocks were seen resting over the pylons of the HTT Lines, which are hazardous to juveniles and young vultures (Bohra and Vyas 2022). The Jorbeer Conservation Reserve is divided into 5 blocks. The only village situated within the vicinity of the conservation reserve is Kotdi. Bikaner Forest Division has developed a fenced enclosure for raptors, such as Aquila species, that roost on the ground, to provide safety from one of their competitors, free-ranging dogs. A multipurpose watchtower has been erected by the forest staff to monitor the area and provide tourists with a better view of the conservation reserve. An Interpretation Centre has also been developed within the Conservation Reserve. The forest department has employed many locals as staff (**Please refer to Figure 26**).

A combined visit to Jorbeer Conservation Reserve by Director BNHS and DyCF, Wildlife, Bikaner, to assess the possibility of establishing the conservation breeding program for vultures at Jorbeer Conservation Reserve, © Rajesh Parmar.

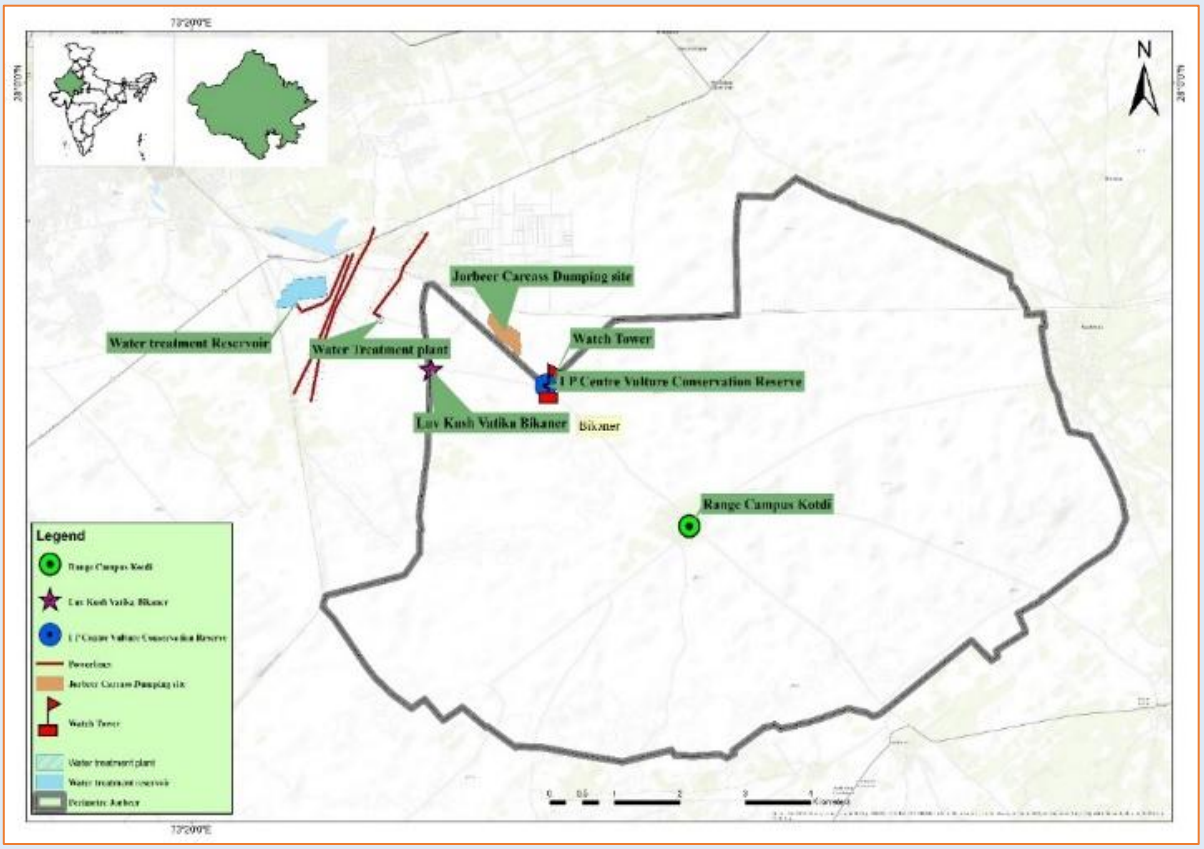


Figure 26: Map of Jorbeer conservation reserve

The Forest Department has implemented innovative and sustainable solutions to provide alternative sources of drinking water for wildlife. One of the key initiatives is the use of

"Guzzlers," which are specially designed catchment systems that collect rainwater. These structures have a sloped roof that directs rainwater into a storage tank, ensuring a consistent water supply for animals in arid regions. In addition, the department has introduced "saucer-shaped waterholes", which are shallow depressions strategically placed to collect and retain runoff. These natural-looking watering facilities are designed to self-fill during rainfall, making them vital sources of hydration for various species. During the summer, water tanks are filled manually by tanker trucks. These methods not only support wildlife but also enhance the overall health of the ecosystem by ensuring that animals have access to safe drinking water year-round. Major faunal species include Spiny-tailed Lizard *Uromastyx hardwickii*, Desert Jird, Indian Jird, Indian Hare *Lepus nigricollis*, long-eared hedgehog *Hemiechinus auritus* and Indian hedgehog *Paraechinus micropus micropus*. The Important floral species observed during our visit to the Conservation reserve were Ganthia *Dactyloctenium scindicum*, Desert Cotton *Aerva javanica*, Ber *Ziziphus mauritiana*, Ker *Capparis decidua*, Khimp *Leptadenia pyrotechnica*. The grass height has been reduced to a minimum due to intensive grazing pressure by the cattle coming from the surrounding villages.

2) Tal Chappar

The Tal Chappar Wildlife Sanctuary is situated in the Churu district of Rajasthan. The nearest town is Sujangarh, which is almost 15 kilometres away (**Please refer to the image below**).

Blackbuck Male lekking site in Tal Chappar © Sujit Narwade

The protected area is spread in the village's southern and southwestern cardinal directions. The place was once a hunting ground for the Maharaja of Bikaner (**see Figure 27**).

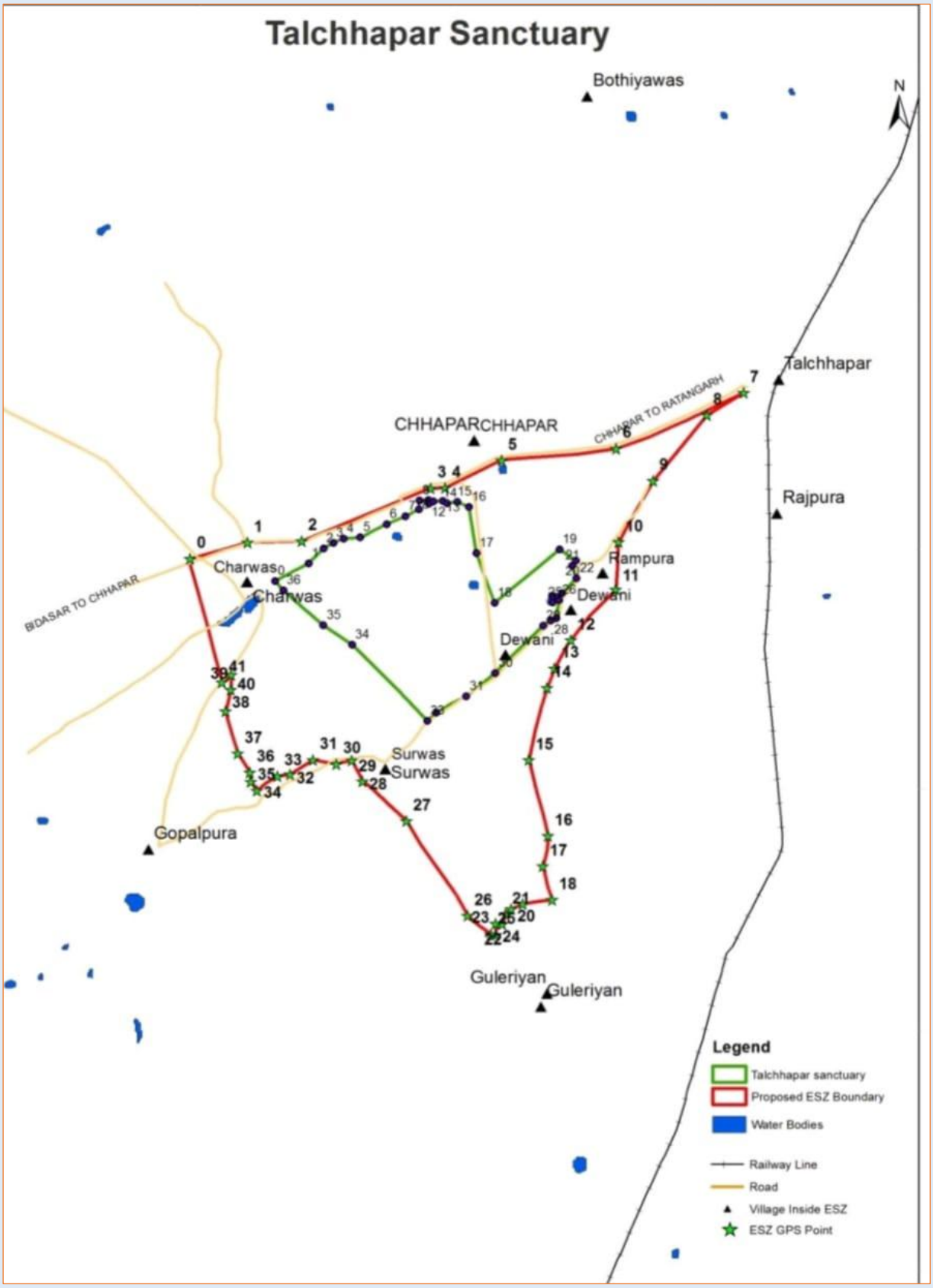


Figure 27: Map of Tal Chappar Wildlife Sanctuary in Churu district.

It is well known for its blackbucks, *Antilope cervicapra*, which the Royals originally introduced from Bikaner (Pers. Comm.). The protected area falls under the Subgroup Northern Tropical Thorn Forests. Category C1 signifies desert thorn forest (Champion & Seth, 1968), and the landscape is primarily flat, with few hillocks erupting on the southwestern side. The area has an extreme climate, where temperatures in summer rise to 48 degrees centigrade and in winter fall as low as zero degrees Celsius. It is a dry grassland, but in the monsoon, the area becomes damp. Tal, in the local language, means a low-lying flat area that gets flooded through the run-offs from local streams in the monsoon. The wildlife sanctuary covers an area of approximately 7.19 square kilometres. As the number of blackbucks has spiked, the department has added another block of approximately 10 square kilometres, which is being developed by the Rajasthan Forest Department on the outskirts of Sujangarh City. The sanctuary was initially developed to restore the Blackbuck population. Mitigation measures were implemented, and threats such as free-ranging dogs, excessive cattle grazing, and hunting were addressed, leading to the ecological revival of this place.

The grassland comprises species such as *Aristida* spp., *Cenchrus ciliaris*, *C. setigerus*, *Lasiurus sindicus*, *Cynodon dactylon*, *Dactyloctenium aegyptium*, along with scattered tree species such as *Acacia nilotica* and *Salvadora persica*. The white shiny appearance of the grassland is attributed to a sedge locally known as Mouthiya *Cyperus rotundus* (Verma, 2010). The protection not only allowed the grasses to rejuvenate but also led to a surge in the populations of other species, such as the Spiny-tailed Lizard, Saara hardwickii, and various other rodents. As the protected area lies within the Central Asian Flyway, a variety of migratory birds, especially raptors, are also attracted to these grasslands. Today it has become a place of choice for photographers from all over the country to capture raptors in their frames. According to Verma (2010), the site is a primary roosting site for passage migrants, such as harriers.

3) Sorsan

The Sorsan Great Indian Bustard Area is a significant region located on the boundary of the Kota and Baran districts in Rajasthan. This area, covering approximately 35 sq. km., was declared a Hunting Closed Area in 1986 to preserve the habitat of the Great Indian Bustard. Enveloped by quaint villages and sprawling agricultural fields, the region boasts a unique landscape comprising of pebbly uplands adorned with outcropping rocks, Jujube bushes, and sparse Khejari *Prosopis cineraria* trees. Vital water sources, including marshes, village tanks, and the Parvan River, contribute to the area's rich biodiversity. An area of 14 sq. km. was later designated as protected forest land to conserve its natural splendour (**Please refer to Figure 28).**

The area experiences a diverse climate, characterised by cool winters and scorching summers with temperatures reaching up to 46°C. Annual rainfall in the region averages 600-650 mm, sustaining the undulating terrain and the open grassland dotted with *Zizyphus* bushes and sporadic Acacia trees. The area is a sanctuary for notable fauna such as the Blackbuck, Chinkara, Wolf, Fox, Jackal, and Hare. However, the current count of Great Indian Bustards is zero, compared to a historical record of 15-20 in the 1988 census. Overgrazing poses a significant threat to the region's ecological balance. Additionally, the area has suffered from significant alterations due to stone quarrying in marginal areas. Developing two 100-ha enclosures in 1985-86 and 1987-88 has been crucial in countering such challenges.

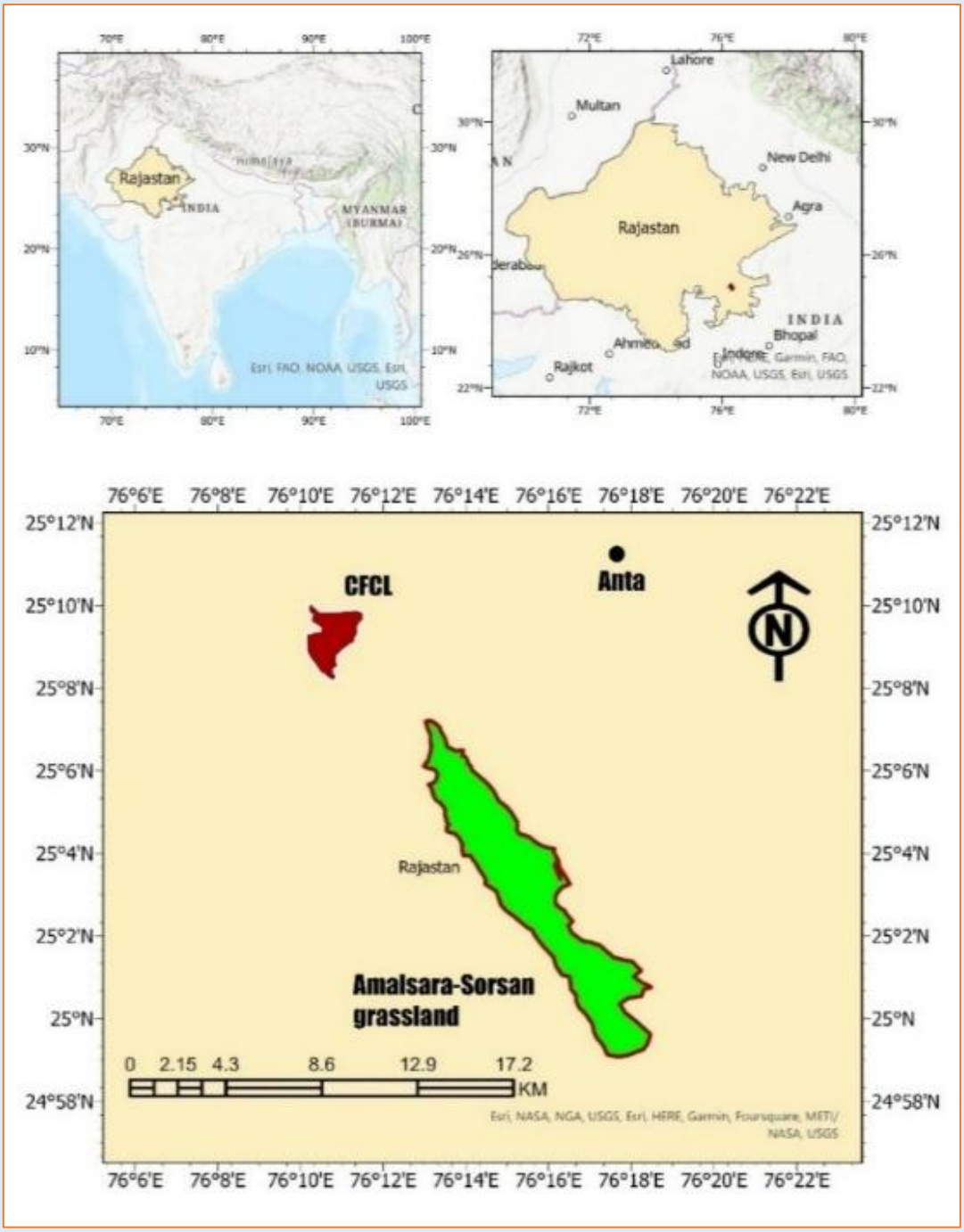


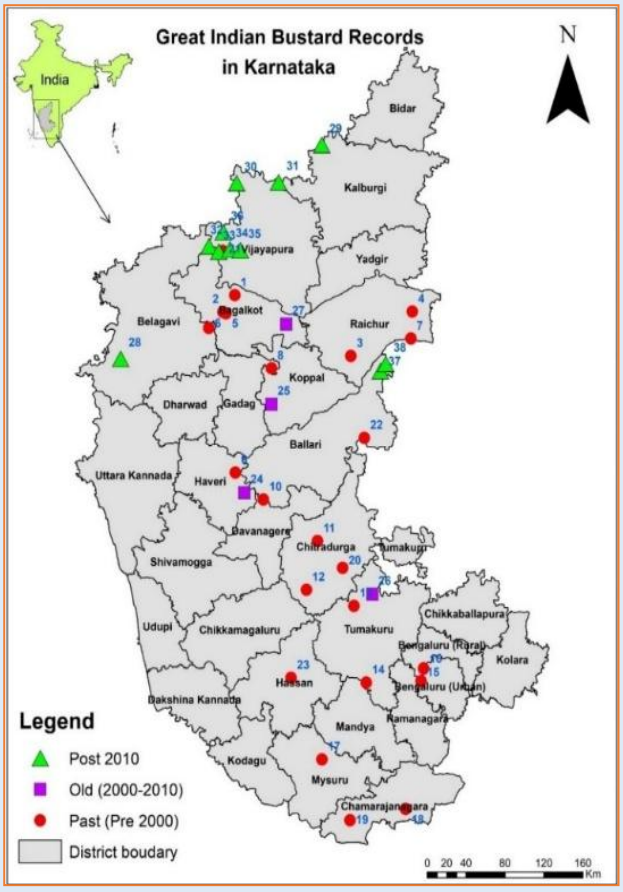
Figure 28: The map illustrates the geographical location of the Amalsara-Sorsan site, showcasing its surroundings and key landmarks. This detailed representation provides valuable insights into the region's topography and features. The map serves as a vital reference for understanding the context and significance of the Amalsara-Sorsan area.

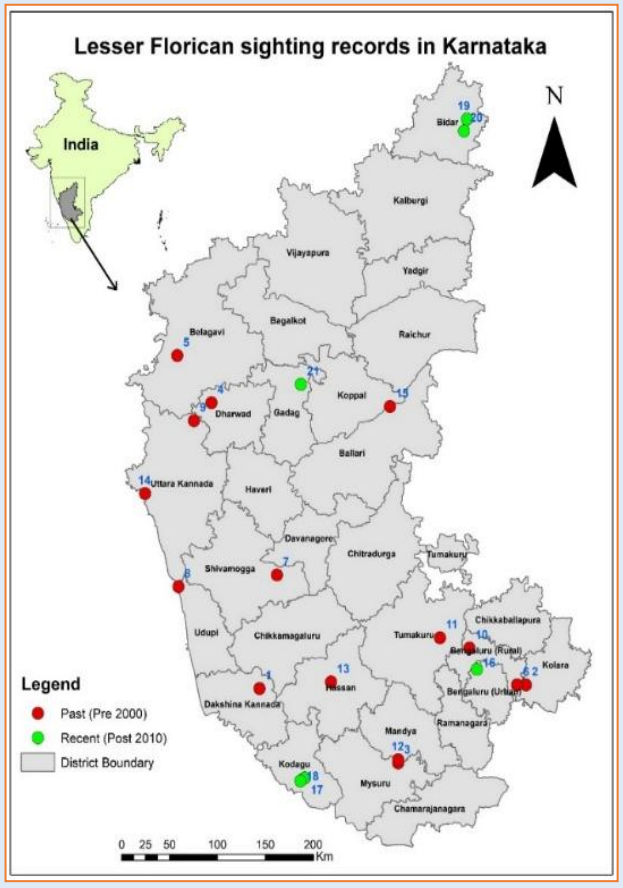
The grassland in the area is the primary source of fodder for livestock, and the villagers plough the marginal grassland near the wetlands to cultivate winter crops. The grassland also acts as a watershed for the Parban River, keeping soil erosion from the plateau land in check. The wetlands also support wild animals and birds during scorching summer months and provide a home to migratory waterbirds in winter.

Chapter 2 – GIB and LF in Karnataka

Based on secondary data collated from published literature and personal interactions with relevant individuals, maps of the current and previous distributions of GIB and Lesser Florican in Karnataka were prepared.

Lesser Florican sighting records in Karnataka





Recent sightings of the Great Indian Bustard and the Lesser Florican have been reported in Karnataka. The presence of these birds in Karnataka highlights the region's importance for avian biodiversity and underscores ongoing conservation efforts to protect these magnificent creatures.

SN	Latitude	Longitude	Old/ New	Place	District	State	Reference
1	12.99273	75.38926	Old	South Kanara (Karavali)	Karavali	Karnataka	Jerdon 1864
2	13.00818	77.95444	Old	Mallur	Kolar	Karnataka	Mcinroy 1880
3	12.33443	76.71935	Old	East Mysore	Mysore	Karnataka	Mcinroy 1880
4	15.50347	74.92625	Old	Dharwar	Dharwar	Karnataka	Butler 1881
5	15.91659	74.59125	Old	Belgaum	Begaum	Karnataka	Butler 1881
6	13.00891	77.86761	Old	Bangalore	Bengaluru	Karnataka	Anderson 1883
7	13.9894	75.55884	Old	Shimoga	Shimoga	Karnataka	And erson 1883
8	13.88767	74.60717	Old	Kanara	Karavali	Karnataka	Barnes 1891
9	15.34506	74.75573	Old	Halyal (=Haliyal) North Kanara	Karavali	Karnataka	Davidson 1898
10	13.33685	77.41365	Old	Bangalore	Bengaluru	Karnataka	Betham 1911
11	13.42968	77.13087	Old	Tumkur	Tumkur	Karnataka	Baker 1912
12	12.36211	76.71935	Old	Mysore	Mysore	Karnataka	Phythian-Adams 1940
13	13.04783	76.07875		Hassan	Hassan	Karnataka	Worth 1953
14	14.70432	74.28222	Old	Belikeri	Uttar Kannad	Karnataka	Abdulali 1969
15	15.46345	76.66361	Old	Tungabhadra, Tungabhadra Wildlife Sanctuary	Ballari	Karnataka	Goriupand Karpowicz 1985
16	13.1492	77.4833	New	Hesaragatta, Bangaluru	Bengaluru	Karnataka	Raghavendra, M., 2011
17	12.20649	75.8222	New	Virajpet, Gonikoppal, Coorg, Karnataka	Kodagu	Karnataka	Monnappa, B., 2012.
18	12.18	75.78	Recent	Virajpet, Gonikoppal, Coorg, Karnataka	Kodagu	Karnataka	Monnappa, B. C, and Santhosh Kumar P. 2018
19	17.97744	77.44432	Recent	Chondi, Bidar, Karnataka	Bidar	Karnataka	Vivekanadhababurao 2020
20	17.87328	77.41423	Recent	Kamtana, Bidar, Karnataka	Bidar	Karnataka	Vivekanadhababurao 2020
21	15.66278	75.79738	Recent	Jigalur and Jakkali	Gadag	Karnataka	WII 2021

Table no 05: Lesser Florican sighting records in Karnataka **(Please refer to Table no. 6)**

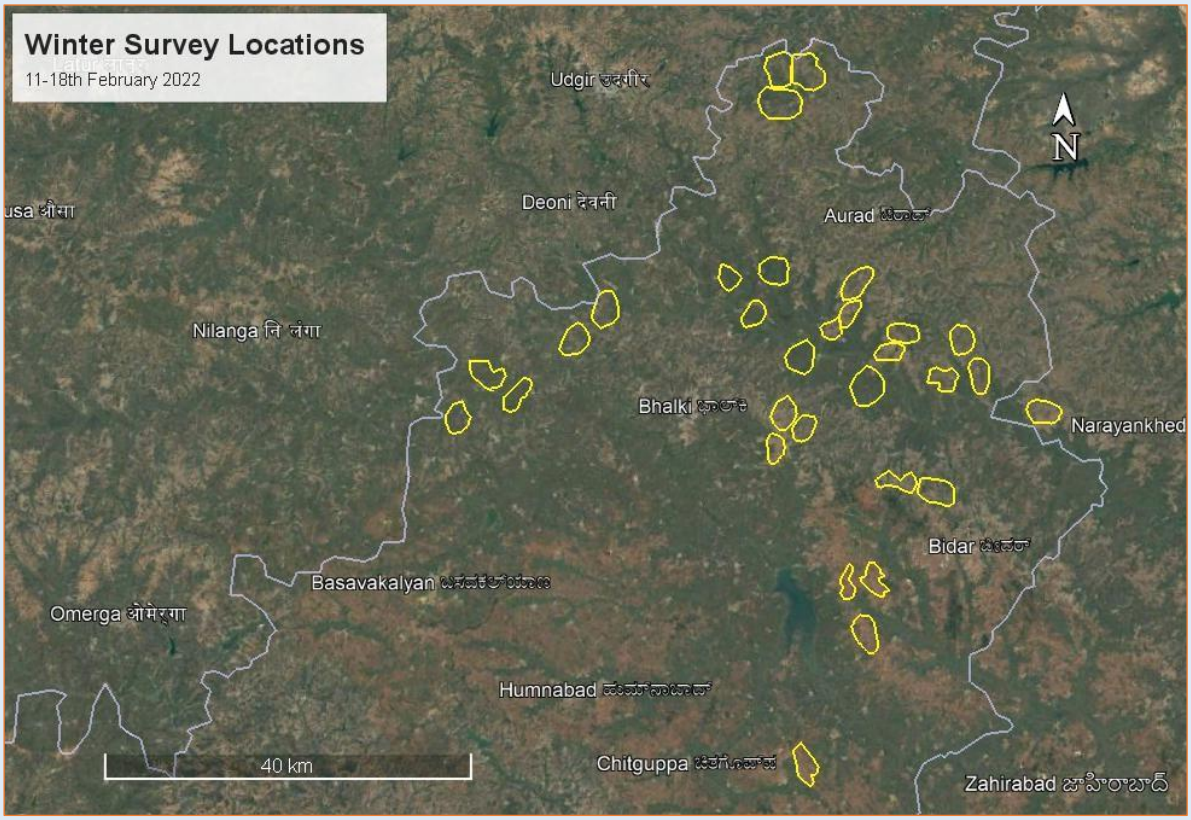
SN	District	Place	Source
1	Bagalkote	Bilgi	Rahmani and Manakadan 1990
2	Bagalkote	Kaladgi	Hamilton 1892
3	Raichur	Pagadadinni, Sindhanur	Ali and Rahmani 1985, Rahmani and Manakadan 1990
4	Raichur	Rampur	Rahmani and Manakadan 1990
5	Bagalkot	Tulsigere	Rahmani and Manakadan 1990
6	Belgaum	Batkurki	Ali and Rahmani 1985; Rahmani and Manakadan 1990
7	Raichhur	Bichale (Tungabhadra)	Cornwallis 1983; Rahmani and Manakadan 1990,
8	Koppal	Hagedal	Neginhal 1983
9	Haveri	Guttal	Rahmani and Manakadan 1990
10	Davangere	Kondajji	Rahmani and Manakadan 1990
11	Chitradurga	Chitradurga	Rahmani and Manakadan 1990
12	Chitradurga	Hosdurga	Neginhal 1983
13	Tumkur	Bukkapatna	Rahmani and Manakadan 1990
14	Tumkur	Yediyar	Rahmani and Manakadan 1990
15	Bengaluru	15 km west of Bengaluru	Baker and Inglis 1930
16	Bangalore Rural district	Nelamangala	Ali and Wistler 1942-1943
17	Mysore	Bilikere	Baker and Inglis 1930
18	Chamarajanagar	Biligirirangan hills	Neginhal 1983
19	Chamarajanagar	Gundlupet	Phythian and Adam 1940
20	Chitradurga	Hiriyur	Ali and Wistler 1942-43
21	Vijayapura	Vijayapura	Rahmani and Manakadan 1990
22	Ballari	Ballari	Rahmani and Manakadan 1990
23	Hasan	Hasan	Rahmani and Manakadan 1990
24	Haveri	Ranibennur Blackbuck Sanctuary	Neginhal 1983, Rahmani and Manakadan 1990, Kumara and Mohan Raj 2007
25	Koppal	Bannikoppa	Kumara and Mohan Raj 2007
26	Tumkur	Sira	Kumara and Mohan raj 2007
27	Gadag	Hagedal	Gorpade 1996, Bhat *et al* 2005
28	Belgaum	Yellur	Niranjan Santh 2016
29	Kalaburagi	Nirgudi	Bilal *et al* 2016
30	Kalaburagi	Chadchan	Bilal *et al* 2016
31	Vijayapura	Agarkhed	Bilal *et al* 2016
32	Vijayapura	Telsang	Bilal *et al* 2016
33	Vijayapura	Gothe	Bilal *et al* 2016
34	Vijayapura	Dhanyal	Bilal *et al* 2016
35	Vijayapura	Khatijapur	Bilal *et al* 2016
36	Vijayapura	Somadevarahatti	Bilal *et al* 2016
37	Mittesugur	Ballari	Samand 2016
38	Basarahalli	Ballari	Samand 2006: Samand 2016

Table no 06: Great Indian Bustard (GIB) sighting records in Karnataka

Intensive studies – Bidar

The field surveys were conducted from August 23, 2021, to March 28, 2023 (N=577 days). Secondary information based on interviews regarding Lesser Florican and associated species, occurrence, and perceived threats was collected from local respondents (Herders/farmers aged 50< were preferred).

1) **A landscape-level survey was conducted in November 2021,** covering the entire Bidar district to assess the status and distribution of Lesser Florican and other grassland-associated species. Interviews with locals (N=75) were also conducted to assess the status of the Lesser Florican and other associated species. For the landscape survey, the 6 km x 6 km grids have been laid over the entire district. Of the 180 grids, 114 were identified for a landscape-level survey based on data gathered from BNHS initial surveys, previous records, and agricultural patterns in the area. The 99 grids (87%) were surveyed during the landscape survey to determine the presence of Lesser Florican grassland-associated species and their habitats (**Please refer to the Image below**).
2) **Late winter survey: February 2022 -**The winter survey was conducted from February 12 to 18, 2022. All 31 sites were demarcated from potential grassland habitats identified and surveys conducted (**Please refer to the image below**).



Identification of Potential Grassland Areas for Conservation Efforts in Bidar. This map outlines specific grassland regions within Bidar that require attention for conservation initiatives. These areas are critical for preserving grasslands, supporting local ecosystems, and maintaining the natural landscape.

Land-use changes, specifically the conversion of grasslands into residential and commercial plots, have been observed in Santhpur. This transformation involves clearing natural grassland ecosystems to develop new human settlements, which can lead to significant ecological impacts, including biodiversity loss and changes in local climate. © Rushikesh Pawar

The locations where satellite-tagged floricans have been tracked by the Wildlife Institute of India (WII) include areas in Ajmer, Rajasthan. These birds have also been recorded in Bidar, particularly at Khanapur. This monitoring effort aims to study the movement patterns and habitat preferences of the florican in the breeding area of Ajmer, Rajasthan, and record them ***in Bidar at Khanapur***

3) **Monsoon survey: July-August 2022 -** The landscape-level survey was conducted during the monsoon from July 20, 2022, to August 3, 2022. A total of 95 grids were surveyed during the landscape survey for the presence of Lesser Florican and grassland-associated species and their habitats.
4) **Winter Survey: September - December 2022**
The regular survey was conducted in the Bidar district from September 2022 to December 2022 to assess the presence of Lesser Florican and grassland-associated species, and their habitats.
5) **Summer survey: January - March 2023 -** The summer survey was conducted from January 2023 to March 2023 to determine the presence of Lesser Florican and other grassland-associated species. The regular survey was carried out at 11 sites identified as potential sites. Continuous observations were made at these sites. The point count and line transect methods were used.

Results

Early winter survey: Nov 2021 - Threat assessment

The major threats in potential grassland areas were assessed during the landscape survey, namely, quarries, power lines, roads, settlements, and free-ranging dogs. The threats were recorded in and near habitat patches at 2 km intervals along the transect line, while those at 1 km from towns or villages were avoided (not considered).

Among the threats recorded across all sampled grids (N=99), roads had the highest probability of occurrence (0.8173), followed by power lines (0.684), settlements (0.1737), dogs (0.0784), and quarries (0.0716). A highly significant (P=0.0000077, P<0.05) moderate positive correlation (r=0.43271) was observed between the probability of powerlines and settlements: as the probability of settlements increases, the probability of powerlines also increases, and vice versa. A significant (P=0.0048, P<0.05) negative correlation (r=0.28068) was observed between the probability of occurrence of roads and power lines. A significant (P=0.011, P<0.05) negative correlation (r=0.25198) was observed between the probability of settlement occurrence and the probability of dog occurrence. With the increased probability of settlements, the probability of dogs will also increase and vice versa. A significant (P=0.022, P<0.05) lower negative correlation (r=0.-22921) was observed between the probability of occurrence of roads and quarry (Please **refer to Figure 29 & Table no 07**).

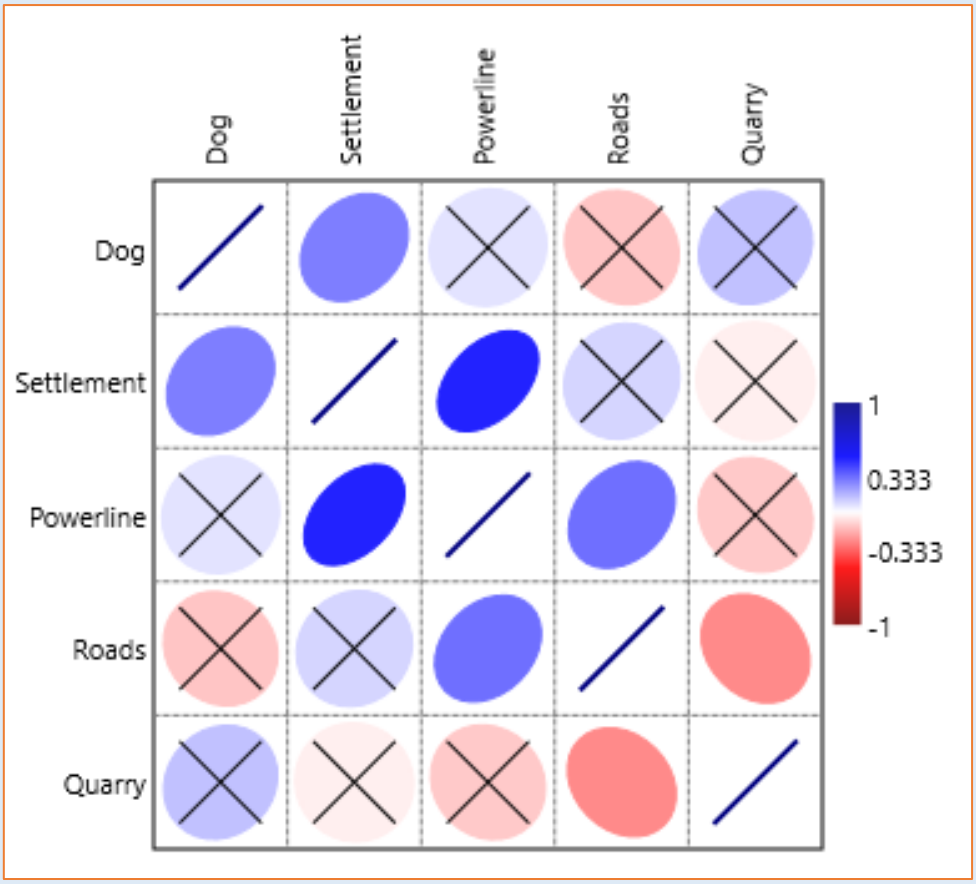


Figure 29: Threat correlation chart: Circles with a cross inside show a non-significant correlation. Ellipses in pale blue indicate a lower positive correlation. Ellipses with dark blue colour show moderate positive correlation, and Ellipses with pale red colour indicate lower negative correlation. The bars in diagonal places indicate self-correlation.

Tehsil	Threats (Avg. Probability of occurrence)				
	Dog	Settlement	Powerline	Roads	Quarry
Basavkalyan	0.0905	0.2765	0.7825	0.7455	0.063
Humnabad	0.094737	0.063158	0.386842	0.762105	0.017895
Bhalki	0.0715	0.309	1	1	0.0275
Aurad	0.037778	0.115185	0.536296	0.848889	0.085185
Bidar	0.097692	0.104615	0.714615	0.73	0.164615

Table no 07: The threat probability across the tehsils of Bidar

The winter survey was conducted from February 12 to 18, 2022. A total of 31 sites were demarcated from potential grassland habitats identified in the post-monsoon Lesser Florican survey conducted in November 2021. In this survey, vegetation, land patterns, and grassland-associated species were observed.

Lesser Florican sightings in Bidar

The species breeds in southern India during the northeast monsoon (October to December), when grass height reaches its maximum. In Bidar, the status and distribution of the Lesser

Florican were assessed systematically from August 2021 to March 2023 by the Karnataka State Forest Department and the Bombay Natural History Society (BNHS), as reported in the following Tables and map (**Please refer to Figure 30**).

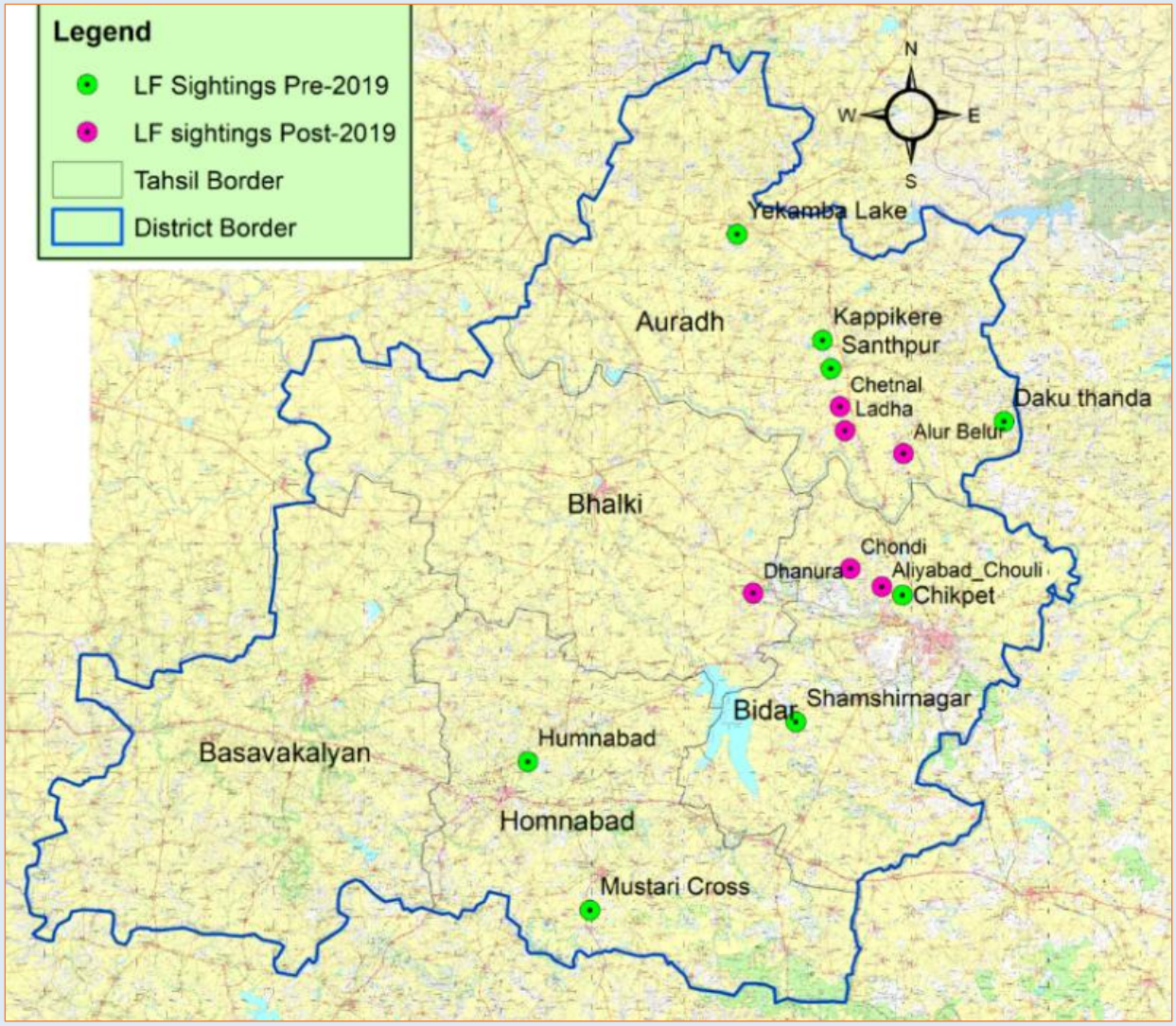


Figure 30: *Lesser Florican sightings in the Bidar district have been documented through both pre-2019 and post-2019 records*

The Lesser Florican has been recorded seven times from Mamdapur–Chondi, Aliyabad, Santhpur, Alur-Belur, Kamthana, and Jyanthi-Hundi K between August 2021 and December 2022. Among these sightings, a female bird was sighted four times, while a male bird was sighted twice (Narwade *et al.*, 2022).

1. A solitary female bird was sighted three times in August, once in Chondi (8 Aug 2021)
2. On Aug 22 and 24, 2021, a female was sighted twice in the Santhpur area for two days.
3. On September 12, 2021, a female was sighted in the Alur grasslands.
4. The survey team recorded a female bird flushed by a trespassing farmer at the Jyanthi-Hungi K. area of the Bhalki range on November 08, 2021. The bird was in the Sorghum *Sorghum bicolor* field, with an average height of 30cm. The bird took flight and landed nearly 100 meters away in the Bengal Gram *Cicer arietinum* field, immediately taking shelter in the field of Pigeon Pea *Cajanuscajan*, with an average height of 150 cm.
5. The survey team at Kamthana, Bidar range, saw a male bird in breeding plumage on

November 11 and 13, 2021, but no display was recorded. Most sightings are from the grasslands near plantations and traditional agricultural areas.

6. On November 22, 2022, a male was sighted for a few minutes at the same site at Kamthana, which indicates that the area used by the birds was just a stopover site.

Satellite-tagged Florican in Bidar at Khanapur.

The site visits were conducted in the areas where a satellite-tagged male Lesser Florican moved to the Bidar district after spending the breeding season in Ajmer (Personal communication and tagging data shared by Dr Sutirtha Dutta, Scientist, Wildlife Institute of India). The bird spent almost two months in Bidar at the following locations (Image 34).

Khanapur is a village in the Bidar district of Karnataka state and falls under Grid 61. During its visit, a total of 1 sq. km area was observed. Alur-Bellur grassland, which is one of the known grasslands, is about 5 km from this sighting location.

1. LF sighting location no. 1

The first location (18°04'08.3"N 77°31'37.2" E) is 426 meters from the Bidar-Wadgoan Road. It is a flat stony terrain, and farmland covers a significant portion of the area. In a small portion of the grassland area, major grasses such as Apluda *Apluda mutica*, Cymbopogon *Cymbopogon citratus*, Themeda *Themeda triandra* are present. In the second week of January 2023 crops such as Safflower *Carthamus tinctorius*, Jowar *Sorghum bicolor*, Jawas *Linum usitatissimum*, Maize *Zea mays*, Toor *Cajanus cajan*, Chickpea *Cicer arietinum* were standing in the agriculture field. Neem *Azadirachta indica*, Tamarind *Tamarindus indica* trees and *Butea monosperma*, *Ziziphus*, *Acacia nilotica* shrubs were seen in the sighting area. Invasive species *Celosia Celosia argentea* was found all over fallow land and grassland. Blackbuck *Antilope cervicapra* were sighted during the field visit. The birds sighted in this region were Black-winged Kite *Elanus caeruleus*, Siberian stonechat *Saxicola maurus*, Indian Peafowl *Pavo cristatus* (call), Rose-ringed Parakeet *Psittacula krameri*, Eurasian Collared Dove *Streptopelia decaocto*, Pied Bushchat *Saxicola caprata*, Black Drongo *Dicrurus macrocercus*, Greater Coucal *Centropus sinensis*, Grey Francolin *Ortygornis pondicerianus* (call), Ashy-crowned Sparrow lark *Eremopterix griseus* (call).

2. LF sighting location no.2

This location (18°04'18.2"N 77°31'30.0" E) is 619 meters from the Bidar-Wadgoan Road. The terrain is flat and stony, with farmland covering a significant portion of the area. Semi-arid grassland and agriculture cover a small portion of the area. Grassland supports major grasses such as Apluda *Apluda mutica*, Cymbopogon *Cymbopogon citratus*, Themeda *Themeda triandra*. Invasive species Celosia *Celosia argentea* were found all over the fallow land and grassland. Two *Butea monosperma* shrubs and one Neem *Azadirachta indica* tree were present at the sighting area. During the visit, Safflower *Carthamus tinctorius*, Jowar *Sorghum bicolor*, Maize *Zea mays*, Toor *Cajanus cajan*, and Chickpea *Cicer arietinum* were the crops in agricultural fields. The birds sighted in this region were Chestnut-bellied Sand grouse *Pterocles exustus* , Pallid Harrier *Circus macrourus*, Bay-backed shrike *Lanius vittatus*, Siberian stonechat *Saxicola maurus* , Blue rock pigeon *Columba livia*, Large grey babbler *Argya malcolmi*, Rufous tail lark *Ammomanes phoenicura*, Rose-ringed Parakeet *Psittacula krameri*, Eurasian collared-Dove *Streptopelia decaocto*, Black Drongo *Dicrurus macrocercus*, Grey Francolin *Ortygornis pondicerianus* (call), Indian Peafowl *Pavo cristatus* (call) and also Blackbuck *Antilope cervicapra* were sighted.

Important Grasslands and Corridors in Bidar

Based on the study conducted in 2021 and 2022, the potential wildlife areas were identified by overlaying the distribution of all grassland indicator species, i.e., Lesser Florican *Sypheotides indicus*, Indian grey wolf *Canis lupus pallipes*, Chinkara *Gazella bennettii*, Blackbuck *Antilope cervicapra*, Montagu's Harrier *Circus pygargus* and Pallid Harrier *Circus macrourus*. A total of six clusters were identified with two major and four minor clusters as potential wildlife areas, and are labelled as Cluster-I, II, III, IV, V and VI (**Please refer to Figure 31**).

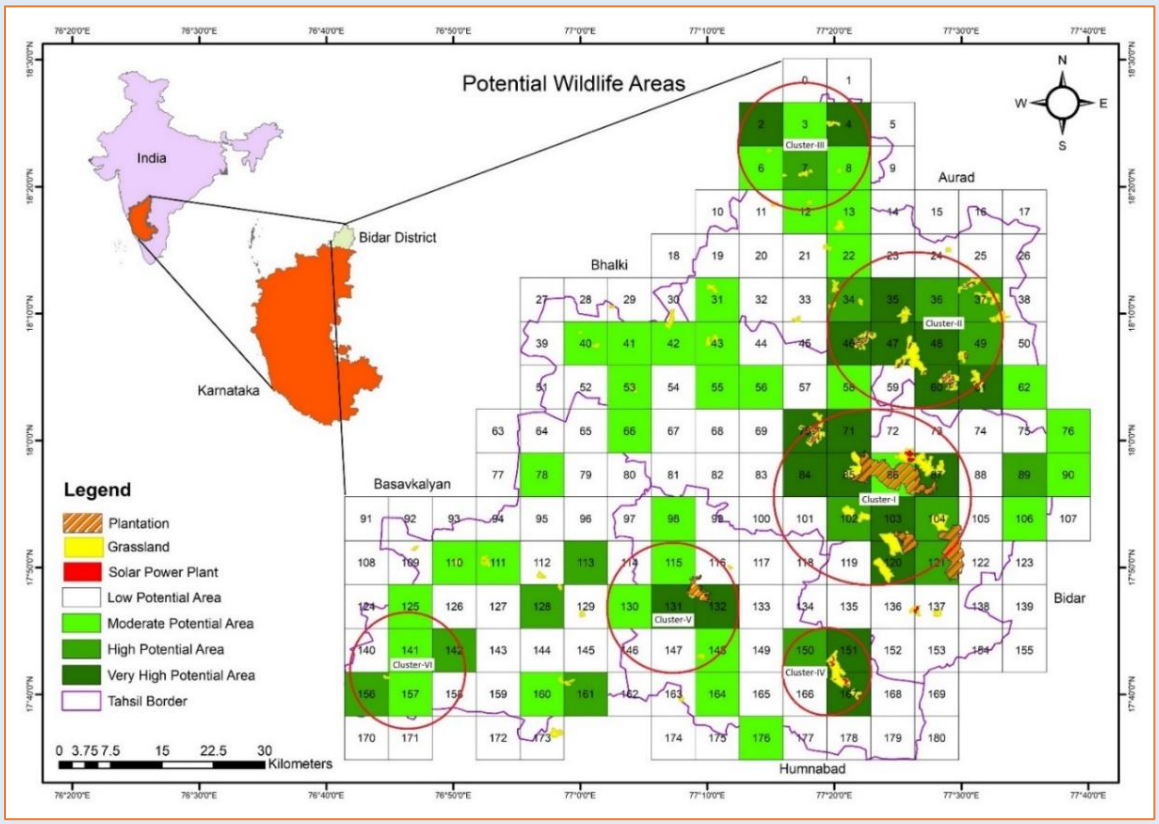


Figure 31: *The vital grasslands and corridors are shown in clusters that weave through the Bidar district. These unique ecosystems are essential lifelines for local wildlife and play a crucial role in maintaining the region's wildlife.*

1. **Block/Cluster I:** Among major clusters, the first cluster (Cluster-I) is a mosaic of plantations, grasslands, and traditional agricultural areas from Kamthana, Shamshirnagar, Dhanura, Konmelkonda, Tegampur, Mamdapur-Chondi, and Chouli-Aaliyabad areas, consisting of grid no. 70, 71, 84, 85, 86, 87, 102, 103, 104, 120 and 121. The major fauna represented from this area are Lesser Florican *Sypheotides indicus*, Indian Grey Wolf *Canis lupus pallipes*, Blackbuck*Antilope cervicapra*, Small Indian Fox *Vulpes bengalensis*, Golden Jackal *Canis aureus*, Jungle Cat *Felis chaus*, Amur Falcon *Falco amurensis*, Bonelli's Eagle *Aquila fasciata*, Montagu's Harrier *Circus pygargus*, Marsh harrier *Circus aeruginosus* and Pallid
2. Harrier *Circus macrourus*. In this cluster, Konmelkonda, Dhanura, Honnekere, Kamthana, Chitta Forest, and Shamshirnagar are the major protected areas (plantations).
3. **Block/Cluster II**: The second cluster is a mosaic of traditional agriculture, fallow lands, grasslands and plantations from Alur-Belur, Khanapur, Ujani, Ladha, Chatnal, Mahagaon, Santhpur, and Hedgapur areas, consisting of grid no. 34, 35, 36, 37, 46, 47, 48, 49, 60 and 61. The major fauna represented from this area are Indian Grey Wolf *Canis lupus pallipes*, Lesser Florican *Sypheotides indicus*, Egyptian Vulture *Neophron percnopterus*, Blackbuck

Antilope cervicapra, Small Indian Fox *Vulpes bengalensis*, Jungle Cat *Felis chaus*, Bonelli's Eagle *Aquila fasciata*, Short-toed Snake Eagle *Circaetus gallicus*, Montagu's Harrier *Circus pygargus* and Pallid Harrier *Circus macrourus*. In this cluster, Alur-Belur, Khanapur, Chetnal, Mahagaon, Ladha and Hedgapur are the major protected areas (plantations).

4. **Block/Cluster III**: Among minor clusters, cluster III is a mosaic of traditional agriculture, fallow lands, and grasslands with undulating terrain at Chikhali, Mudkhed, Hokrana, Dapka, Kherda and Lingi areas, consisting of grid no. 2, 3, 4, 6, 7 and 8. The fauna represented from this area are Chinkara *Gazella bennettii*, Indian Grey Wolf *Canis lupus pallipes*, Small Indian fox *Vulpes bengalensis*, Blackbuck *Antilope cervicapra*, Montagu's Harrier *Circus pygargus*, & Pallid Harrier *Circus macrourus*.
5. **Block/Cluster IV**: It is a mosaic of grasslands, traditional agriculture, and fallow lands near Nirna village, consisting of grid no. 150, 151 and 167. The major fauna from this area are Blackbuck *Antilope cervicapra*, Indian Grey Wolf *Canis lupus pallipes*, Pallid Harrier *Circus macrourus* and Montagu's Harrier *Circus pygargus*.
6. **Block/Cluster V**: It is a mosaic of plantations and grasslands at the outskirts of Humnabad near "Chota Falls", consisting of grid no. 130, 131, 132, 148 and 115. The major fauna from this area are Blackbuck *Antilope cervicapra*, Lesser Florican *Sypheotides indicus*, Indian Jackal *Canis aureus indicus*, Jungle Cat *Felis chaus*, and Montagu's Harrier *Circus pygargus*.
7. **Block/Cluster VI**: It is dominated by traditional agriculture and fallow lands with undulating terrain from Ladwanti, Siruri, Bhosga, Batgera, and Attur, consisting of grid no. 141, 142, 156, and 157. The major fauna represented in this area are the Indian Grey Wolf *Canis lupus pallipes*, blackbuck *antilope cervicapra*, Indian Jackal *Canis aureus indicus*, and Montagu's Harrier *Circus pygargus*.

Loss and degradation of grasslands

Bidar district is an area known for its grasslands, characterised by a mix of herbaceous and woody vegetation. These grasslands have been undergoing continuous changes over the years due to various anthropogenic causes, some of which are discussed below:

1. **Land use changes**: Land use change is one of the major reasons for grassland changes in Bidar, causing direct loss by shrinking the area. Conversion of grasslands into agricultural/croplands, the invasion by industries such as renewable energy projects, solar energy projects, and real estate and plots for commercial sale, and urbanisation are the present causes of the shrinking area. Other forms of disturbance occur in particular areas adjacent to urban centres and transportation routes, where increased human activity places greater pressure on land and natural resources (see **Figure 32**).
2. **Grazing:** Grazing is another important factor affecting the Bidar grasslands. Uncontrolled grazing can lead to overgrazing and trampling of vegetation, resulting in a decline in biodiversity and ecosystem functions.
3. **Fire:** Fire is a natural process in grasslands that helps maintain their structure and biodiversity. However, changes in fire frequency and intensity resulting from human activities and climate change can negatively impact grassland ecosystems.
4. **Invasive species:** The invasion of non-native plant species can also lead to changes in the grassland ecosystem. Invasive species can outgrow native species, reduce biodiversity and alter ecosystem processes.

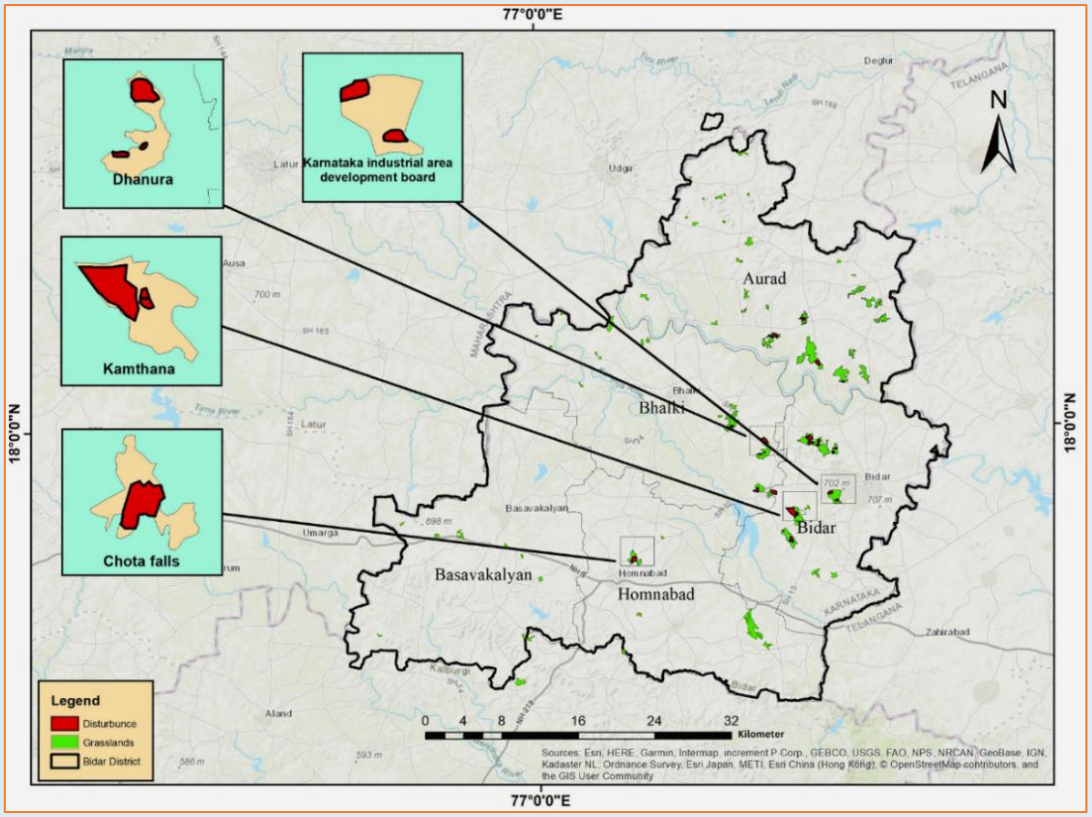


Figure 32: Since 2021, there has been a significant decline in grassland habitat in the Bidar district, largely driven by various land use changes. These alterations, which include agricultural expansion, urban development, and infrastructure projects, have resulted in the fragmentation and degradation of the grasslands. As a consequence, the local ecosystem, which is home to diverse flora and fauna, has been profoundly affected, raising concerns about biodiversity loss and the sustainability of the region's natural resources.

Of the 23 sites, land-use changes were recorded at 15. In those 15 sites, 12,018.98 acres of grassland in 2021 have now been reduced to 10,502.15 acres, resulting in a loss of 1,516.83 acres, which is nearly 13% of the grassland habitat. Overall, the grasslands in Bidar are undergoing rapid changes due to anthropogenic causes. Understanding the causes of these changes is critical for developing effective management strategies. To conserve these valuable ecosystems. This habitat loss can significantly impact the wildlife that depend on grasslands for survival. The reduction in grassland area is likely due to the expansion of agriculture and other human activities. If this trend continues, the entire grassland area will likely be lost within the next 10 years. This would be a devastating blow to the ecosystem and the wildlife that depend on it. The loss of grasslands is a warning sign of the complete loss of this vital ecosystem. The consequences of losing grasslands can be severe and far-reaching, and we must work together to conserve and protect them for the benefit of both wildlife and humans.

Survey conducted in Kalaburgi and Yadgiri

- **Duration –August 09 to August 16, 2022**
  - Grid size: **15 km x 15 km**;
  - Grids excluded due to heavy settlement and non-suitable areas- 48
  - Actual grids covered and sampled- **31**
  - Dedicated teams involved-**04**
  - Observers in Each Team - **04**

- Average distance covered in each grid- **20 km**
- Total distance covered–31x20 =**620km**.
- Observation time – 06:00 hrs to noon, 15:00 hrs to 18:30 hrs
- Total Observation – 220 Point counts x 10 min = **2200 Min**
- Total Human Hours in Landscape survey = 220 Point counts x 4 observers in each team = **660 Minutes** or **14.66 Human Hours**

Kalaburagi and Yadgiri landscape

Kalaburagi district – It is one of the three districts transferred from Hyderabad State to Karnataka State during the reorganisation of the state in 1956. The district is one of Karnataka State's 30 districts. It is in the Deccan Plateau in the northern part of the state and lies between 76°04 ′ and 77°.42 E, and 17°.12′ and 17°.46′N, covering an area of 10,951 km². It is bounded on the west by the Bijapur district of Karnataka and the Sholapur district of Maharashtra, on the west by the RangaReddy and Medak districts of Telangana State, on the north by the Bidar district of Karnataka, the Osmanabad district of Maharashtra and on the south by the Yadgiri district of Karnataka. Two main rivers, the Krishna and the Bhima, flow in the district. Black soil is the predominant soil type in the district. The district has many tanks that irrigate the land and rivers. The Upper Krishna Project is a major irrigation venture in the district (**Please refer to Figure 33**).

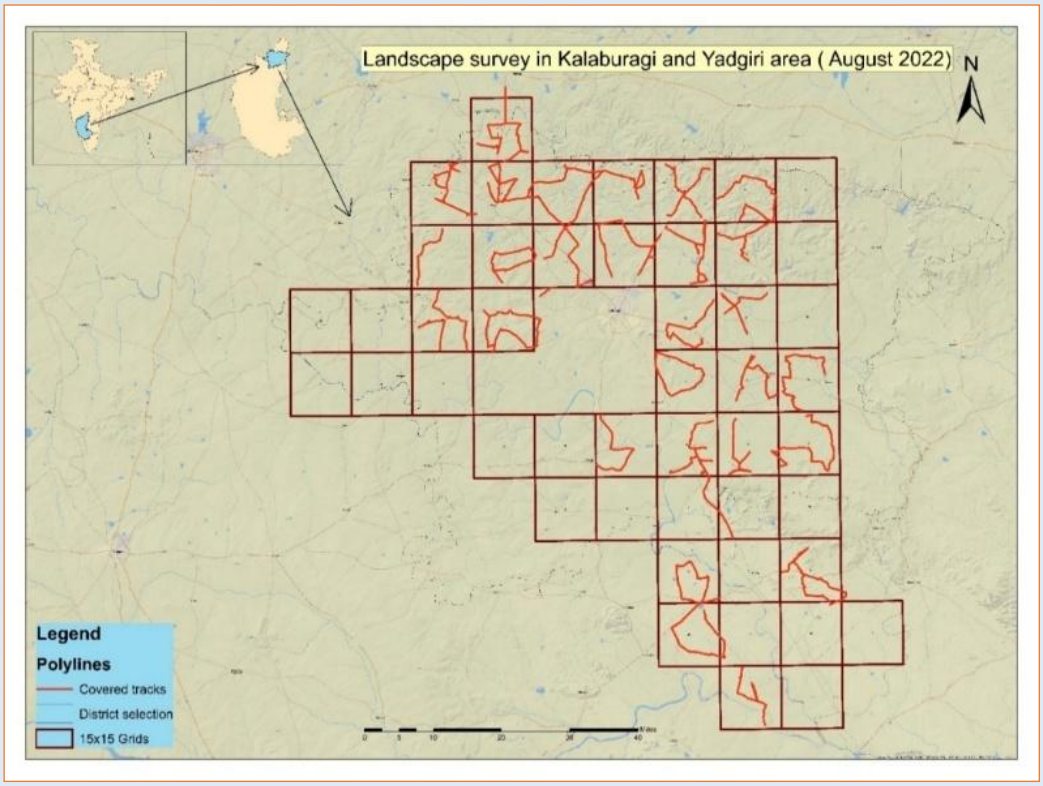


Figure 33: Areas covered during the landscape survey conducted in Kalburgi and Yadgiri districts in August 2022

Bajra *Pennisetum glaucum*, Toor *Cajanus cajan*, Sugarcane *Saccharum* spp., Groundnut *Arachis hypogaea*, Sunflower *Helianthus annus*, Sesame *Sesamum indicum*, Castor bean *Ricinus communis*, Black gram *Vigna mungo*, Jowar *Sorghum bicolor*, Wheat *Triticum* spp., Cotton *Gossypium herbaceum*, Ragi *Eleusine coracana*, Bengal gram *Cicer arietinum*, and linseed *Linum usitatissimum* are grown in this district (District Gazetteer).

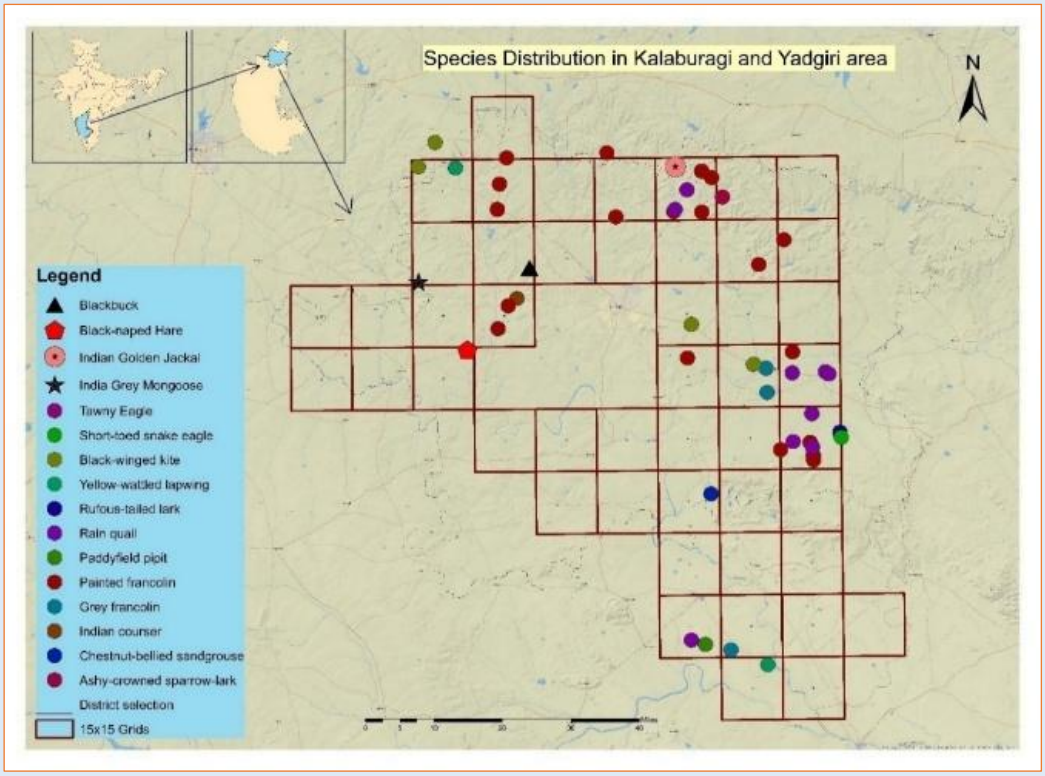


Figure 34: Species sightings in Kalaburagi and Yadgiri area

The weather in Kalaburagi consists of 3 main seasons. The summer spans from late February to mid-June. It is followed by the southwest monsoon, which spans from late June to late September. Heavy rainfall may up to 750mm. It is then followed by a dry winter until mid-January. Barring the hot summer months, the salubrious weather of Kalaburagi makes this historical city pleasant. Temperatures during the different seasons are Summer: 38 °C to 44 °C; Monsoon: 27 °C to 37 °C, and Winter: 11 °C to 26 °C (District Gazetteer).

Yadgiri District – It was carved out from the erstwhile Kalaburagi District as the 30th district of Karnataka on December 31, 2009. It is in the Northeastern part of the state, surrounded by Kalaburagi in the North, Raichur in the South, Vijayapur in the West, and the state of Telangana in the East. Yadgiri District is the 2nd smallest district in the state, spread across 6 talukas, namely Shorapur, Hunasagi, Shahpur, Wadagera, Yadgiri, and Gurmitkal, and with Yadgiri as the district headquarters. The district's vast stretch of fertile black soil is known for bumper Red gram and Jowar Crops, and it is also referred to as the "Daal bowl" of the state. Yadgiri district is spread over an area of 5,270 sq. km, constituting 8.46 per cent area of Karnataka State (District Gazetteer). The geographical location of Yadgiri is 16°20′ to 17°45′ N and 76°4′ to 77°42′ E. The region is generally hot, with temperatures of approximately 45ºC (max) and 22ºC (min). Yadgiri has been blessed by the constant flowing of two main rivers, 'Krishna' and 'Bhima'. In addition to these two, a few tributaries flow in this region. Jowar *Sorghum bicolor* and Paddy *Oryza sativa* are the major crops grown in this district. The major commercial crop grown is Cotton *Gossypium herbaceum*. The district has a net sown area of 75.11 per cent of the total geographical area, covering 5,16,088 hectares (District Gazetteer).

Rest of the Northern Plains of Karnataka

(Vijayapura, Bagalkote, Koppal, Gadag, and Ballari districts of Karnataka)

Objective

1. Identify the distribution of grasslands in selected parts of the Northern Plains.
2. To evaluate the status of grassland obligatory species in selected parts of the Eastern Plains.
3. To assess the threats that cause degradation of the grassland habitats.
4. To suggest measures for conserving grasslands in relation to the Great Indian Bustard (GIB) and Lesser Florican.

About Northern Plains

The study of the Northern Plains of Karnataka was carried out with a private funding agency. The Eastern Plains of Karnataka refer to the eastern region of Karnataka in India, characterised by flat plains and plateaus. This region covers the districts of Ballari, Raichur, Koppal, Bidar, and Kalaburagi. The Eastern Plains of Karnataka are part of the Deccan Plateau and are characterised by a semi-arid climate, featuring hot summers and dry winters. The region is predominantly agricultural, with Cotton *Gossypium herbaceum*, Groundnut *Arachis hypogaea*, Maize *Zea mays*, Paddy *Oryza sativa*, Sugarcane *Saccharum* spp., Ragi *Eleusine coracana*, Jowar *Sorghum bicolor* and Sunflower *Helianthus annus* being grown extensively. The area is also rich in mineral resources, boasting significant deposits of iron ore, manganese, and gold.

The Eastern Plains are known for their grasslands, which are spread across several districts of the region, including Ballari, Raichur, Koppal, and Kalaburagi. These grasslands are typically dry and semi-arid, with scattered trees and shrubs. The grasslands of the Eastern Plains of Karnataka are an important habitat for several wildlife species, including the Blackbuck *Antelope cervicapra*, Chinkara *Gazella bennettii*, and Indian Wolf *Canis lupus pallipes*. These grasslands are divided into two main types: tropical savanna grasslands and thorn scrub forests. The tropical savanna grasslands are characterized by tall grasses and scattered trees, while thorny shrubs and small trees dominate the thorn scrub forests.

The grasslands of the Eastern Plains of Karnataka are home to a rich diversity of plant species, including grasses, shrubs, and trees. Some of the prominent grass species found in the region include *Cenchrus ciliaris*, *Eragrostis* spp., and *Panicum* spp. The grasslands also have medicinal plant species, including *Aloe vera* and *Gymnema sylvestre*. The grasslands of the Eastern Plains of Karnataka are an important source of livelihood for the local communities, who depend on the grazing lands for their livestock. However, the grasslands also face several threats, including land-use change, overgrazing, and habitat fragmentation, which have led to a decline in grassland ecosystems and the loss of several wildlife species. Efforts are underway to conserve the grasslands of Karnataka's Eastern Plains, including the establishment of protected areas and the promotion of sustainable land-use practices.

Study Area

The survey area was divided into four blocks based on the districts' geographical areas, as shown below.

a. Vijayapura - heavy energy infrastructure (Kudgi, Basvan Bagewadi).
b. Bagalkote - area under the influence of the Alamatti dam and its backwater, mining and intensive agriculture (Hungund-Ilkal).
c. Koppal - Rocky undulating terrain (Gajendragadh).
d. Gadag - open flat traditional croplands.
e. Ballari – Siruguppa Great Indian Bustard (GIB) area.

Vijayapura

The Vijayapura study area falls under the Basavana Bagewadi taluka of Vijayapura district in Karnataka, India. It is 44.4km away from the main city of Vijayapura district, located at 16°20'30"–16°34'30" N and 75°47'30"–75°58'0" E. Sindgi bounds the Taluka on the North and North-East, Vijayapura on the North and North-West, Muddebihal Taluka on the South-East, Bilgi on the West and Bagalkote Taluka on the South.

The entire taluka is categorised as Deccan Pedi plain. Physiographically, it can be divided into four units: residual hills, pediments, pedi plains and valleys. The long and narrow stretch of flat land along the course of the river Krishna in a few villages, namely Almatti, Abbihal, Benal, Devalapur, Gonal, and Nidagundi, remains submerged under the backwaters of the Almatti dam for most of the year.

The taluka experiences a semi-arid climate with extreme summer. Dryness and hot weather prevail for most of the year. The year is usually divided into four seasons: summer from March to May, rainy season, or southwest monsoon, from June to September, post-monsoon from October to November, and winter from December to February. The annual rainfall of the taluka is 665 mm. The taluka is occupied by two types of soil: clayey and loamy. The soil texture varies from coarse granular murrum to fine clayey deposits. In the richest part, the soil is formed of alluvial clay, which is pretty deep along the river and shallow in the hilly region. The natural vegetation is a Dry, Deciduous, or Thorn Forest type.

In Grassland, the vegetation is dominated by grasses *Dichanthium*, *Chrysopogon* spp. Common tree species found in this area are Neem *Azadirachta indica*, *Eucalyptus*, Mango *Mangifera indica*, Tamarind *Tamarindus indica*, Banyan *Ficus benghalensis*, Coconut *Cocus nucifera*. It is also observed that shrub species like Babul *Acacia nilotica*, Khair *Senegalia catechu*, and Bare are also found in this area. In addition to artificially regenerated plantations of tree species like *Ficus* spp, *Gliricidia*, ornamental species like Gulmohar *Delonix regia*, *Peltophorum*, Rain tree, Agave spp, etc., have been introduced in the same area. Remaining area are much diverse and supports the extensive growth of invasive species like *Prosopis juliflora*, *Parthenium*, *Senna uniflora*, *Cassia tora*, *Alternanthera*, *Hyptis*, *Lantana camara*.

Agriculture is the main occupation in Basavan Bagewadi taluka. Major crops grown in the area include the cereal crops Jowar *Sorghum bicolor*, Maize *Zea mays*, Bajra *Pennisetum glaucum* and Paddy *Oryza sativa*, minor millets, Bengal gram *Cicer arietinum*, green gram *Vigna radiata*, Toor *Cajanus cajan*, Horse gram *Macrotyloma uniflorum*, Cowpea *Vigna unguiculata*, Black gram *Vigna mungo*, etc. Horticulture crops include fruits and vegettable crops. Cash crops like Sugarcane *Saccharum* spp., Cotton *Gossypium herbaceum*, Soyabean *Glycine max*, etc., and oilseed crops like Sunflower *Helianthus annus*, Groundnut *Arachis hypogaea* and Safflower *Carthamus tinctorius* are grown here.

The absence of large forest areas, the scattered nature of the existing forests, and the low extent of grassland result in extremely low wildlife density. Information on various other forms, such as birds, reptiles, butterflies, and amphibians, is either unavailable or only crude. Primates like Grey Langur *Semnopithecus* spp. are occasionally sighted in many localities of Basavan Bagewadi areas. Black-naped Hare *Lepus nigricollis* and Wild Pig *Sus scrofacristatus* are commonly distributed throughout the district.

Bagalkote

Bagalkote division is situated in the northern part of Karnataka at an average elevation of 533 meters (1,749 ft). It is situated at 16°08'08.5"N, 75°37'14.9"E. The total extent of the forest area of Bagalkote division is 83,893 hectares, which constitutes about 12.76 of its geographical area of 6,575 Km². The division is spread over six talukas: Bagalkote, Badami, Hungund, Bilagi, Mudhol and Jamkhandi. Bagalkote division has one Wildlife Sanctuary, namely, Yadahalli Wildlife Sanctuary, which is situated in the forests of Bilagi and Mudhol talukas to protect the Chinkara (Indian Gazelle) *Gazella bennettii*. The Sanctuary covers an area of 9,636 hectares.

The climate is warm and dry year-round, with little rainfall. The temperature ranges from 15° C (minimum) to 42° C (maximum). The district receives an average rainfall of 562 mm, with 40% of the total falling during the southwest monsoon from June to September. Bagalkote is devoid of large canopy tree vegetation; the region is semi-arid. The Rivers Krishna, Ghataprabha and Malaprabha flow through the region but are non-perennial. Soil in the area can be categorised as either predominantly black or predominantly red. Black soil retains moisture and is often used to cultivate cotton *Gossypium herbaceum*. Besides Groundnut *Arachis hypogaea*, Cotton *Gossypium herbaceum*, Maize *Zea mays*, Bajra *Pennisetum glaucum*, Wheat *Triticum* spp., Sugarcane *Saccharum* spp., Tobacco *Nicotiana* spp. and Jowar *Sorghum bicolor* are primarily cultivated in Bagalkote. Common rock types in the region include greenstone, quartzite, sandstone and limestone. The dry climate makes the region susceptible to drought and crop failure.

Koppal

Koppal District, located in the northern interior of Karnataka state between 15°-21'–15° ' 45'N, 76°-10' – 76°-32' E, covers an area of 8,458 sq. km, bounded by the districts of Raichur, Bagalkote, Gadag, and Ballari. The district comprises seven talukas: Koppal, Gangavathi, Yelburga, Kustagi, Kanakagiri, Kukanoor, and Karatagi. In the north of the district, the Krishna River flows, and Vedavathi flows along the southern border.

Different soils, such as black cotton soil, red soils, deep black soils, and red sandy soil, are predominantly present in the Koppal region (Ramamurthy *et al.*, 2009). The district witnesses' regular showers ranging from 546 mm to 701 mm rainfall; maximum rainfall is observed from July to October. The temperature ranges between 16 ° C to 42° C. The landscape of this region is a mixture of flat and undulating terrain with a mosaic pattern of rocky hills, stony open fallow land, agriculture, grassland, and forest areas.

Agriculture is monsoon and groundwater-dependent, with fewer irrigational advances. The southwest monsoon is active from Oct to Nov, causing rainfall in the region. The crops grown here are mainly cereals, pulses, oil seeds and commercial crops, which include Jowar *Sorghum bicolor*, Bajra *Pennisetum glaucum*, Wheat *Triticum* spp., Maize *Zea mays*, Millets Ragi *Eleusine coracana*, Toor *Cajanus cajan*, Horse gram *Macrotyloma uniflorum*, Green gram *Vigna radiata*, Ground-nut *Arachis hypogaea*, Sunflower *Helianthus annus*, Safflower *Carthamus tinctorius*, Sesame *Sesamum indicum*, Cotton *Gossypium herbaceum*, Sugarcane *Saccharum* spp., Tobacco *Nicotiana* spp., Arecanut *Areca catechu*, etc. Fruits such as Banana *Musa* spp., Pomegranate *Punica granatum*, Grapes *Vitis* spp., Pineapple *Ananas comosus*, Mango *Mangifera indica*, etc are also grown in this region. Many horticultural plantations grow a variety of flowers in this region.

Tree species like Ballarijali, Banni and Neemare are predominantly found in this area (Pratibha *et al.* 2019). Shrubs such as Lantana spp., *Parthenium* spp., *Prosopis* spp., *Hyptis* spp., *Cassia* spp., *Senna* spp., *Calotropis*, Babool, etc are commonly found in the open lands of the region. These

grasslands, often categorized as "wastelands", are home to a wide number of species, both herbivores and carnivores. Blackbuck *Antilope cervicapra*, Chinkara *Gazella bennettii*, Wild boar *Sus scrofacristatus*, Striped Hyena *Hyaena hyaena*, Sloth Bears *Melursus ursinus*, Leopard *Panthera pardus*, Civet cat *Viverricula* spp., Rusty-spotted cat *Prionailurus rubiginosus*, Jungle cat *Felis chaus*, Indian Eagle-owl *Bubo bengalensis*, Small Indian Fox *Vulpes bengalensis*, Indian Jackal *Canis aureus*, Mongoose and Monitor lizard, and Wolf thrive in this environment.

Though neglected for many years, Koppal grasslands have been home to some of the rarest wildlife that is found in India. Wolves, the apex predators of the area, are not just dependent on the wild herbivores but also feed on sheep and goats. The Striped Hyena *Hyaena hyaena* and critically endangered Great Indian Bustard (GIB) *Ardeotis nigriceps* are still struggling to survive in these lands without any protection. It is said that less than 100 Great Indian Bustards are left in India and about 4-5 Bustards are recorded in Ballari and Koppal districts.

Gadag

Gadag district of Karnataka was formed in 1997 when it was split from Dharwad District. It is located between 15.4°N and 65,75°E. It borders Bagalkote, Koppal, Ballari, Haveri, Dharwad and Belgaum District. The district comprises seven taluks: Gadag, Mundargi, Nargund, Ron, Shirahatti, Gajendragad, and Lakshmeshwar. The Malaprabha River flows in the north border, and the Tungabhadra River flows in the south border.

Black soil is prominent throughout the district, but red soil with sand is also present in some parts. It has a moderate temperature; the weather is pleasant and healthy. The maximum temperature is up to 42° C in April and May and a minimum of 16° C in some months. The Kappatgudda hill ranges are considered to have shrubby vegetation and medicinal plants. The Kappatgudda forests were declared a Wildlife Sanctuary in 2019, covering an area of 17,872 hectares. Mining is one of the major industries in the district. Mineral resources are rich in the district. Building sandstone, grey and pink granite, iron ore and gold are mineral mining resources in Gadag, Mundaragi and Shirahatti talukas.

The peak rainfall is during July and August, the Kharif season is predominant, and the Rabi season is unsure about cropping. The whole district represents a uniform rainfall pattern. Cropping during Rabi season is always open to the risk of moisture deficits. Gajendragadh (Gajendra: Elephant; gadh: fort), is a historical place in the Gadag district. The name is because the city looks like an elephant's body in the bird's eye view. This place is known for its hill station and hill strip. Gajendragadh is located at 15.73°N 75.98°E with an average elevation of 643 meters (2109 feet). Minerals and Metals Trading Corporation (MMTC) Limited has installed over 25 windmills in the Gajendragadh region.

Environmental issues: Windmills set up to generate wind energy threaten the very existence of rare hyenas and wolves at Gajendragad. Three years ago, Gajendragadh was recognised as a haven for highly endangered species like the Indian Grey Wolf *Canis lupus pallipes* and Striped Hyenas *Hyaena hyaena*, but then came wind farming and windmills with huge noisy fans and human traffic to maintain these machines. It drove away these species from their habitat. The Indian Grey Wolf *Canis lupus pallipes* found in the Deccan plateau is considered as secondary predator with significant roles in the food chain, the numbers of this nocturnal and diurnal species are dwindling rapidly due to poaching, loss of habitat and threat from feline species. The Indian Striped Hyena *Hyaena hyaena*, a scavenger species is also found in this area.

Ballari

Ballari (15.15^0 N, 76.93^0 E) district extends from southwest to northeast and is situated on the eastern side, almost in the centre of Karnataka state. The district is bounded on the north by Raichur district, on the west by Vijayanagara district, on the south by Chitradurga district and on the east by Ananthapur and Kurnool districts of Andra Pradesh. Ballari district comprises the talukas of Ballari, Kampli, Sandur, Siruguppa, and Kurugodu. The district stands amid a wide, level plain of black cotton soil. Granite rocks and hills are prominent features of Ballari. The district has the highest deposits of iron ore in India. The mining industry has increased in number in recent decades. The district's yearly temperature is 29.730 C, with a minimum of 23.990 C and a maximum of 32.560 C., which is higher than India's averages. Ballari typically receives about 22.89 millimetres of precipitation and has 28.1 rainy days annually. The Great Indian Bustard (GIB) area falls in the interior parts of Siruguppa taluka of Ballari district.

More than 90% of the population of these villages depends on agriculture as their main source of income. Most of the agriculture depends on rain, and some farmers get water from the Tungabhadra irrigation canals. The GIB area spread across 55 sq. km with black soil, between Raravi-Kuruvalli-Hacchlli-TsallaKudluru-Ravihal-Bommalapura, is an important region. The area was once grassland and has been converted into farmland for the cultivation of rainfed crops. Farmers traditionally cultivated Jowar *Sorghum bicolor*, Pearl millet *Pennisetum glaucum*, Fox-tail millet *Setaria italica*, etc. Lately, however, they have switched to cash crops like BT Cotton *Gossypium herbaceum*, Bengal gram *Cicer arietinum*, Sunflower *Helianthus annus* and Chilly. The change in crop patterns also plays a role in the survival of Great Indian Bustards amid heavy population and busy agricultural activities. The cotton plants provide excellent shelter and nesting sites for the birds. When the crop is dry, the bird camouflages itself against its snuff-coloured background. Therefore, the crop pattern also influences birds' preference for the landscape in this region.

The flora found in the region are Bengal quince *Aegle marmelos*, Bitter albizzia *Albizzia amara*, Neem *Azadirachta indica*, Banyan tree *Ficus bengalensis*, Peepal tree *Ficus religiosa* , White fig tree *Ficus virens*, Toddy palm *Borassus flabellifer*, Khejri tree *Prosopis cineraria*, Gum tree *Eucalyptus mannifera*, Indian beech tree *Millettia pinnata*, Cape gum, *Agave*, Desert Date *Balanites aegyptiaca (L.) Delile*, Apple Sodom *Calotropis procera*, Indian mulberry *Morinda citrifolia*, Mesquite tree *Prosopis glandulosa*, etc. The fauna found are, Blackbuck *Antilope cervicapra*, Indian Fox *Vulpes bengalensis*, Indian Jackal *Canis aureus indicus*, Jungle Cat *Felis chaus*, Indian Grey Mongoose *Herpestes edwardsii*, Black-naped Hare *Lepus nigricollis*, etc.

Survey efforts were taken in the brief

- Landscape Survey Date–**September 25, 2022 to October 08, 2022**
- Grid size- **5 kmx5km;**
- Grids planned to cover, excluding heavy settlement and non-suitable areas **- 178**
- Actual grids covered and sampled- **132**
- Average distance covered in each grid- **8 km**
- Total distance covered–132 Grids X 8 Average distance =**1056km**.
- Observation time – Morning & Evening Observation – **7.30 Hours**
- Total Observation Per day - 07:30 hours x 03 Observers = **21.9 Hours**
- Total Observation Days - **13 Days**
- Total Observation Hours in Landscape survey - Total Observation per Day x total Observation Days- 21.9 hours x13 Days = **284.7 Hours**.

Observations

The typical vegetation comprises scrub and thorny plants. The rainfall is low. Thorny shrubs, Babul trees *Acacia nilotica*, Elephant apple *Dillenia indica*, Gooseberry *Phyllanthus acidus*, and Soapnut trees *Sapindus* spp. were observed during the survey. Across the study area, traditional agricultural areas were also observed. The soil type of this region comprises rich alluvial soil from the plains of Krishna River to a dry alkaline soil from the arid hill region. Vegetation mainly consists of crops, grasses, shrubs, and trees. The distribution of vegetation is represented graphically.

Crops such as Jowar *Sorghum bicolor*, Maize *Zea mays*, and Cotton *Gossypium herbaceum* are the major crops of this landscape. Sugarcane *Saccharum* spp., Groundnuts *Arachis hypogaea* and Tobacco *Nicotiana* spp. are some of the commercial crops. Pigeon pea *Cajanus cajan*, Green gram *Vigna radiata* and Black gram *Vigna mungo* are some of the pulses. Groundnuts or peanuts *Arachis hypogaea*, common sunflower *Helianthus annus L.* and soyabean *Glycine max* are commonly cultivated crops. Dominant grasses observed are *Dichanthium*, *Chrysopogon*, *Heteropogon*, *Aristida*, Yellow-Bristle *Stygobromus lucifugus*, etc. Shrubs observed are mainly invasive species such as *Prosopis*, *Lantana*, *Cassia*, *Hyptis*, *Parthenium*, etc. Trees seen were *Acacia*, Neem *Azadirachta indica*, Palm, Coconut *Cocus nucifera*, Mango *Mangifera indica*, etc. Fauna includes the Indian Wolf *Canis lupus pallipes*, Indian Small Fox *Vulpes bengalensis*, Golden Jackal *Canis aureus*, and Jungle Cat *Felis chaus* representing the apex mammalian predators. The Blackbuck *Antilope cervicapra*, is a large and important herbivore mammal that dwells in this region. This landscape is also home to Critically Endangered Bustard species like Lesser Florican *Sypheotides indicus* and Great Indian Bustard (GIB) *Ardeotis nigriceps*.

Along with Grey Francolin *Ortygornis pondicerianus*, Painted Francolin *Francolinus pictus*, Rain Quail *Coturnix coromandelica*, Barred Buttonquail *Turnix suscitator*, Rock Bush-quail *Perdicula argoondah*, Yellow-legged Button-quail *Turnix tanki*, and lark species like Rufous-tailed Lark *Ammomanes phoenicura*, Sykes's lark (Tawny Lark) *Galerida deva*, Ashy-crown Sparrow-Lark *Eremopterix griseus*, and Indian Bush lark *Mirafra erythroptera* are common. Chestnut-bellied Sand grouse *Pterocles exustus*, Yellow-wattled Lapwing *Vanellus malabaricus*, Indian Nightjar *Caprimulgus asiaticus*, Savanna Nightjar *Caprimulgus affinis* are some of the frequently seen avian species. Raptors like the Short-toed Snake-eagle *Circa etusgallicus*, Tawny Eagle *Aquila rapax*, Bonelli's Eagle *Aquila fasciata*, and Harriers are commonly found in this region.

Two Forest watchers, Rajashekhar Reddy and Mahesh, showed the entire GIB area to the team. There are vast stretches of cotton fields, and in between are some chilly fields, neem trees, *Azadirachta indica*, *Prosopis juliflora*, and other invasive plants. Blackbucks were sighted from a distance of more than 600m. There was no sighting of GIB, but the watchers reported seeing the birds in June-July 2022.

The Great Indian Bustard (GIB) and Lesser Florican populations can be conserved and protected by increasing natural grassland vegetation and following traditional agriculture. Identifying potential landscapes, conserving areas, and encouraging traditional agriculture are the best ways to conserve these species. Lesser Florican is recorded in the northern plains of Karnataka.

Visit to Jigalur and Jakkalli (15°39'46.0"N 75°47'50.6" E): A tagged Florican by the Wildlife Institute of India in Ajmer in 2020 was traced to study its movements in the Deccan. It was recorded near Jigalur and Jakkalli in Gadag during the winter season. This location is near Nidagundi and Jigalur, and Jakkalli is an area of a mosaic landscape with agriculture, shrubland, and fallow land.

None of our team members found any GIB or Lesser Florican during the survey period. However, secondary information indicated that these two species have been reported at two sites near the survey area. LF has been recorded at two sites (Jakkalli and Mullal) during the non-breeding (winter) period, and GIB at Sompur (during the survey period). Lesser Floricans are reported to breed in the north-west parts of India during the monsoon and spend winter in the southern parts of the Deccan Plateau. If there are no corridors left, then the movement of these landscape species will be restricted. This shows the importance of the survey area, especially Koppal and Gadag blocks, for the survival of the last remaining individuals of Bustards/Floricans in Karnataka. With proper assessment and site-specific conservation action plans, one can save the fast-declining populations of grassland-associated species.

Threats observed

The habitat in Vijayapura Block was found to be disturbed by rapid changes in land use and intensive agricultural practices. Windmills and High-tension power lines were found to be major threats to the habitat and the wildlife. There was not a single sighting of Blackbucks *Antilope cervicapra* in this region. Similarly, the habitat of Bagalkote Block was also disturbed by major changes in agricultural patterns and irrigation facilities, and by a significant increase in water availability due to the Almatti Dam. Traditional crops (grains and pulses) have been replaced by commercial crops such as Sugarcane (Saccharum spp.), which is unsuitable for grassland-dependent species. In Koppal Block, the area is disturbed by mining and a surge of high-tension power lines.

However, wildlife was encountered easily here. Blackbucks *Antilope cervicapra*, Indian Fox *Vulpes bengalensis*, Grey Wolves *Canis lupus pallipes*, etc., were observed in this block. There was a continuous expansion of windmills and high-tension power lines in Gadag Block. Traditional crops like grains dominate agriculture. Blackbucks *Antilope cervicapra* were widely distributed, indicating that the area is still less disturbed. There is a Chinkara Wildlife Sanctuary in Yadhalli in Bagalkote district, which is nearly 40 km away from the survey area polygon, where 100 Chinkaras *Gazella bennettii* reside in shrubby vegetation and rocky plateaus. The habitat of Siruguppa is less disturbed by human activities, but changes in agricultural patterns from traditional to commercial crops negatively impact the GIB area.

Overall, major threats included wind turbines, rapid land-use changes, existing and proposed heavy energy infrastructure (power substations, HT power lines, thermal plants), intensive agriculture (chemical use, changes in cropping patterns), and unplanned development (sugar factories, mining, etc.). From our field observations, the Vijayapura and Bagalkote blocks were more highly disturbed areas than the Koppal and Gadag blocks.

Human activities such as mining, solar plants, windmills, and high-tension transmission lines are causing significant loss of wildlife by disrupting their natural habitats. The rapid pace of land-use conversion is uncontrolled, making it difficult to manage. Developmental projects must consider the impacts on natural habitats and minimize environmental losses. To restore grasslands, forest departments and private organisations must take strict action, control land-use changes, regulate human activities such as mining, solar plants, windmills, and high-tension transmission lines, and educate the public about grassland restoration.

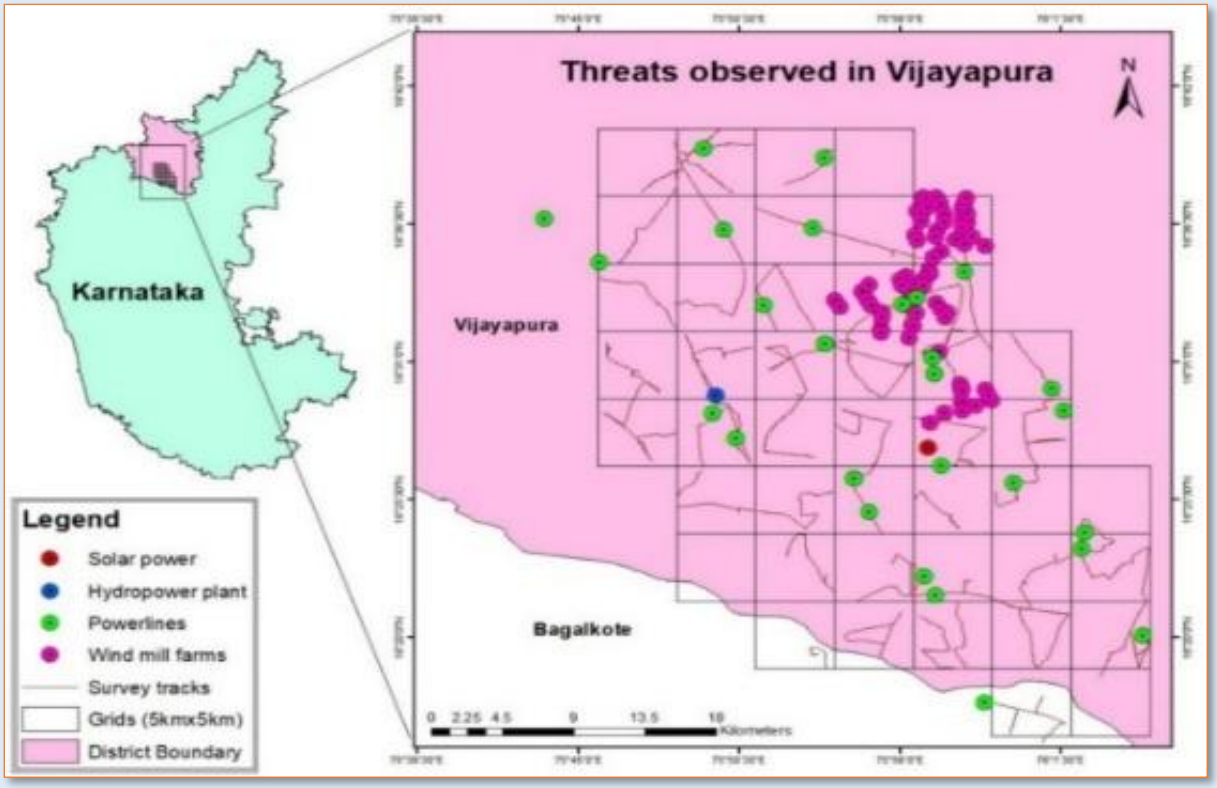


Figure 35*A:* ***Various threats observed a****cross Vijaypura district* ***during the landscape survey.***

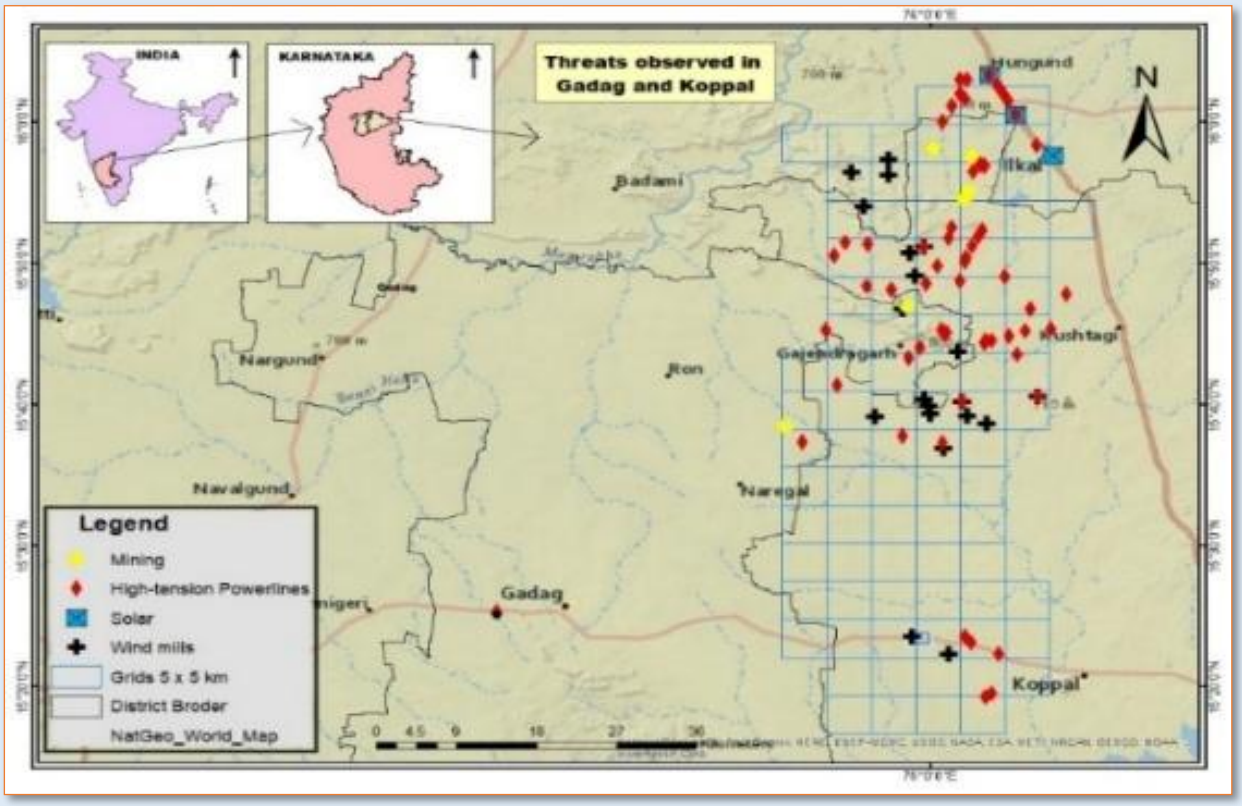


Figure 35*B:* ***Various threats observed a****cross Gadag and Koppal districts* ***during the landscape survey.***

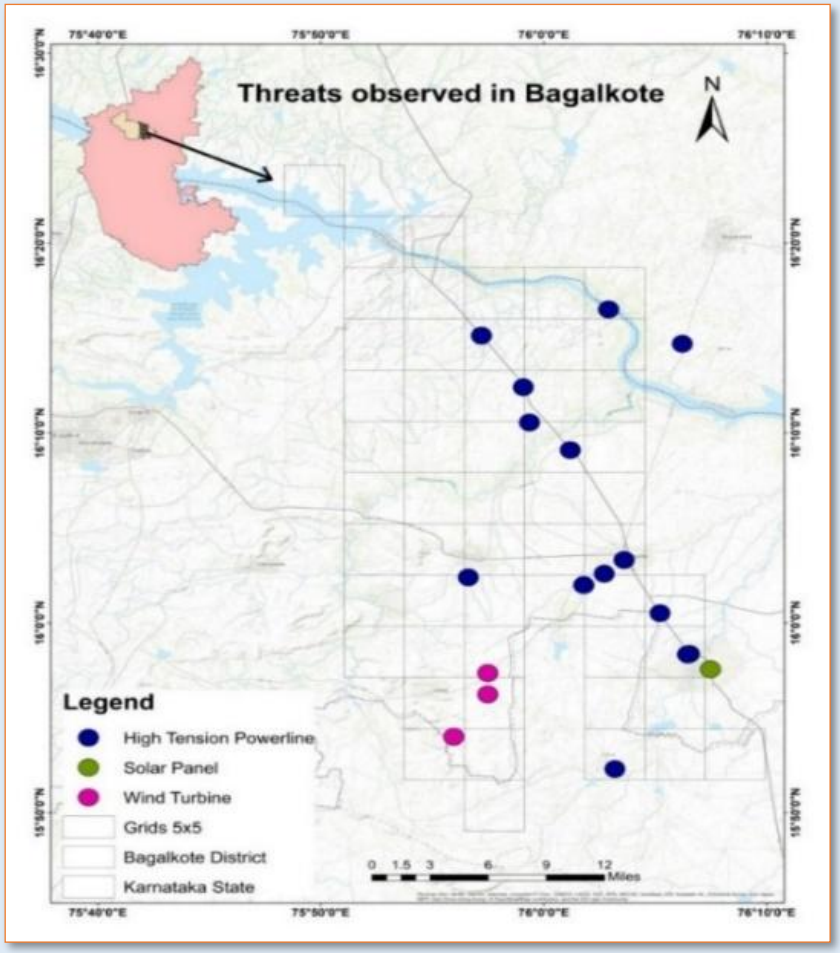


Figure 35C: Various threats observed across Bagalkote district during the landscape survey.

GIB is recorded in the northern plains of Karnataka

- **Bannikoppa** (15°24'24.9"N 75°57'48.2" E): An individual GIB was sighted near Bannikoppa railway station on December 08, 2001, while travelling by train from Koppal to Gadag (Kumara & Mohan Raj, 2007). The Bannikoppa region is suitable for birds, characterised by vast, flat terrain with agriculture, shrubland, and fallow land.
- **Sompur** (15°25'03.5"N 75°53'21.4" E): In October 2022, Mr Mandar Khadilkar from Mumbai sighted the Great Indian Bustard (GIB) near Sompur Road Railway station while travelling from Koppal to Gadag (10-15 km away from Bannikoppa). The terrain is a flat, mosaic pattern of agriculture, fallow land, and scrubland. The soil type of this region is black cotton soil.

Additional important sites covered in Karnataka

Ranebennur WLS, the case of the grassland turned into a woodland

The Ranibennur Black Buck Sanctuary, situated in the Deccan Plateau of Karnataka, India, has long been renowned for its diverse flora and fauna, with a particular emphasis on the graceful blackbucks. Ranebennur Blackbuck Sanctuary is in the Haveri district of Karnataka, India. It was declared a wildlife sanctuary on 17 June 1974, covering an area of 119 km². The sanctuary is approximately 118 km from Hubli, 302 km from Bangalore, and only 8 km from the town of Ranebennur. The sanctuary is divided into three blocks for administrative purposes: Hulathi, Hunasikatti, and Alageri. It comprises a core zone of 14.87 km² and a buffer-cum-tourism zone

of 104.13 km², which is open to tourists. The sanctuary's landscape primarily consists of scrub forests and Eucalyptus plantations, with surrounding agricultural fields. The original vegetation included *Acacia catechu*, *Dodonaea viscosa*, and *Cassia auriculata* until 1956. To increase vegetation cover, *Eucalyptus* and some indigenous species were planted. Today, the predominant top canopy is *Eucalyptus*, with some *Hardwickia binata* and *Albizia amara*. The middle and lower storeys include *Acacia catechu*, *Prosopis juliflora*, *Dodonaea viscosa*, *Acacia sundra*, *Zizyphus mauritiana*, *Lantana camara*, *Randia* spp., sacred Tree, and *Cassia auriculata*. The western portion of the sanctuary has more open scrubland, with patches of Subabul *Leucaena leucocephala*. Various other plant species, such as *Cassia fistula*, Neem *Azadirachta indica*, *Holoptelia integrifolia*, *Madhuca indica*, *Ficus* spp., and bamboo, have been planted along the sanctuary's roads.

The sanctuary is renowned for its blackbuck population, which has steadily increased since its establishment. The sanctuary is also home to wolves, wild boars, foxes, jackals, langurs, porcupines, common mongooses, Bengal monitors, hares, and pangolins. The most noteworthy aspect of the sanctuary is the presence of the highly endangered Great Indian Bustard. The Ranebennur Sanctuary is believed to have housed up to 14 of these birds. In 1974, Neginhal (1980) documented a few Great Indian Bustard sightings at the Ranibennur Blackbuck Sanctuary. These sightings continued until 1982, as confirmed by Neginhal (1980), Ali and Rahmani (1983), and Karanth and Singh (1990). In 1997, Neginhal (1997) reported the discovery of a Great Indian Bustard nest and eggs at Ranibennur. Bhat *et al.* (2005) compiled Great Indian Bustard status data from 1981 to 2005 using secondary sources, which indicated regular sightings of up to 5 birds from 1981 to 1997, with a peak of 14 birds in 1990. However, starting in 1998, there was a significant decline in Great Indian Bustard numbers within the Sanctuary, with only one bird reported in 2003.

Since 2003, there have been no reported sightings of the Great Indian Bustard in Ranibennur Blackbuck Sanctuary, except for a single sighting on June 6, 2004, near Bustard plots. Interviews with local residents have not revealed any additional sightings. H N Kumara (2006) noted this lack of evidence. On October 15, 2023, the Bustard team visited the sanctuary to explore grassland ecosystems in eastern and northern Karnataka. We informed RFO Ganesh Shettar of our visit and were welcomed by local watcher Shridar. The sanctuary's changes and the uncertain fate of the critically endangered Great Indian Bustard reflect both hope and concern.

The landscape has been entirely converted into vast agricultural fields, with increased human activity and development. We noted extensive maize fields, cotton plantations, and chilli crops flourishing in the region's fertile soil, indicating comprehensive agricultural practices. Above, a reminder of the modern world's encroachment on the landscape. These electric lines not only underscored the landscape's proximity to human settlements but also raised concerns about potential threats to wildlife. Additionally, we could not help but notice a change in the cropping pattern, hinting at evolving agricultural practices in the region. The landscape's transformation from traditional grasslands to intensive agriculture further emphasised the challenges faced by native wildlife, particularly black bucks and the critically endangered Great Indian Bustard, which historically called this place home.

The Changing Landscape:

As we approached the sanctuary's entrance, we were confronted by an unexpected sight. Instead of the sprawling open grasslands we had envisioned, we found ourselves in a dry, deciduous forest with an extensive Eucalyptus plantation. This marked a substantial departure from historical records, casting a shadow of uncertainty on the sanctuary's transformation.

***Eucalyptus* Plantation: Disrupting the Balance**

The Eucalyptus plantation, while valuable for commercial purposes, has disrupted the sanctuary's natural balance. This non-native species outcompetes native flora and impacts the sanctuary's original biodiversity. The dominance of Eucalyptus serves as a stark reminder of the challenges faced in preserving the sanctuary's integrity (**Please refer to the image below**).

Eucalyptus plantation at Rannebennur WLS © Sujit Narwade

Habitat Loss and lack of knowledge of grassland Management:

Our observations revealed a significant loss of the original grassland habitat, with several factors contributing to this decline, including *Eucalyptus* plantations and unethical management practices. This drastic alteration has had a ripple effect, impacting not just the plant life but also the animals that depend on these unique grasslands.

The Need for Restoration

1. Conversations with Shridar, the local watcher, emphasised the sanctuary's significance as a haven for blackbucks. He mentioned that the sanctuary currently houses an impressive population of blackbucks, estimated at 13,000-14,000 individuals (Shridar, 2023). While this population is a testament to the sanctuary's conservation success, it also underscores the dire need to restore their native habitat.
2. **The Great Indian Bustard's Struggle:** The sanctuary has a significant historical connection with the critically endangered Great Indian Bustard (GIB). Historical records revealed high activity and sightings of the GIB between 1985 and 1997, indicating the sanctuary's role as a potential stronghold for this iconic bird.

Our observations

1. Agricultural Surroundings: The sanctuary is entirely encircled by agrarian fields, which amplify anthropogenic pressures and intensify grazing activities.

2. Poor Grassland Management: The grasslands have deteriorated due to the absence of scientific management practices, allowing invasive species and woody vegetation to thrive.
3. Horticultural Intrusion: Remnants of horticultural species like *Syzygium*, *Artocarpus*, and *Mangifera* have encroached on the sanctuary's natural habitat, impacting its ecosystem.
4. Dwindling Blackbuck Population: We observed a notably reduced number of blackbucks, suggesting an unsuitable habitat overrun by invasive weeds and woody vegetation.
5. Habitat Transformation: The sanctuary's landscape has undergone a profound transformation, with open grasslands giving way to bushes and invasive weeds.

Recommendation for Conservation:

1. Scientific Grassland Management: Implement scientifically sound grassland management practices to restore and maintain open grasslands.
2. Invasive Species Control: Develop strategies to control invasive weeds and woody vegetation.
3. Habitat Restoration: Launch a comprehensive habitat restoration program to reclaim the sanctuary's original grasslands.
4. Community Engagement: Collaborate with local communities to reduce grazing pressure and raise conservation awareness.
5. Research and Monitoring: Conduct research and continuous monitoring to understand the sanctuary's changing dynamics, the status of its wildlife, and the impact of restoration efforts.
6. Awareness Campaigns: Raise awareness about the sanctuary's significance and biodiversity conservation.

The Ranibennur Black Buck Sanctuary finds itself at a crossroads, battling transformation and environmental

challenges while holding the keys to restoration and rejuvenation. Although our observations reveal both hope and concern, emphasize the urgent need for collective conservation efforts. With the right actions, the sanctuary can regain its lost glory and symbolise nature's resilience and our commitment to its preservation. The road ahead, though challenging, is the only path to secure the sanctuary's future and the unique biodiversity it harbours, including the critically endangered Great Indian Bustard. This species deserves our utmost attention and protection.

Chapter 3 – GIB and LF in Maharashtra

Survey areas and introduction

Status survey for grassland-associated species, including the Great Indian Bustard and Lesser Florican in Maharashtra, India. Areas surveyed were Solapur, Osmanabad (now Dharashiv), Latur districts, with a quick visit to Chatrapati Sambhaji Nagar (now Sambhajinagar) and Chandrapur districts

Maharashtra State includes the districts of Solapur, Dharashiv and Latur. The entire Solapur district lies in the basins of the rivers Bhima and Seena and is on the Southeast edge of Maharashtra State. Diverse resident and migratory birds that use the habitat for breeding, foraging, wintering, and moulting are found in the grassland ecosystem. Several bird species in the avifaunal community breed in thorn forests and grasslands. Dharashiv is situated on the Deccan plateau, around 600 meters above sea level. With approximately 600 mm of precipitation per year, the Dharashiv district is situated in a low-rainfall area (Narwade & Fartade, 2011). The monsoon season from July onwards is the primary time for planting crops, while harvesting begins in October and November. (Narwade and Fartade 2011).

GIB in Maharashtra

The Great Indian Bustard Sanctuary was established in 1979 in the Solapur and Ahmednagar districts of Maharashtra. It is unclear whether birds outside the sanctuary are part of the same population or constitute a new population. To better understand this, the Wildlife Institute of India and the Maharashtra Forest Department proposed and executed satellite telemetry. The first telemetry exercise was conducted in Warora, Chandrapur District, Maharashtra, and the birds were identified in three sites. The second exercise was executed in Nannaj Bustard Sanctuary. Birds are usually sighted in Nannaj during the breeding period from April to October.

On February 10, 2015, two male bustards arrived at the Bustard Sanctuary. In April, the dominant male started displaying, and a female GIB was seen in the same area on April 8th. After two days of courtship, the female departed on the 10th of April. The sub-adult male was captured on 17th April 2015 in Nannaj using noose traps. tracking the bird from April to December 2015. Bird travelled to Nannaj, Tolnoor in Karnataka, vairag, Akkalkot, Nilanga village, and Latur district.

The First GIB was captured on 25 December 2013 at Warora and tagged with 70 g PTT. The bird was tracked till 19 January 2014. The overall distance this bird has moved is around 25 km. The area this individual primarily uses consists mainly of agricultural land on the outskirts of Warora. (Habib *et al.* 2016).

In 2007's monsoon and winter seasons, the Great Indian Bustard *Ardeotis nigriceps* was observed in the Devkuruli-Katgaon area and Kemwadi-Savargaon in Osmanabad District 1 and 3, respectively (Narwade *et al.* 2010). One can judge how wide-ranging and abundant the Great Indian Bustard was in the Deccan, in days gone by, from notes in The Oriental Sports Magazine, where it was mentioned that Robert Mansfield, a British officer, killed 961 bustards in Ahmednagar District during 1809–1829 (Burton 1920).

The Great Indian Bustard was recorded from various parts of Maharashtra such as Nagpur, Wardha, Yavatmal, and Chandrapur districts of the Vidarbha region (Kasambe *et al.* 2007;

Thosar *et al.* 2007); Vaijapur Taluka of Chatrapati Sambhaji Nagar District, Mukhed-Udgir and Parbhani (Ali and Whistler 1939,1940), Ahmednagar (Dangre 1966; Kurhade and Jagtap 1998); and Pune (Nalavade 1992). The population of the Great Indian Bustard in the Great Indian Bustard Sanctuary was 50–60 birds in the 1980s (Kulkarni 1981; Rahmani and Manakadan 1990; Kumar *et al.* 1997), and 30–40 during 2000–2006 (Rahmani and Kalra 2005) (**Please refer to Figure 36**).

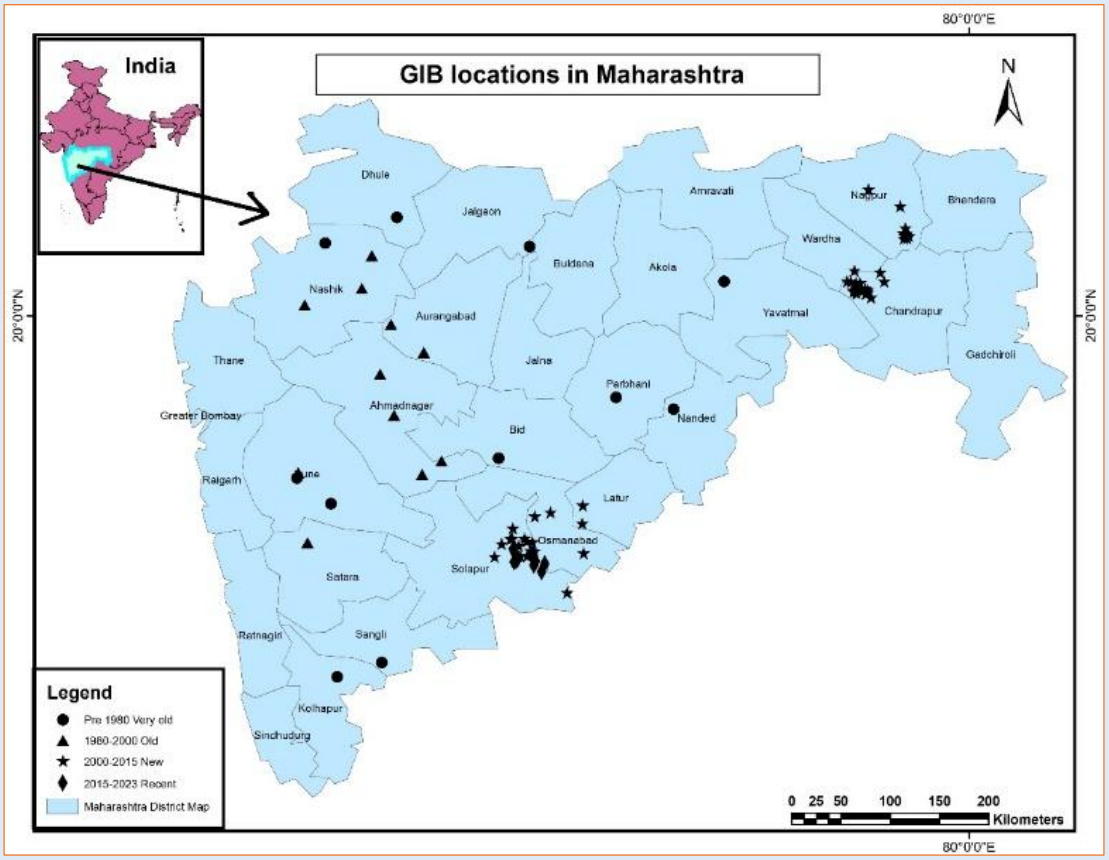


Figure 36: Historically, GIB was widely distributed but is now confined to Solapur and Chandrapur districts

This population declined to 13 in 2010, to 5 in 2015, and then to a single bird in 2016 in the Great Indian Bustard Sanctuary, Maharashtra (366.73 sq. km in the districts of Solapur and Ahmednagar). During 1980–1990, after its initial success, bustard conservation failed in many areas because of poor habitat management in protected areas, by the forest department, and the change in land use in non-protected areas (Ali *et al.* 1984; Rahmani 1989; Rahmani *et al.* 2014). Extensive infrastructure developments, such as high-tension overhead wires, roads, industries, and canals, completely changed the habitat on a landscape level. For example, during our study, an adult male Great Indian Bustard collided with a power line in the Nannaj area in September 2015 (Bhagwat Mhaske from Great Indian Bustard Sanctuary, Nannaj, verbally, September 2015). A female bustard, with a leg injury (probably due to a collision with a power line), was brought to the forest department in February 2012. She was treated and kept in a cage for one-and-a-half months but died in March 2012 (Source: Pune Wildlife Division).

Lesser Florican was recorded in Maharashtra till the year 2015

The Lesser Florican has been recorded from Pune, and its adjoining areas, such as the Sinhagad Hills, Mulshi Hills, and the Saswad-Dive Ghats (Mahabal & Lamba, 1987; Kalpavriksh, 2001). It was mentioned as 'rare' in Mumbai (Anonymous, 1909). A bird was shot near Pen, in Raigad District, in November 1896 (Anonymous, 1898). It was reported from the Nannaj Bustard Sanctuary in Sholapur District (Islam & Rahmani, 2002), and a chick was rescued in 2006 from the Karmala area of Solapur (Rahmani *et al.*, 2014). It was common in Nashik and Ahmednagar Districts (Hume & Marshall, 1879), and sighted in the Gangapur and Hosor grasslands in Nashik District in 1998 (Pittie, 1998; Raha & Prakash, 2001). A local person rescued a female of the species in October 2002 at Ambap village, 20 km off the Pune–Bengaluru highway (Rahmani *et al.*, 2014). In the Vidarbha region of Maharashtra, which is part of Central India, the Lesser Florican has been recorded from Borgao Manju, Akola, and Darwha, in Yavatmal District (Kasambe & Gahale, 2010). Kaustubh Pandhari Pande from Akola, Maharashtra, is working successfully with the Phase Pardhis, a tribal community known for their wildlife-hunting skills, and is now involved in a monitoring programme to protect the Lesser Florican in Washim and Akola Districts (Pallavi, 2014). The BNHS team sighted two Floricans in the area near Wanoja village, 2 km from Warora, on 22 March 2013 (Narwade *et al.*, 2015). The Lesser Florican *Sypheotides indicus* was occasionally seen in the Nannaj area in the 1980s (Rahmani, 1989). The last record of this species in the Nannaj area was in 2006 at Karmala of Solapur District (Rahmani *et al.*, 2014). There were two instances of rescue and release of this bird from the study area: one on 19 September 2017 from Bhigwan village, Pune District (Swapnil Jared, pers. comm. 2017), and the other on 25 November 2017 from the ground near the police headquarters, Solapur city. (Mukund Shete, pers. Comm. 2017) (Please **refer to Figure 37)**.

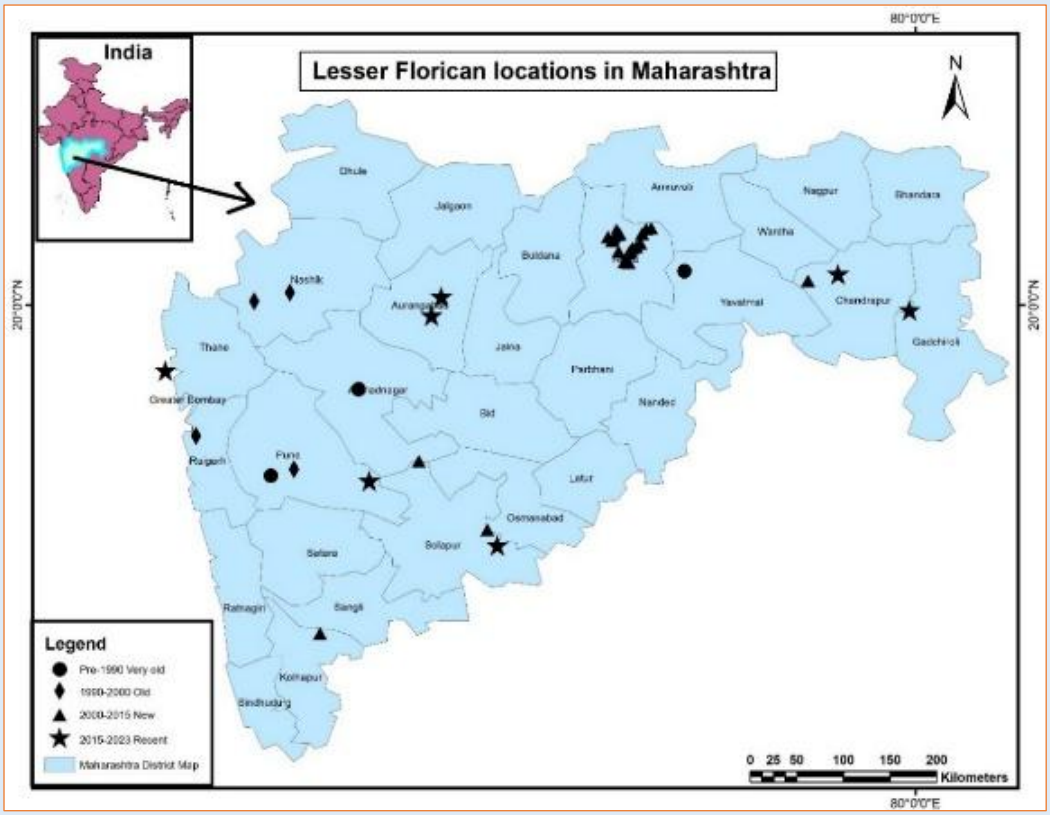
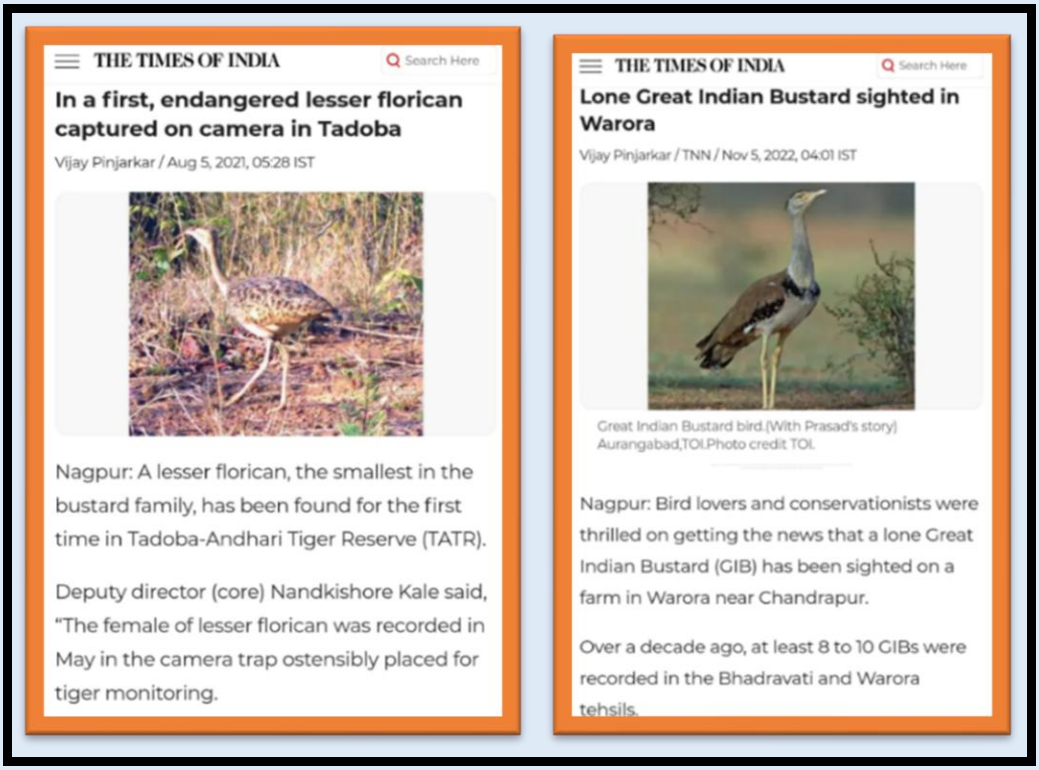


Figure 37: Lesser Florican Sites in Maharashtra

A solitary female GIB was sighted at the Gangewadi-Katgao-Boramani area of Solapur. Even the bird was seen crossing the tar road on 22nd July 2022, © BNHS archival

Recent sightings of GIB and LF in Maharashtra

On August 5, 2021, the Times of India published a story about a Lesser Florican discovered for the first time in Tadoba-Andhari Tiger Reserve (TATR), Chandrapur District, Maharashtra. According to Deputy Director (Core) Nandkishore Kale, a female Lesser Florican was observed in the video trap set up for tiger monitoring. On 5 November 2022, the Times of India reported that a Great Indian Bustard (GIB) had been sighted on a farm in Warora, near Chandrapur, Maharashtra (see **Images below**).



THE TIMES OF INDIA

In a first, endangered lesser florican captured on camera in Tadoba

Vijay Pinjarkar / Aug 5, 2021, 05:28 IST

Nagpur: A lesser florican, the smallest in the bustard family, has been found for the first time in Tadoba-Andhari Tiger Reserve (TATR).

Deputy director (core) Nandkishore Kale said, "The female of lesser florican was recorded in May in the camera trap ostensibly placed for tiger monitoring.

THE TIMES OF INDIA

Lone Great Indian Bustard sighted in Warora

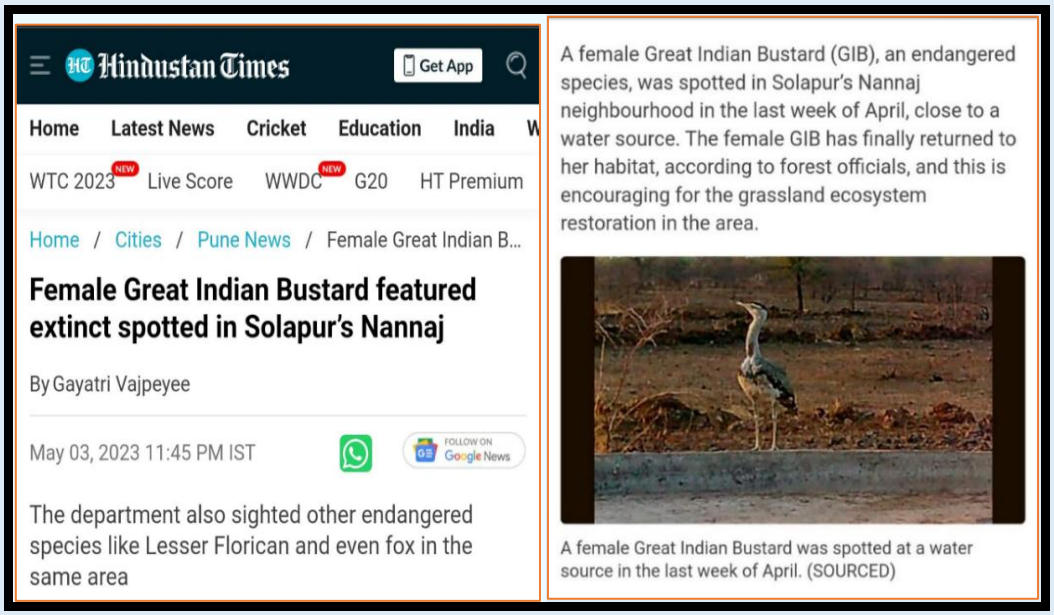
Vijay Pinjarkar / TNN / Nov 5, 2022, 04:01 IST

Great Indian Bustard bird.(With Prasad's story) Aurangabad,TOI.Photo credit TOI.

Nagpur: Bird lovers and conservationists were thrilled on getting the news that a lone Great Indian Bustard (GIB) has been sighted on a farm in Warora near Chandrapur.

Over a decade ago, at least 8 to 10 GIBs were recorded in the Bhadravati and Warora tehsils.

Article about the Lesser Florican sighting in Tadoba, Maharashtra



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Female Great Indian Bustard featured extinct spotted in Solapur's Nannaj

By Gayatri Vajpeyee

May 03, 2023 11:45 PM IST

The department also sighted other endangered species like Lesser Florican and even fox in the same area

A female Great Indian Bustard (GIB), an endangered species, was spotted in Solapur's Nannaj neighbourhood in the last week of April, close to a water source. The female GIB has finally returned to her habitat, according to forest officials, and this is encouraging for the grassland ecosystem restoration in the area.

A female Great Indian Bustard was spotted at a water source in the last week of April. (SOURCED)

Article about the Great Indian Bustard sighting in Nannaj, Maharashtra

Over a decade ago, at least 8-10 GIBs were reported in the Bhadravati and Warora tehsils. The Wildlife Institute of India (WII) and the Forest Department jointly performed a 5-day landscape-level survey for the critically endangered GIB in 2017. However, they could not find even one bird in the entire state.

On 3 May 2023, the Hindustan Times published news about a Female Great Indian Bustard sighted in Nannaj Village in Solapur district, Maharashtra. A female Great Indian Bustard (GIB) has returned to her habitat in Solapur's Nannaj, promoting grassland ecosystem restoration. Once part of the grassland ecosystem, the bird has been sighted in the area, along with the Lesser Florican and Bengal fox. Previously, 30–40 GIB were recorded during 2000–2006 in Maharashtra (Rahmani and Kalra 2005), but a survey in 2017 found not a single bird. In 2023, only one female GIB was sighted in Nannaj, and it is moving in the border areas between Maharashtra and Karnataka.

Study Area

The current Solapur district was once a part of the districts of Ahmednagar, Pune, and Satara. It was made a sub-district of Ahmednagar in 1838. It includes the subdivisions of Barshi, Mohol, Madha, Karmala, Indi, Hippargi, and Muddebihal. This Sub-district was disbanded in 1864. In 1871, this district was reorganized by including the Subdivisions of Solapur, Barshi, Mohol, Madha, and Karmala, as well as two Subdivisions of Satara district, Pandharpur and Sangola, and in 1875, Malshiras Subdivision. Solapur was included in the Mumbai State after the state reorganisation in 1956, and it became a full-fledged district of the Maharashtra State in 1960. (Administration, Solapur District, 2023). The Great Indian Bustard's protected area is found in the Solapur district's Madha, Mohal, Karmala, and North Solapur talukas, Ahmednagar district's Karjat, Srigonda, and Newasa talukas. It has a total size of 8496.44 km2. The location is accessible by road via Nannaj on the Solapur Barshi Road (22 kilometres from Solapur) or Rehekuri on the Karjat-Valvad Road (8 km from Karjat). A range of vegetation and wildlife may be found in the protected region. Southern tropical thorn forest is the forest type, and it is in biogeographical zone 6 B. (Deccan Peninsula Central Plateau). *Prosopis juliflora*, *Acacia nilotica*, *Ziziphus mauritiana*, *Dalbergia latifolia*, and various grass species are present in this region. (Administration, Solapur District, 2023).

Latur is a district in the Maharashtra state of India. It is the sixteenth-largest city in Maharashtra, lying on the Deccan Plateau between 17°52′ North and 18°50′ North and 76°18′ East and 79°12′ East. The district is part of the Marathwada area of Maharashtra. It is typically 631 metres (2,070 feet) above mean sea level. The entire district is located between 540 and 638 metres above mean sea level on the Balaghat plateau. The district's population is primarily agricultural. (Administration, Latur District, 2023). The southernmost region of the state is home to the Osmanabad district. The district's terrain is mostly rocky, with plain areas in between. The district is 600 millimetres above sea level. The "Balaghat" mountain range encircles most of the district. The Balaghat mountain range includes the tahsils of Bhoom, Washi, Kalamb, Osmanabad, and Tuljapur. This district includes portions of the large rivers Godawari and Bhima. The district is located on the east side of the Marathwada region (Administration, Osmanabad district, 2023) **(Please refer to Figure 38).**

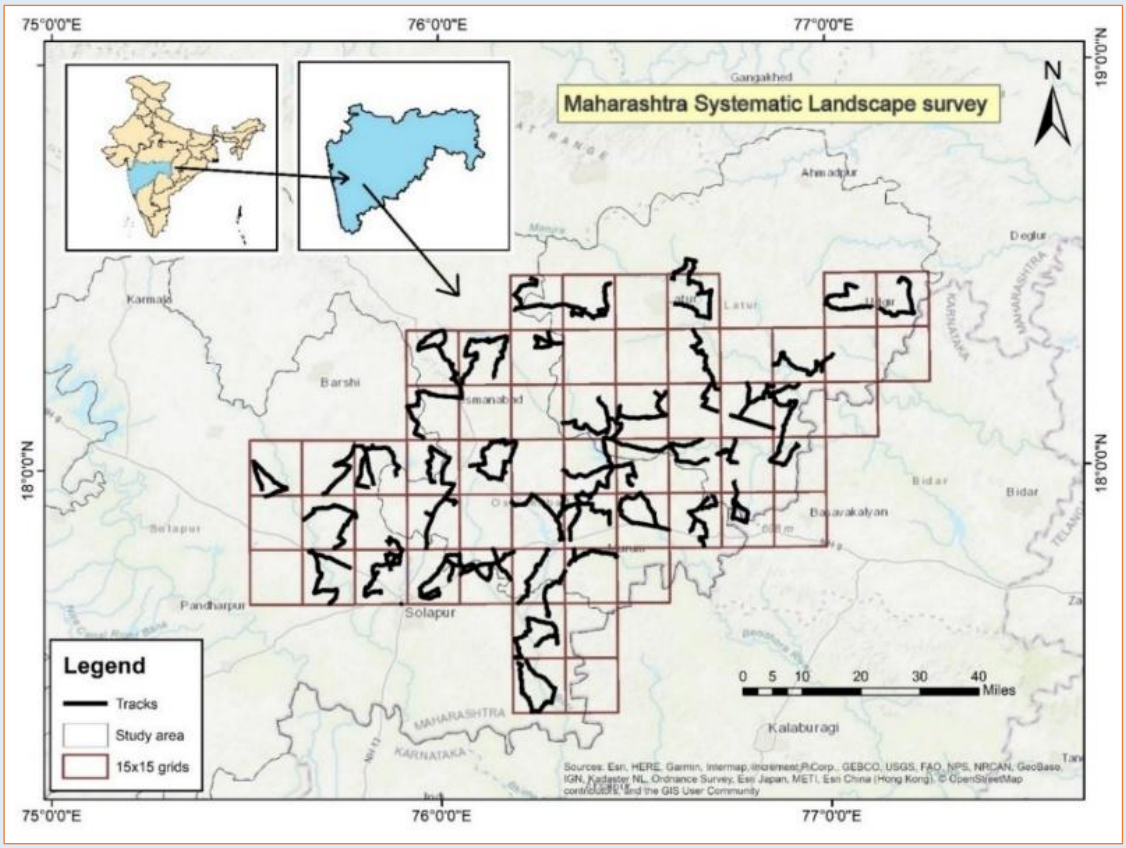


Figure 38: Covered area during the landscape survey of Maharashtra

Results

Survey efforts in brief

- **Duration – 17 August to 27 August 2022**
  - Grid size: **15 km x 15 km**;
  - Grids planned to cover **-59**
  - Actual grids covered and sampled **- 41**
  - Dedicated teams involved**- 04**
  - Observers in Each Team **- 03**
  - Average distance covered in each grid**- 20 km**
  - Total distance covered – 41 X 20 = **820 km**.
  - Observation time – 06:00 AM to 12:00 PM, 03:00 PM to 06:30 PM
  - Total Observation – 435 Point counts X 10 min = **4350 Min**
  - Total Human Hours in Landscape survey = 435 Point counts X 3 observers in each team = **1305 Minutes** or **21.75 Human Hours**

Land type

During the landscape survey observation, The Land type was observed such as, 62% of the land was used for agriculture, with the remaining 21% for grasslands, 12% for fallow land, 4% for scrub, 1% for plantations, and 1% for stony land cover.

Vegetation cover

During the landscape survey, the vegetation cover of the land was observed. 34% of the area is covered by grass and 33% by crops. The remaining vegetation is 8% trees, 11% shrubs, and 14% invasive species.

1. **Grasses**

55% of the grasses during the landscape survey were unidentified due to undeveloped grass, while the remaining grasses were 19% *Dactyloctenium* spp., 10% *Dicanthium* spp., 10% *Typha* spp., and 6% *Heteropogon* spp.

2. **Crops**

In the landscape survey, the crops were observed. The three main crops are Sugarcane *Saccharum officinarum* (22%), Moong *Vigna radiata* (24%), and Soybean *Glycine max* (30%), while Toor *Cajanus cajan* (15%) and jowar *Sorghum bicolour* (9%%) are minor crops.

3. **Shrubs**

We observed throughout the landscape survey that *Prosopis juliflora* 35%, *Acacia nilotica* 28%, *Lantana camara* 16%, and Unidentified Shrubs 21%.

4. **Invasive plants**

During the landscape survey, *Parthenium* and *Hyptis* were two of the dominant invasive species observed

5. **Tress**

We observed 38% *Ziziphus* spp., 33% Mango *Mangifera indicus*, 13% *Acacia nilotica*, 10% Neem *Azadirachta indicus*, and 6% Coocount trees *Cocos nucifera* during the landscape survey.

Threats

Some of the key factors contributing to the mortality of the GIB and LF include:

1. Habitat Loss: The species relies on grasslands and open savannas for nesting, feeding, and breeding. However, extensive habitat loss due to agricultural expansion, urbanisation, and industrial development has fragmented and degraded its habitat. This has led to increased mortality rates as the birds struggle to find suitable areas for survival.
2. Poaching and Hunting: Illegal hunting and poaching have been a major threat to the Great Indian Bustard. The birds are targeted for their meat, feathers, and body parts, sometimes used in traditional medicine or as trophies. This unsustainable hunting pressure has contributed to the species' decline.
3. Collision with Power Lines: The Great Indian bustard is a large, terrestrial bird and is prone to colliding with power lines, especially during its flight. Collisions with power lines cause direct mortality and pose a significant threat to the species, particularly in Rajasthan and other areas where power infrastructure overlaps with their habitat.
4. Predation: Increased predation by natural predators, such as feral dogs, foxes, and birds of prey, has been reported to contribute to the mortality of the GIB and LF. Habitat fragmentation and disturbance can increase vulnerability to predation, especially during nesting and breeding periods.
5. Disturbance and Habitat Degradation: Human activities, including tourism, agricultural practices, and infrastructure development, can disturb the bustard's natural habitat. This disturbance can lead to stress, displacement, and reduced breeding success, ultimately increasing mortality rates. (**Please refer to Figure 39**)

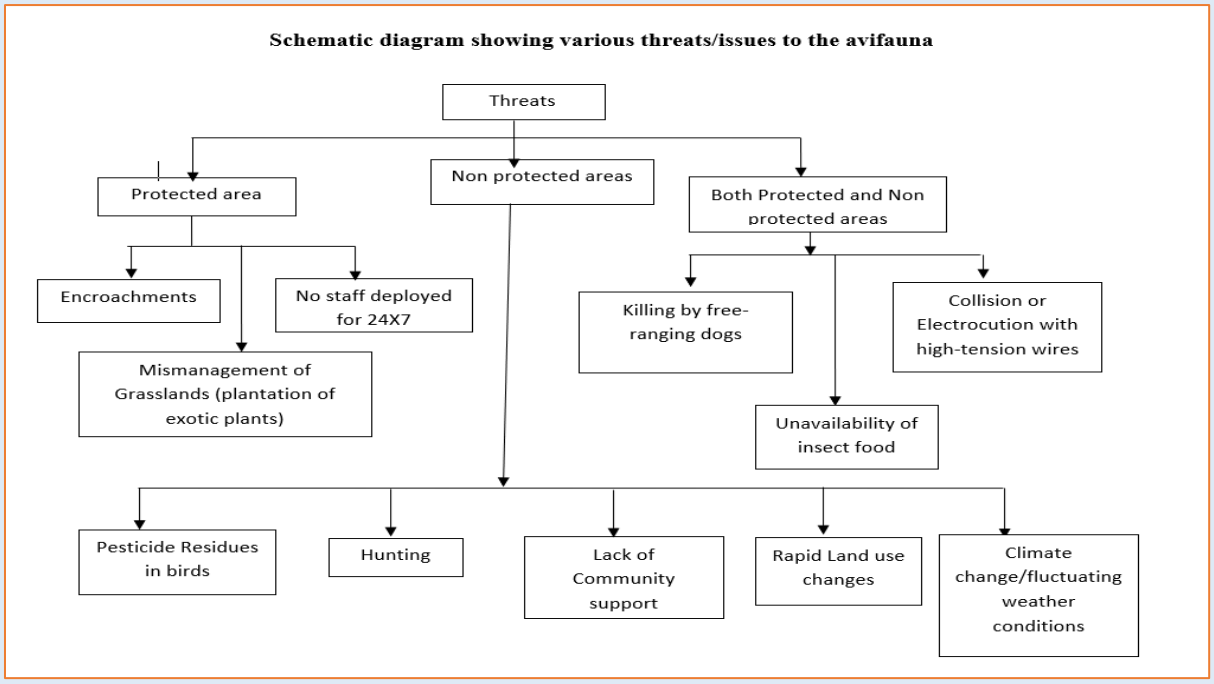


Figure 39: A diagrammatic representation of various threats to avifauna.

Most threats during the landscape survey were anthropogenic, which include 26% of human threats, 19% of road threats, 14% of noise threats, 11% of high-tension power line threats, 9% of settlement threats, 9% of grazer threats, 7% of dog threats, 3% of fencing threats, 1% of spraying threats, and 1% of industry threats.

Site visit to understand the habitat used by the PTT-Tagged Lesser Florican in Solapur

1. A site visit was conducted based on WII data to observe the habitat of the PTT-tagged Lesser Florican in its non-breeding area for a better understanding of the region.
2. Land use in a 1 km radius - Within a one-kilometre radius, all areas are under the cultivation of sugar cane except for a few 2- to 3-hectare barren patches.
3. Vegetation details in a 100 m radius—There is no specific vegetation in the 100 m radius because it is an agricultural plot (barren plot). At a distance of 300 meters, there are about 1-2 acres of Udad and papaya plantings, and the area is surrounded by sugarcane cultivation.
4. Threats - road, humans, free-ranging dogs, powerlines, urbanisation, pesticides, etc. The power line is 500 meters from the provided location; the Raw Road is agricultural, and the tarred road is about 700 meters away, with farmer bungalows within a 2 km radius. Feral dogs were seen.
5. Any significant information relevant to bustards and Floricans - The area's status may not be appropriate for birds (Bustards and Floricans)
6. All areas are under cultivation, with a monotonous sugar cane crop (Height 4-8 feet) and a few small plots of papaya, Jawar, corn, and grass for livestock.

In the study area, the avifauna includes Ashy-crown Sparrow-Lark *Eremopterix griseus* Tawny lark *Galerida deva*, Barred button quail *Turnix suscitator*, Indian bush lark *Mirafra erythroptera*, Indian courser *Cursorius coromandeliscus*, Paddyfield pipit *Anthus rufulus*, Rain Quail *Coturnix coromandelica*, Grey Francolin *Ortygornis pondicerianus*, Rock bush quail *Perdicula argoondah*, Chestnut-bellied Sand grouse *Pterocles exustus*, Yellow-wattled Lapwing *Vanellus malabaricus*.

These grassland-associated birds were observed. Black-winged kite *Elanus caeruleus*, White-eyed buzzard *Butastur teesa* and Rock Eagle-owl *Bubo bengalensis* were observed. In the Study area, Blackbuck *Antelope cervicapra and Chinkara Gazella bennettii are important herbivorous mammals present in very small* numbers. Indian golden jackal *Canis aureus*, *Canis lupus pallipes*, Small Indian fox *Vulpes bengalensis*, Indian grey mongoose *Herpestes edwardsi*, Jungle cat *Felis chaus* Black-napped Hare *Lepus nigricollis* are some notable mammalian fauna observed.

Additional important sites covered and surveys conducted

1) Tadoba Andhari Tiger Reserve

The city of Chandrapur in Maharashtra state is approximately 150 km from Nagpur. Situated on the outskirts of Chandrapur is the Tadoba Andhari Tiger Reserve (TATR), created in the year 1955. It is Maharashtra's oldest and largest National Park. The National Park covers 116.54 sq. km and is surrounded by the Andhari WLS, which covers 590 sq. km. The Tiger Reserve gets its name from the local deity Tadoba, who is worshipped by local tribes, and from the Andhari River, which passes through the protected area. The area receives a mean annual precipitation of 1041 mm (Kunhikannan and Rao 2013). The forest type is Southern tropical dry deciduous forest and falls under Group 5 sub-group 5A (Champion and Seth 1968). The Tiger Reserve is spread among three forest ranges: Tadoba North Range, Kolsa South Range, and Moharli Range. The Reserve is home to a variety of typical central Indian Floral species *Tectona grandis*, *Chloroxylon swietenia*, *Lagerstroemia parviflora*, *Anogeissus latifolia*, *Terminalia crenulata*, *Holarrhena antidysenterica*, *Aegle marmelos*, and *Diospyros melanoxylon* (Kunhikannan *et al., 2017).*

The majority area of the tiger reserve has a canopied jungle dominated by *Tectona grandis* followed by savanna vegetation. The dominant grass and plants in the reserve are *Acanthospermum hispidum*, *Heteropogon contortus*, *Themeda quadrivalvis*, *Apluda Bothriochloa mutica*, *Bothriochloa pertusa*, *Aristida Celosia setacea*, *Celosia argentea*, *Chrysopogon fulvus*, *Crotalaria berteroana*, *Merremia tridentata*, *Murdannia nudiflora*, *Phyllanthus urenaria*, *Polycarpaea corymbose.*

We visited areas that humans once inhabited, and the ruins of these small hamlets were still visible. The Maharashtra Forest Department (MFD) has initiated a programme to rejuvenate grasslands, particularly in areas affected by cattle overgrazing. The MFD has a team comprising locals who collect seeds from the park and the seed bank during the post-monsoon period. Fenced enclosures have been developed by the MFD for sowing these seeds. The grassland enclosures are strategically maintained open during the summer months to facilitate access for wild grazers, such as deer and bison, to access and interact with the habitat. The foraging activities of animals improve soil aeration, increasing water infiltration and oxygen diffusion, which in turn stimulates microbial activity and accelerates nutrient cycling. This symbiotic relationship between wildlife and flora is essential for maintaining the ecological balance within the protected area. Narwade *et al* (2014) sighted approximately 5 to 6 Great Indian Bustards in the Warora tehsil of Chandrapur district. These birds used an area between Wanoja and Marda villages as their breeding grounds (Rahmani *et al.* 2014). In 2021, a camera-trap study was conducted to monitor tigers, Panthera tigris, within the TATR. A Lesser Florican was captured in a camera trap placed on the boundary of Chandrapur and Moharli Range of the TATR (Hushangabadkar *et al.* 2023). The nearest sightings of the LF in this region were in Warora tehsil in 2014 (Narwade *et al.*, 2015). The restored grasslands within the TATR might play a crucial role in the population reintroduction of bustards in Maharashtra. (Please **refer to the image below**.

A view of a meadow in areas from where villages have been rehabilitated from TATR, © Dr Sujit Narwade

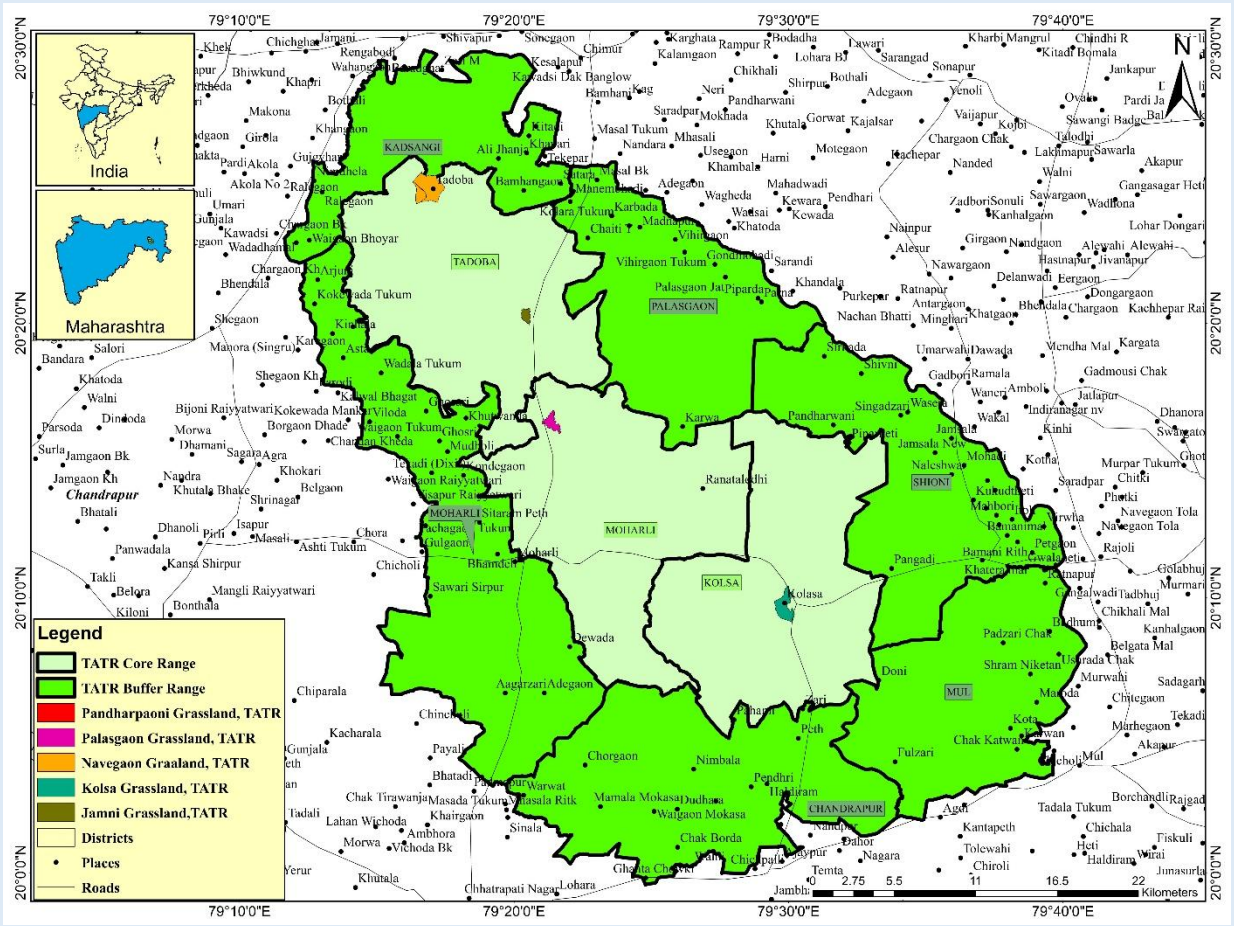


Figure 40: All grassland patches within the core and buffer areas of TATR have been mapped for further systematic study. and buffer areas of TATR mapped for further systematic study

From September 2025 to June 2026, a structured conservation framework was implemented to study the grasslands within the tiger landscape of Vidarbha, focusing on the Tadoba–Andhari Tiger Reserve (TATR). The project aimed to identify major threats to grassland birds and their habitats, establish objectives, and take action to mitigate these challenges. The roles and responsibilities were shared between TATR and the Bombay Natural History Society (BNHS), integrating monitoring strategies and relevant policies into conservation practices. Grassland restoration efforts were carried out by TATR in areas reshaped by village relocations, directly supporting the recovery of the Lesser Florican. Primary Response Teams (PRTs) and the Special Tiger Protection Force (STPF) were mobilized to respond quickly to human-wildlife conflicts, enforce legal measures, and contribute to grassland management.

Survey protocols were implemented to assess vegetation, insects, birds, mammals, and wildlife corridors. Field teams documented vegetation succession, biodiversity indices, and site-specific ecological dynamics. Sightings of the Lesser Florican were recorded in buffer zones, and extensive road transect surveys provided additional insights into species distribution. Training workshops were held to build the capacity of frontline staff, while observational reports captured variations in plant diversity across surveyed sites. Data were collected from more than 25 meadow sites, strengthening the evidence base for conservation planning. Annexures were prepared, which included photographic documentation, wildlife sighting records, maps of surveyed areas, bird species lists, and inventories of grasses, trees, and shrubs. These inventories highlighted both dominant native species and invasive species that posed ecological threats.

Preliminary recommendations were formulated, including establishing monthly monitoring cycles and developing actionable conservation plans. Collectively, these activities advanced species recovery, habitat restoration, law enforcement, and community participation, laying the groundwork for the sustained conservation of tiger corridors and microhabitats supporting the Lesser Florican and other key species.

The population of the critically endangered Rajasthan florican faces a severe risk of decline because these birds nest in heavily cultivated agricultural fields. This situation underscores the urgent need to identify and protect suitable habitats that are free from human disturbance. While many floricans migrate south during the non-breeding season to the Deccan region of southern India, recent observations have been promising. Although no breeding activity has been documented, sightings in notable areas such as the Tadoba Andhari Tiger Reserve (TATR), Pench National Park, Warora, and Gautala Wildlife Sanctuary in Maharashtra suggest possible movement corridors or residual occupancy of floricans in these regions.

The habitat conditions within these tiger reserves, including optimal grass height, abundant insects, and a relatively undisturbed environment, may provide an ideal foundation for future rewilding initiatives to support these vulnerable ground-nesting birds. In light of this, TATR, in partnership with BNHS, is poised to launch a comprehensive grassland restoration program. This initiative aims to rejuvenate habitats essential for wildlife, especially ground-nesting birds such as the florican, ensuring that the ecological conditions needed for their breeding and survival are restored.

2) Gadchiroli

In the two reported Lesser Florican, one LF has been reported dead in Nimgaon Riyyatwari near Chamorshil tehsil, Gadhchiroli District (Please refer to Figure **41**).

Figure 41: The map illustrates the specific location of the mortality site for the tagged Lesser Florican. A Lesser Florican, which had been tagged in Gujarat for tracking purposes, was discovered dead in close proximity to Nimgaon, located in the Chamorshi tehsil of Gadhchiroli District. Team BNHS conducted a site visit to thoroughly assess the circumstances and better understand the ground situation.

Figure 42: This site is located near the Wainganga River. The survey was conducted within a 5 km radius of the LF mortality location to assess the habitat and disturbance in that area.

3) Warora, Bhadrawati, Chandrapur

According to old reports, there are five to six GIB records and one to two Lesser Florican in the Warora tehsil of Chandrapur District (Narwade *et al.* 2015). These birds were using an area between Wanoja and Marda villages (20.25144'N, 78.95265'E) for breeding (Rahmani et al. 2014). The BNHS team recorded two Lesser Floricans on 20 November 2014 near the Maharashtra Industrial Development Corporation (MIDC) Mohbala, Warora, which is 3 km from Marda-Wanoja village (Narwade *et al.* 2015). Therefore, the team visited the Warora and Bhadrawati areas of Chandrapur District on 21 October and 22 October 2022. The area was dominated by agricultural lands with small pockets of fallow land and grassland. The Marda-Wanoja village area has come under the development of Western Coalfields Limited (WCL) at Ekona. Warora is a city and municipal council in Chandrapur district in the Indian state of Maharashtra. Warora is located at 20.23°N 79.0°E. Its average elevation is 250 meters (820.21 feet). The total area of the Warora is 22.5 sq. km. The average annual temperature of Warora is 44.3 °C, and the average annual minimum temperature is 12.7 °C, though these values can vary. The area falls within the Deccan plateau; a major part of the Warora survey area is occupied by agricultural lands, and some parts are dry open grassland dominated by trees, thorny shrubs, and perennial trees. The Forest Department protects some potential semi-arid land by fencing off that habitat.

Design for the survey

Based on the past sighting records of the LF and GIB, surveys were planned in parts of the Warora tehsil of the district Chandrapur. Habitat data were collected using an Android data collection application, followed by GPS location data for the survey sites. Data for the LF mortality site in Chamorshi tehsil of district Gadhchiroli were collected using a systematic, round, grid-based vehicle survey; the grid had a 5 km radius around the GPS location of the LF dead site.

Survey efforts in a brief

- Duration: 21 October 2022 to 23 October 2022.
- Number of surveyors: Two people conducted surveys in one vehicle.
- Area covered: There are 22 locations in the survey area of Warora—Bhadrawati tehsil of Chandrapur district, including Chamorshi tehsil of Gadhchiroli district, which is 1,128 sq. km.
- Point counts: At every GPS point, a 10-minute point count was taken, totalling 26 points in and around the area.
- Hours of field observation: Ten minutes at 26-point counts = 260 minutes or 4.3 hours.
- Distance covered by vehicle survey: According to the GPS, the distance is 390 km.

The survey area is rich in black cotton soil and in cotton, wheat, jowar, paddy, gram, and linseed. Some pulses are grown on a large scale, but the most grown crop is cotton in the Warora tehsil and paddy in the Chamorshi tehsil. The farmers in this area take two crops in two seasons; these vary from year to year and according to market demand. Some patches of grassland in Marda-Wanoja village are waterlogged due to the rainy season, with grass heights of 1-1.2 m, but are sandwiched between agricultural lands and surrounded by settlements and small industries. The LF and GIB usually avoid using such disturbed areas but have been found using these agricultural fields and Fallow lands (Narwade *et al.* 2015).

The potential sites in the Marda-Wanoja villages where the LF and GIB were found have large reservoirs nearby, namely the Marda Dam on the Wardha River. These sites are also near the WCL Ekona mining area and the MIDC industrial area. The LF mortality site was visited, and the vegetation was observed. Dominant vegetation included paddy fields, with only a patch of dry land featuring thorny shrubs and perennial trees within a 5 km radius of a hilly landscape.

Habitat/Vegetation

The major portion of the survey area was dominated by agriculture (Crops - Cotton, Wheat, Jowar, paddy, Gram, etc) and some portion is occupied by the dry open grasslands interspersed by thorny bushes (*Prosopis juliflora*, *Acasia* spp, etc) and trees (*Azadirachta indicus*, *Mangifera indicus*, *Tectona grandis*, etc). The major grasses are *Cynodon* spp, *Dicanthium* spp, *Chrysopogon* spp, etc. Some herbaceous weeds like *Parthenium hysterophorus*, *Celosia* spp and annual shrub *Casia tora, and Lantana camara* **(Please refer to Figure 43)**.

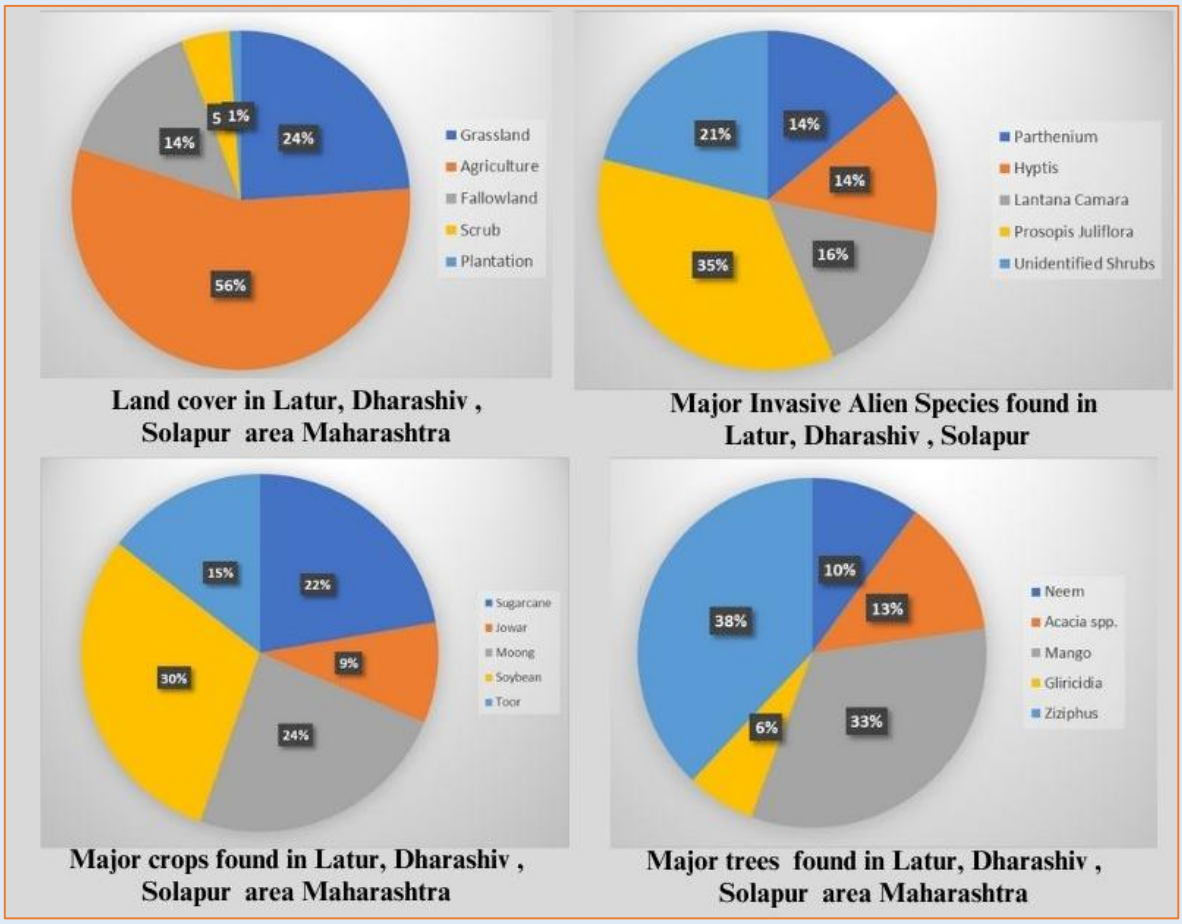


Figure 45: Vegetation graphs of the study sites

Threats to the habitat and birds

- **Settlement**: The area is near Warora town, lots of people from Warora have their agricultural land outside the town, close to their villages. The villages are also developing, and people are buying land and developing infrastructure near their agricultural land.
- **Roads**: The widening and making of tar roads to connect the roads to villages and villages to towns, increasing the chances of road kills of wild animals and restricting their free movement.

- **Industries**: Cotton Mills are developing because cotton is cultivated on a large scale. Open land is being converted into Mills near the Marda-Wanoja village road, which is important for birds like GIB.
- **Invasive Species**: Species like *Prosopis juliflora* and *Lantana camara* are spreading all over the fallow land, dominating the native species and thus reducing the LF habitat.
- **Electrocution and High-Tension Power Lines**: The death of large birds is increasing due to collisions with cables ever since power lines have been put up around the agricultural fields.
- **Poaching**: The possibility of poaching by the people for meat and money.
- **Coal Mines**: A coal mine near Ekona is known as the WCL Ekona mine. There is a chance that this mine will be extended right into the sites where the LF is sighted, which is also a breeding site of the GIB. This is also a great threat to the habitat.

4) Chatrapati Sambhaji Nagar

Visit – 16 and 17 October 2022.

Site – Gautala WLS and Hasnabad grassland site.

Gautala Reserve Forest, also renowned as "Gautala Autramghat Wildlife Sanctuary is situated in the west-north direction of the Chatrapati Sambhaji Nagar District, Marathwada region. It has a region of about 261 sq. km. It covers a 64 sq. km area of Jalgaon District and a 197 sq. km area of Chatrapati Sambhaji Nagar District. Its geographical position is at longitude E 74 ° 05', latitude N 19 ° 54', and altitude 1904 ft. The annual rainfall is about 550-600 mm. The temperature goes up to 45°C in summer and falls to 8°C in winter. The Gautala Sanctuary is well known for its avifauna and mammal diversity. The Gautala has a flora of medicinal plants, including woody shrubs and herbs, that grow under natural conditions. (District Gazetteer Chatrapati Sambhaji Nagar). Team BNHS visited the Gautala WLS observed site and studied its habitat and land patterns.

Hasnabad is a small Village/hamlet in Sillod Taluka in Chatrapati Sambhaji Nagar District of Maharashtra State, India. It falls under the Hasnabad Panchayath and is part of the Chatrapati Sambhaji Nagar Division in the Marathwada region. It. It is located 53 km north of the District headquarters, Chatrapati Sambhaji Nagar. Hasnabad is surrounded by Khultabad Taluka to the South, Chalisgaon Taluka to the North, Phulambri Taluka to the East, and Bhadgaon Taluka to the North. Chalisgaon, Talode, Chatrapati Sambhaji Nagar and Pachora are the cities near Hasnabad. Hasnabad has a grassland area nearby. (District Gazetteer Chatrapati Sambhaji Nagar). Team BNHS visited the site to observe GIB and LF occurrences and study the habitat and land patterns. The Chatrapati Sambhaji Nagar region has a mosaic pattern of agricultural and grassland areas, which is favourable for the occurrence of the Lesser Florican.

Ravi, a male Lesser Florican (named after the late Dr Ravi Sankaran, for his pioneering research on this species), tagged near Ajmer in August 2020, migrated over 600 km and was located in December 2020 near Chatrapati Sambhaji Nagar, Maharashtra (MoEFand CC). A Lesser Florican was rescued on 27th October 2022. Shaikh Shoeb, a bird watcher, had spotted the Lesser Florican lying in the nullah behind the Mughal-era Garden on the afternoon of October 27 when he saw a few stray dogs barking at the bird that was unable to fly. He then called the honorary wildlife warden of Chatrapati Sambhaji Nagar, Kishor Pathak and informed the forest department about the bird and the injuries under its wings (Source - https://timesofindia.indiatimes.com/city/Chatrapati_Sambhaji_Nagar/forest-dept-faces-flak-after-rescued-lesser-florican-dies/articleshowprint/95243076.cms)

Chapter 4 - Lesser Florican in Madhya Pradesh

Introduction

The known distribution of the Lesser Florican in Madhya Pradesh is restricted to the Ratlam and Neemuch districts of Ujjain Forest Circle, as well as the Dhar and Jhabua Forest Divisions of Indore Forest Circle. Now found only in Sailana WLS, Sardarpur WLS and the Petlawad area of Zabua district, Madhya Pradesh. India has two exclusives Lesser Florican sanctuaries, both in Madhya Pradesh, established following a 1983 visit by the renowned Ornithologist Dr Sálim Ali to the region. The two sanctuaries are Sailana Wildlife Sanctuary in Ratlam district (12.96 sq. km, where its Shikarwadi compartment comprises 354 ha and Amba compartment, 1000 ha) and Sardarpur Wildlife Sanctuary in Dhar district (348 sq. km area, which is under rationalisation for excluding settlements and private lands, with 628 ha of grassland and a new plot of 50 ha of grassland has been developed in Panpura) (**Please refer to Figure 46**).

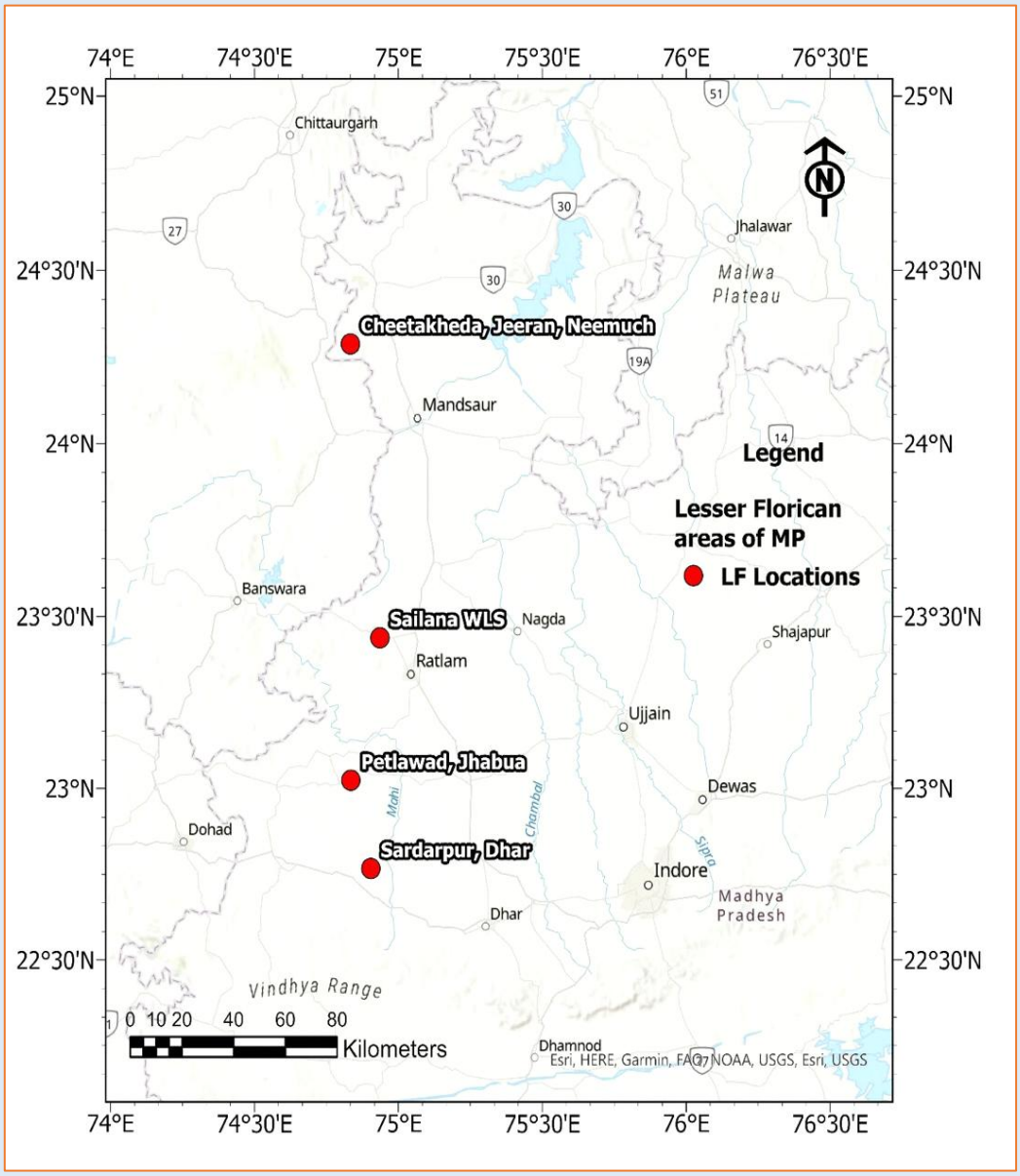


Figure 46: Lesser Florican sites in Madhya Pradesh

Lesser Florican in the western MP in 2023

The team from BNHS, dedicated to the preservation and conservation of the Florican, recently (October 2023) conducted an extensive landscape survey in the western region of Madhya Pradesh. During the survey, the team visited various sites known for their distribution of Lesser Florican (LF). The survey aimed to gather crucial data on the birds' presence, habitats, and other factors affecting their survival in the region.

1) Sardarpur

The Sardarpur LF Sanctuary is a wildlife sanctuary near the village of Dhulet, on the Dhar-Ahmadabad Dhar National Highway 47. Notably, while approaching the sanctuary, a metallic wall was observed on the right side of the road, which serves as a soundproof barrier to minimise disturbances to the displaying grounds of the Florican (**Please refer to the Image below**).

The soundproof wall on NH 47, as a mitigation measure suggested by the National Wildlife Board for the Florican displaying areas of Florican, © Neelkanth Bora.

Since male Lesser Floricans signal their presence with wing-fluttering sounds, road noise can hamper their breeding activities. The National Board of Wildlife suggested this mitigation measure to ensure the safety and well-being of the Floricans in the sanctuary. During our visit, we had multiple sightings of harrier species on the way to the grassland enclosure near Panpura. This enclosure is near five villages: Timaji/Timaichi, Bhangarh, Amodiya, Songarh and Kumar Rundi. However, it was concerning to note several breaches in the enclosure's peripheral fencing, allowing cattle to enter and graze. Overgrazing could harm the grassland ecosystem and the species that depend on it (**Please refer to the image below**).

Grazing is fine, but overgrazing by cattle can alter the entire availability and composition of grass in the landscape. © Neelkanth Bora

Moving on to another block a few hundred meters ahead, we came across a well-maintained enclosure with a gated entrance and a sturdy watchtower. Seeing the efforts made to maintain the area, which featured pristine, undulating grassland and a herd of Nilgai, was heartening. The enclosure seemed to be a haven for the species, and the watchtower provided a vantage point for sanctuary staff to monitor the area and ensure the species' safety. Overall, the Sardarpur LF Sanctuary is a valuable ecosystem that needs to be protected and conserved. It is important to take necessary measures to ensure the species' safety within the sanctuary and maintain the integrity of the ecosystem. The area featured pristine, undulating grassland and a herd of Nilgai (Boselaphus tragocamelus). The dominant grass species identified included *Heteropogon* spp., *Cymbopogon* spp., and *Chrysopoghon* spp. There is sparse vegetation of *Butea* species.

2) Petlawad

During their field visit, the team observed two different areas: one at Banni beat, a compartment near the Ratamba/Dhannia village close to Raipuria. The team noticed free-ranging dogs in the area, which could threaten local wildlife. Settlements were visible on all sides of the area, indicating human presence in the surrounding forested landscape. The area was overgrazed, which could lead to soil erosion and ecosystem degradation. The second site was Bolasa and Tarkhedi near Petlawad – this area had sparse plantations until 2007-2008. After the plantation was removed, maize cultivation was carried out for some time. Later, the area was converted into grassland, and around 522 hectares were fenced to protect it. The removal of the plantation and the emergence of open grasslands attracted the Lesser Floricans to this landscape. However, the locals have breached the premises, and currently, the area is under severe grazing pressure, which could lead to the destruction of the grasslands and a decline in the Lesser Florican population. Previously, the grassland and the beat were managed by a Joint Forest Management Committee (JFMC), responsible for appointing guards to protect the area. The committee collected revenue during the monsoon season when the grasses were harvested. A portion of the generated revenue was distributed among the guards as an incentive to protect the area. However, the current situation suggests that the area is highly overgrazed, which

could lead to the decline of the ecosystem and the wildlife in the landscape. The landscape has a sparse distribution of *Prosopis juliflora* and other grasses, including *Heteropogon* spp. (**Please refer to the image below**.

Severe grazing pressure can be seen in and outside Tarkhedi Beat Enclosure, Petlawad, © Neelkanth Bora

3) Sailana

Dr Salim Ali, in the 1970's, advocated for developing this place as one of the first Lesser Florican dedicated sanctuaries. The place was once the optimal spot for spotting a displaying male florican. However, over time, various infrastructure developments occurred on the outskirts of this protected area. Today, a network of windmills can be seen extending from the northeast towards the south and southwest. There is a water body within the Shikarwadi enclosure (354 hectares), adjacent to the *Shikargah* (a palace where the nobility used to reside and hunt). The current presence of LF has been sporadic: as per Khima ji (chowkidar and watcher), in 2018 five males were seen in the sanctuary; in 2022, he sighted an LF female; and a male was sighted in September 2023. The grassland within the enclosure has a variety of grasses, the major species being *Gundradi Themeda* spp., *Sukhli Heteropogon* spp., *and Rosa Cymbopogon* spp. The grass is harvested here in late November. We have received information that the Shikarwadi enclosure of the Sailana LF sanctuary has been proposed for de-notification. Another important area is the Amba enclosure, which has three separate blocks numbered 169, 170, and 171. The total area is 852 hectares. As per the information, if the land from Shikarwadi is de-notified, two blocks shall be added to the Amba Area. The compounds adjacent to the sanctuary are 168, 172, 174, and 167. (**Please refer to the image on the next page**).

Visit to the Amba enclosure near Sailana, excessive growth of wild Tulsi needs to be managed, it is one of the important grasslands for the Critically Endangered LF © Neelkanth Bora.

4) Cheetah Kheda

In the year 2018, three Lesser Florican individuals were sighted in the Cheetah Khera beat of Jeeran range in an All-India Survey conducted by various agencies, including the forest department of Madhya Pradesh and the BNHS, to understand the population and distribution status of this Critically Endangered bustard species. In a recent visit in 2023, we came across a well-managed grassland with dominant grass species such as *Heteropogon*, *Chrysopogon*, *Themeda*. In the Cheetah Khera beat, there are 21 compartments, of which compartments 5 and 6 have been dedicated to LF conservation. (**Please refer to the Image below**)

Although it has been designated as a Florican conservation area in Jeeran beat, there is a need to declare it a Conservation Reserve through due process. © Sujit Narwade

5) Gandhisagar Wildlife Sanctuary

The Gandhisagar reservoir and hydroelectric power plant are built upstream of the Chambal River. It is situated on the border between Rajasthan and Madhya Pradesh, with the backwaters extending into MP. In 2023, a report by the Wildlife Institute of India (WII) detailed the tagging of four Lesser Floricans—two males and two females—between August and September 2022. These birds were tagged near Bandanwara, Dhantol, and Kalyanpura villages in Ajmer district, and their movements were tracked until they reached their wintering grounds. One of the tagged males, fitted with an Ornitela OT-103GC tag weighing 10g, remained in the Gandhisagar area. The last transmission from this tag was recorded on October 24, 2022, after which it malfunctioned.

To understand the habitat, a visit was planned, and a request was made to the forest department officials. On December 5th, 2023, we visited the Gandhisagar Wildlife Sanctuary, accompanied by the Assistant Conservator of Forest, Shri Rakesh Thakur. The river Chambal flows through a canyon here. We saw a hundred Indian cormorants along with river terns. The canyon's cliffs are one of the finest nesting sites for the Critically Endangered Indian Vulture and the White-backed Vulture in the country. We sighted a couple of individuals sitting over a nest at a height of almost 70 meters. The vultures occasionally face threats and disturbance from the Hanuman Langur. We drove to the Chaurasigarh Fort site, where the team from the Wildlife Institute of India and the Forest Officials had sighted the individual Florican. This was a dry-deciduous forest, which was notable because the Florican is a grassland-obligate species. It is the same part of the sanctuary where an enclosure is being developed for the Cheetah Reintroduction Programme (**Please refer to the image below**).

Predator-proof fencing is being developed for the Cheetah Reintroduction Program in the Gandhi Sagar Wildlife Sanctuary, Madhya Pradesh © Sujit Narwade

This was an open scrubland forest, and we sighted chinkaras and nilgai. A mixed flock of vultures was seen feeding upon a carcass; the flock had three Indian Vultures, eighteen Griffon Vultures, and six Egyptian Vultures. Along with this, a Golden Jackal was seen. We observed the substantial pressure exerted by free-ranging dogs on natural scavengers.

Threats to the Lesser Florican in Madhya Pradesh

Major problems are habitat loss and alteration, paucity of ecological information and lack of proper policy and governance of grasslands.

1. **Poaching**, trapping and egg collection
2. **Disturbance from unethical photography** – because of the revolution in digital photography and social media, many people are engaged in unethical photography
3. **Pesticides** – The rampant use of pesticides is affecting the food chain of the Floricans.
4. **Inappropriate conservation incentive schemes brought out by the Forest Department -** such as rewards to the people showing nests of the floricans. It was found that people started moving nests to their land to claim the reward, which boomeranged as ecological disasters.
5. **Land use changes** – because of the intensification of agriculture, changes in crop pattern, encroachment of grasslands, inappropriate grassland management and rapid development, Floricans are losing habitat
6. **Overgrazing** – there are chances of trampling of eggs because of overgrazing in the Florican areas
7. **Mining**—Mining, especially open-cast mining, is one of the main causes of habitat loss for this species.
8. **Inadequate knowledge** of current distribution, population status, demography, movement-dispersal and habitat use
9. **Inadequate research** on the association of the Lesser Florican with grass species/vegetation of the area.
10. **Power projects** – Windmills and the associated heavy electric lines connected with tall towers for power transmission have resulted in the loss of habitat as well as the death of the birds as they get electrocuted when they hit these power lines during flight.
11. **Afforestation -** The grasslands, which do not have any status like forests and are usually considered as wasteland, are targeted for all sorts of developmental activities, including all types of afforestation. Afforestation not only encroaches upon grassland ecosystems but also fragments the landscape, altering habitat continuity and reducing the availability of suitable breeding sites. Additionally, it introduces vertical structural elements that create visual obstructions, which are particularly detrimental to LF. As a lekking species, LF rely on open landscapes for uninterrupted visibility during their aerial courtship displays and for effective predator vigilance.
12. **Indirect Threat**: Climate change (irregular precipitation) - Being a monsoon breeder, it changes its breeding grounds depending on the monsoon conditions, which makes its conservation difficult. The decrease in fluctuation and irregular precipitation in many parts of the LFs' distribution range as a result of increasing temperature or global warming (an effect of climate change) has led to the disappearance or irregular sighting of the Lesser Florican in those parts of its distribution range.
13. **Less research attention**: Presently, research on the LF ecology, behaviour, and habitat is of high priority. Presently, little or no attention is paid to filling this gap. This information is necessary for the conservation and long-term survival of this species throughout its range.

Conservation Measures by the Government of Madhya Pradesh

A letter from Dr Salim Ali, the most renowned Ornithologist in India, to the CWLW, Madhya Pradesh, for the conservation of the Lesser Florican, is now of historical importance. Based on his recommendations, the Government of Madhya Pradesh established two wildlife sanctuaries in 1983 exclusively for the preservation of the breeding habitat of the Lesser Florican. These are - Sailana Wildlife Sanctuary in Ratlam district and Sardarpur Sanctuary in Dhar district. Both these sanctuaries were inaugurated by Dr Salim Ali on the 8th and 9th of August 1983, respectively. These are favourite courtship and breeding grounds for Lesser Floricans. However, the value of these sanctuaries is limited by the movement of monsoon conditions, which determine which areas Lesser Floricans choose to breed in. If weather conditions are unfavourable in any given year due to delayed monsoons and intermittent periods of drought, the number of Floricans visiting the sanctuaries may decrease drastically. The creation of a cattle camp in Ratlam district (near Sailana Kharmor Sanctuary), Madhya Pradesh, by the Forest Department, wherein more than 600 head of cattle were stall-fed, resulted in decreased grazing pressure on the grassland habitat and significantly helped rejuvenate vegetation in the Florican habitat.

Issues need to be addressed and some solutions

1. Habitat restoration by removal of *Lantana* and some amount of *Butea* Plantation, especially in the Amba and Sherpur areas.
2. Providing suitable habitat with some manipulation practises like sowing Florican-friendly crops in marginal areas of the Sanctuary
2. Limit the setting up of new renewable energy power plants and other industries in all the sites
3. Control of cattle grazing, mainly in the Amba area
4. Make schemes/strategies that involve local people in LF conservation, on all sites
5. Designing a scheme for incentives to be given to local farmers for Florican-friendly agricultural practices
6. Monoculture crops like Soybeans and their impact on native biodiversity are to be studied, and farmers are to be educated on the same.

Chapter 5 – GIB and LF in Rollapadu WLS

Introduction

In southern states, the Rollapadu Wildlife Sanctuary (RWS) in Andhra Pradesh has historically been a stronghold for the Lesser Florican. Studies conducted in the 1990s (Sankaran and Manakadan, 1990; Manakadan & Rahmani, 1999) provide valuable baseline data on the presence and breeding activities of the species in this region. However, in recent years, the Lesser Florican's presence in Andhra Pradesh has declined significantly, and its population remains precarious. Apart from Rollapadu, the species has been reported from various parts of Karnataka, Telangana, and Maharashtra (Collar *et al.* 2001).

Objectives

The primary objectives of the project are:

1. Assess the status, habitat, and conservation issues of the Critically Endangered Great Indian Bustard *Ardeotis nigriceps*, Lesser Florican *Sypheotides indicus* and associated species to formulate a conservation action plan for the species in the RWS landscape.
2. To propose the management recommendation for the conservation of the Lesser Florican by improving its habitat in and around the Rollapadu Wildlife Sanctuary.

Study Area

The Rollapadu Wildlife Sanctuary, located in the Kurnool district of Andhra Pradesh, India, is a vital refuge for conserving key avian species, most notably the Great Indian Bustard. Established in 1988, this sanctuary covers approximately 6.14 km². Its primary objective is to protect and preserve the critically endangered Great Indian Bustard and the Lesser Florican, both of which face significant threats to their populations (**Please refer to the Image below**).

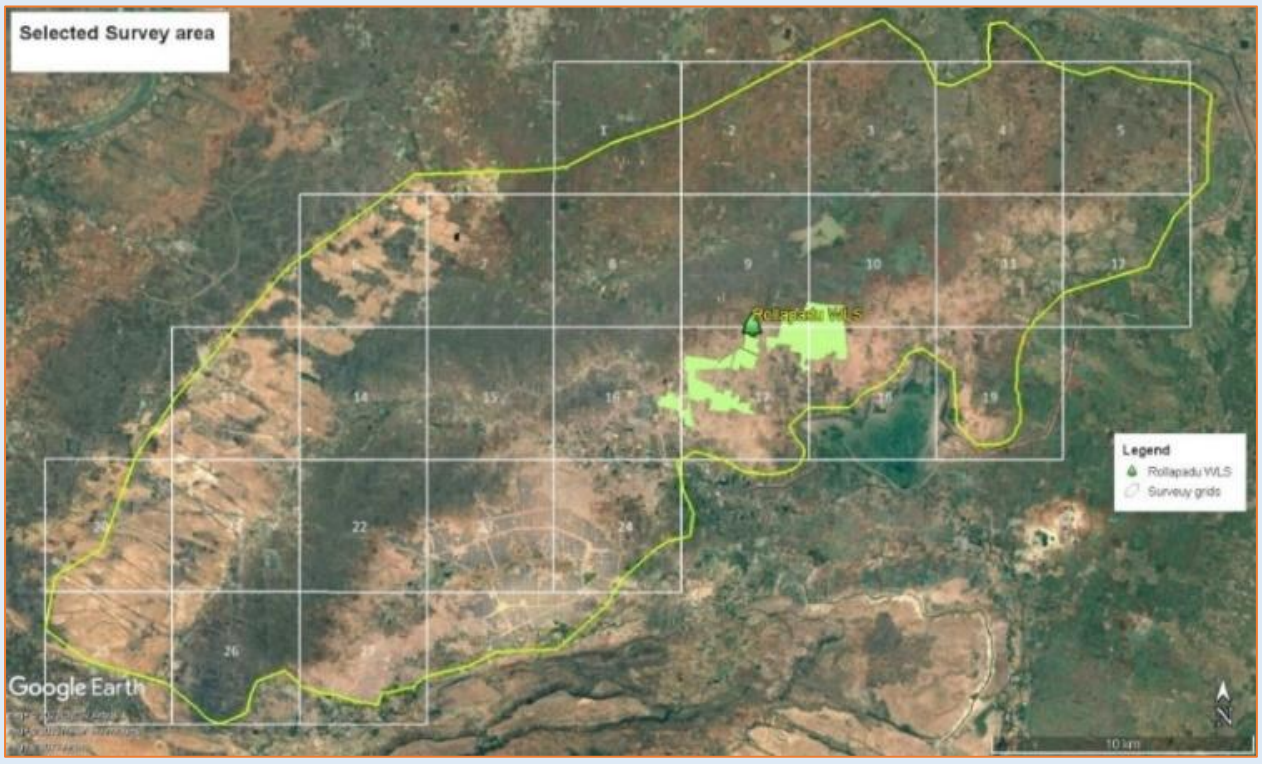
Lesser Florican foraging in its suitable habitat in RWS in 2022 @Karan Dabholkar

During a comprehensive field survey of the Rollapadu Wildlife Sanctuary, a diverse range of fauna was documented, contributing to our understanding of the region's biodiversity. The survey recorded approximately 245 species, spanning various taxonomic groups. Notable findings included eight species of *rotifers*, five species of *cladocerans*, one species of *Diplostaca*, one species of *Decapoda*, four species of *Blattodia*, 10 species of millipedes and centipedes, four species of *Aranea*, three species of scorpions, eight species of odonates, three species of moths, 61 species of butterflies, 26 species of aquatic insects, four species of molluscs, four species of fishes, eight species of amphibians, 18 species of reptiles, 71 species of birds, and five species of mammals.

Among the mammalian inhabitants, the Black Buck *Antilope cervicapra* and the Indian Fox *Vulpes bengalensis* are notable and form essential components of the sanctuary's ecosystem. It is worth noting that ongoing efforts are directed towards the systematic identification of invertebrate faunal groups and other microscopic fauna within the sanctuary, thereby enhancing our understanding of the region's intricate and diverse ecological tapestry. These findings underscore the ecological significance of the Rollapadu Wildlife Sanctuary, not only as a critical habitat for threatened bird species but also as a repository of diverse wildlife and an area of ongoing scientific investigation.

Survey period

The survey was carried out over a 135 km2 area, including the Rollapadu WLS grassland enclosures and the surrounding area, comprising agricultural lands, open scrub (a mixture of scrublands and grasslands), and some potential sites during the October 2022 monsoon (**Please refer to the map below**).



Selected area for surveying the landscape

This area has been divided into 5×5 sq. km grids, for a total of 27 grids. To cover larger areas of preferred habitat and increase the chances of finding the species of interest, the survey was limited to specific habitat types such as grasslands, agricultural lands, and open scrub. Settlements, water bodies and industrial areas were excluded from the survey. In each grid, at most 75% of the area was simultaneously covered by multiple observers. The reasoning for the timing of these surveys is based on published information on the occurrence of birds in RWS and their surroundings (Manakadan 1997; Sankaran and Manakadan 1990). The surveys have been conducted in the early morning (06:00-11:00 h) and late afternoon (16:00-19:00 h) when birds are most active. In fair weather conditions, daylong surveys can be conducted.

RWS in the Kurnool district of Andhra Pradesh has its origins in 1982, with the 'discovery' of the Great Indian Bustard, Ardeotis nigriceps, in the area's grasslands. Following the discovery, the Forest Department, on the recommendations of BNHS, undertook measures to protect the habitat by establishing three grazing- and disturbance-free grassland enclosures. In 1989, an area of 614.19 ha was designated as the Rollapadu Wildlife Sanctuary (RWS). These developments benefited the Great Indian Bustard (GIB), Lesser Florican (LF) and many other species of grassland fauna. BNHS undertook major studies on the GIB and other grassland fauna in the 1989s and 1990s, and hence the flora and fauna of the sanctuary are well-documented (Manakadan and Rahmani 1989; Rahmani 1989; Manakadan 1997). After the addition of 323.56 ha, the area of the Sanctuary has gone up to 937.75 ha. Survey period – October 2022.

Results

Vegetation

The quantitative analysis of land cover in our study area has revealed several dominant categories that collectively define the landscape. Notably, cropland, dedicated primarily to agriculture, accounts for the largest share at 45%, underscoring the region's agricultural significance as its dominant land use. This emphasis on agriculture indicates its central role in shaping the local environment (**Please refer to Figure 47**).

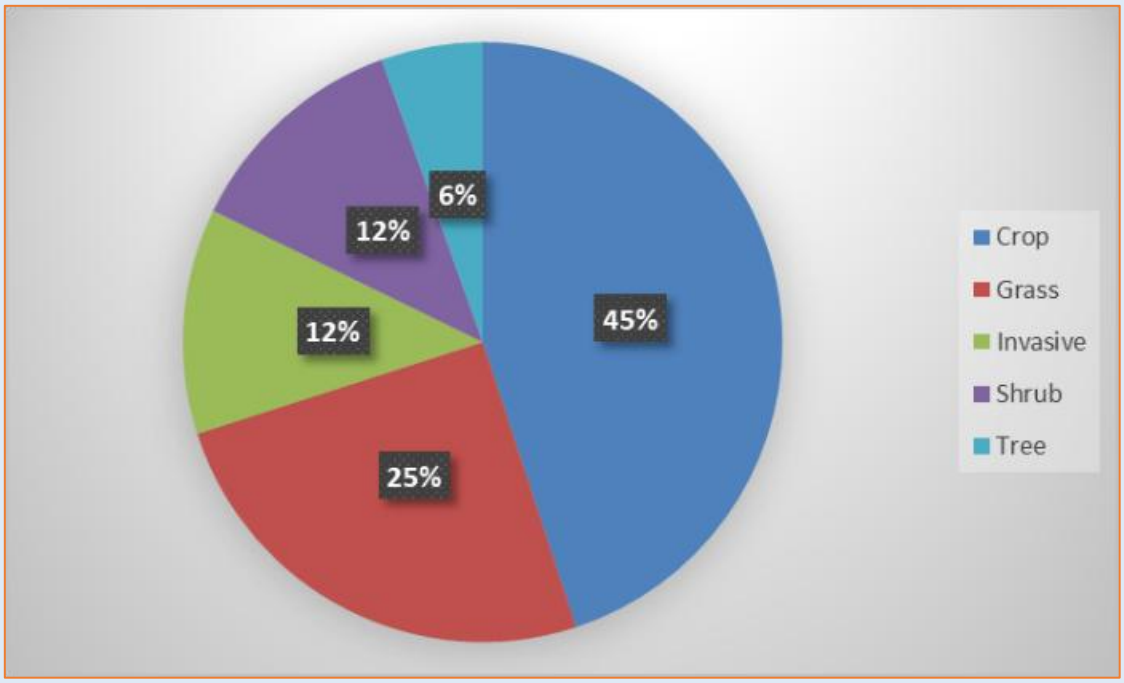


Figure 47: Land cover observed during the survey in Rollapadu area

Additionally, the presence of grasslands, which cover 25% of the area, is ecologically important. These spaces serve as open, natural areas. These spaces hold the potential to provide essential habitats for various wildlife species, contributing to biodiversity and ecosystem health. However, the study has also revealed concerns regarding invasive species, which occupy 12% of the landscape. Invasive species can outcompete native flora and disrupt the local ecosystem. Therefore, this finding underscores the need to implement management strategies to mitigate the adverse impact of these invaders on the region's ecological balance.

Moreover, the dual presence of shrub cover and tree cover, both at 12% and 6%, respectively, is noteworthy. Shrub cover signifies a transition zone between open areas and denser forested regions and can serve as a vital habitat for a diverse array of wildlife species. Meanwhile, the relatively modest tree cover, at 6%, still plays a crucial role in contributing to local biodiversity and providing valuable ecosystem services.

Dominant Species

The sanctuary is characterised by the prevalence of dominant plant species, particularly *Acacia auriculata* and *Phoenix sylvestris*. These species serve as vital ecosystem components, providing cover and sustenance for resident wildlife.

Seasonal Floral Phenomenon

The sanctuary's flora undergoes pronounced seasonal changes. From July to October, in the monsoon period, numerous grasses thrive and turn lush green, adorning the landscape with a verdant carpet; the grasslands appear dotted with small trees and shrubs. As the monsoons wane and winter arrives, the lush greenery gives way to a vibrant yellow hue, lending the ecosystem a different character. *Cymbopogon* spp., a particular grass species, remains green from January to September, coinciding with its flowering phase.

Flowering and Fruiting

The grasses within the sanctuary exhibit a distinct pattern of flowering and fruiting, typically observed from September to December. The awns, or bristle-like appendages, on the grass seeds during this period drop completely. However, this phase also renders the grasslands more susceptible to fire hazards. Notably, *Tridax procumbens* remains green from February to April and flowers for the rest of the year. *Morinda tinctoria* occurs sporadically in the grasslands; it flowers and fruits in September, contributing to the region's floral diversity. The fruits of *Zizyphus mauritiana*, commonly known as Regu in Telugu, also form a part of the diet for the Bustards, particularly during the winter season. This intricate interplay of plant species and their seasonal dynamics not only contributes to the aesthetic beauty of the sanctuary but also provides sustenance and habitat for the diverse wildlife that inhabits it.

Crop

In the landscape survey, crops were observed. The three Major crops are Cotton *Gossypium*, Maize *Zea mays*, and Onion *Allium cepa*, while Tobacco *Nicotiana tabacum*, Toor *Cajanus cajan* and Chilli *Capsicum frutescens* are minor crops. During the extensive survey conducted in our study area, a thorough analysis of the landscape's crop patterns revealed a diverse distribution of crops. Cotton emerged as the dominant crop, covering 21% of the agricultural landscape. This underscores the pivotal role of cotton cultivation in the region, reflecting its substantial contribution to the local agricultural economy (**Please refer to Figure 48**). Similarly, maize fields accounted for 20% of the crop pattern, emphasising maize's significance as a staple crop. This allocation suggests its importance in ensuring regional food security and supporting both human and animal nutrition. Equally prominent was onion cultivation, covering 20% of the agricultural landscape, signifying its integral role in local agricultural practices. This

prominence may indicate that onion farming holds a substantial share of the local agricultural economy, serving as both a cash crop and a dietary staple. Tobacco fields, which occupy 16% of the landscape, reflect cash-crop farming in the region, with potential economic implications and a likelihood of specific farming regulations and practices. Further contributing to agricultural diversity, the cultivation of Toor, or Pigeon pea (Cajanus cajan), was observed, covering 15% of the crop pattern. Toor is a valuable pulse crop, known for its nutritional and economic benefits, highlighting the multifaceted nature of crop cultivation in the area. Chilli farming, accounting for 8% of the agricultural landscape, involves cultivating spices for both local consumption and trade. This percentage underscores the significance of spice production in the region. This detailed crop pattern analysis offers comprehensive insights into the variety of crops grown in the study area. It sheds light on the prominence of cotton, maize, onion, and tobacco cultivation, as well as the significant presence of Toor and chilli crops.

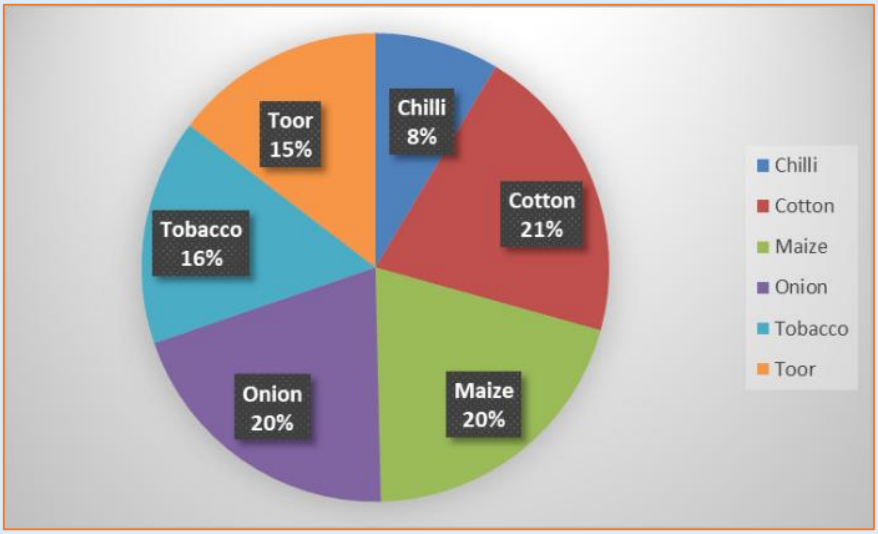


Figure 48: Crops observed during the survey

Grass

Most of the grasses during the landscape survey were unidentifiable due to the grass being undeveloped in the survey period, while the remaining grasses were *Cynodon dactylon*, *Heteropogon* spp., *and Aristida* spp. (Needle grass) (**Please refer to Figure 49**).

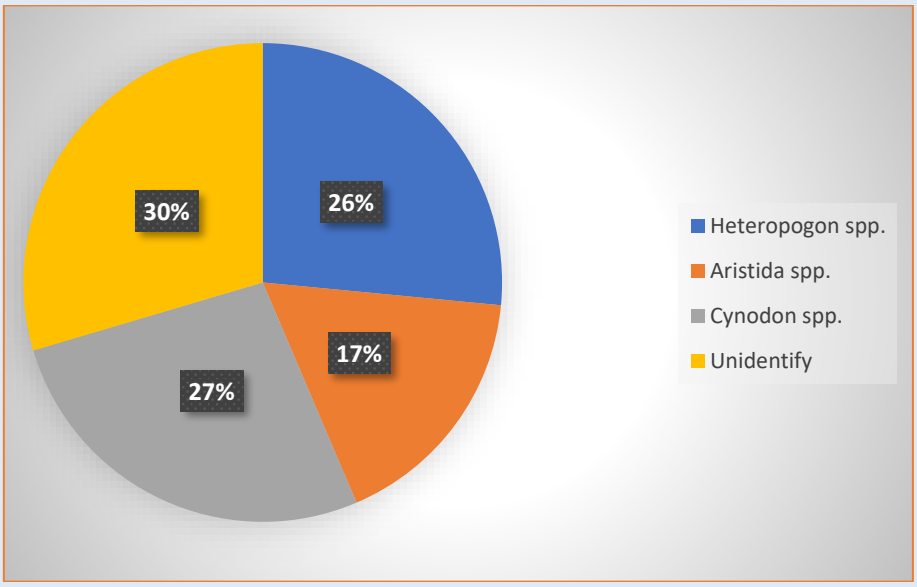


Figure 49: Grasses observed during the survey

Invasive plants in Rollapadu Wildlife Sanctuary

During the landscape survey, *Parthenium hysterophorus* and *Cassia uniflora*, *Prosopis juliflora* and *Hyptis* spp. were the dominant invasive species observed. The scrutiny of invasive species revealed the following prominent invasive plant species and their respective distribution within the surveyed areas (**Please refer to Figure 50**):

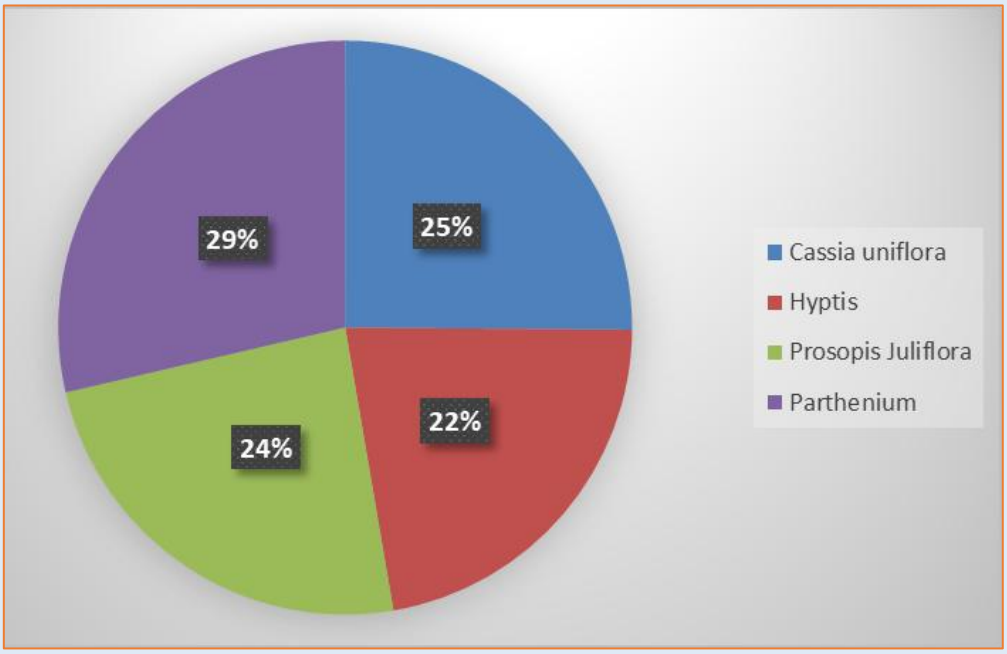


Figure 50: Invasive species observed during the survey

Cassia uniflora: *Cassia uniflora* emerged as a significant invasive species, covering 25% of the surveyed areas. This finding underscores the prevalence of this invasive plant and highlights its potential to outcompete native flora and disrupt the local ecosystem. The substantial presence of Cassia uniflora warrants attention for implementing management strategies to mitigate its impact on the sanctuary's biodiversity.

Hyptis: *Hyptis*, another invasive species, occupied 22% of the surveyed areas. Its substantial distribution signals the ecological challenges posed by this invasive plant. The need for targeted interventions to control and manage *Hyptis* is apparent, as it can alter the balance of native vegetation.

Prosopis juliflora: *Prosopis juliflora* was recorded as covering 24% of the surveyed areas, signifying its noteworthy presence. This invasive species can have wide-ranging ecological consequences, given its ability to thrive in diverse ecosystems. Effective management practices are crucial to prevent the further spread of *Prosopis juliflora* within the sanctuary and its vicinity.

Parthenium: At 29% coverage, *It represents a considerable invasive-species* challenge. Its dominance in the surveyed areas is cause for concern due to its potential to displace native plants, affect wildlife habitat, and cause health issues in both humans and animals. Urgent and comprehensive management efforts are needed to control the spread of *Parthenium.* This comprehensive analysis of dominant invasive species within and around the Rollapadu Wildlife Sanctuary underscores the significance of invasive plant management. The presence of *Cassia uniflora*, *Hyptis*, *Prosopis julliflora*, and particularly *Parthenium*, emphasises the need for proactive measures to preserve the sanctuary's native flora and fauna.

Shrubs
The shrubs observed throughout the landscape survey were *Cassia* spp., *Mimosa* spp., *Acacia nilotica, Zizipus* spp. and some unidentified Shrubs as well.

Tree
We observed Neem *Azadirachta indicus*, *Prosopis juliflora*, and some Unidentified trees during the landscape survey.

Lesser Florican sighting

Among the three visits to the sanctuary, the team observed the Lesser Florican twice. Once on 11 October 2021 and the second time in the succeeding year on 12 October 2023. During three visits to the sanctuary, the team observed the Lesser Florican twice, first on October 11, 2021, and again on October 12, 2023. A male Lesser Florican was sighted at the same location on both occasions (15.760347°, 78.368738°), indicating interesting site fidelity. According to Mr Gaffur, a local field guide, the bird is regularly seen at this location each year. The habitat consisted of flat grassland. The bird was observed foraging in the grassland enclosure. For the observation and study, four teams were deployed. The team collected behavioural data on the Lesser Florican. During the observations, the presence of grazers, dogs, and humans was noted, which appeared to influence the birds' movements. According to Mr Gaffur, a local field guide, the bird is regularly seen at the same location. The habitat was grassland, and the terrain was flat. The bird was seen foraging in the grassland enclosure. On October 11, the bird was sighted at coordinates 15.738676 and 78.3570221. Four teams were deployed to observe and study the bird. The team collected behavioural data of the Lesser Florican. Grazers, dogs, and humans were observed during the observation, affecting the bird's movement.

Great Indian Bustard Occurrence

Although the Great Indian Bustard has not been sighted in the last few years (since 2019), special attention was given to searching for the species during the survey. Despite special efforts in the survey period, no sightings of the Great Indian Bustard were recorded. Therefore, it is inferred that there may be no surviving birds in the vicinity of Rollapada Wildlife Sanctuary.

Blackbuck Count

Block counts were conducted on 13th October 2022 in Rollapadu WLS by multiple observers (4 Observers) to avoid the double count of animals, who surveyed the entire WLS study area in a single day. The study area was divided into 6 zones, delineated by roads within the Rollapadu WLS. Each zone was surveyed by 1 observer from 8 a.m. to 12 p.m., and after completing the zone, each observer was counted as a single individual present in the open grassland. The survey is conducted from the Machan (a watchtower), which provides clear visibility of the study area. Nikon Binoculars (12 x 50 mm) were used to observe Blackbuck activities from a distance. Mature Males and females were differentiated by their body colour and horns, and the immature were differentiated by keen observation from size.

There is a scattered population of Blackbuck in the grassland of Rollapadu WLS, Andhra Pradesh. On 13th October 2022, multiple Blackbuck herds were sighted in different zones of WRS. Out of 6 zones, the maximum number of Blackbuck was recorded in the 3rd zone. The 3rd zone is larger than the other zones and contains a small stream. The observation started early in the morning, around 08:00 a.m., and the Blackbuck were found to be more active in the morning after surveying the entire area.

Four observers were counted differently and given different numbers. To calculate the estimated population, we use the mean formula: the sum of the observations divided by the total number of observations.

Mean Formula = (Sum of Observations) ÷ (Total Numbers of Observations)
We added the final counts for all four observers.
The result was n=420, given below:
Mean = (440+ 417 + 423 +403) ÷ 4 = 1683/4 = 420

Hence, the overall result suggests that the population can vary over time due to continuous movement of individuals, long distances, poor visibility, disturbance, and human error. We estimate this count based on these factors.

Threats observed in and around RWS Sanctuary

The comprehensive survey conducted in the Rollapadu Wildlife Sanctuary and its adjacent regions over the 27 grids has revealed several prominent threats to the area's biodiversity and ecological balance. These threats are as follows:

1. **Human Activity**: Expanding agricultural activities, human settlements, and various developmental projects have significantly disrupted the landscape, endangering the natural habitat and wildlife. Notably, human activities within the sanctuary and its surroundings, including movement, settlements, and agricultural practices, pose a direct and pervasive threat to the local fauna.
2. **Free-ranging Dogs**: Free-ranging dogs represent a direct menace to the sanctuary's wildlife. These dogs pose a threat by hunting blackbucks, ground-nesting birds, and other species, disrupting the natural balance and potentially leading to ecological imbalances.
3. **High-Tension Power Lines**: High-tension power lines in the surveyed areas pose a grave danger to avian species. They limit birds' flight, leading to collisions that cause severe injuries or fatalities. These lines disrupt birds' natural flight patterns and movement.
4. **Wind Turbines**: High wind turbines divert birds' flight patterns, resulting in collisions and fatalities. These man-made structures significantly impact the natural behaviour of avian species and pose risks to their survival.
5. **Industrial Activities**: Industrial sites occupy extensive areas and release pollutants into the air and water, affecting the surrounding environment. This industrial pollution leads to habitat loss, collisions, environmental contamination, and behavioural adjustments among local wildlife.
6. **Solar Plants**: Large solar plants, particularly in grids 23 and 24, restrict animal movement within their vast coverage. These solar projects affect wildlife both during the day and at night. During daylight hours, the reflected sunlight affects insects, birds, and other animals, causing heat-related issues and, in some cases, fatalities. At night, artificial light disrupts animals' nocturnal activities, attracting insects and exposing them to predators. Additionally, these large panels can create illusions of water surfaces for birds in flight, potentially leading to collisions.
7. **Grazing and Habitat Disruption**: Grazing within the protected area, combined with habitat disruption from human activities and vehicle movements, disrupts the harmony of the grassland habitat. This poses a significant challenge to maintaining the diverse grasslands that support local wildlife, including blackbucks and other species.
8. **Disease Spread**: Free-ranging dogs impact biodiversity through predation, competition, and the spread of diseases among wildlife. They disrupt the natural prey-predator cycle, leading to potential starvation among natural predators and affecting the ecological balance. Furthermore, crossbreeding between domestic and wild canids can create biological imbalances in the natural environment. In conclusion, the survey's findings

have highlighted a complex array of threats, including human activities, infrastructure development, habitat disruption, and disease spread, that collectively jeopardise the unique biodiversity and ecological balance of the Rollapadu Wildlife Sanctuary and its adjacent regions

Lesser Florican records

According to previous studies and observations, Rollapadu RWS is one of the breeding and non-breeding habitats for Lesser Floricans, where the birds are seen year-round, including males, females, chicks, and nests (Manakadan & Rahmani, 1999; Sankaran & Manakadan, 1990). 3-4 males were seen in 1987-88; later, in 2017, six (6) males were seen (Dutta et al., 2018). However, in the last few years (especially after 2020), only one or two birds have been spotted. This shows a drastic decline in the population of Lesser Floricans. This could result from changes in habitat quality within the sanctuary plots and from habitat degradation in the vicinity of the WS. Earlier in 1990, small to medium patches of grassland were present, and traditional crop patterns were dominant.

Great Indian Bustard records

In 2003, 28-35 females and chicks and two males (1 subadult and 1 adult) were recorded throughout the year. After that, the birds were reported on several occasions until 2019, with a gradual decrease in number (**Please refer to Figure 51**).

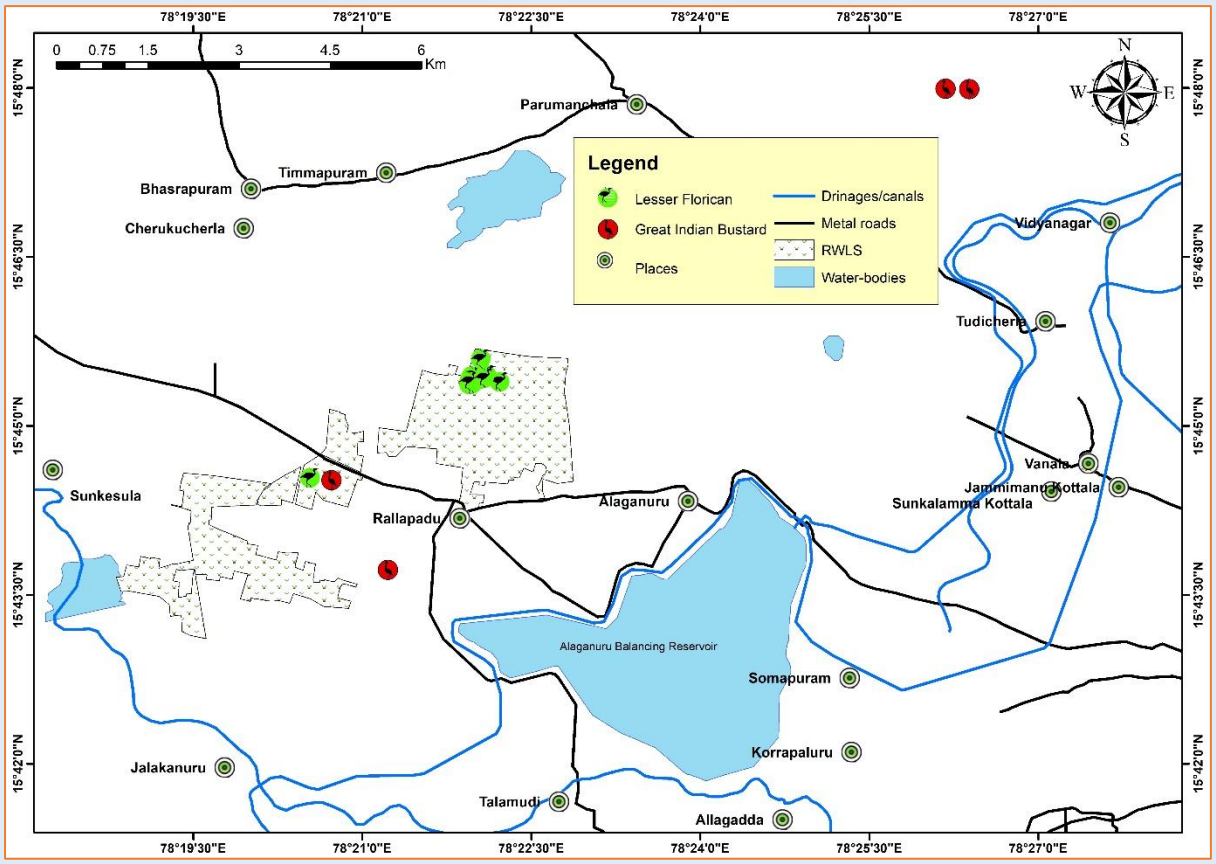


Figure 51: Sightings of Lesser Florican and Great Indian Bustard in RWL

Chapter 6 - Bengal Florican in North-East India

Objectives of our study

1. Assess the status and distribution of Bengal Florican and its threats in North-east India
2. Assess the population status/population size of Bengal Florican in North-east India
3. Assess the Habitat used by the Bengal Florican during the breeding season in NE India
4. Raise awareness among communities for Bengal Florican conservation

Study Area

The project was carried out in protected and non-protected grasslands of Assam (24° 09' - 27° 58' N and 89° 42' - 96° 01' E) and Arunachal Pradesh (26° 40'–29° 27' N and 91° 35'–97° 24' E), India. The project area is located in the north-easternmost part of India. The grasslands of the Himalayan Foothills and the Brahmaputra Floodplains are the project sites. Surveys were conducted in seven protected and six non-protected areas of Assam and Arunachal Pradesh to assess the distribution and status of the Bengal Florican. The protected area includes two UNESCO World Heritage Sites- Kaziranga National Park and Manas National Park. The study area includes *Orang* National Park and Tiger Reserve, Laokhowa Wildlife Sanctuary, Burachapori Wildlife Sanctuary, Dibru-Saikhowa National Park, and D'Ering Memorial Wildlife Sanctuary.

Methodology

Objective 1: Assess the status and distribution of Bengal Florican

Field methods: Grids of 4 km² size were laid on the overlaid maps. A random sampling method was used to select at least 30% of the grids from each site. Each selected grid was surveyed once or twice during the breeding season of the bird (from February to June). If a grass patch suitable for BF is in the grid cell, then the grass patch point count for 1-3 hours during the morning and evening was conducted to record the presence of Bengal Florican. The observations were made during 0500-0900 hr. and 1500-1800 hr. from vantage points (viz., Machaan, Tree, and the top of the Vehicle) when possible. Otherwise, the observation was done from the ground. GPS coordinates of the vantage point and several Bengal Florican, if sighted, were recorded. Cluster analyses were done to identify suitable dry savannah grasslands in Assam and Arunachal Pradesh, and the Habitat Suitability Map was overlaid (**Please refer to Figure 52**).

Each grid cell was visited at least once, and in some cases twice, especially where the grass was taller, making it harder to spot the birds. This approach enabled the team to cover more grid cells, increasing the likelihood of detecting the species. Given the high visibility of displaying males, the team was confident in their ability to spot the birds if they were present, leading to the assumption that the detection probability was high and did not require explicit modelling. This allowed the primary focus of objective one to be on conducting a widespread survey across many grid cells.

Threat monitoring: Data were collected from each point count to assess the species' threat tolerance. For every point where Florican observations were made, threats within a 100-meter radius were recorded, including the percentage of cattle grazing, the number of people, vehicles, and dogs, recent fires, the percentage of invasive plant species, and recent flooding.

Objective 2: Assess the population status of Bengal Florican in North-east India

Only those grids where the bird was sighted in the objective were intensively surveyed for population status/population size.

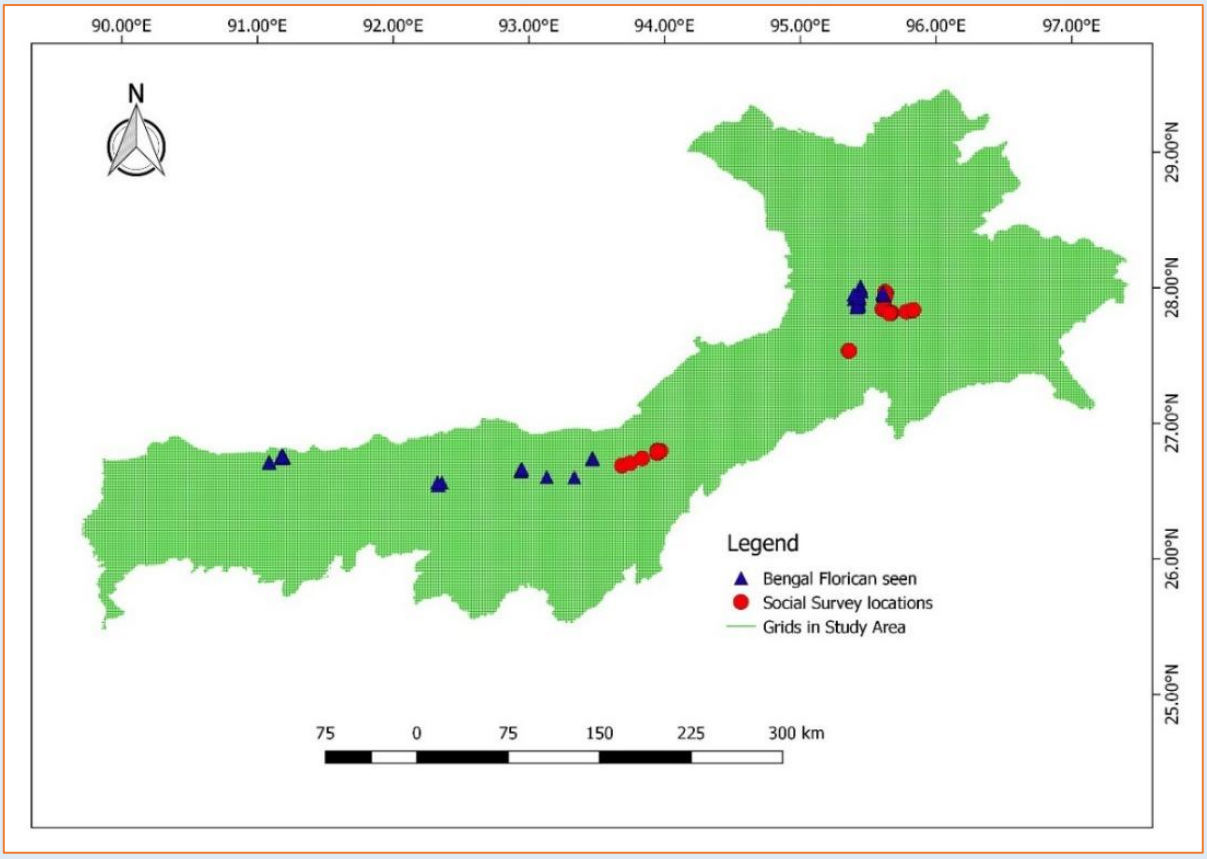


Figure 52: Map showing survey areas, sightings of Bengal Florican

Field methods: Similar to those mentioned in objective 1, field methods were used to count territorial adult male Bengal Florican during the breeding season (February-June). Sampling was conducted simultaneously after the Bengal Florican was sighted during activity 1.2. Where grid visibility was lower, intensive surveys were conducted in smaller sub-grids of 1 km² to maximise the detection probability. If any individual is sighted in activity 1.2, neighbouring suitable areas of 1 km² were intensively surveyed simultaneously. In each randomly selected grid, 2-3 observations of 1-3 hours, looking for displaying males, were made from a vantage point. The observations were made during 0500-0900 hr and 1500-1800 hr. Sightings of non-displaying males and females were also recorded. Sightings of Floricans during movement between two grids were also recorded.

Objective 3: Habitat use by Bengal Florican during the breeding season in NE India

Habitat information: Dominant tree species, dominant grass species, dominant herb species, grass height percentage, grassland cover percentage, invasive species percentage, number of tall trees (>5 m), Small trees (<5m) and shrubs within a 50 m radius of the point were recorded from each point count location.

Field methods: Vegetation sampling was carried out in selected grids where the Bengal Florican was present and absent in the potential habitat. The visual obstruction method (Robel *et al.* 1970) and the Sward stick methods were followed for vegetation sampling. In each selected grid, two plots with a radius of 30m were laid out. Each plot was at least 100 m apart. Visual obstruction measurements were taken using a Robel pole at the centre of each plot. The maximum and average height of grasses were recorded in the centre and at 30 m in each direction (i.e. five measurements in each plot). Vegetation cover was estimated visually within a 2 m x 2 m quadrat at the centre and at 30m intervals in four directions.

Objective 4: Raise Bengal Florican conservation awareness

Priority sites for raising awareness regarding the conservation of the Bengal Florican were identified. Threats to the Bengal Florican, as listed in previous BNHS studies, were also assessed. Background research was conducted on the cattle graziers/villagers and their livelihoods at selected sites. The scheduled survey was conducted among cattle graziers/villagers near the Bengal Florican habitat to understand their knowledge and perceptions of the bird, as well as their level of dependence on grasslands for their livelihoods. Local cattle graziers//villagers were randomly selected for the survey. A pilot survey was carried out to finalise the questions. The findings of this survey were used to plan and conduct an awareness programme for the local community/stakeholders. The survey was carried out in 100 grids to understand the distribution of Bengal Floricans in more than ten sites of NE India.

Results

Bengal Florican presence was recorded from seven sites, five of which were protected areas and the other two were non-protected areas. The distribution of the Bengal Florican was fragmented in the Brahmaputra floodplains due to several human-induced activities. The updated MaxEnt model predicted the most probable distribution of the species in three large clusters in NE India: the terai grassland of Manas, the floodplain grasslands of Kaziranga TR in the middle, and the D'Ering and Dibru-Saikhowa cluster in the known easternmost range of the species. D'ering Memorial WLS and its neighbouring chaporis (river islands) of the Siang, Lohit and Dibang rivers could be the best site for the Bengal Florican (**Please refer to Figure 53 & Table 13**).

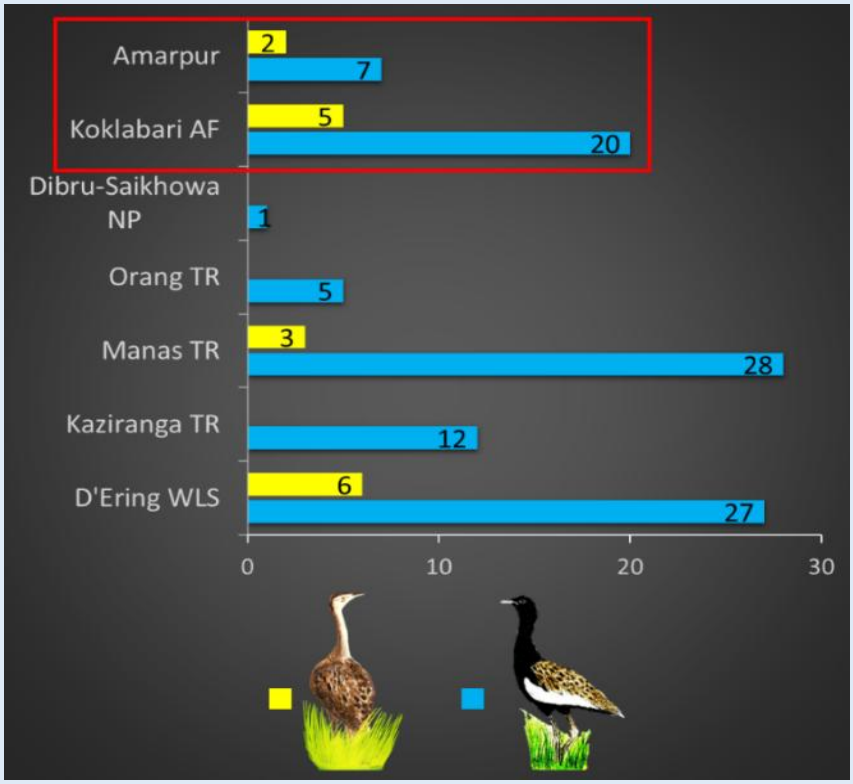


Figure 53: Number of Bengal Floricans recorded during 2019-2021 in Assam and Arunachal Pradesh. The red box indicates a non-protected area (Yellow = Female and Blue = Male)

During the study period, 100 male and 16 female Bengal Floricans were recorded. Of these, 27 males and 7 females were recorded in non-protected areas. Five males and 3 females were also recorded from Nizamghat grassland, Arunachal Pradesh, in 2017. Therefore, a total of 105 males were recorded from NE India. The highest number of individuals at a site in a particular year was considered when surveys were carried out over more than one year.

Bombax ceiba and *Ziziphus* spp. were the most widespread and common tree species recorded in the study area's protected and non-protected grasslands. *Chromolaena odorata*, *Lantana camara* and *Leea* spp. were the most dominant among shrubs. Livestock overgrazing, the spread of invasive alien plants and grass cutting were the major threats to the species in the landscape. Invasive alien plants were recorded in most of the points surveyed. Among invasive alien plants, *Chromolaena odorata* was significantly most common in grasslands where Bengal Florican was recorded (Chi-square test:$\chi^2 = 43.84$, df = 4) and not recorded (Chi-square test:$\chi^2 = 58.26$, df = 4,). Grazing and grass cutting were common in the study area (Chi-square test: $\chi^2 = 115.62$, df = 4, $p<0.001$). These threats were not only common in unprotected areas but also affected most protected areas. Overgrazing by livestock in Dibru-Saikhowa National Park and Sadiya areas was particularly alarming, with very few suitable grasslands available. Additionally, untimely burning of grasses during the Bengal Florican's breeding season was observed in some protected areas (**Please refer to Figure 54**).

Site	Livestock overgrazing	Hunting/egg collection	Spread of Invasive plants	Fire	Human presence	Grass Cutting	Stray dogs	Habitat conversion
Kaziranga NP and TR	Medium	Low	Medium	Medium	Low	Low	Low	Low
Manas NP and TR	High	Low	Very high	Medium	Medium	Low	Low	Low
Orang NP and TR	Medium	Low	Medium	Medium	Low	Low	Low	Low
Dibru-Saikhowa National Park	Very high	High	High	Low	Very high	Very high	Medium	High
D.Ering Memorial WLS	Very high	Medium	Very high	Medium	Low	Medium	Low	Low
Amarpur	Very high	Very high	Very high	Medium	High	High	Medium	High
Sadiya	Very high	Very high	High	Low	High	Very high	High	Very high
Majuli	Very high	Very high	High	Low	High	Very high	Medium	High
Koklabari Agriculture Farm	High	Low	Low	Low	High	Medium	Medium	Medium
Simen Chapori	Very high	Very high	High	Low	Very high	Very high	Very high	Very high
2 No. Bhakat chapori	High	Low	Low	Medium	Medium	Medium	Low	Low

Figure 54: Probability of occurrence of Bengal florican in Protected and non-protected areas in relation to various threats.

The adult male birds mostly used a short, sparse grass composition consisting of *Saccharum spontaneum* and *Imperata cylindrica*. In addition to these, *Vetiveria zizanoides* grass was preferred by the species. The Bengal Florican was also recorded from less disturbed crop fields at Koklabari Agriculture Farm and outside D'Ering WLS. Ground cover in grasslands where Bengal Floricans were present was significantly lower compared to grasslands where the birds were not observed (One-way ANOVA: $F_{1, 288} = 5.385$, $p = 0.02$;). Also, a significant difference was observed between grass heights in grasslands having Bengal Florican, and without Bengal Florican (Z-test: $Z = -2.88$, $n_1 = 164$, $n_2 = 126$, $p<0.005$;) (**Please refer to Figures 57 & 58**).

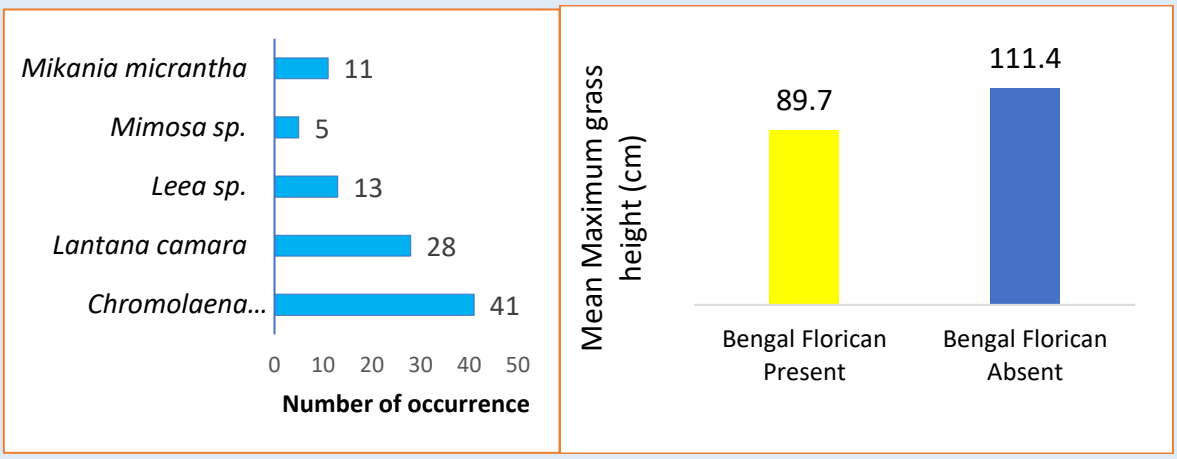


Figure 57: Occurrence of invasive plants in Bengal Florican presence grasslands

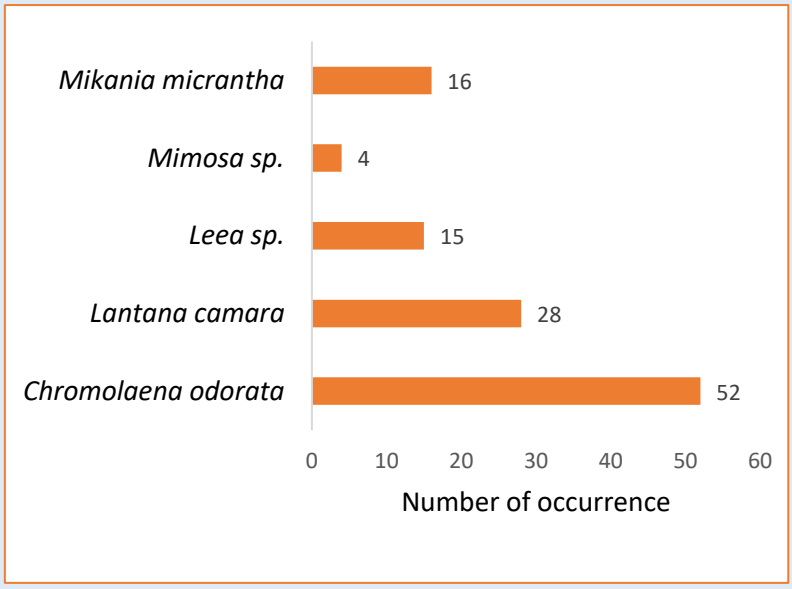


Figure 58: Occurrence of invasive plants in Bengal Florican absence grasslands

A total of 63 livestock graziers and villagers from Amarpur, Sadiya, and chapories near Kaziranga were interviewed. Among those interviewed, 49% were familiar with or had heard of the Bengal Florican, while 35% were not. Additionally, 49% of the livestock graziers reported being Bengal Floricans in their area; of these, 68% had seen the bird within the past 10 years, and 32% had observed it over 10 years ago, with all sightings occurring in grassland habitats. None of the interviewees reported seeing Bengal Florican eggs. About 50% of livestock graziers believed the Bengal Florican population had decreased, 3% thought it was stable, and the remaining 48% were uncertain about the trend. Most of the livestock graziers identified hunting

(33%), human disturbance (20%), and overgrazing (16%) as the primary reasons for the decline in the Bengal Florican population. Additionally, 7% of livestock graziers reported witnessing the birds' hunting. Most (83%) of livestock graziers rely on grasslands for grazing their livestock. Significantly more livestock graziers (73%) utilise grasslands throughout the year. About 66% of livestock graziers engage in grass collection. Livestock graziers mostly opted for villagers (47 responses) and the forest department (23 responses) to protect Bengal Floricans. Approximately 50% of the graziers expressed willingness to help conserve the Bengal Florican, with 80% citing ethical reasons for their support.

A total of five awareness programs were organised for school and college students near Bengal Florican habitats, reaching over 300 students. Around 2,000 posters and leaflets on Bengal Florican conservation were printed in both English and Assamese for distribution among local communities. About 2000 posters and leaflets on Bengal Florican Conservation were printed in English and Assamese for distribution among local communities. Also, 50 t-shirts and 300 Bengal Florican lapel pins were prepared to raise awareness among the local masses. Articles on the Bengal Florican in Assamese were published in a local popular daily newspaper. A dedicated page was created on a social networking site to share information about Bengal Florican research activities.

A total of three capacity-building training programmes were organised in Assam and Arunachal Pradesh. Training programmes were organised in *Orang* National Park and Laokhowa-Burachapori Wildlife Sanctuaries of Assam, and D'Ering Memorial Wildlife Sanctuary of Arunachal Pradesh. More than 70 frontline forest staff received training in Bengal Florican identification and monitoring, as well as hands-on training in equipment use. Before organising training programmes, about 87% of the forest staff had seen and could identify the male Bengal Florican. During post-training evaluation, all of them could identify the bird. A total of nine staff out of 21 frontline staff of Laokhowa-Burachapori WLS hadn't seen Bengal Florican before. Most of the staff know the bird's preferred habitat.

Awareness programme on Bengal Florican conservation was organised jointly by the BNHS and D'Ering Wildlife Sanctuary Division in collaboration with Eco-Development Society of D'Ering Memorial Wildlife Sanctuary at Mer Village of East Siang District near Assam-Arunachal Pradesh border on 25th May 2022. The awareness programme was attended by the Member of Legislative Assembly (MLA) of the 37th Pasighat West, the Deputy Commissioner of East Siang District, the DFO, the D'Ering Wildlife Division, and 60 local villagers from Mer and Paglam villages. Awareness materials and kits were distributed to participants to support the conservation of the Bengal Florican outside D'Ering Memorial Wildlife Sanctuary. The communities inhabiting in the fringe villages of the Sanctuary were previously involved in the hunting of wild animals. In 2021, more than 300 Airguns were surrendered by the people of East Siang district during the launch **of 'Air Gun Surrender Abhiyan'** by the state government. The programme was organised to sensitise local communities to proper management of grasslands and to control the hunting of Bengal Floricans.

Status of Bengal Florican (April–May 2025)

Note: These estimates are provisional and may vary following detailed validation with Forest

A rapid field assessment was undertaken by the BNHS during the last week of April through the first week of May 2025 across key grassland habitats in Assam. The purpose of this survey was to update the population estimate of the Bengal Florican (*Houbaropsis bengalensis*) in critical Protected Areas. The observations, based on direct sightings and discussion with local forest personnel, organisations, institutes, and NGOs, are summarised below:

Department records, local NGOs, Institutions, and longitudinal data. Tall grass cover and early rains during the survey period may have reduced detectability, leading to underestimation in some areas. Nevertheless, community insights — particularly from Kokilabari's Bodo residents — provided critical context on recent shifts in the species' habitat use, underscoring the importance of integrating local ecological knowledge into conservation monitoring.

Discussion

Bengal Florican distribution is now fragmented in northeastern India. It survives in a few protected areas in northeast India and a few non-protected grassland patches in river islands of the Brahmaputra River **(Please refer to Figure 59**).

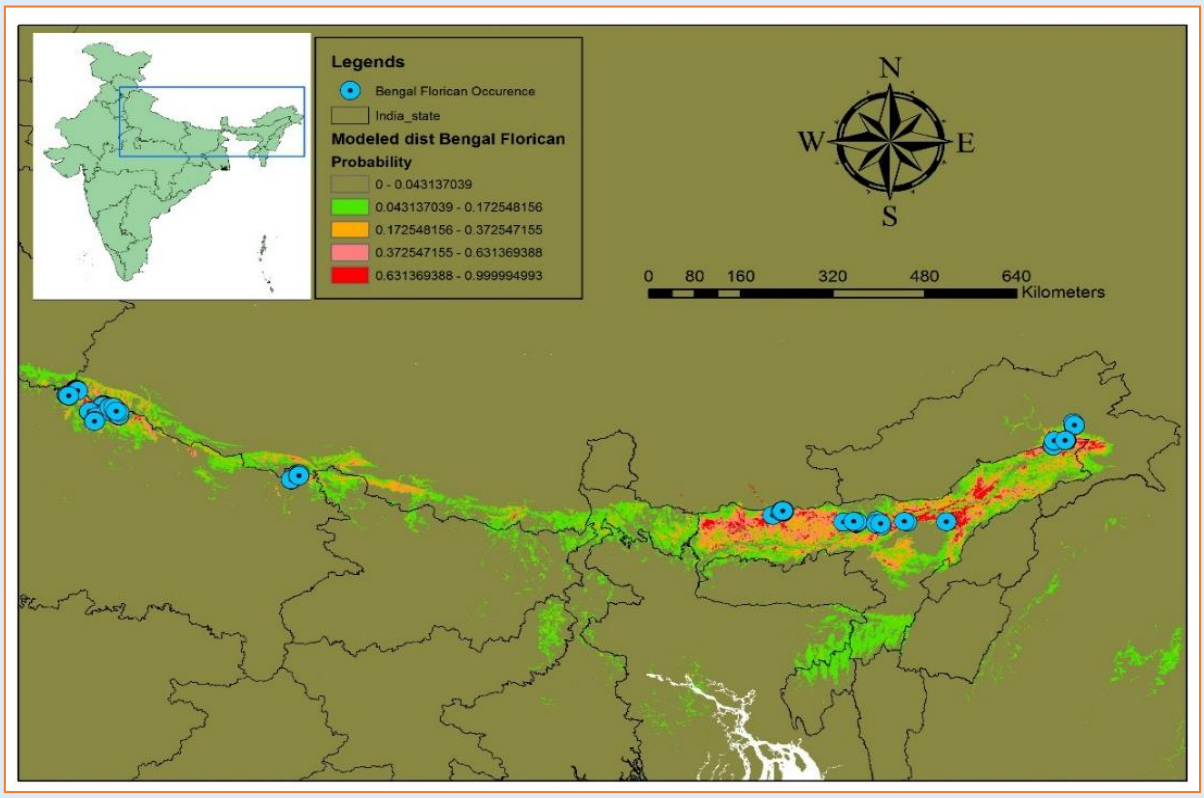


Figure 59: Species distribution model showing potential sites of the Bengal Florican

The Maxent model corroborates this fragmentation by highlighting similar patterns of suitable sites in the landscape. Historical data indicate that natural succession and human disturbances have led to local extinctions in several areas where the species was once present, such as Sonai-Rupai Wildlife Sanctuary, Bornodi Wildlife Sanctuary, Nameri National Park, and Pobitora Wildlife Sanctuary (Collar *et al.* 2007).

Our survey recorded 100 adult males and 13 females. Due to logistical and accessibility constraints, we were unable to survey all potential habitats, including Nizamghat grassland, where BNHS had previously recorded five territorial males in 2017. Our findings and previous data estimate that there were approximately 150-160 adult males in northeast India in 2017. Historical surveys from 2013 to 2017 reported 137-140 territorial males and 18 females, with an estimated adult male population of 174-198 (Rahmani *et al.* 2016, 2017).

Currently, the primary strongholds for the Bengal Florican are D'Ering Memorial Wildlife Sanctuary, Manas National Park and Tiger Reserve, and Kaziranga National Park and Tiger Reserve. Additionally, the *Orang* National Park and Tiger Reserve support a smaller population. We couldn't survey all the suitable habitats in Kaziranga due to logistics problems Rahmani *et al.* (2017) documented sightings of 25 male Bengal Floricans in Kaziranga National Park, including both direct observations and secondary records. However, due to logistical constraints, our survey did not cover all suitable habitats in Kaziranga, leaving the full extent of the population there uncertain. The newly identified grasslands on the northern side of the Brahmaputra River and adjacent chapories present potential habitats for the Florican. A solitary male was recorded in Dibru-Saikhowa National Park, but recent authenticated records are lacking; the last confirmed sighting was reported in 2015 by Rahmani *et al.* (2017). Outside protected areas, Koklabari Agriculture Farm, Amarpur, and Nizamghat Grassland are critical sites with notable Bengal Florican populations that require immediate conservation efforts. The establishment of the Bengal Florican Research Centre at Koklabari Agriculture (**Please refer to Table 8**).

Site	Preliminary Estimate (April–May 2025)	Remarks
Kokilabari Agricultiral Farm	~20–25 individuals	Local Bodo community members reported a noticeable westward shift in bird activity. This is attributed to increased human settlements and changing agricultural practices in the eastern part of the landscape.
Manas National Park (total)	~40 individuals	Includes all ranges within the park; tall grass and early rainfall limited visibility during surveys.
Kaziranga National Park	~27–30 individuals	Sightings are distributed across multiple grassland pockets; numbers may be conservative due to grass height.
Orang National Park	~7–10 individuals	Patchy sightings; wet ground and tall grasses likely affected detection rates.

Table No 08: Estimated population of Bengal Florican at various protected and non-protected sites.

Farm highlights ongoing conservation initiatives. However, habitat alterations in Koklabari could negatively impact the Florican population, prompting concerns among experts about recent developments in the area. Previously published records and reports from local cattle graziers in the Sadiya area suggest a potential presence of Bengal Floricans, though recent

surveys did not confirm sightings. This lack of confirmation is likely due to the degradation and fragmentation of grasslands into small patches, coupled with significant human disturbance. Despite these challenges, the remote islands of Sadiya may still harbor Bengal Floricans.

The Bengal Florican prefers sparse, short grasses such as *Imperata cylindrica*, *Saccharum spontaneum*, and *Vetiveria zizanoides* during the breeding season (Narayan, 1992). Our observations also indicate a similar preference, with *Imperata cylindrica* and *Saccharum spontaneum* as the predominant grass species utilised (please refer to Figures **57 and 58**).

We also noted that males predominantly use short grasses less than one meter in height for courtship displays during the breeding season. Females, being generally shyer, prefer taller grasses and were only observed when visiting territorial males for courtship or while in flight. However, at Koklabari Agriculture Farm, males and females exhibit distinct habitat preferences: both prefer short grasses, but with different species compositions. During the survey, birds were mostly observed in less disturbed habitats, except at Koklabari Agriculture Farm, where they were seen using crop fields with human activity. Additionally, females have been observed in agricultural fields outside D'Ering WLS. The agricultural field is located on elevated land, which remains unaffected by the annual flooding that inundates most of the grasslands in D'Ering during the rainy season. This highland area could provide important shelter or nesting sites for females and should be monitored closely. Our observations showed that the recorded territories were mainly in dry areas, with males frequently using flowering *Imperata cylindrica* patches for both ground and aerial courtship displays.

Overgrazing by livestock and the spread of invasive alien plants are major threats to Bengal Floricans across both protected and non-protected sites. In particular, Dibru-Saikhowa and D'Ering Wildlife Sanctuaries have been significantly impacted by these issues. Numerous livestock sheds are present in Dibru-Saikhowa NP and around the boundary of D'Ering. Rahmani *et al.* (2017) highlighted the concern over invasive plant species in D'Ering and recommended the removal of *Lantana camara* and other weeds from the sanctuary. The sanctuary was also affected by annual erosion during the rainy season. Large grassland patches that supported Florican territories have been eroded over the past few years. The Bengal Floricans were opportunistically poached using tractors and jeeps in D'Ering and Manas reserves in the 1990s and early 2000s (Anwaruddin Choudhury *pers. obs.* in Collar *et al.* 2007). Currently, there is a low likelihood of hunting and poaching in the protected areas. However, in D'Ering Memorial WLS, there remains a possibility that local livestock graziers might hunt the Bengal Florican. There are reports of hunting of Bengal Floricans and the collection of their eggs by locals in Amarpur.

Restoring grassland habitats in D'Ering WLS and Dibru-Saikhowa NP is crucial. It should involve controlled livestock grazing and the removal of invasive species such as *Chromolaena odorata* and *Lantana camara*, as well as trees like *Bombax ceiba* and *Zizyphus* spp. Additionally, it is important to address the issue of burning grassland patches late in the Bengal Florican breeding season within these protected areas. Social surveys among local communities residing in non-protected grasslands and using these areas for livestock grazing revealed that these Bengal Florican habitats are highly susceptible to overgrazing and other human disturbances. Most livestock graziers are economically disadvantaged and depend on the grasslands for their livelihoods. Despite this dependence, the graziers generally have a good knowledge of the Bengal Florican, including its identification and behaviour.

Although hunting is common in these regions, only 7% of respondents reported observing it. This low reporting rate may be due to respondents' reluctance to share information about

hunting. Additionally, the limited awareness among graziers regarding the legal protection status of the Bengal Florican may lead to unintentional disturbances or even opportunistic hunting. Due to a lack of knowledge about the bird's conservation significance and legal safeguards, some graziers may unknowingly engage in activities that threaten its survival, such as habitat degradation, accidental nest destruction, or illegal hunting. Raising awareness about the species' legal protection and ecological importance could help mitigate these threats. Most graziers do not burn grasses but instead collect grasses for household uses, including livestock fodder and construction materials for their homes and livestock sheds. Hunting of Bengal Floricans could be higher in areas such as Amarpur and Sadiya due to local practices. Despite this, many respondents believe that villagers should protect the birds in their area. Knowledge of these livestock graziers could be valuable for identifying Bengal Florican territories and involving them in conservation efforts through alternative livelihood opportunities. An awareness program was organised among communities involved in hunting practices, including the distribution of posters and leaflets in local languages to educate the community about the conservation of this unique species. Local school and college students have shown a strong interest in learning about the Bengal Florican.

Capacity-building training has been conducted in major protected areas that have significant Bengal Florican populations and suitable habitats. Most frontline staff were knowledgeable about the bird and could identify it. This training will support the monitoring and conservation of the species in these areas. The frontline staff at D'Ering WLS and *Orang* NP have already conducted Bengal Florican counts after receiving hands-on training to perform annual monitoring and collect field data. However, protected areas such as D'Ering, Manas, and Kaziranga, which have extensive grasslands, require additional manpower to conduct Bengal Florican counts effectively.

Impacts

The following are the major impacts to Bengal Florican in Northeast India

- **Habitat Fragmentation and Degradation:**
  The Bengal Florican's distribution in Northeast India is fragmented, with populations confined to a few protected areas and non-protected grassland patches.
- **Grassland Degradation:** Large grassland patches that supported Florican territories have been eroded, and remaining grasslands are subject to significant degradation due to agricultural conversion and human disturbance.
- **Overgrazing:** Livestock overgrazing is a major threat, leading to habitat degradation (**Please refer to Figure 60**).

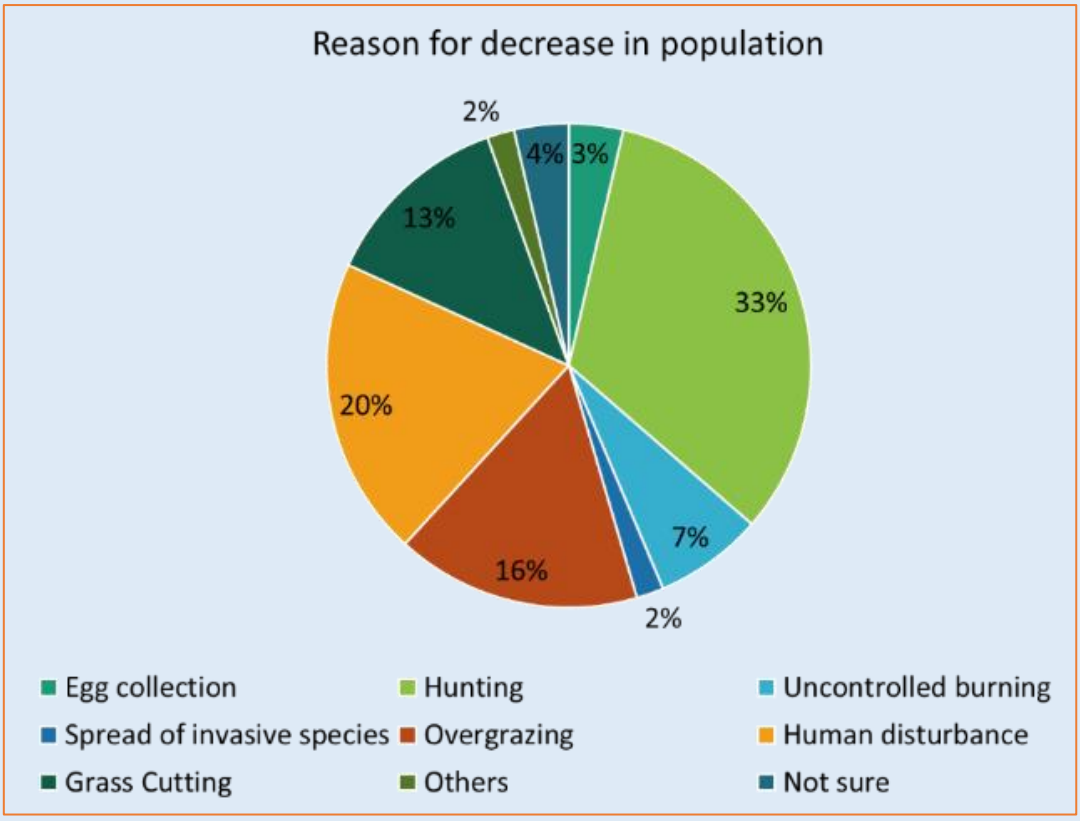


Figure 60: Livestock graziers' views on the Bengal Florican population trend (Chi-square test, $\chi 2 = 55.413$, df =3, $p<0.001$)

- **Invasive Species:** The spread of invasive plants like *Chromolaena odorata* and *Lantana camara*, and trees such as *Bombax ceiba* and *Zizyphus* spp., negatively affects the grassland habitats.
- **Poaching and Hunting:** Historically, Bengal Floricans were opportunistically poached, and while the likelihood of such activities is currently low, there are still concerns about potential poaching by local livestock graziers and egg collection.
- **Inadequate Management:** Areas like D'Ering WLS and Dibru-Saikhowa NP are affected by invasive species and erosion, requiring improved management and habitat restoration efforts.
- **Limited Monitoring:** Inadequate manpower and resources for monitoring and counting the Bengal Florican in large protected areas.
- **Community Impact: Economic Dependence:** Livestock graziers' economic dependence on grasslands contributes to habitat degradation and potential conflict with conservation efforts.
- **Lack of Awareness:** Many graziers need to be made aware of the legal protection status of the Bengal Florican, which may lead to opportunistic hunting.
- **Breeding Habitat Concerns:** During the breeding season, males use short grasses for courtship, while females prefer taller grasses. The availability of suitable breeding habitats is affected by habitat degradation and human disturbance.
- **Need for Conservation Efforts:** To protect and restore Bengal Florican habitats, targeted habitat management, controlled livestock grazing, and removal of invasive species are needed.

- **Community Involvement:** Awareness programs and community participation are crucial for effective conservation, especially given the local dependence on and knowledge of the grasslands.

Way Forward

1. **Territory Mapping and Monitoring:** We will map all Bengal Florican territories within both protected and non-protected areas. Trained staff will regularly monitor these sites during the breeding season. The resulting maps will be shared with the respective Protected Area (PA) authorities to facilitate Bengal Florican-friendly grassland management practices.
2. **Study of Movement Patterns:** An urgent study on the movement patterns of the Bengal Floricans in Northeast India is essential. Currently, there is a lack of knowledge regarding the species' habitat use during the non-breeding season in this region. Understanding these patterns will be crucial in formulating effective conservation strategies and identifying critical habitats that need protection. Satellite tracking of small populations from various sites in Northeast India will provide valuable insights into their movement patterns and habitat use during the non-breeding season.
3. **Protection of Non-Protected Territories:** The *chapories* of the Brahmaputra River and its tributaries still contain valuable habitats for the Bengal Florican, with small populations persisting in these areas. We will focus on establishing community reserves with active participation from local communities to safeguard these territories outside protected areas. This approach will engage the community in conservation efforts and ensure the sustainable protection of these critical habitats.
4. **Restoration and Management of Grasslands in Protected Areas:** Effective management of grasslands within protected areas is crucial for preserving biodiversity and supporting species such as the Bengal Florican and other grassland obligate species. Eradication of invasive alien plants and native tree species such as *Bombax ceiba* and *Ziziphus* spp. needs to be done in D'Ering WLS, Manas NP, and the newly added areas of Kaziranga NP and TR (**Please refer to the Images below**).
5. **Development of Eco-Tourism:** Bengal Florican-focused ecotourism is possible in a few sites to provide alternative livelihood opportunities for local communities. This initiative will create economic benefits, raise awareness, and garner support for the species' conservation. By promoting sustainable tourism, we aim to highlight the unique biodiversity of these areas while ensuring the long-term protection of Bengal Florican habitats.
6. **Grazing Policy Implementation:** Non-protected grasslands face severe pressure without a proper grazing policy. To address this, we will actively advocate for the development and implementation of a sustainable grazing policy. This policy will be essential in managing these grasslands effectively and mitigating the threats to the Bengal Florican's habitat.

View of restored grassland habitat

The height of the grass was taken every alternate day, and it was found that it regained its height in two weeks

Chapter 7 – Addressing the issue of Free-Ranging Dogs

The Bustard team from BNHS has been working in the Thar Landscape since 2019, in close coordination with the local community and the village Gram Panchayats of various villages in Pokhran tehsil, Jaisalmer district. The town is well known for the Field Firing Range, spread across two thousand square kilometres. Its pristine habitat consists of scrublands, grasslands, and dunes. This heavily guarded territory is also home to numerous native faunal species of the Thar, including the majestic and Critically Endangered Great Indian Bustard. As per our estimate, around 35 individuals survive within this territory; this rare bird's largest population outside any Protected Area worldwide.

Introduction

The studies conducted by the BNHS team showed that the area near the field firing range is critical for the survival of the last remaining GIB population in Pokhran. The Bustards tend to move out of the area beyond firing range during the non-breeding season; around the same time, the Indian Army has increased its activity in the region. The increased presence of GIB provides more food for dogs near army settlements, attracting dogs from nearby villages. This uninterrupted food supply from the settlements and the availability of water in the villages pave the way for dogs to increase their population; the concern arises with the onset of summer and a drop in Army presence, leading to a lack of food sources. The dogs have switched to their basic hunting instincts due to a lack of food. It was observed that these Free-Ranging Dogs (FRD) have begun preying on native fauna such as Chinkara, smaller mammals, and, in some cases, even scavengers such as vultures (**Please refer to the Image below**).

A Chinkara is killed by a Free-Ranging Dog in Khetolai village. Such scenes have become common in this landscape, © Kamlesh Jani.

This has caused great concern among the locals. The villages surrounding the Pokhran Field Firing Range (PFFR) are inhabited by the Bishnoi community. These people are deeply affectionate towards wildlife and worship native flora and fauna, such as Khejri and Chinkara. The daily attacks and killing of Chinkaras by FRDs have raised alarms among the villagers, as

they approached the BNHS team to help them in technical and financial terms to tackle this menace. We have received letters from the *Gram Panchayat Sarpanch* to resolve this issue. To support locals, we conducted a short-duration dog relocation programme in 2022. The situation has become alarming once again with the onset of summer, as we receive daily reports of chinkaras being chased by free-ranging dogs.

The population of FRDs in India is rapidly increasing, posing a severe threat to the dwindling population of various wildlife species. This violates the Wildlife (Protection) Act of 1972, which mandates the protection and conservation of wildlife in India. Despite orders issued by the Hon'ble Supreme Court and the Ministry of Environment, Forests and Climate Change (MoEFCC) to protect endangered species, the endangerment of stray dogs is becoming a severe threat within and outside Protected Areas (PAs). The measures taken for in-situ conservation and government interventions are becoming ineffective due to the FRD's predation of wild animals. The FRD population has significantly threatened wildlife, especially the Great Indian Bustard and other threatened animals in human-dominated landscapes. These dogs pose a severe threat to the already declining population of the Great Indian Bustard by preying on their nests and chicks and disturbing adult birds. India is taking significant steps to conserve its wildlife and control invasive species. Invasive species are non-native species that can endanger or adversely affect wildlife or their habitats. Free-ranging and stray dogs are invasive species that cause havoc to wildlife and require control and removal. The focus should be on finding a solution to protect wildlife and domestic animals. The petitioners are not opposed to domestic and pet dogs but emphasise the need to control the FRD population and prevent it from becoming a threat to wildlife. Wildlife conservation and protection in India are essential, and removing invasive species such as FRD is crucial to achieving conservation targets.

It is important to note that there are two categories of dogs: domesticated and free-ranging. FRDs are not dependent on human-subsidised food and are found in the wild. According to the ABC rule, after neutering, the dogs must be released back to the areas where they were captured. However, the National Tiger Conservation Authority (NTCA) guidelines suggest rehabilitating such dogs. This implies that they should be cared for with food, shelter, and medical care before being returned to their natural habitat. It is essential to urgently address the impact of FRD on wildlife areas. Releasing dogs in wildlife areas after sterilisation may not effectively solve the problem of FRDs. Sterilisation may not yield the desired results, as another male dog can quickly replace a captured alpha male. This can increase aggressive behaviour among male dogs, further exacerbating FRD-animal conflict cases. While there is a rule for rehabilitating hundreds of thousands of dogs, we often neglect the welfare of an evolutionarily distinct species, such as the Great Indian Bustard. Dogs can easily prey on birds, and their presence can disrupt their mating behaviour. In a recent verdict, the Supreme Court held that birds also have the right to live, and that we must prioritise wildlife conservation over threats.

Bustards, Floricans and FRDs

The Great Indian Bustard is a critically endangered bird species. It cannot perch anywhere and spends its entire life on the ground. Bustards inhabit open plains, semi-desert regions, and agro-pastoral habitats in human-dominated landscapes. Its viable population is in the Thar Desert region of Rajasthan, India. Males can reach up to 4 feet in height, while females are slightly smaller. They typically lay a single egg, and the chick stays with the mother for at least a year to learn how to survive. The growing population of free-ranging dogs in the area poses a significant threat to the survival of the Great Indian Bustard. These dogs, known to attack nests, eggs, chicks, and nesting females, make the birds more vulnerable. Even short-distance flights by adult birds are conducted at lower altitudes, making them especially susceptible to dog attacks (please **refer to the image below**).

The FRDs have also been sighted chasing down the Critically Endangered Great Indian Bustard © Radheyshyam Bishnoi.

With a population of only around 100 birds in the wild, losing even one bird means losing 1% of its population. This underscores the urgency of controlling the dog population in these areas to prevent the species from becoming extinct.

Male Great Indian Bustards maintain territories in the lek area, where they perform an elaborate breeding display to attract females. The females visit the leks, compare the males' performances, and choose a suitable breeding partner. During this time, males puff out their gular pouch, raise their tails, and make a series of "hum" calls to attract females. Females may nest within or near the lek from mid-February to early October. The leks are breeding grounds and social hubs for gathering before more extended seasonal movements. Unfortunately, the population of Great Indian Bustards is dwindling, and there are only four lekking sites left in the Thar Desert:

1. Ramdevra-Loharki-Sujasar
2. Pokhran (Firing Range of the Indian Army and surrounding villages)
3. Sam-Sudasari, Desert National Park
4. Salkha-Kanoi area

It is crucial to control the dogs in lekking and wintering sites.

This is not just about protecting the Great Indian Bustard species but also preventing the extinction of other grassland-dependent birds like the Lesser Florican from the known grassland sites across India.

1. Thar Desert, Rajasthan (sites mentioned above)
2. Great Indian Bustard Sanctuary, Solapur-Ahmednagar districts, Maharashtra, and surrounding areas (Dharashiv and Latur districts)

3. Great Indian Bustard and Lesser Florican area, Chandrapur, Maharashtra
4. Gautala-Autramghat Wildlife Sanctuary and nearby areas of Chhatrapati Sambhaji Nagar, Maharashtra
5. Ghatigaon Wildlife Sanctuary, Madhya Pradesh
6. Sardarpur Wildlife Sanctuary, Dhar, Madhya Pradesh
7. Sailana Wildlife Sanctuary, Ratlam, Madhya Pradesh
8. Jeeran proposed the Lesser Florican conservation area, Neemuch, Madhya Pradesh
9. Petlawad Florican site, Jhabua, Madhya Pradesh
10. Karera Wildlife Sanctuary, Shivpuri, Madhya Pradesh
11. Rollapadu Wildlife Sanctuary, Kurnool, Andhra Pradesh
12. Shokaliya landscape and Arwar Lesser Florican Conservation Reserve, Ajmer-Kekri districts of Rajasthan
13. Bustard-Florican areas of Bellary and Gadag-Koppal districts, Karnataka
14. Ranebennur Blackbuck Sanctuary, Karnataka
15. Velavadar National Park, Bhavnagar, Gujarat
16. Kutch (or Kachchh) Bustard Sanctuary, Taluka Abdasa, Gujarat

During winter, bustards are known to form sex-specific groups (males and females form separate groups) and tend to move to larger areas near or away from the breeding grounds, depending on resource availability. To successfully release captive bustards in the future, it is crucial to address the menace posed by dogs across all present and past distribution sites. This means taking a comprehensive approach to ensure that current sites and any areas where bustards have previously been reported are free from the threat of FRD. Monitoring dog-related fatalities in bustards across the vast desert landscape is critical, and citizen science has proven effective in this endeavour. We can better understand the issue by providing local people with training in a simple monitoring and recording protocol and with cameras to capture confirmatory evidence. This community-based approach has yielded significant results, with trap-camera studies indicating that dogs are present across the landscape and that their hunting rate is higher near waterholes. Packs of free-ranging dogs are encountered almost daily, chasing and killing wildlife. Around 500 chinkara/blackbucks get killed by dogs annually in the Thar Desert, based on estimates from mortality and rescuing injured animals. The BNHS team and friends of GIB could photo-document the incidences of dog-chasing bustards three times in Solapur and four times in Pokhran. Even the last Great Indian Bustard in Solapur is struggling to survive due to threats from dogs. The threat is real, and the time to act is now.

Pokhran area – a collaboration with the Bishnoi community and the Indian Army

The Pokhran Field Firing Range (PFFR) is the largest and most important Field Firing Range of the Indian Army in Rajasthan. Several villages surround the area, including Khetolai, Loharki, Chacha, Odhaniya, Channani, Askandra, Ajasar, and Didhoo. The landscape is unique and diverse, with arid desert terrain and several oases scattered throughout the region. The area is also home to several species of flora and fauna, including the Great Indian Bustard (GIB), which is native to the region. The Bishnoi community, which follows 29 principles or commandments imparted by Guru Jambeshwar, is not a caste but a sect, primarily found in the Thar Desert of Rajasthan. They are known for their deep connection to nature and commitment to protecting animals and the environment. The presence of the Bishnoi community in the surrounding areas of the Pokhran Field Firing Range (PFFR) has helped preserve the ecosystem and protect wildlife in the region. The PFFR is regularly used for military training exercises and is strictly monitored 24x7 to ensure the safety of the area and its inhabitants. The Indian Army has taken several measures to reduce the impact of military activities on the

environment and wildlife, such as limiting the use of heavy artillery, providing water to the animals, and creating safe zones for wildlife. The area's GIB population has recently declined due to habitat loss and poaching. However, with the support of the Bishnoi community and the Indian Army, the GIB mortality rate has significantly reduced, and the sighting of GIB chicks in the Pokhran area has increased. The Bishnoi community has played a crucial role in protecting the GIB and other wildlife in the region, and their efforts have been commendable.

The issue has been addressed on an ad-hoc basis to date.

After discussions with Gram Panchayats, veterinarians, and local enthusiasts, we initiated a translocation program in two villages, Dholiya and Khetolai, which were significantly affected by feral dogs (FRD). BNHS acquired two iron cages for the process. Water sources like *Naadi* attract wildlife, especially Chinkaras, making them vulnerable to FRD attacks. A team composed of local enthusiasts, veterinary experts, and Gram Panchayat representatives tracked casualties of wild animals reported by the Forest Range Departments. Dogs involved in hunting were identified, as they often linger near injured animals or kills.

Trap Camera Studies

BNHS has developed a couple of waterholes in the Model Grassland Enclosure, which are regulated and monitored by field staff at Khetolai Base Camp. Trap cameras have been set up to accumulate systematic data on the wildlife visiting the water hole. To our surprise, exciting findings revealed that the water hole prepared for native wildlife was also being used by unwanted visitors, namely wild boars, and Free-Ranging Dogs (**Please refer to Images below**).

A pack of free-ranging dogs uses the water holes created for wildlife. The Image was captured by the installed trap camera.

Chapter 8 - Site visits in other grassland areas

1) Kaziranga National Park

Kaziranga is a wildlife sanctuary located in the Golaghat and Nagaon districts of Assam, India. It is renowned for its rich biodiversity, with diverse wildlife species, including the famous one-horned rhinoceros, tigers, elephants, and wild water buffalo. The park covers an area of around 1300 sq km, of which 500 sq km is land area, and 800 sq km is the area of the Brahmaputra River, including some Chapories. The park's landscape is diverse, with 51.91% grassland, 29.13% mixed dry deciduous forest, 6.62% waterlogged bells, 7.12% sand, and 5.21% swampy, marshy area (**Please refer to the image below**).

Kaziranga's natural wonder landscape @ Sujit Narwade

One interesting fact about Kaziranga is that it does not have chital deer, a species commonly found in many other wildlife reserves in India. Instead, the park is home to other deer species, such as the hog deer and the sambar deer. The park's management plan includes cutting down Silk cotton trees to control their spread and create space for grasslands. This has been done with special permission granted to cut down native trees, and it is essential to maintain the ecosystem's delicate balance. Kaziranga National Park is a unique wildlife reserve with its own set of characteristics that set it apart from other parks in India. The park has a high density of visitors throughout the year, and the animals have become accustomed to the presence of humans. The park authorities have taken measures to ensure that visitors do not disturb the wildlife and that the animals remain protected. The elephants in Kaziranga appear smaller than their counterparts in other parts of India because of the tall grasses in the park, which can grow up to 15 feet tall. The grasses make it challenging to spot the elephants from a distance, making them seem smaller than they are. The park is also home to Pallas's Fish and grey-headed fish eagle, which breed in the area (**Please refer to the image below**).

To ensure that herbivores like the Indian rhinoceros have access to a nutritious food source, it is common practice in Kaziranga to burn elephant grass before the monsoon to remove its silica layer, which reduces its nutritional value. As elephant grass grows taller and more prominent,

it loses nutritional value due to silica deposition, rendering it unpalatable to animals. Burning the grass helps eliminate this silica layer, ensuring that the grass's nutritional value remains intact. During the flood situations in July-August every year, nearly 80% of the park was underwater due to the overflow of the Brahmaputra River. While this can be challenging for the animals, it also helps eliminate weaker animals, keeping the population healthy. Indian rhinoceros is a grazer and relies on smaller grasses near wetlands, unlike African browsers. Kaziranga National Park is home to more than 20,000 Hog Deers, 2500 rhinos, 1000 elephants, around 1,000 to 1200 Swamp Deers, and 6000 wild buffalo, all of which depend on the grasslands for survival. Dr Salim Ali, a renowned Indian ornithologist, visited KNP in 1949, 1956, and 1964 and suggested aerial surveys.

Grasses reach their maximum height in the Kaziranga Landscape. @ Sujit Narwade

He also assumed that only the southern part of the park would have more animals, and this assumption still holds merit. The gestation period of the Rhino is 22 months, and the calf stays with the mother for about 1 to 2 years. Therefore, the female rhino will come into heat only after three years. It indicates how a single rhino matters to the entire park and population. During the visit, notably Grey-headed fish eagle with fish catch, Hog badger digging in the soil were seen. A Sohola Lake—a merger of six lakes that has transitioned from deep to shallow over the years—a diverse array of wildlife was documented. A mixed flock of 27 Griffon and Himalayan Vultures was noted. Approximately 1,100 Bar-headed Geese were seen foraging on grasses.

2) Velavadar Blackbuck National Park

The Velavadar Blackbuck National Park is a crucial sanctuary for this species. It is known for its well-managed habitat and serves as a major roosting site for various wildlife. The park's small protected grassland habitat of 50 square km accommodates as many birds as those found in agriculture-dominated terrains covering 1000 to 2000 square km.

Grassland Management Strategies

1. Controlled Grazing and Fire Management - Velavadar employs livestock-controlled grazing to maintain the open grassland structure essential for Blackbucks and other species. Controlled grazing helps prevent overgrowth of grasses and promotes a diverse plant community. Additionally, periodic prescribed burning is conducted to prevent the encroachment of woody vegetation, which can alter the grassland ecosystem and reduce habitat suitability for grassland-dependent species
2. Lesser Floricans prefer large, continuous grasslands for breeding and survival. Preservation efforts should focus on managing these areas and preventing invasive plant species from encroaching.
3. Habitat restoration efforts involve restoring degraded grassland areas from grazing and fire to allow native vegetation to recover and include techniques like green haying to reintroduce native plant diversity.
4. The park maintains artificial waterholes and salt licks throughout the grasslands to ensure essential resources are available during the dry season.

Developing Grasslands

Removing non-native and invasive plant species during the summer is important to restore a site. Once this is done, the site must be carefully examined to see if any native grass species and *Ziziphus* spp. are present. This information will help determine the appropriate grass species for restoration. It is best to choose native palatable grass seeds from the surrounding areas, ensuring they are suitable for the soil and climate of the restoration site. Seed ball preparation is an effective way to sow grass seeds in degraded areas. This process involves mixing the seeds with a suitable medium, such as compost or soil, forming them into small balls, and then distributing them evenly across the restoration site. Seed balls protect the seeds from being eaten by birds and other animals and provide a suitable environment for germinating (Narwade *et al* 2023, Pawar *et al* 2023). During the monsoon season, it is important to take several steps to ensure that the restoration site is properly prepared and maintained. One of the most crucial steps is to plough the site with seed balls to promote uniform grass growth. Distributing the seed balls evenly across the site is essential, as it helps ensure uniform grass growth and prevents bare patches. After sowing the seed balls, it is critical to protect the site from grazers, dogs, and other animals that may damage the newly developed grassland. This can be achieved by enclosing the site with a fence or by appointing guards to monitor and protect the site. To guarantee the success of the restoration project, continuous monitoring is crucial. It is important to involve the local community in monitoring the site and spreading awareness about grassland conservation. The responses of other species to the newly developed grassland should be observed, and grass growth and the maintenance of grass height for grass-oriented species should be monitored as well. This will help assess the success of the restoration project and identify any issues that need to be addressed. (Narwade *et al.* 2023, Pawar *et al.* 2023).

Monitoring should be done regularly, and data too should be recorded regularly for future reference as this will help make informed decisions about the maintenance and management of the restored grassland. It is also important to ensure that the site is adequately maintained during the dry season when there may be a fire risk. By taking these steps, we can ensure the long-term success of the restoration project and help conserve the grasslands for future generations. (Narwade *et al* 2023, Pawar *et al* 2023).

Benefits of Grassland Management for the Lesser Florican

Implementing these grassland management strategies can provide significant benefits for the conservation of the Lesser Florican:

1. Habitat Restoration and Expansion: Consolidating and restoring large, contiguous grassland habitats will increase the availability of suitable breeding and foraging

grounds for the Lesser Floricans, supporting their population recovery. (Shivakumar *et al* 2016, Ram *et al* 2023)

2. Reduced Disturbance and Threats: Controlling livestock grazing, pesticide use, and invasive species encroachment will help mitigate the key threats to the Lesser Florican, allowing the species to thrive in its preferred grassland habitats. (Ram *et al* 2023, Rawat and Adhikari 2015)
3. Increased Breeding Success: Promoting Florican-friendly agricultural practices and controlling nest/chick predators will enhance the breeding success and survival of the Lesser Florican, contributing to the species' long-term viability. (Rawat and Adhikari 2015, Dutta *et al* 2018)
4. Community Engagement and Support: Strengthening local participation in conservation efforts will foster a sense of ownership and commitment among communities, ensuring the sustainability of Lesser Florican conservation initiatives. (Rawat and Adhikari 2015)

Chapter 9 – Grasslands legal framework at present

Waste Land (Claims) Act of 1863 and its implications on the grassland ecosystem

The Governor-General of the Indian Council passed the Waste Land (Claims) Act of 1863, which was based on the premise that uncultivated lands, often classified as grasslands or scrublands, were unproductive and needed to be converted into economically viable agricultural areas. However, these grasslands were not barren; they were vital ecosystems supporting a rich diversity of flora and fauna, including unique grass species and other natural vegetation of significant ecological value. These ecosystems played a critical role in maintaining biodiversity, yet the Waste Land Act misclassified them as "waste" and permitted their conversion into agricultural land. As a result, there was widespread destruction of grasslands, which were converted for the cultivation of cash crops at that time, such as indigo, cotton, and rice. The ecological legacy of the Waste Land Act remains evident in many regions today, as vast expanses of grassland have been permanently converted to agricultural or urban landscapes, severely reducing the overall extent of grassland ecosystems in India. The impact on pastoralism, particularly the displacement of pastoral communities, underscores the long-lasting socioeconomic and environmental consequences of these policies.

The reclassification of grazing lands as "waste" and their subsequent conversion into agricultural fields disrupted traditional seasonal migration patterns, resulting in a decline in grazing areas available for livestock. This caused economic hardship and marginalised pastoral communities, eroding their traditional way of life. Complementary colonial policies, such as the Criminal Tribes Act of 1871—which declared pastoralists and other communities as "criminals by birth"—further marginalised these groups. These policies restricted their mobility and access to resources, adding to the environmental and economic stresses faced by pastoral communities. Similarly, the Forest Acts designated forests producing commercially valuable timber as "Reserved" and others as "Protected," allowing pastoralism only with special permits, which further complicated access to natural resources and grazing land for these communities.

The current state of grasslands reflects the cumulative impact of these historical policies. The extensive conversion of grasslands into agricultural land, industrial zones, and urban settlements has led to the near disappearance of natural grassland ecosystems. The remaining grasslands are now fragmented, making it difficult for native species to survive and adapt. Consequently, there has been a substantial decline in biodiversity, with many native plant, animal, and insect species disappearing due to habitat loss and the introduction of exotic invasive species. Additionally, grasslands, which once played a significant role in ecosystem services such as carbon sequestration and water regulation, are increasingly vulnerable to environmental degradation. The loss of these functions exacerbates climate change, as degraded grasslands can no longer effectively sequester carbon dioxide, leading to increased greenhouse gas emissions.

Moreover, overgrazing, monoculture farming, and deforestation in former grassland areas have contributed to soil erosion and a decline in soil fertility, making the restoration of these ecosystems increasingly challenging. The degradation of soil health not only reduces agricultural productivity but also diminishes the land's capacity to support diverse ecosystems, further diminishing the ecological and socio-economic value of grasslands. As a result, the environmental role of grasslands has been severely compromised, impacting both local communities and the broader environment. In conclusion, the Waste Land Act and subsequent colonial policies have had profound and lasting impacts on grassland ecosystems. The

conversion of these critical ecosystems into agricultural land has led to biodiversity loss, soil degradation, and habitat fragmentation. The marginalisation of pastoral communities and the disruption of their traditional land-use practices have further compounded the adverse effects on both the environment and society. The ecological functions of grasslands, including carbon sequestration, water regulation, and support for diverse species, have been severely compromised, highlighting the urgent need for restoration efforts to reverse the damage caused by historical land-use policies.

Wastelands refer to lands owned by the government that are classified as barren, degraded, or unproductive for agriculture. These lands are often used for afforestation, pasture development, industrial projects, or infrastructure expansion. However, they hold significant potential for ecological restoration, particularly for conserving LF and other grassland-dependent species.

Crucial environmental and wildlife laws of India

1. The Environment (Protection) Act of 1986;
2. The Forest (Conservation) Act (FCA) of 1980 played a pivotal role in curbing deforestation and preserving habitats critical for wildlife survival.
3. The Wildlife Protection Act of 1972 was amended to include "Conservation Reserves" and "Community Reserves," which can be considered a stepping stone towards recognising CCAs.
4. The Water (Prevention and Control of Pollution) Act of 1974;
5. The Air (Prevention and Control of Pollution) Act of 1981;
6. The Biodiversity Act, 2002: This act introduced the concept of "Biodiversity Heritage Sites," which can encompass areas traditionally conserved by local communities, offering another avenue for CCA recognition.
7. Wetlands (Conservation and Management Rules) 2017 -wetlands in summer get converted into grasslands, which are crucial for many ground-nesting birds

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Environmental and wildlife laws are as follows

1. The Environment (Protection) Act of 1986;
2. The Forest (Conservation) Act of 1980;
3. The Wildlife Protection Act of 1972;
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5. The Air (Prevention and Control of Pollution) Act of 1981;
6. The Biodiversity Act, 2002

Beyond sanctuaries - Community Conserved Areas (CCAs)

In India, the legislative and policy framework for conserving Community Conserved Areas (CCAs) primarily relies on the following acts: the Wildlife Protection Act (WPA) of 1972, the Biological Diversity Act (BDA) of 2002, and the Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act (FRA) of 2006, which collectively provide recognition to community-managed conservation areas through categories like Conservation Reserves, Community Reserves, Biodiversity Heritage Sites (BHS), and Community Forest Resource (CFR) rights, although there is currently no dedicated national policy specifically for CCAs as a separate entity. CCA can include a variety of natural ecosystems voluntarily conserved by local communities, such as forests, grasslands, wetlands, marine areas, and even

sacred groves, all managed based on their cultural significance, biodiversity value, and the need to sustain local livelihoods, essentially, any area where a community actively protects the environment using their customs and traditions as the primary management tool.

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Key characteristics of CCAs in India

1. **Community-driven management:** Local communities hold primary decision-making power regarding the area, including setting conservation rules and regulations.
2. **Cultural significance:** Many CCAs are linked to religious beliefs, ancestral practices, or traditional knowledge systems, like sacred groves managed by tribal communities.
3. **Biodiversity conservation:** The main goal is to protect the natural ecosystem and its diverse flora and fauna.
4. **Livelihood benefits:** Communities often rely on the CCA for resources like food, medicine, and timber, while also managing sustainable practices to ensure long-term benefits.

Examples of CCAs in India:

1. **Sacred groves:** Forests revered by local communities for spiritual reasons, often containing unique biodiversity.
2. **Village common lands:** Grazing areas or community forests managed by village councils.
3. **Community-managed fisheries:** Coastal areas where local communities regulate fishing activities to ensure sustainable harvest.
4. **Traditional water conservation systems:** Locally designed irrigation systems that protect water sources.

Important points to remember:

- **Recognition by law:** While CCAs are not formally recognised under Indian law in all states, there is growing recognition of their importance in conservation efforts.
- **Challenges faced:** CCAs can face challenges like external pressures from development projects, lack of government support, and internal conflicts within communities.
- **Role of NGOs:** Several non-governmental organisations work to support and document community conservation efforts in India.

Key points about the legislative framework for CCAs in India

1. Wildlife Protection Act (WPA), 1972

This act was amended to include "Conservation Reserves" and "Community Reserves" which can be considered as a stepping stone towards recognising CCAs.

2. *Biological Diversity Act (BDA), 2002*

This act introduced the concept of "Biodiversity Heritage Sites" which can encompass areas traditionally conserved by local communities, offering another avenue for CCA recognition.

3. *Forest Rights Act (FRA), 2006*

This act provides tribal communities with "Community Forest Resource" rights, allowing them to manage and conserve forest areas that can overlap with CCAs. Additionally, the Scheduled Tribes and Other Traditional Forest Dwellers recognise the rights of forest-dwelling communities, aiming to integrate their traditional knowledge and participation in conservation efforts.

4. *Community participation*

The Indian government is increasingly emphasizing the involvement of local communities in conservation efforts, which aligns with the principles of CCAs.

5. *Traditional knowledge recognition*

Policies are gradually recognizing the value of indigenous knowledge systems used by local communities in managing conserved areas.

Challenges in implementation

Despite the legal framework, challenges remain in effectively recognizing, supporting, and managing CCAs due to issues like a lack of clear guidelines, inadequate funding, and potential conflicts with other land use demands. The Forest Conservation Act of 1980 further strengthened legal protections for wildlife by regulating the diversion of forest land for non-forest purposes. This Act was pivotal in curbing deforestation and preserving habitats critical for wildlife survival. It mandated prior approval from the central government for any conversion of forest land, thereby creating a significant legal barrier against indiscriminate deforestation (The Forest Conservation Act, 1980). In the 1990s, the global focus on biodiversity conservation culminated in the Convention on Biological Diversity (CBD), which India signed in 1992 and ratified in 1994. The Biological Diversity Act of 2002 directly resulted from India's commitments under the CBD. This Act aimed to conserve biological diversity, promote sustainable use of its components, and ensure fair and equitable sharing of benefits arising from using biological resources. It established the National Biodiversity Authority (NBA) and State Biodiversity Boards to oversee the implementation of the Act, thus institutionalising biodiversity conservation in India's legal framework (The Biological Diversity Act, 2002).

The National Wildlife Action Plan (2017-2031)

provides a strategic framework for wildlife conservation, emphasizing landscape-level conservation, human-wildlife conflict mitigation, and community participation.

Challenges in implementation

1. Inadequate Funding and Resources
2. Insufficient Manpower and Training
3. Corruption and Political Interference
4. Socio-Economic Pressures
5. Habitat Fragmentation and Degradation
6. Climate Change
7. Legal and Bureaucratic Hurdles
8. Lack of Community Involvement

Proposed Solutions & Recommendations for Legal Frameworks

1. **Strengthening Legal Frameworks and Imposing Stricter Penalties**

- Aligning Laws and Policies for Greater Cohesion

- Empowering Enforcement Agencies to Act Effectively
- Increasing Financial Investment and Resource Allocation
- Fostering Capacity Building and Training Initiatives
- Establishing Robust Anti-Corruption Measures

2. Empowering Communities

- Launching Conservation Programs that Benefit Local Ecosystems
- Offering Sustainable Livelihood Alternatives

3. Harnessing Technology

- Utilizing Advanced Monitoring Tools for Better Oversight
- Advancing Wildlife Forensics to Combat Poaching

4. Enhancing International Collaboration

- Upholding Treaties such as CITES and CBD to Protect Biodiversity
- Developing Transboundary Initiatives for Comprehensive Action

5. Raising Awareness

- Implementing Impactful Campaigns to Educate the Public
- Promoting Education to Foster a Culture of Conservation

Declaring a Private Wildlife Sanctuary in India

In India, private land can be declared a wildlife sanctuary through the "Community Reserve" provision under the Wildlife Protection Act of 1972, where the state government can designate private land as a protected area if the landowner voluntarily agrees to conserve wildlife on their property, with proper management and community involvement; essentially creating a "private wildlife sanctuary" in practice. Key points about declaring a private wildlife sanctuary in India:

1. **Legal basis:** Section 36C of the Wildlife Protection Act allows for the declaration of a Community Reserve on private land if the community or individual owner volunteers to conserve wildlife and its habitat.
2. **State government authority:** The state government has the power to declare a community reserve by issuing a notification.
3. **Management committee:** A community reserve management committee is formed, which includes the landowner, representatives from the Forest Department, and local community members.
4. **Restrictions on land use:** Once declared a community reserve, the landowner cannot change the land use pattern without approval from the management committee and the state government.
5. **Landowner consent:** The landowner must actively agree to dedicate their land for wildlife conservation to establish a community reserve.
6. **Ecological significance:** To be considered a community reserve, the area must be deemed ecologically crucial for wildlife conservation.
7. **Community involvement:** Local communities should be involved in the management and decision-making process of the community reserve.

State Government Institutions

The state government can create reserved forests, national parks, and wildlife sanctuaries, but needs central approval for de-reservation and logging. Forest Secretariat. The Forest Minister and Principal Secretary oversee forests and wildlife policy. State Forest Department Led by the Principal Chief Conservators of Forests (PCCF), this department manages forests and wildlife reserves. The Chief Wildlife Warden (CWLW) heads the Wildlife Wing, overseeing Protected Areas with the authority to address illegal activities. Other Key departments include Revenue (land control), Police (enforcement of forest laws), Irrigation (water resources), and Public Works (road maintenance).

Conflicts of interest between the central and state governments

Forests represent a primary source of non-tax revenue for the latter. Thus, while recent forest policy is gradually shifting from commercial forestry to conservation, state governments often face competing demands on forests from various powerful interest groups, including the state treasury and forest-based industries.

Strategic efforts needed

Furthermore, the conservation and management objectives of the Forest Departments are not well formulated; projects are often underfunded, under-equipped, and understaffed; and ongoing efforts are rarely monitored.

The United Nations Development Programme (UNDP) proposes a **radical restructuring of the forest sector through a clear separation of protective and productive functions.**

The Panchayati Raj institutions

Gram Panchayats at the village level, the Tehsil Panchayats at the Tehsil level, and the Zilla Panchayats at the district level form a three-tier system of decentralised, democratic local self-governance. State legislatures can legislate and devolve certain powers to the Panchayats under the Panchayat Raj Act on matters concerning agriculture, animal husbandry, fisheries, rural housing, electrification, roads and water management, social welfare, etc.

Statutory Bodies

Several key statutory bodies oversee forest, wildlife, and environmental issues:

a. **NBWL**: Advises on wildlife policies and impact assessments, chaired by the Prime Minister.
b. **SBWL**: State-level boards that advise on wildlife protection but often lack effectiveness.
c. **National Biodiversity Authority**: Established by the Biodiversity Act, 2002, to advise on biodiversity conservation.
d. **Pollution Control Boards**: Regulate industries in ecologically sensitive areas under the Environment Protection Act, 1986.
e. **Central Empowered Committee**: Monitors compliance with Supreme Court orders on environmental protection.
f. **National Green Tribunal**: Resolves environmental disputes quickly.
g. **Forest Advisory Committee**: Advice on forestland diversion for non-forestry purposes.

Corporations, Cooperative Societies and Business

1) **Forest Development Corporations:** These entities manage funds from logging and develop plantations, sometimes illegally converting protected areas.
2) **Cooperative Societies:** These groups extract and market forest products but often prioritize profit over biodiversity. I am running a few minutes late; my previous meeting is running over.

Other Effective Area-based Conservation Measures (OECMs)

It is a new conservation approach, separate from protected areas, where effective conservation of biodiversity is achieved mainly as a by-product of other management objectives. A wide variety of sites in India have the potential to become OECMs.

Chapter 10 – Habitat Restoration and Grassland Management

Introduction

Grasslands cover 37% of the globe's terrestrial area and are an important component of the global ecosystem (Mara, 2012). The three distinct types of grasslands worldwide are steppes, tropical savannahs, and temperate grasslands (Chandran, 2015). Rich biodiversity and various ecosystem processes support their status as important locations for biodiversity conservation and the provision of numerous vital ecosystem services (Bezbarua *et al.*, 2008; Sanbi, 2013). Grass is considered as the most developed group of plants. It takes them a little time from germination to maturity, making them outstanding plants with a short life cycle and extended lifespan. They do not take long to regrow after being chopped, unlike trees. They can support or transform into enormous volumes of biomass. They also provide habitat to a wide range of fascinating wildlife. With over 500 million animals, the grasslands are under extreme biotic pressure from grazing and conversion to other uses. The large number of cattle and the rural populace's reliance on them underscore the need for grassland protection, restoration, and sustainable use as imperatives for both policy and the environment.

Grasslands have a vital role in soil health (Lehmann & Kleber, 2015), biodiversity enhancement (Hooper *et al.*, 2005), and carbon sequestration, which helps slow down global warming (Conant *et al.*, 2017). Additionally, they are essential for controlling runoff and enhancing groundwater recharge (D'odorico *et al.*, 2010). Economically, grasslands are vital for animal grazing, supporting agriculture and the livelihoods of communities (Teague *et al.*, 2013). These ecosystems are threatened by a variety of factors, which can lead to the loss of biodiversity and ecosystem degradation. These threats include invasive species (D'antonio & Vitousek, 1992), overgrazing (Teague *et al.*, 2013), habitat conversion for agriculture and urban development (Foley *et al.*, 2005), and climate change (Parmesan, 2006). As grasslands provide the majority of the local population's livestock with food, they have significant economic value. Moreover, the grasslands can serve as a gene bank to protect wild fodder species for future use. In addition to its high economic value, it also possesses significant ecological and conservation value. For instance, the grasslands support over 90% of the critically endangered Great Indian Bustard population in Rajasthan, Gujarat, Madhya Pradesh, and Maharashtra, as well as over 90% of the endangered Lesser Florican breeds. However, the grasslands have been severely degraded due to a steady increase in the number and quality of forage species, changes in land use practices, and heavy infestation by invasive alien and unpalatable plants. This has resulted in the loss of ecosystem services and biodiversity, as well as the loss of pastoral livelihoods and desertification (Faber-Langendoen & Jose 2010; Fao, 2013).

Grasslands of India

Dhadabgao and Sankarnarayan (1973) in their book "The Grass Cover of India" identified the following five broad types of grass cover found in India:

1. **Sehima-Dichanthium Grasslands**
   This type of grass is primarily found at elevations between 300 and 1200 meters above mean sea level in the Deccan Plateau, Chota Nagpur Plateau, and the Aravallis. Dominant grasses like *Dichanthium* and *Sehima* define the flora of this kind of grassland.
2. **Dichanthium - Cenchrus - Lasiurus Grasslands**
   These grasslands are found at elevations of 150 to 300 meters above mean sea level in the northern regions of Gujarat, Rajasthan, the Aravalli hills, southwest Uttar Pradesh,

Delhi, and Punjab. Along with other herbaceous plants like *Cleome* and *Tribulus*, *Dichanthium*, *Cenchrus*, and *Lasiurus* make up the majority of the local flora. Shrubs like *Capparis* and *Acacia* are frequently strewn throughout this kind of grassland.

3. **Phragmites - Saccharum - Imperata Grasslands**
   The *Phragmites*, *Saccharum*, and *Imperata* grasslands are mainly found at elevations of 300 to 500 meters above mean sea level in the Gangetic plains, the Brahmaputra Valley, and the plains of Punjab. Dominant species that flourish in the nutrient-rich soils typical of wetland habitats, such as *Saccharum spontaneum*, *Phragmites karka*, and *Imperata cylindrica*, define this ecosystem.
4. **Themeda - Arundinella Grasslands**
   The *Themeda-Arundinella grasslands are found in the foothills and lower hills of Manipur, Assam, northern West Bengal, Uttarakhand, Himachal Pradesh, and Jammu and Kashmir, occurring* at elevations ranging from 350 to 2000 meters above mean sea level. This grassland type primarily comprises *Themeda triandra* and *Arundinella*, often interspersed with forested areas featuring species such as Oak and Rhododendron.
5. **Temperate - Alpine Grasslands**
   The temperate-alpine grasslands are situated in the Himalayan states and temperate high-altitude areas of Nagaland, Manipur, and the Western Ghats, occurring at altitudes exceeding 2000 meters above mean sea level. This ecosystem is characterized by resilient grasses and alpine flora, including species such as *Stipa* and *Carex*, as well as various alpine flowers like *Edelweiss*.

Ecosystem services provided by grasslands

India's grasslands provide numerous ecosystem services essential to maintaining environmental integrity and promoting human well-being. According to Nandi *et al.* (2020), these ecosystems promote ecological stability by providing habitats for various plants and animals and maintaining biodiversity. They help preserve soil fertility by reducing soil erosion and promoting nitrogen cycling (Bhattacharyya *et al.*, 2018). Additionally, by storing carbon in soil and biomass, Indian grasslands successfully mitigate climate change through carbon sequestration (Raghubanshi *et al.*, 2012). They control the hydrological cycle by lowering the risk of flooding and promoting groundwater recharge (Sharma *et al.*, 2014). Moreover, grasslands promote agricultural production and food security for rural areas by offering livestock feed and wild food sources (Singh *et al.*, 2016). According to Kumar *et al.* (2019), these ecosystems also serve as vital habitats for pollinators, which are essential for the reproduction of many plants, including crops. Moreover, Indian grasslands contribute to community well-being by providing leisure activities and cultural values (Reddy *et al.*, 2021). Subsequently, according to Yadav *et al.* (2017), they are home to medicinal plants that support conventional medical procedures. To sustain these priceless ecosystem services for future generations, sustainable management and preservation of Indian grasslands are essential.

Major threats to grasslands

1) Lack of Policy guidelines for the conservation of grasslands

Many state-owned grasslands and village pasture areas have been heavily planted with tree species, including *Prosopis juliflora*, because of insufficient policies and management techniques for grassland conservation or a mindset that views grasslands as wastelands (Bhardwaj *et al.*, 2011). Like this, under several afforestation programs managed by the State Forest Departments, thousands of hectares of natural grasslands in the Thar region have been planted with Israeli babul *Acacia tortilis*. Many grasslands have been converted to croplands or forests, and the remaining ones are deteriorating due to overgrazing.

2) Habitat degradation and loss

Significant loss of biodiversity and ecosystem services results from habitat degradation in India's grasslands, primarily caused by overgrazing, urbanisation, agricultural expansion, and the invasion of non-native species (Sundararaman, 2012; Chandran *et al*., 2017). Native plants and animals are displaced as agricultural lands encroach on these habitats, and overgrazing by cattle damages vegetation and accelerates soil erosion (Kumar *et al*., 2018). According to Ghosh *et al.* (2020), urban expansion significantly fragments grassland ecosystems, isolating wildlife populations and hindering their ability to roam and reproduce. The spread of alien plants, such as *Lantana camara*, puts native grasses in competition, exacerbating the loss of native biodiversity (Mishra et al., 2013).

3) Plantation and spread of invasive species

Since invasive species are spreading across Indian grasslands and being planted there, native biodiversity and ecosystem health are seriously threatened. Invasive species, such as *Prosopis juliflora* and *Lantana camara*, can alter plant community dynamics, which frequently flourish in disturbed environments and dominate local flora for resources like sunlight, water, and nutrients (Mishra *et al.* 2013). Juliflora was first introduced to control erosion and promote afforestation. However, it has since spread to dry and semi-arid areas, displacing native plant species and reducing biodiversity (Bhat *et al*., 2014). *Prosopis juliflora* has become well-established, endangering the natural equilibrium of grasslands and the means of subsistence for nearby communities that rely on native species for grazing and other purposes (Ghosh *et al*., 2020).

4) Invasive and Exotic Species:

a) ***Lantana camara***: A perennial shrub native to Central and South America, *Lantana camara* forms dense thickets that surpass native vegetation, significantly reducing biodiversity. Its rapid growth can alter habitat structures and impede the regeneration of native flora (Singh *et al.* 2018).

b) ***Parthenium hysterophorus*** (Carrot weed): Originating from the Americas, this aggressive weed spreads quickly in disturbed areas. It is known to cause allergic reactions in humans and livestock and inhibits the growth of surrounding plants through allelopathic properties, further worsening its invasive impact (Kumar *et al.* 2019).

c) ***Ageratum conyzoides*** (Billygoat weed): This herbaceous perennial thrives in disturbed habitats and can dominate areas, reducing native plant diversity. Its rapid growth also allows it to be a host for various pests, affecting agricultural productivity (Rani and Kumari, 2020).

d) ***Cynodon dactylon*** (Bermuda Grass): Widely used for lawns and as forage, *Cynodon dactylon* can become invasive in grasslands, spreading rapidly and outcompeting native grasses, thus altering local ecosystems (Prasad *et al*., 2021).

e) ***Eucalyptus* spp.** : Introduced for timber and fuelwood, various species of *Eucalyptus* can significantly affect local ecosystems by consuming large amounts of water, leading to reduced soil moisture and altered vegetation dynamics (Ghosh *et al*., 2015).

f) ***Prosopis juliflora*** (Mesquite): This invasive tree species competes aggressively with native flora for resources, often dominating the landscape. Its deep root systems can draw significant moisture, impacting surrounding plant communities and soil health (Gandhi *et al*., 2017).

g) ***Cortaderia selloana*** (Pampas grass): Native to South America, this perennial grass spreads aggressively, forming dense stands that surpass native grasses. Its biomass accumulation increases fire risk in grassland ecosystems (Gupta *et al*., 2018).

h) ***Ailanthus altissima*** (Tree of heaven): This fast-growing tree, native to Asia, can invade various habitats, including grasslands. It produces allelopathic chemicals that inhibit the growth of surrounding plants, allowing it to dominate (Gandhi *et al*., 2017).
i) ***Mikania micrantha*** (Bitter vine): A climbing vine native to Central and South America, this species can smother native vegetation, drastically altering ecosystems. It grows rapidly and can cover trees and shrubs, hindering their growth (Sangwan *et al*., 2016).
j) ***Saccharum spontaneum*** (Kans grass): While native to the Indian subcontinent, this species can become invasive, forming dense stands that outcompete other grasses and alter habitat structures, particularly in disturbed areas (Sinha *et al*., 2019).
k) ***Opuntia ficus-indica*** **(Prickly Pear**): This cactus, native to the Americas, can become invasive in grasslands and arid regions of India. It spreads rapidly and can surpass native plants, impacting local biodiversity (Kumar & Singh, 2018).

5) Use of pesticides

The biodiversity and health of the ecosystems are seriously threatened by the usage of pesticides in Indian grasslands. Despite being designed to eradicate agricultural pests, pesticide runoff can negatively impact species that are not intended targets, upsetting food chains and endangering wildlife, birds, and beneficial insects (Ghosh *et al.* 2020). Reducing reliance on chemical pesticides and adopting integrated pest management (IPM) strategies are crucial for promoting the sustainability of these ecosystems (Saha *et al*., 2021).

6) Indiscriminate developmental activities

In India, indiscriminate development initiatives, such as industrialisation, urbanisation, and infrastructure development, are seriously harming grassland ecosystems. As concrete buildings and agricultural areas replace natural landscapes, these activities damage wildlife corridors, fragment habitats, and reduce biodiversity (Chandran *et al*., 2017).

7) Poaching

India's grassland species are seriously threatened by poaching, which harms ecosystem stability and biodiversity. Wild animals, such as the Indian Blackbuck and various deer populations, which are primarily hunted for their horns, skin, and meat, are becoming increasingly vulnerable due to unlawful hunting methods (Bhat *et al*., 2014). As they are essential to seed distribution and vegetation structure maintenance, the fall in these populations upsets the ecological balance (Kumar *et al.* 2018). Further harming endangered species, poaching may increase competition among surviving wildlife for resources (Ghosh *et al*., 2020).

8) Overgrazing

Overgrazing is a significant threat to grassland species in India, resulting in habitat degradation and a decline in biodiversity. Excessive grazing by livestock, particularly in regions like Rajasthan and Gujarat, strips native vegetation and prevents the regeneration of grasses, which are vital for sustaining wildlife such as the Indian Blackbuck and various bird species (Kumar *et al.* 2018). This reduction in vegetation not only diminishes food availability for herbivores but also disrupts the overall ecological balance, leading to increased soil erosion and degradation of land quality (Sundararaman, 2012). According to Rahmani (1989, 1996), the bustard's preferred habitat is dry, short grasslands with flora less than one meter high or below eye level. Moreover, this terrestrial bird stays away from crowded grasslands where it is difficult to migrate. The habitat of the bustard is improved by light grazing by livestock or wild herbivores, but overgrazing, which is common in India, negatively affects the bustard's ability to reproduce.

Grassland Restoration

Grasslands, being a mixture of different grass species, legumes, and herbs, act as carbon sinks, erosion preventers, and sources of nitrogen fixation (Carlier *et al*., 2009). Grasslands have local importance for maintaining biodiversity and food production, and they affect ecological processes such as pollination, regional water regulation, and recreation (Bengtsson *et al*., 2019). A report was submitted to the Planning Commission, Government of India, in 2006 by the task force on Grasslands and Deserts. It stated that grasslands and deserts are the most neglected ecosystems. It also stated that the protection, development, and sustainable use of grassland are essential to the rural economy and livestock.

The Thar Desert supports many bird species, including the critically endangered Great Indian Bustard *Ardeotis nigriceps* (Rahmani, 1997). Historically, this area was sparsely populated, with agriculture restricted to select low-lying areas. From the 1980s, however, the Indira Gandhi Canal, along with other irrigation schemes, has promoted cultivation in this region (Rahmani & Soni, 1997). With the easy availability of water in these remote grasslands, livestock concentrations are higher in many areas and are expected to increase further as water channels are developed (Rahmani 1997a, 1997b; Islam & Rahmani, 2004). The IGNP has also altered the crop pattern and agricultural expansion from subsistence farming to commercial farming (Rahmani, 1997c; Rahmani & Islam, 1997; Islam & Rahmani, 2004, 2008). The state of Rajasthan falls under the *Dichanthium-Cenchrus-Lasiurus* type of grassland (Dibadghao & Shankarnarayan, 1973), *Lasiurus sindicus* is one of the most important grasses of the Thar region and is underrepresented. The other important grasses of this region are Bui *Aerva psuedomentosa*, Murat *Brachiaria ramose*, Phog *Calligonum polygonoides*, Bhurat *Cenchrus biflorus*, Chag *Crotalaria burhia* and Ganthia *Dactyloctenium sindicum.* The Pokharan tehsil of Jaisalmer district falls within such a habitat and is crucial for conserving the Critically Endangered GIB, as well as many other essential floral and faunal species. Grasslands have also suffered from the spread of *Prosopis juliflora* (Islam & Rahmani, 2011).

Methods and Practices

Grassland restoration in India is crucial for biodiversity conservation, supporting local livelihoods, and mitigating climate change. Grasslands provide habitats for endangered species like the Great Indian Bustard, Lesser Florican, Bengal Florican, Pigmy Hog, Hispid Hare, Indian Grey Wolf, and Blackbuck. Restoring these ecosystems protects both flora and fauna. Restoration also benefits local communities by offering sustainable grazing grounds for livestock, improving soil fertility, and supporting traditional pastoral livelihoods. In addition to these socio-economic benefits, grassland restoration enhances carbon sequestration by storing carbon in soils and improving water infiltration, making it a vital strategy for combating climate change. Grasslands reduce soil erosion, promote flood control, and contribute to groundwater recharge, especially in water-scarce regions. However, grasslands worldwide have been significantly degraded due to human activities, including intensive agriculture, urban development, overgrazing, and climate change. Encroachment of grasslands by invasive alien plants is considered one of the primary factors contributing to habitat degradation. Restoring these ecosystems is crucial for preserving biodiversity, enhancing ecosystem resilience, and promoting sustainable livelihoods (**refer to Figure 61**).

National policy on the management of grasslands

A national policy for managing grasslands in India is essential to recognise the ecological services these ecosystems provide. Because of our current lack of understanding of the ecological benefits grasslands provide, they are primarily regarded as wastelands. Grasslands should not be used for the forest department's tree-planting operations. Furthermore, it is time

to reevaluate the current practice of viewing grasslands solely as a source of cattle feed. The National Policy must strongly emphasise the sustainable use of grassland resources without compromising their ecological benefits. The policy must also recommend for wildlife-friendly grassland management in India, particularly for bustards (**Please refer to Figure 61).**

This detailed flowchart outlines the key steps involved in grassland restoration, emphasising the importance of careful planning and monitoring for successful ecological recovery.

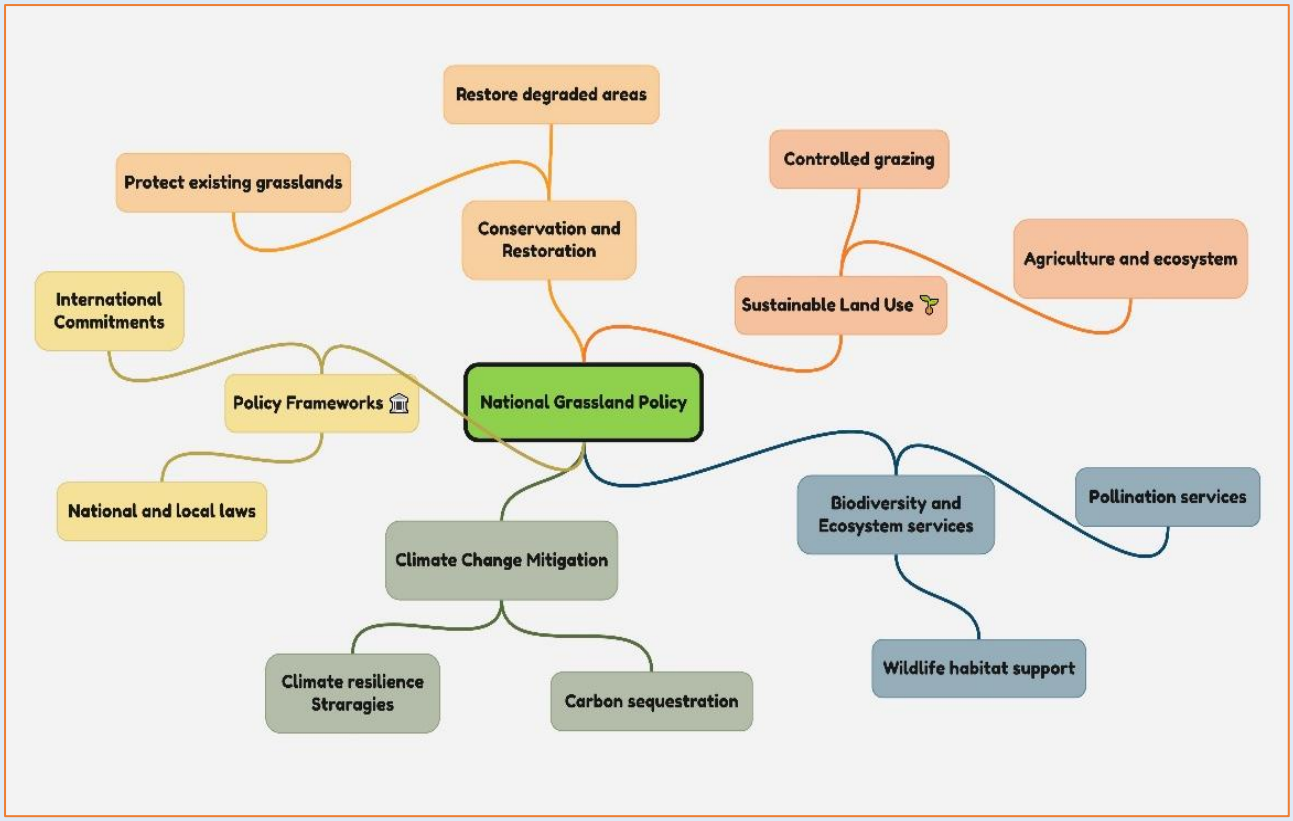


Figure 61: Model Diagram showing components of the proposed national policy for the management of grasslands

Rotational grazing systems

Implementing sustainable grazing practices is essential for maintaining the health of grasslands. Rotational grazing systems enable livestock to graze in a specific area for a limited time, preventing overgrazing and allowing grass to recover (**Please refer to the image below**).

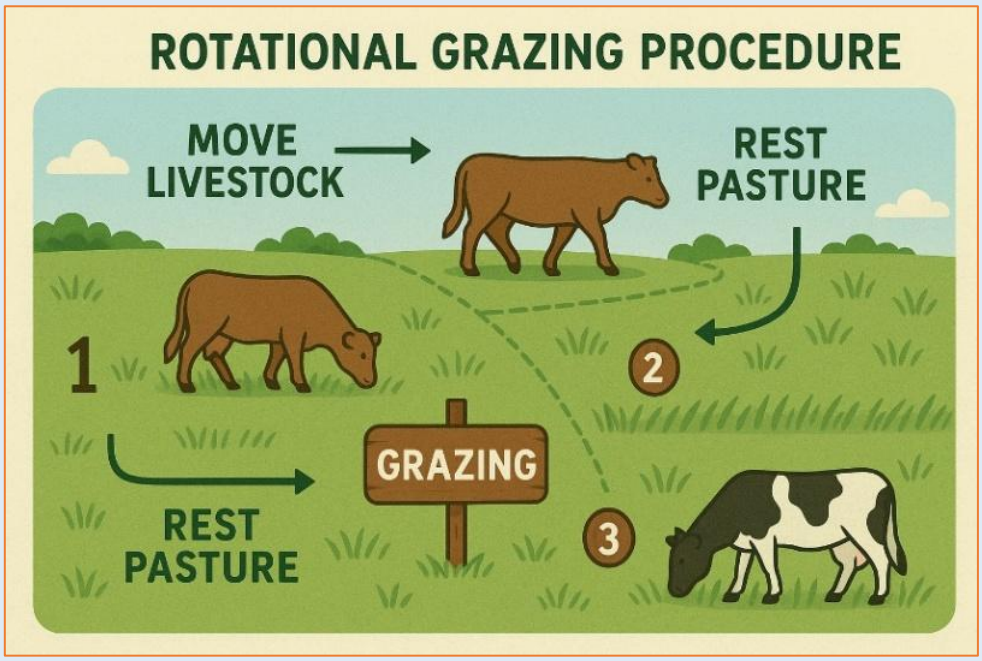


Diagram representing rotation grazing methods

Additionally, assessing the land's grazing capacity helps determine the sustainable number of livestock, ensuring that the ecological balance is maintained and preventing soil degradation. By promoting vigorous plant regrowth, rotational grazing improves forage quality and quantity over time, which is crucial for livestock nutrition (Teague *et al.*, 2013). Additionally, this practice enhances soil structure and increases organic matter, leading to improved nutrient cycling and water retention (Rao *et al.*, 2018). It also supports biodiversity by preventing overgrazing and allowing various plant species to flourish, which enhances ecosystem resilience (Fisher *et al.*, 2017).

The Deccan Plateau region of Maharashtra provides a successful case study that demonstrates the efficacy of rotational grazing. The local farmers implemented a planned grazing schedule that reduced overgrazing and improved pasture health by dividing their pastures into multiple paddocks. This resulted in increased soil fertility due to improved soil organic carbon levels, increased biomass output, and increased species diversity. Farmers reported higher milk yields and improved animal health, demonstrating the practice's economic sustainability (Bhattacharyya *et al.* 2020). The results highlight rotational grazing's promise as a long-term strategy for raising the resilience and productivity of India's grassland ecosystems.

Strategies for Involvement of Local Communities

I. **Participatory Approaches**: Participatory methods, such as community workshops and meetings, can facilitate collaboration between scientists, land managers, and local stakeholders. By incorporating local perspectives, restoration efforts can be tailored to the area's specific needs and conditions.
II. **Capacity Building**: Training local communities in restoration techniques, such as native species planting, soil management, and sustainable grazing practices, empowers them to take active roles in the restoration process. This capacity building is essential for ensuring the long-term sustainability and resilience of the grasslands.
III. **Incentive Programs**: Establishing incentive programs, such as payments for ecosystem services (PES), can encourage local communities to engage in restoration efforts. These programs can provide financial support for practices that enhance ecosystem health, such as reforestation and sustainable grazing.
IV. **Traditional grazing practices:** Traditional grazing practices often contribute to improved soil health. Controlled grazing can enhance nutrient cycling, increase organic matter, and promote soil microbial diversity. By maintaining a mosaic of different grazing intensities and practices, traditional systems can support a wider variety of plant and animal species. Engaging local communities in traditional grazing practices helps preserve cultural heritage while providing economic benefits through sustainable livestock production. This integration enhances community resilience and fosters a sense of ownership over restoration efforts.

In Rajasthan, a study by Sukumar *et al.* (2020) demonstrated that involving local pastoral communities in restoration initiatives led to significant improvements in biodiversity and ecosystem health by integrating their traditional knowledge and grazing techniques. Similarly, research by Wang *et al.* (2018) on the Tibetan Plateau highlighted the positive outcomes of engaging local herders in grassland management, with their use of traditional grazing methods resulting in improved pasture quality and successful restoration of degraded areas.

Control and management of alien invasive plants in grasslands

Alien invasive plants pose significant threats to grassland ecosystems by displacing native species, reducing biodiversity, and altering habitat structures. Effective management is

critical not only for restoring native plant communities but also for preserving the overall ecological integrity of grasslands. According to a 2003 study conducted in North America by Sheley and Krueger-Mangold, combining mechanical, chemical, and biological control techniques produced the most significant outcomes. Their study highlighted the value of community participation in management and monitoring initiatives, which improved the efficiency of invasive species removal. Bennett *et al.* (2016) concentrated on controlling invasive grasses in South Africa and assessed the effects of focused herbicide treatments. Their research showed that using herbicides alongside native species for revegetation significantly reduced the dominance of invasive grasses and aided the restoration of native flora. Collectively, these studies show that to effectively address the issues posed by invasive plants in grassland ecosystems, diverse management strategies and community engagement are essential.

Patch mosaic burning technique

According to Lehkuhl's (1994) research, using patch mosaic burning or managed fire in grassland habitats can increase grass productivity and biomass. The patch mosaic burning technique is an effective strategy for managing grasslands. It entails separating some blocks for burning and preventing the remaining blocks from burning, which gives species that depend on grasslands a place to breed and escape cover (Lahkar 2008). A decision on how to burn a section of grassland should always be based on an understanding of the ecosystem's characteristics and ecological requirements, as well as a well-defined set of management objectives for the grassland (Sanbi 2013).

Monitoring of ecological parameters

Monitoring ecological parameters enables the early detection of environmental changes, the identification of trends, and the evaluation of management practices. It is crucial for understanding ecosystem dynamics, informing conservation efforts, and ensuring that management strategies effectively maintain ecological integrity. Key Ecological Parameters to Monitor

I. **Biodiversity Assessment**: Tracking species diversity, abundance, and distribution is fundamental for understanding ecosystem health. High biodiversity often indicates a resilient ecosystem, while declines can signal environmental stress.
II. **Soil Health Monitoring**: Soil parameters, including pH, organic matter content, nutrient levels, and microbial activity, are crucial for evaluating soil health and its ability to support plant growth. Healthy soils play a crucial role in enhancing ecosystem productivity and resilience.
III. **Water Quality Monitoring**: Assessing parameters such as pH, dissolved oxygen, turbidity, and nutrient levels in water bodies is crucial for understanding the impacts of land use and management practices on aquatic ecosystems.

Monitoring techniques

a) **Remote Sensing**: Remote sensing technologies, including satellite Imagery and aerial photography, are increasingly utilised to monitor land cover changes, vegetation health, and ecosystem dynamics across large areas.
b) **Field Surveys**: Ground-based surveys are essential for collecting detailed data on plant and animal species, soil conditions, and habitat characteristics. These surveys can be conducted using standardised protocols to ensure consistency and comparability.

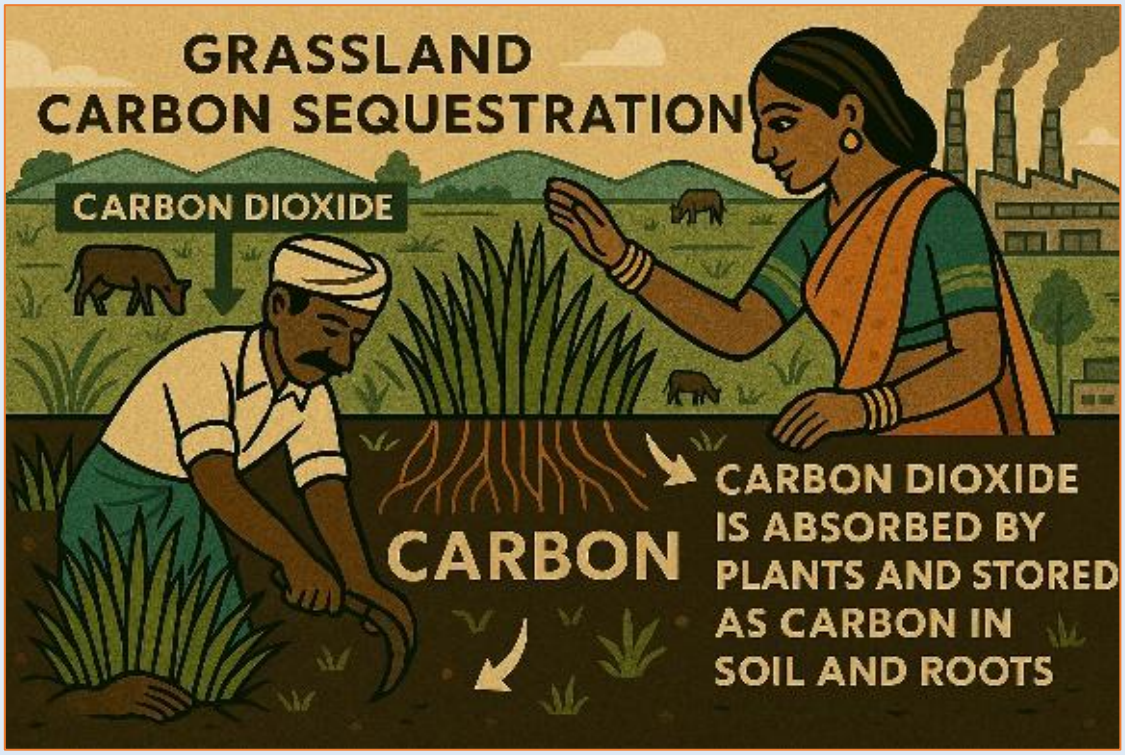
Innovations in Grassland Restoration

Assisted Natural Regeneration (ANR)

Assisted Natural Regeneration (ANR) is a sustainable method for restoring degraded ecosystems by promoting the natural regrowth of native vegetation. It minimises human disturbances and enhances natural regeneration by protecting existing plants, controlling grazing, and managing fires. Essential practices include removing invasive species and using techniques like pruning and mulching to support growth. Continuous monitoring and local community involvement are key to success. ANR is cost-effective compared to tree planting, restores biodiversity, improves soil and water conservation, and enhances carbon sequestration to combat climate change. However, it can have lengthy timelines and be vulnerable to disturbances. Successful examples in the Philippines and Indonesia demonstrate their potential for large-scale restoration.

Carbon Sequestration and Climate Resilience

Grasslands play a crucial role in combating climate change by sequestering carbon, primarily in their soils, through the development of deep root systems. This long-term carbon storage makes them effective carbon sinks. Sustainable management practices, such as rotational grazing and no-till farming, enhance carbon storage and prevent its release. Grasslands also boost climate resilience by withstanding droughts, reducing soil erosion, and supporting biodiversity (**Please refer to the image below**).



Grassland Carbon Sequestration

Their roots help retain water, making them drought-tolerant, and they recover quickly from fires, maintaining soil carbon. Therefore, preserving and restoring grasslands is crucial for mitigating climate change, as factors such as soil texture, moisture, and microbial activity have a significant impact on carbon sequestration. These variables help to break down organic matter and stabilise carbon in the soil (Lal, 2004). Due to their extensive root systems that may penetrate deep into the soil, where carbon can be retained for extended periods, healthy grassland ecosystems, which are characterised by a diversity of plant species, are particularly

successful at sequestering carbon (Conant *et al.*, 2017). Sustainable practices, such as controlled grazing, rotational grazing, and the use of cover crops, can enhance soil health and reduce soil disturbance (Smith *et al.* 2008) **(Please refer to Figure 62).**

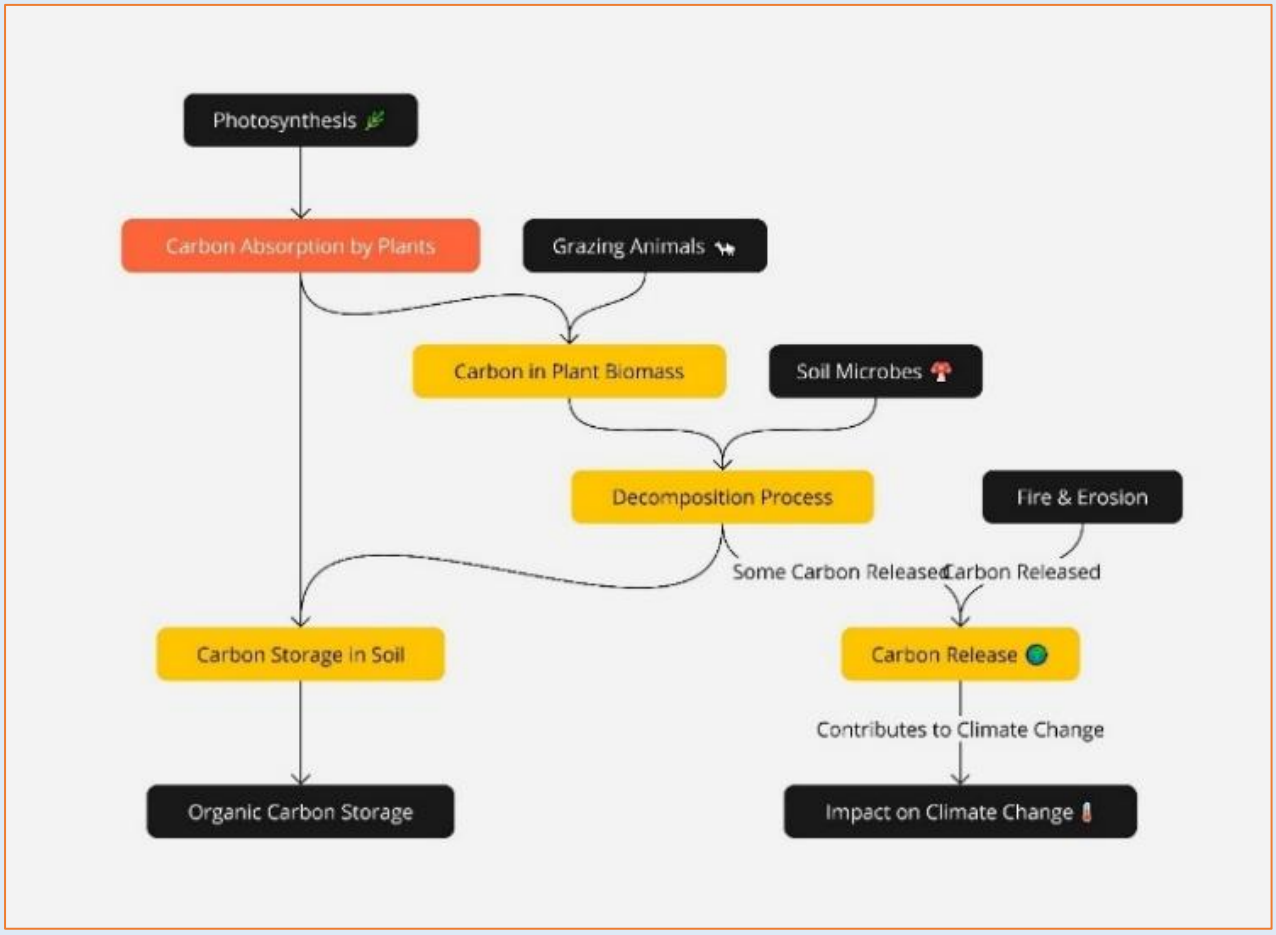


Figure 62: Flowchart of carbon sequestration in grasslands

Carbon sequestration in grasslands

The Future of Grassland Restoration

Grassland restoration is a complex but essential process for sustaining global ecosystems, protecting biodiversity, and ensuring the resilience of these vital landscapes in the face of ongoing environmental pressures. By employing a holistic, science-based approach that integrates local knowledge, ecological principles, and adaptive management, grassland restoration efforts can effectively create healthy, functioning ecosystems that benefit both nature and people.

Eradication of Invasive Alien Plants

Here is a detailed account of the invasive alien plants in the Bustard and Florican's habitat, along with their eradication methods:

A) Lantana camara (Lantana)

1. Impact on Habitat: Displaces native grasses, reducing foraging for wildlife like the Florican, and increases fire risk by accumulating fuel loads. It's unpalatable, leading to fodder scarcity in pastures.

2. *Eradication Methods* (Manual/Mechanical): Hand-pulling or machinery removal before flowering. The "cut-rootstock" method is most effective, as it cuts below the root collar to prevent re-sprouting.
3. *Chemical method:* Herbicides like triclopyr and glyphosate, especially when combined with cutting.
4. *Biological method*: Introduction of insects like *Teleonemia scrupulosa and Ophiomyia lantanae* for control.

B) Mimosa diplotricha (Creeping Sensitive Plant)

1. *Impact on Habitat:* Invades grasslands and forest edges, forming dense covers that displace native grasses and impede access for grazing animals.
2. *Eradication Methods:* Mechanical: Manual cutting or uprooting before seed set.
3. *Chemical method*: Glyphosate or triclopyr applied early in growth.
4. *Biological method*: Introduction of *Heteropsylla spinulosa* for control.

C) Chromolaena odorata (Siam Weed)

1. *Impact on Habitat*: Invades fallows, preventing secondary vegetation growth & shading out native species crucial for the Bengal Florican, while altering fire regimes.
2. *Eradication Methods*: Manual: Cutting or uprooting small patches before flowering; effective in long-term monitoring.
3. *Chemical method*: Systemic herbicides, such as glyphosate, require repeated applications.
4. *Biological method*: Introduction of insects like *Pareuchaetes pseudoinsulata* and Cecidochares connexa to limit the spread.

D) Mikania micrantha (Bitter Vine/Mile-a-minute)

1) Impact on Habitat: Rapidly spreads across grasslands, reducing native grass growth
2) Eradication Methods: Manual: Regular cutting or uprooting before seed dispersal.
3) Chemical method: Herbicides like glyphosate or triclopyr on leaves and stems.
4) Biological method: Use of the rust fungus Puccinia spegazzinii in some areas.

E) Prosopis juliflora: Most abundant and widespread exotic invasive alien species

Prosopis juliflora, also known as Mesquite or Videshi Babool, is an evergreen, broad-leaved, perennial woody shrub. It grows to a height of 3 to 12 m with spreading, round, and cylindrical branches and spines with persistent green foliage; the size of the spines varies from 0.5 to 5 cm. Geographically, this species has spread in two separate ranges; one is the native range that consists of countries like Mexico, Central American countries such as Costa Rica, El Salvador, Guatemala, Panama, Honduras, the Caribbean nations, and the northern part of South America, such as Colombia and Venezuela (Chapman *et al.*, 2019). The other range is the introduced range, which includes the EPPO (European and Mediterranean Plant Protection Organization) region. Under this category are countries such as Algeria, Jordan, Israel, Morocco, Spain and Tunisia. On the African continent, it has spread to Botswana, Chad, Djibouti, Egypt, Liberia, Libya, Madagascar, Mauritius, Somalia, Sudan, Uganda, Zimbabwe, and South Africa. In Asia, it has spread to the Middle East, the Arabian Peninsula, the Indian subcontinent, and Southeast Asian countries. It has also been introduced in the Hawaiian Islands and Brazil; in Oceania, it has been introduced to Australia, French Polynesia, and Papua New Guinea (Chapman *et al.*, 2019). This species generally begins to flower and fruit after 2 to 3 years. However, a lot depends upon the conditions, as it has been seen that a plant as young as 12 months has seen to flower, whereas in unfavourable conditions, old trees up to 15 years old have never been seen to flower (Pasiecznik *et al.* 2001). In India, continuous flowering can be observed in *Prosopis juliflora* (Goel and Behl 1995).

Prosopis juliflora is a very hardy species, and its shrubby nature allows it to regenerate even from lateral meristems in case the above-ground tissues degenerate (Bhimaya *et al.* 1967). This species persists in a wide range of environments; it thrives in regions of low rainfall up to 100 mm to the foothills of the mountains, where it may rain as much as 1500 mm per year. *Prosopis juliflora* was introduced to the Indian Subcontinent in the 1800s and was widespread throughout present-day India, Pakistan, and Sri Lanka till 1900 (Chapman *et al.* 2019). *P. juliflora* was first introduced in the erstwhile princely state of Marwar in 1913 mainly to stabilise dunes and cease the spread of desert (Muthana and Arora 1983).

P. juliflora is an aggressive invader that potentially outcompetes and replaces the native vegetation it has been invasive in grasslands in Gujarat and xerophytic woodlands in Rajasthan (Kaur *et al.* 2012). It is seen that the dominance of the climax species such as *Acacia Senegal*, *Maytenus earginata*, *Ziziphus nummularia* and *Acacia nilotica* decreases in the presence of *Prosopis juliflora* (Kumar and Mathur 2014). *P. juliflora* is known to produce a large number of pods per plant (Muthana and Arora 1983). The pods are produced in March - April and are available as food for various animals during the harsh summers when the availability of food is scarce in such times the animals pollinate the seeds through their droppings which act as a seed bank and the very first rain triggers the germination of these seeds, thus even in this persistently harsh environment a single episode of rain can trigger the invasion activity of *P. juliflora* (Chapman *et al.* 2019, Rejmanek 1989, D'Antonio 1993). *P. juliflora* has been more invasive in disturbed and open grasslands. The main reason is herbivory (by livestock), which promotes the spread of this species even in adverse conditions (Chapman *et al.* 2019).

There is an urgent need to restore the habitat, as the ever-increasing encroachment by this Videshi Babool has caused greater damage to the grasslands of the Thar Desert and to the various floral and faunal species that thrive there. It has been observed that increased invasion by P. juliflora leads to the local displacement of native endangered species such as *C. wightii* (Kumar & Mathur, 2014). Habitat degradation has also affected grassland-obligatory species, such as the GIB and Chinkara, as the invasion of Videshi Babool has reduced vast open tracts of grassland. Several methods have been suggested to control the spread and invasion of this exotic species. One of them is hand clearance, which is a labour-intensive method and effective only in case of small land holding or can be used in combination with mechanical or chemical methods (Chapman *et al.* 2019; Pasiecznik *et al.*, 2001). The mechanical method includes root ploughing and chaining, which is the most effective means of removing *P. juliflora* stumps and has a treatment life of up to 20 years (Jacoby & Ansley, 1991).

F. Gliricidia sepium – wrong plantation with good intention

Gliricidia sepium, commonly known as *Gliricidia* or quick-stick, is a fast-growing tree species widely introduced in tropical and subtropical regions, including India. Originally from Central America, this species has been favoured for its numerous applications, such as providing shade, serving as fodder for livestock, acting as green manure, and its potential in agroforestry systems. However, its ability to grow rapidly and produce many seeds can lead to invasive behaviour, out-competing native flora and disrupting local ecosystems.

Gliricidia has been planned for forest lands in India, particularly in Karnataka, Maharashtra, Tamil Nadu, and Kerala. Despite its benefits, there are growing concerns about its invasive potential, particularly in areas where it displaces native species, alters habitat structures, and affects biodiversity. Therefore, effective control and management strategies are essential to mitigate its negative impacts. *Gliricidia* has a strong potential to spread vigorously and may gradually become invasive throughout the country, as reported from various parts of India. It

is also one of the most preferred species for plantations and forest restoration programmes throughout the Indian subcontinent (Kaushik *et al*., 2024)

Control Measures: Manual cutting is the simplest method for controlling *Gliricidia*. Regularly cutting the trees can prevent them from maturing and producing seeds. This should be done before the flowering season to minimise seed dispersal. Additionally, mechanical removal can be used to clear larger areas of Gliricidia in cases of significant infestation. However, care must be taken to avoid damaging the surrounding ecosystem. It is also important to engage with local communities, as there is a prevailing belief that *Gliricidia* is a forest tree. Educating farmers and communities about the invasive nature of *Gliricidia* can lead to more effective management practices.

G. Some examples of native trees

In the case of the Bengal florican, there is a need to control native trees like *Bombax ceiba* and *Zizyphus* spp.)

1) Impact on habitat: These trees threaten grassland habitats essential for the Bengal Florican and other associated species
2) *Control Measures:* Manual Removal: Cut and burn saplings before flowering
3) *Debarking:* Ring debarking of Bombax ceiba can suppress growth.

Chapter 11 – Need to form the Grassland Authority of India (GAI)

Grassland ecosystems are often overlooked and wrongly considered as wastelands. However, they play a vital role in maintaining unique biodiversity and providing essential fodder for cattle. In India, grasslands are found in several regions, including the Himalayas, the Ganges and Brahmaputra River Basin, the Little and Great Rann of Kutch, the Deccan Plateau, the Thar Desert, and the Western Ghats. Unfortunately, natural grasslands have been replaced by intensive agricultural plantations, and some of the most endangered wildlife species are found in grasslands and deserts. To protect and conserve grasslands in India, they should be recognized as forest land, and restrictions on non-forest use should be imposed. The Union Government could direct state governments to instruct revenue departments not to divert any grassland identified in the landscape for bustard/florican protection. The new Environmental Impact Assessment (EIA) guidelines should be modified to include ecologically fragile and environmentally sensitive areas. The Ministry of Agriculture and Animal Husbandry should also be involved in protecting grasslands. A National Grazing Policy is urgently needed to ensure the sustainable use of parks and the conservation of biodiversity. Mapping all critical grasslands and desert habitats would also be extremely useful.

Farmers and pastoralists must be incentivised to continue their traditional practices to ensure the sustainable use of grasslands. Community-conserved areas containing grasslands should be encouraged and legally protected. Communities should be assisted in regenerating and restoring degraded grasslands. Grasslands are the community's common lands and were once sustainably managed by robust traditional institutions. However, due to government takeover or the breakdown of traditional institutions, they are now no one's responsibility. Although they are the most productive ecosystems in India, they belong to all but are controlled by none. In conclusion, the conservation and management of India's grasslands are of utmost importance. The government and the public must recognise the significance of the grassland ecosystem and take necessary steps to protect and preserve it. The formation of the Grassland Authority of India to conserve India's grasslands is the need of the hour. The Planning Commission (Environment and Forests Division), vide letter number M13033/1/2006-E&F, dated 21 August 2006, constituted a Task Force on Grasslands and Deserts for the Environment and Forests Sector for the Eleventh Five-Year Plan (2007-2012). However, nothing moved further on this front.

In line with the Wetland Rule 2017, the Grassland (Conservation and Management) Rules need to be introduced by the Ministry of Environment, Forest, and Climate Change (MoEFCC) to protect and preserve grasslands in India. These rules prohibit various activities in grasslands to prevent their degradation and loss. To further these efforts, the **Centre for Grassland Conservation and Management (CGCM)** should be established. The CGCM aims to work towards the conservation, restoration, and management of India's grasslands. The CGCM will help build partnerships and networks, apply integrated approaches, and assist in designing and implementing policy and regulatory frameworks. The Grassland Conservation and Management Rules may include provisions for establishing a State Grassland Authority in each state and Union Territory. The State Grassland Authority will regulate and permit activities within notified grasslands. The rules prohibit the destruction and degradation of open habitats, the conversion of grassland areas for non-grassland purposes, and the construction of permanent structures on declared grasslands.

BNHS is eager to extend its support to the Ministry of Environment, Forest, and Climate Change (MoEF&CC) in the formulation of the Grassland Authority of India, which would be

responsible for the management and conservation of India's grasslands. BNHS has extensive experience spanning several decades in studying grasslands across India, dating back to Dr Salim Ali and his team. The society has conducted studies in several important grasslands in India, including Rajasthan, Madhya Pradesh, Karnataka, Maharashtra, Assam, and Arunachal Pradesh. It has an in-depth understanding of the biodiversity and ecological importance of India's grasslands. Currently, BNHS is compiling a comprehensive report based on the last four years of studies, which could provide a valuable framework for establishing the Grassland Authority of India.

1. The Grassland Authority of India (GAI), a crucial and significant initiative akin to the Wetland Authority, should be formed as a consortium to conserve the bustard and associated species across all Bustard and Florican range states in India. All new renewable energy projects in grasslands in Rajasthan, Gujarat, Madhya Pradesh, Maharashtra, Karnataka, Telangana, and Andhra Pradesh can contribute financially to the GAI or consortium.
2. Releasing captive bustards is a significant and crucial step that underscores the critical need for approximately 300 to 500 sq km of grassland habitat without infrastructure to support their survival. This highlights the paramount importance of grassland habitat for GIB survival.
3. Examining the large-scale green energy infrastructure projects in Jaisalmer, Rajasthan, the captive-raised birds should be released into the grassland habitats of Maharashtra, Madhya Pradesh, and Karnataka. The proposed Grassland Authority of India (GAI) to prepare grassland conservation and management plans for these states and work on post-release GIB conservation. Later, this should also be implemented in Gujarat, Telangana, and Andhra Pradesh.
4. It is crucial to install high-quality Bird Flight Diverters and replace any poor-quality ones currently installed across the power lines in the region.
5. It is essential to establish priorities for urgent in-situ actions by the GAI, focusing on undergrounding power lines, installing Bird Flight Diverters, habitat restoration work, grassland development, and controlling free-ranging dogs, among other initiatives.
6. A special mission must be initiated to address the problems caused by free-ranging dogs in bustard areas, as they are the second most serious threat to the GIB population in the DNP-PPFR landscape.
7. Safe habitats for releasing captive-bred bustards need to be created across various states in India through GAI and state-level GAs.
8. EIA studies for all new renewable energy projects should be made compulsory by the grassland bird research organisation
9. Long-term research and monitoring of the bustards and associated species across range states should be supported
10. Since there are some transboundary movements of bustards, the India-Pakistan border area must be kept free from heavy energy infrastructure
11. Two power lines—220 kv (18.2 km) Dholiya to Chacha and 132 kv (17.7 km) Odhaniya to Dholiya—need to be undergrounded immediately to save more than 50% of the breeding Great Indian Bustard (GIB) population.
12. In a phase-wise manner, all the High-Tension Transmission Lines (HTTL) in 12 villages near PFFR army areas, namely, need to be undergrounded within a year.
13. *Oran*s (sacred groves) in the western part of the Thar Desert with known GIB distribution need to be protected from heavy energy infrastructure

Annexure 1- Academic achievement through the program

Students enrolled for a PhD.

1. **Rushikesh Pawar – 2023 (Enrolled)**
   Title - The status assessment of Blackbuck *Antilope cervicapra* in rapidly changing land use changes in Deccan Plateau, Bidar district, Karnataka.
   Institute – BNHS through the University of Mumbai.

Students enrolled for MSc

1. **Vikram Hinoniya – 2019**
   Title - Mapping of Lesser Florican *Sypheotides indicus* sites in Ajmer, Rajasthan, India. Course - Master of Wildlife Science degree from the University of Kota, Kota, Rajasthan.
2. **Pranjali Bhujbal – 2022**
   Title - activity pattern of smaller mammals in winter using camera traps in Khetolai, Rajasthan. Course - Wildlife Studies from Kerala Veterinary and Animal Sciences University
3. **Vinayak Kursange - 2022**
   Title - Resource mapping of proposed Community Conserved Areas (CCAs) for conservation of Critically Endangered Lesser Florican *Sypheotides indicus* in Ajmer, Rajasthan. Course - Wildlife Conservation Action through the Institute of Environment Education and Research, Bharati Vidyapeeth Deemed University, Pune, Maharashtra, India.
4. **Atharva Togattiwar – 2023**
   Title - Den structure of white-footed fox *Vulpes vulpes pusilla* and opportunistic denning and burrowing species sharing the same habitat in Khetolai, Rajasthan. Course - Master of Science in Biodiversity, Wildlife Conservation, and Management of VPM's B. N. Bandodkar College of Science (Autonomous), Thane.
5. **Nikhil Ghadigaonkar - 2023**
   Title - Assessment of The Blackbuck *Antilope cervicapra* In Human-Dominated Landscape of Bidar District, Karnataka. Course - Master of Science in biodiversity, wildlife conservation and management of VPM's B. N. Bandodkar College of Science (Autonomous), Thane.
6. **Sanchi Shrivastav – 2024**
   Title - Revitalizing Grassland Ecosystem: A Comprehensive Study for Habitat Restoration and Conservation Research. Course - Wildlife Science from the University of Kota, Kota (Rajasthan).
7. **Habiba Sayyad 2025** - Monitoring and Conservation Assessment of Vultures in Jorbeer and Surrounding Areas

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2.	Bishnoi, Pankaj, Neelkanth Bora, Karthik N.J. & **Sujit S. Narwade** (2024): Sighting of a suspected wolf-dog hybrid in the Deccan Plateau of Karnataka, India. J. Bombay Nat. Hist. Soc. 121(2). doi: 10.17087/jbnhs/2024/v121/170894. https://www.bnhsjournal.in/index.php/bnhs/article/view/170894
3.	Rahmani, Asad R., Musa Khan and Sujit S. Narwade (2024): Annotated checklist of the birds of Desert National Park, Rajasthan, India. J. Bombay Nat. Hist. Soc. 121(1). doi: 10.17087/jbnhs/2024/v121/166291 https://www.bnhsjournal.in/index.php/bnhs/article/view/16629
4.	Bolde, P., C. Prajapat, N. Bora, U. Mitra and S. Narwade (2024): A note on courtship and mating behaviour of Lesser Florican Sypheotides indicus from Shokaliya, Ajmer, Rajasthan, India. JBNHS. 121(2). https://www.bnhsjournal.in/index.php/bnhs/article/view/164893
5.	Bora, N., U. Mitra, A. Mohan, P. Bishnoi, M. Khan, and S.S. Narwade (2023). Notes on threatened raptors seen during a landscape survey in Jaisalmer district, thar desert, Rajasthan. JBNHS April 2023. https://www.bnhsjournal.in/index.php/bnhs/article/view/164982
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The BNHS base camp area was frequently utilised as a crucial habitat in Khetolai during the winter season. This location offers a supportive environment for these birds, providing them with essential resources. The intensive use of this area underscores its importance to the conservation of the GIB population, especially during the colder months, when they seek refuge and sustenance.

Annexure 2 - Team involved

1. **Dr Sujit Narwade,** Deputy Director, BNHS, lead of the project. He has 21 years of experience working in ornithology and 15 years in grassland bird conservation research, focusing on the Great Indian Bustard (GIB) and the Lesser Florican (LF). He belongs to one of the GIB landscapes in Maharashtra, India, where he conducted his PhD work and has a deep understanding of grassland ecology. He also extends his help to the Bengal Florican project in the northeastern states of Assam and Arunachal.
2. **Dr Neelkanth Bora, Assistant Director, is** a dedicated team member, hailing from Jodhpur, Rajasthan. He is well-versed in the conservation issues of the Thar Desert. Having left his medical profession, he has been fully committed to the BNHS's Lesser Florican and GIB projects since July 2018. His commitment and local knowledge make him an invaluable asset to the project.
3. **Rushikesh Pawar -** the Project Fellow of the LF Project in Bidar, Karnataka. He is a zoologist and a photographer with a deep passion for wildlife. He worked as a Project Associate for the LF project in Bidar for six months and is now working as a Project Fellow for the same project for one year. Along with the LF project, he has also worked on the Karanja waterbird and Blackbuck projects in Bidar. Currently, he is focusing on the preservation of the Lesser Florican and grassland-associated species in Bidar, Karnataka. In addition to his work, he is pursuing a PhD in Blackbucks in the same area.
4. **Pankaj Bishnoi,** the Community Engagement Officer for the GIB project, is a local from the village of Khetolai, Jaisalmer. His deep roots in the community and his association with the GIB project since February 2020 make him an effective networker in the Bishnoi community. In addition to his role in bird and habitat surveys, completing his basic teacher training equips him to assist with education, awareness, and outreach programmes, further strengthening his role in the project.
5. **Sachin Bishnoi** – is a dedicated Community Engagement Officer working for the LF project in Ajmer. Native of Khetolai, Jaisalmer, he holds a Basic School Teaching Certificate (BSTC). He began by volunteering for the Great Indian Bustard project in Jaisalmer in 2022 for one year and now serves as a Community Engagement Officer for the LF project in Ajmer. Sachin has experience conducting various surveys in Karnataka, Maharashtra, and Rajasthan.
6. **Rajesh Parmar -** is a field assistant cum driver working on the LF project in Ajmer. Native from Vadodara, he has extensive experience conducting surveys and working on a wide range of projects, including long-term Marine projects. Rajesh Parmar has been an invaluable asset to BNHS for many years and is currently working on the GIB-LF project since 2022. Rajesh Parmar has participated in surveys for the Lesser Florican in Karnataka, Maharashtra, and Rajasthan in 2023.
7. **Aakash Rajuvar -** Akash Rajuwar, a resident of Bokakhat, Assam, has been working as a Field Assistant with the Bombay Natural History Society (BNHS) on the Bengal Florican & Threatened Grassland Bird Project. After an initial stint from 2019 to 2022, he resumed his role in November 2023, continuing his efforts in wildlife conservation and research, focusing on preserving the region's unique biodiversity.
8. **Kishor Rithe** is the Director of the Bombay Natural History Society and has been overseeing the project. He is one of three members of the panel constituted by the Honourable Supreme Court of India to advise the Government on preventing the extinction of GIB. He has spent more than three decades in the central Indian landscape and provided conservation-based alternative livelihoods to thousands. As a member of the State Wildlife Board of Rajasthan, he will be crucial in recommending executable plans.
9. **Praveensinh Pardeshi, IAS (Retd):** He is the president of the BNHS and provides guidance and support for the Bustard and Florican program. With over 38 years of experience as an

Indian Administrative Service (IAS) officer, he has served as a former Additional Chief Secretary (ACS) and held various other senior leadership roles within Maharashtra across different administrative services. During his deputation at the United Nations, he focused on post-disaster and conflict recovery programs, public administration, governance reform, wildlife conservation, and public health efforts in Maharashtra, India. His recent appointment is as CEO of the state think tank MITRA in Maharashtra.

Special mention

In the past year, we welcomed several talented members to our BNHS team, including Miss Sanchi Shrivastav, Mr. Vinay Sharma, Mr. Md Tahir Shaikh, and Mr. Rahul Nandi. Initially joining us as interns, their enthusiasm and hard work quickly earned them vital roles as project fellows. Each has made significant contributions, enhancing the quality and impact of our initiatives.

Volunteers worked

Mr Dharmendra Kumar, Mr Alap Bhatt, Miss Ashley Chiu, Mr Kalyan Singh, Mr Vinayak Khursunge, Miss Akshata Palve, Miss Vaishnavi Pathak, Miss Shakti Charan, Mr Shoaib Silawat, Miss Pooja Dange, Miss Lini Kaladharan, Mr Amey Parker, Mr Atharva Togattiwar, Mr Tarkik Varma, Miss Supriya Hangal, Miss Pooja Gosavi, Mr Rohit Kulkarni, Miss Sakshi Sindol, Miss Minal Pawar, Mr Nikhil Ghadigaonkar, Mr Susmit Bole, Mr Nachiket Ghag, Miss Mitali Jadhav and Mr Krishna Jani.

Former staff

1. **Dr Biswajit Chakdar -** Lecturer, Don Bosco University, Guwahati, Assam and formerly worked in BNHS during 2017-2024, Bengal Florican and other threatened grassland birds in the Brahmaputra floodplains of Northeast India.
2. **Arindam Sinha,** Senior Project Fellow, BNHS - He is a field biologist with expertise in bustard species like the Lesser and Bengal Florican. A native of Islampur, West Bengal, and holding an M.Sc. in Environmental Science from Bharati Vidyapeeth, Pune, he has worked with organisations like the Himachal Forest Department, ZSI, and BNHS since 2019. Currently a Senior Research Fellow at BNHS, he focuses on the conservation of the Bengal Florican in Assam's Brahmaputra floodplains.
3. **Mr A. Mohan**—Former Research Fellow, worked in BNHS from 2020 to 2022 on Great Indian Bustard and Lesser Florican projects in Rajasthan and Karnataka. Currently, he is an ecologist at Deloitte, Hyderabad.
4. **Unmesh Mitra -** Former research Fellow Who worked at BNHS from 2020 to 2022, specifically on the Great Indian Bustard project in Rajasthan. He is currently serving in the West Bengal State Services.
5. **Natasha Rajpurohit -** Former research Fellow Who worked at BNHS for a short period from 2020 to 2021 on the Great Indian Bustard project in Rajasthan.

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For details on the BNHS team working on bustards and floricans, please visit the blog. (https://blog.bnhs.org/meet-the-bnhs-team-saving-vanishing-wildlife-in-indias-grasslands/)

Acknowledgements

Tribute to Dr G.V. Reddy, former CWLW, Rajasthan

By - Sujit Narwade, Dy Director, BNHS

I was saddened to hear about the passing of Dr G. V. Reddy, the former Chief Wildlife Warden (CWLW) of Rajasthan, on 14th July 2024. Dr Reddy was known for his exceptional knowledge of wildlife and the ecosystem. In 2017, the office of the DyCF (DyCF), Ajmer, sought assistance from the BNHS to conduct a status assessment of the Lesser Florican as per the suggestion of Dr Reddy and the National Green Tribunal (NGT). Dr Reddy played a crucial role in finalising the project proposal. In February 2019, he invited BirdLife International, BNHS, and WCS-India to discuss in situ conservation issues to save the critically endangered Great Indian Bustard. I had the privilege of meeting Dr Reddy to discuss BNHS's Bustards and Floricans Programme. He was pleased with BNHS's decision to deploy a Senior Scientist in response to his invitation.

In 2019, Dr Reddy took on the role of Chairman of the Rajasthan State Biodiversity Board (RSBB). This position allowed him to further his visionary conservation work beyond Protected Areas. His visit to Ajmer on 7th September 2019, where he invited me to join him in the field to search for the Lesser Florican. We discussed conservation strategies for the Lesser Florican in non-protected areas in Eastern Rajasthan, showcasing his proactive leadership. Dr Reddy's vision and leadership led to the establishment of not only the first Conservation Reserve for the Lesser Florican in Rajasthan, but also a significant milestone in declaring more conservation reserves across Rajasthan. He was very keen on removing the exotic, invasive plant Prosopis juliflora as part of long-term habitat restoration work to bring more suitable areas under the protection of the Lesser Florican. Upon returning to Jaipur, he sanctioned a project to organise a farmer's meeting called "Kisan Choupal". He suggested the creation of a Hindi booklet on the Lesser Florican, locally known as "Kharmor." He provided his expertise in editing and designing the booklet. I consider it a privilege to co-author the publication "जन सहयोग से खरमोर संरक्षण" with Dr. Reddy.

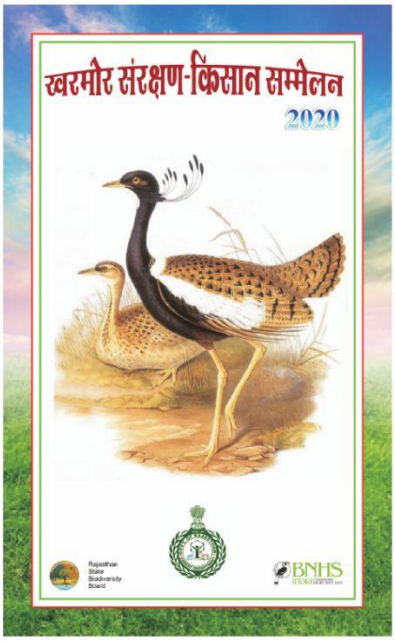
Additionally, he advised the Team BNHS to visit the Tal Chapar Wildlife Sanctuary to explore the successful Blackbuck conservation efforts. He was planning to create a satellite sanctuary to translocate some blackbucks to address the overpopulation in Tal Chapar. In 2020, a devastating incident occurred at Sambhar Lake, resulting in the death of thousands of migratory birds due to botulism. Following directives from the Chief Wildlife Warden, I led Team BNHS to Sambhar Lake to gather crucial firsthand information. Dr Reddy acknowledged BNHS's presence at the bird mortality event by honouring the individuals and organisations involved with a National Emblem. Even in retirement, he continued to actively guide and support conservation efforts in non-protected areas, particularly for the GIB and the Lesser Florican, demonstrating his enduring commitment to wildlife conservation.

The passing of Dr Reddy is a profound loss. His vision for ongoing wildlife conservation efforts, always guided by science-based conservation actions and a willingness to listen to both sides of the issue, leaves a significant void. We have lost a visionary officer who demonstrated an unwavering dedication to wildlife conservation, a loss that will be deeply felt in the field.

We thank Dr. G.V. Reddy for inspiring us to think critically about conservation plans beyond protected areas

Dr Reddy (second from the left) discusses conservation needs for the Lesser Florican and proposed Community Conserved Areas (CCAs) in Rajasthan. (7 September 2019)

It is an honour to share co-authorship with Dr Reddy and to be complimented by him as an encouragement. (24 February 2020)



As chairman of the Rajasthan Biodiversity Board (RSBB), Dr. Reddy encouraged us to publish outreach materials in Hindi in 2020

Dr Reddy (second from right standing) invited BirdLife International, BNHS, and WCS-India to discuss in-situ conservation issues for saving GIB in Rajasthan (February 2019)

Dr Reddy (third from left) explained the management issues of GIB during a visit to Desert National Park (DNP), Jaisalmer (February 2019)

A tribute to Dr G.V. Reddy

RAJASTHAN

Jaipur

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Jaisalmer

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BIDAR AND NORTHERN PLAINS OF KARNATAKA

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HORNBILL HOUSE - BNHS HEAD OFFICE

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