BUSTARD RECOVERY PROGRAM

2022

Wildlife Institute of India

भारतीय वन्यजीव संस्थान
Wildlife Institute of India

Government of Rajasthan
FOREST DEPARTMENT

Project title: Habitat Improvement and Conservation Breeding of Great Indian Bustard
Project duration: 2016-2021 and No cost extension 2021-2023
Project report period: April 2020- March 2022

Total sanctioned budget: 33.85 crore INR
Funds received :

First Installment (**Released at the end of 2016**)**:** 9.95 crore INR
Second instalment (**Released in February 2020**)**:** 4.30 crore INR
Third instalment (**Released in March 2021**)**:** 2.86 crore INR
Fourth instalment (**Released in February 2022**)**:** 5.93 crore INR
Total amount released: 23.04 crore INR

Project implemented by: Wildlife Institute of India

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Partner agencies:
Ministry of Environment, Forest & Climate Change
Rajasthan Forest Department
Gujarat & Maharashtra Forest Departments

Collaborating agencies:
International Fund for Houbara Conservation / Reneco
The Corbett Foundation
Humane Society International
Jivdaya Charitable Trust

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Background

The Great Indian Bustard (GIB) and the Lesser Florican (LF) are Critically Endangered with about 150 and 1000 individuals left in the wild, respectively, and almost exclusively restricted to India. Their populations have dwindled due to the compounded effects of hunting and habitat loss on their slow life-history traits. The Ministry of Environment, Forest & Climate Change (MoEFCC) has developed the National Bustard Recovery Guidelines, in consultation with experts and managers (2013) that recommend:
a) establishing and protecting enclosures to improve breeding success,
b) mitigating threats in intensively used areas that are identified through research,
c) factoring livelihood concerns into conservation plans by incentivising bustard-friendly land-uses,
d) conservation breeding for insurance and rewilding birds in future restored habitats (Dutta et al., 2013).
Bustard range state Forest Departments were mandated to implement these actions. However, the vast expanses of bustard habitats, multiple conflicting stakes and limited control of the Forest Department over these lands, compounded with the paucity of critical conservation information have delayed the implementation of these actions. A workshop held in New Delhi (2014) to decide if conservation breeding should be opted for the Great Indian Bustard found overwhelming national support for this measure. The Wildlife Institute of India (WII) was mandated by the MoEFCC with the task of implementing this specialised activity and guiding agencies on science-based in-situ measures, with funding support from the National CAMPA Authority. The Bustard Recovery Project commenced for an initial period of five years (2016-21) and an extension of two years (2021-23). The project activities are being implemented in collaboration with MoEFCC, Rajasthan and other bustard range state Forest Departments, International Fund for Houbara Conservation and NGO partners. These activities need to be sustained for at least 15-20 years to improve the status of India's endangered bustards.

The Project objectives are:
1. Conservation Breeding, to secure ex situ populations of GIB and (if needed) LF
2. Applied research, to a) prioritise areas for conservation, b) characterise threats, c) monitor populations and habitats for assessing management effectiveness, d) understand livelihood issues, and e) understand population genetics to inform conservation management
3. Capacity building, awareness and advocacy, to a) improve protection, b) sensitise stakeholders and decision-makers on bustard conservation, c) raise public awareness, and d) incentivize bustard-friendly land uses
4. Pilot habitat management, to demonstrate good practices through experimental interventions that can be replicated by State Forest Department and other conservation agencies

Activities & Outcomes

1. Conservation Breeding

a. Background

The project is implementing conservation breeding of GIB and LF for future rewilding. Sites in Ramdevra and Sorsan were selected for long-term conservation breeding facilities for GIB and LF. Since the construction and operation of new facilities would require a few years, a temporary facility was established in Sam, Jaisalmer, in June 2019 that currently houses 16 artificially incubated hand-reared GIB, and another temporary facility was established in Bijainagar, Ajmer that currently houses two artificially incubated hand-reared LF, from wild-collected eggs.

b. GIB nest search and egg collection

Field teams observed females for signs of nesting from remote vantages during the breeding season (March and June - October) in/ around Desert National Park and Pokhran Field Firing Range. Some nests were detected using telemetry of female GIB. During the 2020-21 breeding seasons, a total of 43 GIB nests with 47 eggs (33 in/ around DNP and 10 in Pokhran-Ramdevra-Firing Range) and 2 neonatal chicks were found in the wild. Most of these eggs were found in the Sudasari ACD enclosure. Of these, 12 fertile eggs were collected for conservation breeding, and 11 hatched successfully.

c Artificial incubation of Great Indian Bustard eggs

All eggs collected from the wild were transported in a foam-padded shock-resistant box inside a slow-moving soft suspension vehicle to the pilot facility at Sam. Eggs were cleaned, measured and then incubated in artificial incubators at 37.5° C. The incubator's humidity was adjusted according to the desired weight (water) loss of the egg. Eggs were incubated for 6-14 days and shifted to the hatcher after external pip (after ~21 days since egg-laying). Once hatched, chicks were left in the hatcher to dry and then weighed and shifted to the brooder for a day.

d. First age (chick rearing)

Chicks were kept in transparent boxes of ~ 100 x 60 x 30 cm dimension with rubber mats, inside a temperature and humidity controlled chick rearing room from 2-20 days. Chicks were reared on Mazuri Omnivore diet along with mealworms, crickets and gradual introduction to dry balanced pellets, alfalfa and seasonal fruits. Chicks were hand fed at this stage at regular intervals of 1-2 hrs. Chicks were shifted to an outdoor cage for exercise from the 10th day onwards, to facilitate normal muscle and bone growth and for acclimatisation

to the weather. Chicks were kept in semi-outdoor cage from 15 days onwards till the transfer to the juvenile cages. Imprinting of birds on bird keepers is an essential act during this stage. Daily massaging and handling habituate them to daily husbandry activities. They were also habituated to various sounds. Chicks were weighed daily and measured regularly to monitor their growth.

e. Second age (juvenile rearing)

Birds were shifted to second age outdoor cage - a large metal cage with an asbestos roof and internal soft netting, between 21 – 30 days' age, where they were housed till 4 months' age. During this time, birds were reared on the Mazuri Omnivore diet in phased-out manner, dry balanced pellets, mealworms, crickets and other live food along with alfalfa, pomegranate, watermelon and other local vegetables and fruits. Birds were fed at regular intervals of 1.5 - 2h during morning (0700-11 00 hrs) and evenings (1600-1900 hrs) which coincides with their natural feeding bouts - and were encouraged to feed by themselves. Birds were closely monitored and weighed daily; habituation to imprinting and handling continued; their wing feathers were routinely trimmed to prevent momentous flights that can cause injury/ trauma.

f. Third age (adult rearing)

Birds were shifted to adult tunnels in different compartments after ~4 months when they were nearly autonomous. To facilitate breeding and provide them with personal space necessary modification have been done in the tunnels. Male and female were separated into individual compartments (male 12m×5m, female 3m×5m). In summers weather becomes very harsh and temprature occasionally exceeds 50° C. To deal with the thermal stress and give them a favorable environment, shade and outdoor coolers have been installed. For enrichment of bird's surroundings, natural plants have been planted in the adult tunnels. Birds were reared on dry balanced pellets as their main feed supplemented with mealworms, crickets, mice, and other live-feed and alfalfa, mustard, pomegranate, watermelon, other seasonal fruits and vegetables were provided. Birds were offered food at regular intervals of 1.5 - 2h during mornings (0700-1100 hrs) and evenings (1600-1900 hrs), and they largely ate by themselves at this stage. Birds were weighed regularly and measured using photogrammetry. Some birds (both sexes) have started to show signs of sexual maturity, and their training for semen collection/ artificial insemination has commenced.

Table 1: Approximate daily food consumption of adult GIB in Conservation Breeding Centre, Jaisalmer

Diet	Balanced Pellet (g)	Invertebrates (g)	Vertebrates (g)	Vegetable (g)	Total (g)
Male	150	30	15	20	215
Female	80	25	15	10	130

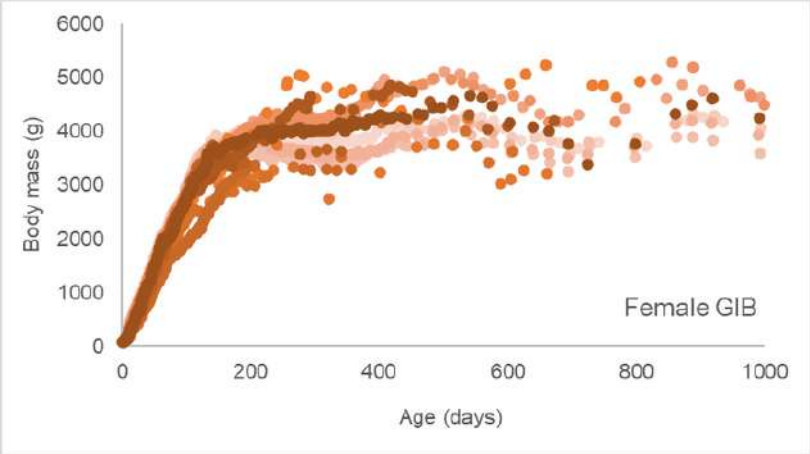


Figure 1: Growth of GIB (female) in Conservation Breeding Centre, Jaisalmer

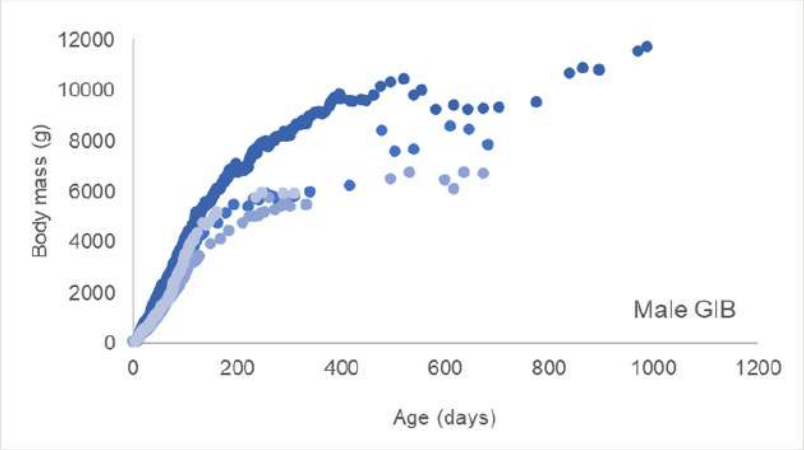


Figure 2: Growth of GIB (male) in Conservation Breeding Centre, Jaisalmer

g. In-house bird feed production

Invertebrates and some vegetables and fruits fed to birds are grown at the facility. The live feed unit produces crickets, mealworms and super worms. These animals are housed in special rooms with specific temperature, humidity and housing. They are kept in boxes according to their stage and are reared on wheat bran, potatoes, apples and lettuce. The farm at the centre produces alfalfa, mustard, and seasonal fruits and vegetables.

Image 1: GIB female (left) and displaying male (right) in Conservation Breeding Centre, Jaisalmer

h. Lesser Florican breeding, Bijainagar

A temporary LF breeding centre was established at a private rental property in Bijainagar, Ajmer. Two eggs were collected from Madhopura, Ajmer from one nest in September 2020 and transported to the centre at Bijainagar. These eggs were incubated and hatched successfully. Chicks were kept in a brooder for one day after hatching to dry up, and were shifted on the second day to a transparent box (60 × 45 × 30 cm) in the chick rearing room for 10 days and thereafter shifted to a small soft net cage on the ground inside the chick rearing room till 20 days. Subsequently, the birds were kept in an outdoor cage (6 × 4 × 3 m iron cage with soft internal netting and a substrate of grass, alfa-alfa and small shrubs for cover). Birds were temporarily housed in an indoor cage of 2 × 1.5 × 2 m during winter and inclement weather conditions, or during routine maintenance of the outdoor cage. A 12 hour feeding schedule is maintained with breaks in between, multiple feeding items (balanced diet pellet, greens, fruits, live feed, water offered in bowls) and additional daily supplements were fed. Cages were cleaned daily. Wing trimming and vaccination of birds were done routinely. Birds gained their adult weight (550gm) within the first two months and then maintained the same till the age of 1.5 years (575 days), increasing slightly in winters (580-590gm) and decreasing in summer (530-550gm).

(a)

Image 2: (a) LF eggs and (b) LF chicks at the Conservation Breeding Centre, Bijainager

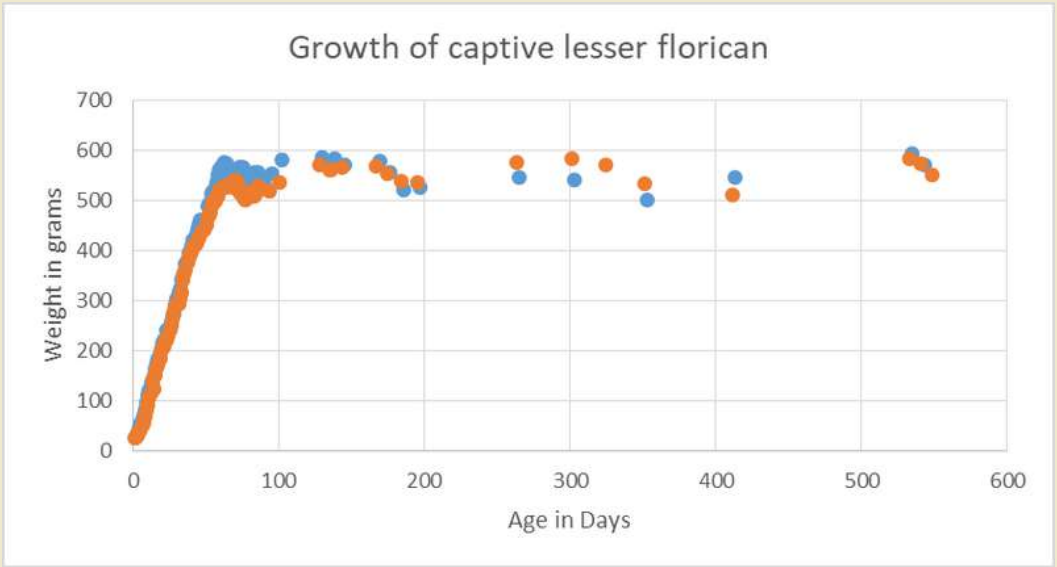


Figure 3: Growth of LF in Conservation Breeding Centre, Bijainagar

i. Sanitation and biosecurity

The Conservation Breeding Centres are maintained with high sanitation standards to avoid disease risk to birds, involving daily cleaning of each room, disinfection of utensils and accessories used in proximity to birds, and cleaning and changing into in-house clothes for every staff working in the Centre. Access to visitors is restricted to avoid contamination and stress to birds, and was particularly avoided during the COVID pandemic. To reduce the risk of COVID infection among centre staff members, they were housed in an isolated basecamp(s) and their movements were restricted only to the centre. All the staff strictly followed COVID precautionary guidelines. The Centre is equipped with round the-clock security and CCTV surveillance for remote monitoring of birds, internal and external activities.

j. Construction of conservation breeding centre at Ramdevra

The long-term Conservation Breeding facility is being constructed at Gomat near Ramdevra. The Forest Department enclosure (~193 ha) has been allocated for this use to WII. The outer fence has been constructed by Rajasthan Forest Department; permanent buildings are being developed by CPWD, of which all technical buildings are nearly complete and staff quarters are 75% complete; water connection work is being carried out by PHED. The establishment and operationalisation of this facility have been delayed due to a shortage of funds, and delays in works by CPWD and PHED. However, the facility is expected to be operational in the current breeding season (2022).

Image 3: Newly constructed buildings at the Conservation Breeding Centre near Ramdevra

Image 4: Newly constructed bird tunnels at the Conservation Breeding Centre near Ramdevra

2.1. Telemetry of GIB

Six GIB females were tagged in Desert National Park (DNP) Wildlife Sanctuary and Pokhran areas of Thar between March 2020 – March 2022, and two birds were tagged in the previous year. These birds were captured using nylon noose traps in foraging paths, nests and water guzzlers. The birds were fitted with solar-powered GSM/ GPRS backpack PTTs (E-obs and Microwave telemetry) using elastic harness material that weighed <1% the birds' body weight. These tags are equipped with GPS and/ or acceleration sensors and data is transmitted through mobile and internet networks. There was no apparent anomaly in their behaviour or any mortality post tagging. These birds, alongside the previously tagged birds, were regularly ground tracked and monitored. Additionally, important life-history events like egg-laying were meticulously recorded. Accelerometer data is being used to determine time-activity patterns of tagged birds. Tagged birds ranged over 100 to 1000 sqkm area and did not take long-distance migrations yet. Space use during the breeding season was restricted to the undisturbed grassland areas (particularly Forest Department enclosures), while the non-breeding space use was more widespread and covered many human-dominated areas including rangelands, community grasslands and fallow agriculture fields. However, these inferences are based on a relatively small sample of female birds, and need to be refined with a larger sample of birds belonging to both genders.

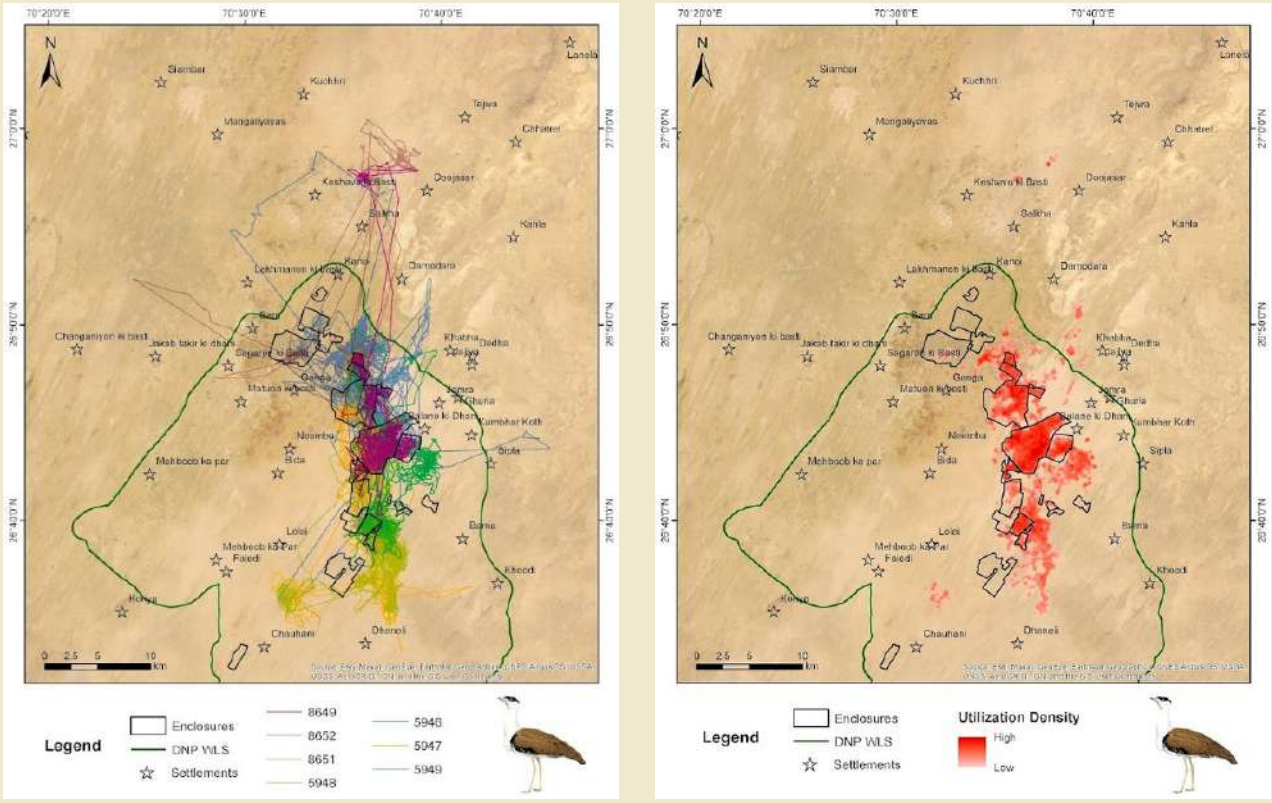


Figure 4: Map of tagged GIB space use in and around Desert National Park (DNP) Wildlife Sanctuary

2.2. Telemetry of LF

a. Five LF males were tagged near Shokaliya, Ajmer during August 2020 and August-September 2021. All birds were trapped with the help of nylon noose traps laid in agricultural fields where they were likely to use for breeding display or cross. Birds were fitted with Milsar S-9 GSM solar-powered light weight tags that weighed <3% of the bird's body weight and transmitted locations via cellular network. The tags were programmed to record GPS co-ordinates at an interval of 180 minutes and transmit the recorded locations every eight hours effectively giving eight location points daily. In 2020, two lesser florican males were tagged near Chat and Dhantol villages of Nasirabad and Bhinai tehsil, Ajmer. Trapping attempts were made during the last week of August. In 2021, birds were tagged near Bandanwara village, Ajmer during the second week of August. A quick response team was on standby in the vicinity of the trapping location, and captured birds were tagged and released within 20 minutes of trapping. Birds weighed between 418 and 503 g. All tagged birds started displaying from their arenas within two days of tagging. Four out of these five transmitters functioned for atleast six months, however, two out of them stopped transmitting after six months.

b. Tagged floricans of 2020 were ground-tracked till February 2021. The tagged floricans provided valuable information regarding their migration patterns and non-breeding habitat use. These birds were localised within 300 m of a particular location before moving to another area. To understand the breeding and the non-breeding site selection criteria, the habitat (land-cover, terrain, vegetation composition, arthropod, disturbances and visibility) was quantified at used locations (points within weekly minimum convex polygons of each bird) and control points.

c. Bird movements

Tag **C4A5DE11** 'Ravi' (named after late Dr. Ravi Sankaran) stayed in Dhantol-Bhinai-Rasoolpura area of **Rajasthan** till October, after which, it started migrating towards south-east and then southwards, entering **Madhya Pradesh** from Gandhi Sagar and crossing cities such as Mandsaur, Ujjain, Rajgarh, Palsud and Ratlam, wherefrom, it entered **Maharashtra**, where it visited Betawad and Pashte (between Shirpur and Dhule), Umberkheda and Ambegaon (Near Gautala Autramghat Wildlife Sanctuary); Phulambri (near Aurangabad) and Jalgaon mete - Shevta Bk. area (approximately 19 km south-west of Sillod). It stayed at the latter location for the longest period till mid-April of 2021, and transmitted till 31st April from a localised area near Silod. His fixes were highly localised. A project representative visited the site in May 2021 and found the tag at the same site. Examination of the harness condition indicated that the bird was predated/ poached, and the local authorities were informed. The bird travelled over 945 km after tagging and covered an aerial distance of 760 km from his tagging site.

Tag **C2A5DE11** 'Dhantol' stayed around his tagging site till 12th October, 2020, after which it travelled through Shahpura, Kotri and Mandalgarh area of **Rajasthan** and reached Ujjain, **Madhya Pradesh** on 19th October passing through Gangdhar and Agar. Its last transmission was on 20th October 2020, close to a power line, However, no evidence of collision or bird carcass was found at the site. It seems that the malfunctioned after 20th

October and did not transmit any location afterwards. He travelled over 390 KM after tagging and covered an aerial distance of 370 KM from his tagging site.

Tag **C5A5DE11** 'Bandu' stayed at the tagging location for two weeks and then shifted his territory 1 km away where he remained till 12th October and further moved 1 km away and spent a week there before starting his migration. He started moving on 20th October, 2021, crossing and stopping at Sarwar, Jahazpur, Mandalgarh and Begun tehsil of **Rajasthan**, Jawad, Malhargarh, Mandsaur, Ratlam, Petlawad, Manawar, Barwani and Sendhwa tehsil of **Madhya Pradesh**, Chopda, Amalner, Parola, Chalisgaon, Kannad, Gangapur, Paithan, Shivgaon, Patoda, Bhum, Barsi, Mohol and Mangalwedha tehsil of **Maharashtra**, Indi, Bijapur and Basavana Bagevadi tehsil of **Karnataka**. He reached the Basavana Bagevadi area of Karnataka on 26th November, 2021 and spent the winter in this area. He was localised within a 2-3 km radius at this site. He moved out of this site on 16th March 2022 and stopped near Mangalwedha in Maharashtra. He has travelled for 1666 km since tagging and covered an aerial distance of 1100 km from his tagging site. His tag is transmitting locations to date.

Tag **49C06811** 'Bhutta' stayed at the tagging site for a week and then shifted his territory 2 km away where he remained till mid-September and again shifted his territory 3 km away where he stayed till mid-October. He started migrating on 16th October, 2021, and crossed and stopped at Sarwar, Shahpura, Kotri and Begun tehsil of **Rajasthan**, Mandsaur, Jaora, Petlawad, Manawar, Rajpur and Sendhwa tehsil of **Madhya Pradesh**, Chopda, Erandol, Soygaon, Kannad, Aurangabad, Paithan, Gevrai, Kaij, Kallam, Barsi and Solapur tehsil of **Maharashtra**, Indi, Bijapur, Basavana Bagevadi, Hungund, Kushtagi, Ron and Mundargi tehsil of **Karnataka**. He spent most of the December in the Basavana Bagevadi area close to another tagged bird (Bandu). He moved on 23rd December and reached Ron on 2nd January 2022, where he spent most of his winter. He has traveled over 1547 km since tagging and covered an aerial distance of 1250 km. His tag is still transmitting.


Image 5: Project team during LF telemetry exercise in Ajmer, September, 2021.

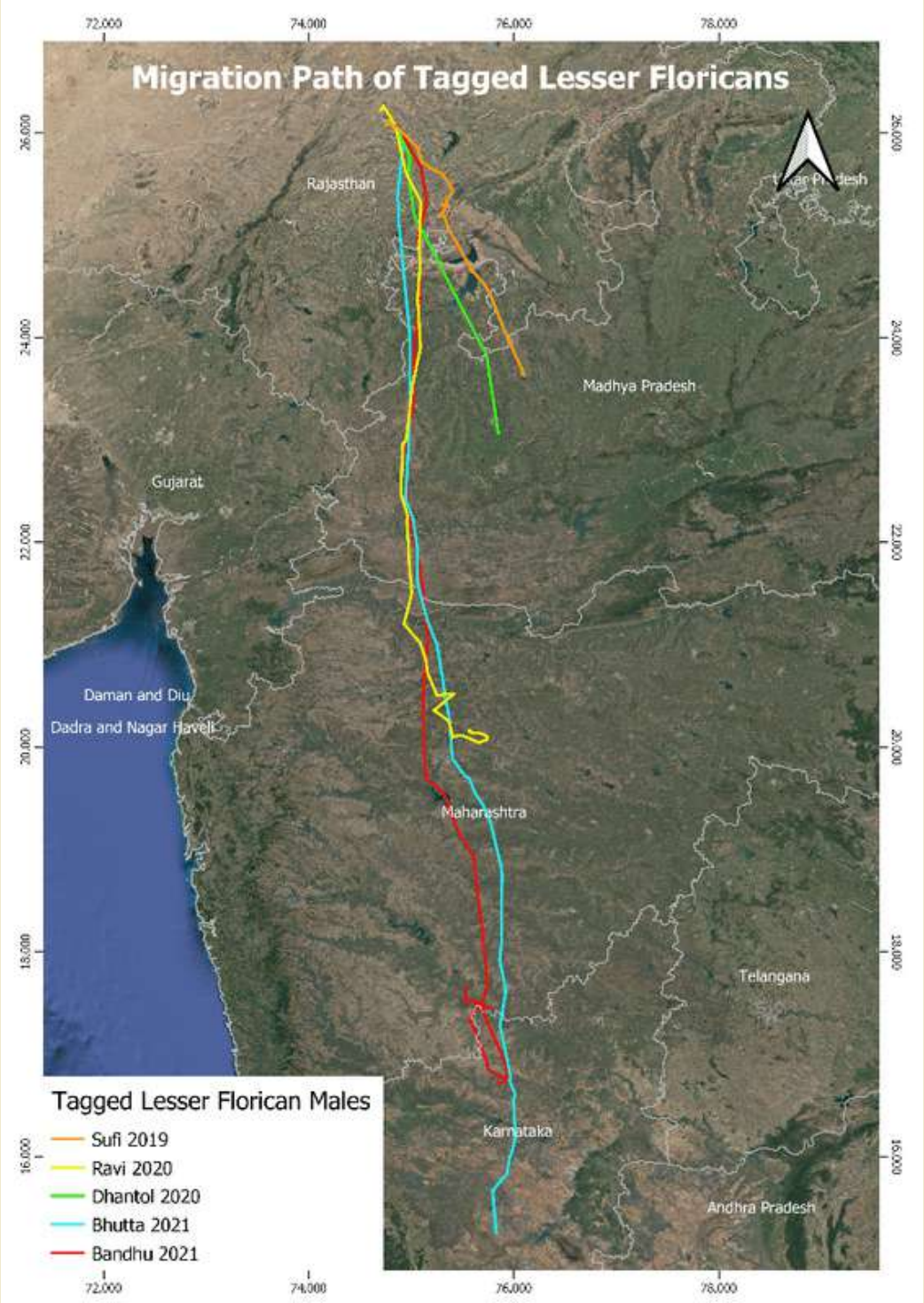


Figure 5: Migration path of tagged LF males

2.3. Lesser florican surveys

a. Nest search: Florican females lay eggs on the ground, sometimes in a little scrape. They prefer to nest in thick vegetation, in grasslands or on the edges of agriculture fields with dense grass patches or in crop fields with grass/weed, where human movements are less Detecting florican nests is extremely challenging since these areas are widely available across Ajmer landscape and due to low visibility and secretive nature of females. Our team searched for breeding males, and once they established territories and mating

events were observed, teams commenced nest search in the vicinity of leks. We targeted Shokaliya and Bandanwada landscape for nest search using the combing method, wherein, a team of 4-6 surveyors walked parallel to one another at 3-5 m distance in agriculture fields and grassland patches. One observer from a vantage or the end of the field scanned for bird movements, while others searched the ground for birds being flushed. Combing operation was carried out in the morning (0600 to 1100 h) and evening (1600 to 1900 h). Nest detection was very poor, with only two nests detected so far (one post-hatching).

Image 6: Nest search team combing moong fields in Shokaliya, Ajmer, 2021

Image 7: Displaying LF male in the agriculture fields of Shokaliya, Ajmer

Table 2: Details of areas searched for Lesser Florican nests near Ajmer, Rajasthan during 2021

Site	Area (sq km)	Date of first sighting of displaying males	No. of Displaying Males	No. of Female sightings	Mating events	End of display	Surveyed till
Bandanwara	0.86	Jul. 3rd week	6	9	4	Aug. 20th	Sept.10th
Sanod-Shokhaliya	0.40	Jul. last week	3	-	-	Aug. 2nd week	August end
Bhuri Nadi-Shokhaliya	1.53	Jul. 3rd week	4	16	3	Aug. mid	August end
Peeproli	0.94	Aug. 2nd week	4		4	Sept. 20th	Sept. 20th
Dhantol	0.81	Aug. 1st week	3	9	-	Sept. 25th	Sept. mid
Kheriya Balaji	0.71	Aug. 3rd week	2	-	-	Sept. 25th	Sept. mid
Bahera	0.22	Sept. 2nd week	1	-	-	Sept. 23rd	Sept. 3rd week
Madhopura	1.38	Jul. end 1	1	-	-	Sept. mid	Sept. 3rd week
Kalyanipura/ Bhagwantpura	1.66	Sept. 1st week	2	1	-	Sept. 22nd	Sept. 3rd week
Sedariya	0.37	Aug. mid	6	-	-	Sept. 22nd	22nd Sept.
Tantoti	0.40	Sept. 1st week	1	-	-	Sept. 20th	20th Sept.
Chat and Bhatiyani	1.06	Jul. end	3- Chat, 1-Bhatiyani	2- Bhatiyani	-	Aug. mid	August end

b. Mapping of degraded grasslands for restoration planning: Florican landscape in Ajmer includes intensive agriculture areas. Land use patterns have changed drastically in the past few decades. In these areas agriculture fields are interspersed with small fragmented grassland patches, which are disappearing rapidly due to encroachment and land conversion. Many of these patches are community pasture lands. These grasslands have high density of *Prosopis juliflora* which makes these areas less productive and inaccessible for many grassland species including lesser florican. *P. juliflora* removal is crucial to restore these habitats. As a first step we have started digitising grasslands using high resolution Google imagery and developed a map of the same (Figure 6). In the coming years, ground truthing of these areas and their legal status will be assessed, following which, *P. juliflora* removal can be commenced in phase-wise manner depending on the willingness of local villagers and forest authorities and the importance of the area to floricans.

Image 8: Grassland patches in between crop fields of Jowar and Moong in Bandanwara, Ajmer, September 2021.

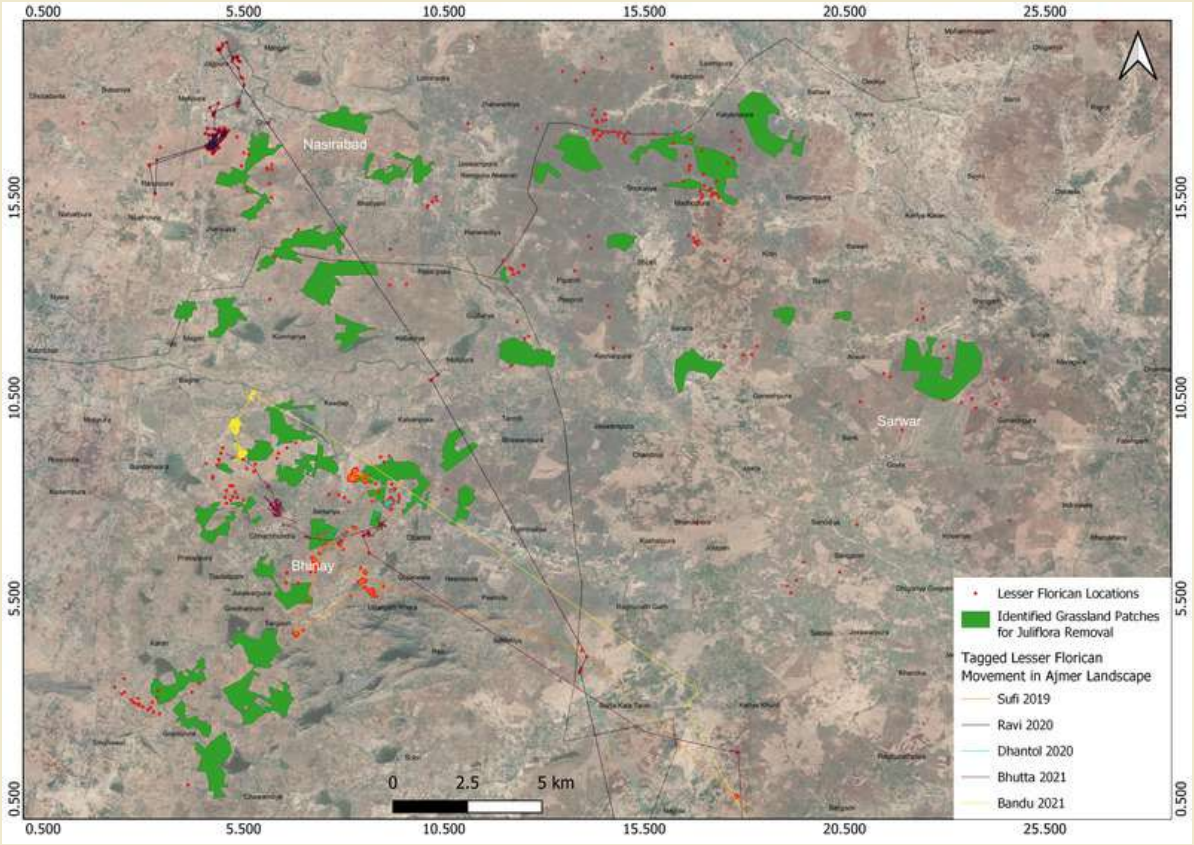


Figure 6: Grassland patches (partially mapped) interspersed in agriculture areas of LF landscape, September, 2021

2.4. GIB demographic surveys

a. Intensive demographic surveys were conducted, to understand the nest and chick survival of the wild GIB population in Desert National Park WLS. This included monitoring nests of both tagged and untagged birds and subsequent surveys to quantify chick survival at the 3-month and 6-month stages.

b. The availability of tagged birds provided us with an opportunity to carry out intensive demographic monitoring. Six out of seven tagged birds laid eggs in the breeding season of 2021, and egg laying ranged from one to five times among females (on average 2.2 times in a year). However, only 26% of eggs which were left in the wild hatched, due to compounded effects of infertility and predation, based on monitoring of 60 eggs in the wild (2019-21). The incubation period for the two hatched eggs was 23 days.

c. Chick recruitment survey was conducted in October 2021 to quantify the first quarter juvenile recruitment rate at the DNP WLS. Juvenile recruitment rate was assessed by quantifying the chick to female ratio. The first quarter recruitment rate is important as most bustard chick mortality happens during these months. A total of 12 adult females were detected, out of which 4 had a chick with them, Yielding a recruitment rate of 0.33 in 2021.

d. More robust estimates of chick survival can be obtained by monitoring chicks of tagged birds. During 2020-2021 (two breeding seasons), four out of five chicks of tagged birds survived till October, but survival rate were highly variable between years; therefore, it requires long-term data.

2.5 Behaviour and habitat assessment of GIB

Behavioural observations to understand the activity, foraging and breeding behavior of GIB were conducted in Thar. Habitat assessment of nest sites and areas used by tagged birds is being carried out. From the satellite-telemetry data of three tagged birds, 42 locations for each of the three major activities namely- morning foraging, afternoon resting, and roosting were chosen along with 126 random points as control. The study was conducted from December 2020 to February 2021. Two 50m×2m belt transects were sampled in two cardinal directions for arthropod abundance estimation. Associated vegetation was recorded in five 1m×1m quadrats inside the belt. Visibility at the eye level of nest predator as well as GIB at 20, 50 and 100 meters was documented.

In the year 2020, 32 nest locations along with three control points for each nesting points were surveyed for landcover, insect abundance and associated vegetation as well as human induced disturbance. The same was done for 10 nest locations in the year 2021.

Based on 95% usage of 5 tagged GIB, 520 sq.km. area in and around the northern part of Desert National Park was identified for assessment of GIB habitat resource for availability. The area was divided into 520 girds (1 sqkm each). Each grid was sampled for vegetation cover and structure, landcover, human disturbances and livestock presence, arthropod abundance, and availability of plant-based food resources for GIB. Visibility at the eye level of nest predators as well as GIB at 20, 50 and 100 meters was documented. Tree and shrub biomass was being recorded in each grid.

2.6 Status survey of migratory birds and key wildlife in Bikaner District

In February 2021, a wildlife survey was conducted in the Bikaner district of western Rajasthan, on the request of many Bikaner district residents, who conveyed their wish of conducting a wildlife survey to the Hon'ble Member of Parliament; who in turn invited the Wildlife Institute of India through the Ministry of Environment, Forest & Climate Change and to execute the survey. The data resulting from the survey were analysed and summarised during the period of April 2021 to February 2022, and disseminated as the Bikaner survey report (Status of migratory birds and key wildlife in Bikaner district, Rajasthan).

a. A total of 89 cells covering 12,816 sqkm area were extensively surveyed using vehicle transect method. In each cell, dirt-trails or unpaved roads of 16.2 (4.1SE) km length was traversed using slow moving vehicles and animals were recorded during peak activity periods (0700hrs-1300hrs and 1600hrs-1900hrs). Data on iconic native fauna (Chinkara, foxes, bustards, cranes and raptors) and key neobiota (dog, pig and Nilgai) were collected on these vehicle transects (1442 km total length). Information on small birds, habitat characteristics and anthropogenic disturbances was recorded at regularly placed transect stop-over points (802 points). Major avian congregations or 'hotspots' (carcass dump at Jodbeed, wetlands and lakes at Gajner, Lunkaransar, RD507 and RD750) were surveyed.

b. Among large birds, the encounter rate of the Demoiselle Crane was estimated at 5.47 (3.14 SE) individuals per 100km. The five most common raptor species (individuals per 100 km) were Griffon Vulture (16.44±6.94 SE), Egyptian Vulture (8.73±2.35 SE), Common Kestrel (7.39±0.88 SE), Black-winged Kite (5.35±0.89 SE) and Long-legged Buzzard (5.13±0.69 SE). Among small birds, 2,859 individuals from 103 species were recorded on point counts. The most abundant species were Common Babbler, Eurasian collared Dove, House Sparrow, White-eared Bulbul, Red-vented Bulbul, Greater short-toed Lark and Variable Wheatear. The total density of small birds, excluding birds in flight and rare species, was estimated at 997 (58SE) individuals per sqkm.

c. A total of 24,674 individual birds belonging to 95 species across 36 families were recorded during hotspot surveys. RD750 had the highest number of individuals and species (15,666 individuals of 76 species) followed by RD507 (6,501 individuals of 34 species), Lunkaransar lake (1,749 individuals of 25 species) and Gajner lake (758 individuals of 38 species). Common Coot, Demoiselle Crane, Common Pochard, Common Teal and Gadwall were the most abundant recorded species. Two Endangered (Egyptian Vulture and Steppe Eagle), two Vulnerable (Common Pochard and River Tern), and six Near-Threatened species (Black headed Ibis, Dalmatian Pelican, Eurasian Curlew, Ferruginous Duck, Northern Lapwing, and Painted Stork) were recorded during the hotspot survey.

d. During the survey, 1,880 Chinkara individuals were detected in 684 herds with an encounter rate of 139.78(18.72 SE) individuals per 100km. The estimated density of Chinkara in the surveyed landscape was 4.27(0.65 SE) individuals per sqkm, yeilding an abundance of 54,745(8,392 SE) individuals in the surveyed study area. Similarly, a total of 112 desert foxes were seen during the survey, and the density was estimated to be 0.58(0.11 SE) foxes per 100 sqkm i.e 7,456(1,356 SE) individuals in the study area. Other mammals recorded during he survey were - Desert Cat (0.57±0.2SE individuals per 100km), Nilgai (14.39±2.91 SE individuals per100km), free-ranging Domestic Dogs (26.07±3.6 SE individuals per 100 km) and Indian Wolf (only one sighting, no population estimate).

Based on the survey, recommendations were made for the conservation of wildlife in the landscape and certain areas were prioritised for management. The survey also provided baseline information on the status of wildlife in the region.

2.7. Bengal Florican survey

The necessity of a range-wide Bengal Florican survey has been mooted by various agencies. Consequently, the Bustard recovery program plans to conduct a survey in 2022-23, on the lines of Great Indian Bustard and Lesser Florican surveys that have been conducted in the past. As reconnaissance for the proposed survey, Bengal florican habitats were visited in the states of Assam and Arunachal Pradesh in March 2022. The project team visited suitable protected and non-protected areas in and around Manas NP, Kaziranga NP, Orang NP, Laokhowa-Burachapori WLS, D'Ering WLS and proposed ELOPA CCR (Dibang Valley). A total of 17 Bengal florican were seen – 15 in Manas NP, 1 in Orang NP and 1 in D'Ering WLS. Additionally, suitable habitats in all the aforementioned areas were surveyed, preliminarily mapped and appropriate local contacts were established.

2.8. Bird mortality due to collision with wind turbines

Bird carcass surveys were carried out to assess bird mortalities caused due to wind turbines and associated power lines in Thar, Jaisalmer. Additionally, surveys were conducted to examine bird crossing rates and the use of wind turbine areas by birds and mammals. Ninety out of the existing 900 wind turbines around Desert National Park were surveyed seven times (January 2020 - September 2021). 124 bird carcasses were found, based on which, bias corrected bird mortality rate was estimated at 0.93 (0.7 - 1.1) individuals/turbine/month. This yields a total estimated annual mortality of about 10,000 birds due to wind turbines in 3000 sqkm area of western Thar.

2.9. Dog surveys

The GIB landscape in Thar holds a large population of free-ranging dogs that partially depend on village-based resources and depredate wildlife, including GIB nests, thereby being a critical threat that needs urgent management. To manage this problem, the population status of free-ranging dogs was assessed in/around Desert National Park in 2017-2018, 2019, and 2021. A dog spay-neuter program was conducted in collaboration with Humane Society International, India, from October 2019- January 2020. In total, 801 dogs (454 ♂ & 347 ♀) were sterilized, vaccinated, and released from 23 settlements in/around DNP. To check the program's effectiveness and to assess the sterilised to unsterilised dog ratio count surveys were performed in 11 settlements where the dog sterilization program was conducted. A repeat dog count survey was conducted in March 2021 in 25 settlements in collaboration with Wildlife Conservation Society (WCS). This survey was conducted in villages where the spay-neuter program was conducted and in villages where the sterilisation program was not conducted but scheduled for phase two of the sterilization program. During the dog count exercise, observers walked on a predesigned route, recording the number of dogs present with a consistent walking effort of ~ 6 km average speed of 2 km per hour) in the settlement area. The age and sex class of dogs were recorded. This activity generated crude counts of dogs in all settlements dispersed across GIB habitat in/around Desert National Park. The dog abundance was estimated using a calibration equation from these crude counts. The total abundance of dogs in 25 settlements is 1386 (41.58 SE). In 25 settlements, 840 free-ranging dogs were recorded, comprising 667 breeding adults, 55 sterile adults and 118 pups.

2.10. Conservation genetics

Genomic analysis was carried out to inform GIB conservation management, wherein, we generated a reference genome of GIB and re-sequenced two more individuals to help in the conservation management of the species. We isolated high-quality genomic DNA (>50KB insert size) using QIAGEN Genomic-tip 100/G genomic DNA isolation kit (Cat No. 13343) following the manufacturer's protocol. The DNA was then quantified using agarose gel electrophoresis (to detect DNA degradation degree, potential RNA and protein pollution) and Qubit (to estimate the accurate concentration values). The samples were processed for library preparation and followed by sequencing of libraries using PacBio Sequel II and Illumina platforms. Data analysis was carried out to create a reference genome for the GIB, that was further used in combination with other two re-sequenced individuals to gain insights into genetic diversity, inbreeding, demographic history and effective population sizes.

SSRs identification: Mono- to hexa nucleotide Simple Sequence Repeats (SSRs) motifs were identified using two different tools (MIcroSAtellite identification tool) MISA (http://pgrc.ipk-gatersleben.de/misa/download/misa.pl) and PERF.

Table 3: SSR statistics and comparison of SSRs identified in three individual GIB samples

	GIB4		GIB3		GIB6	
Type of SSRs	**Number of SSRs**	**Length of SSRs**	**Number of SSRs**	**Length of SSRs**	**Number of SSRs**	**Length of SSRs**
Mono	127753	1955278	121910	1824949	120782	1812932
Di	8799	138840	8890	133928	8515	128350
Tri	12373	173514	12436	169572	12094	165570
Tetra	22800	302460	23085	296036	22523	289376
Penta	5502	103680	5507	105515	5361	103950
Hexa	217230	2617128	198181	2388000	191494	2306778
Total	394457	5290900	370009	4918000	360769	4806956

Demographic changes in past: We ran PSMC analysis using the resequencing data with 40.297 coverage filtering by excluding sex chromosomes and missing sites. To check for variance in Ne, we performed 100 bootstrap replicates (the number of replicates limited by computational time). A generation time of 9 years and a mutation rate of 1.4*10-9 year/site were applied.

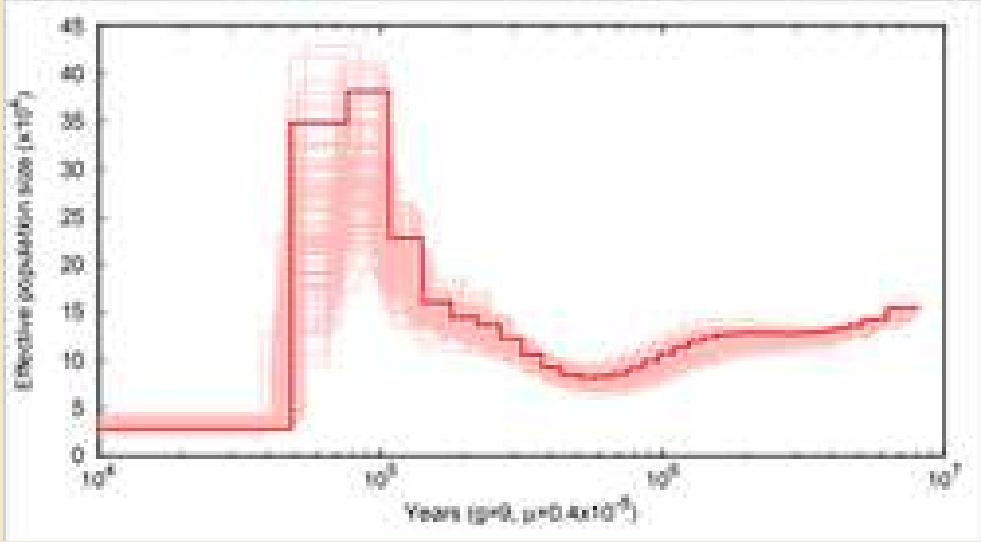


Figure 7 : Demographic History Analysis and PSMC Effective Population Size estimates for GIB.

Gene Gain/Loss Analysis: We used Orthofinder to define gene families across 8 genomes: GIB, Ardeotis nigriceps (from this study), and *Meleagris gallopavo, Anas platyrhynchos, Taeniopygia guttata, Ficedula albicollis, Gallus gallus, downloaded* from *Orthovenn2, Chlamydotis macqueenii* and *Apteryx mantelli* species downloaded from GenBank. We then estimated gene gain and loss rates within the eight species using two-lambda model (one lambda value for bustards and other for rest of the species) implemented in the package CAFE (computational analysis of gene family evolution; v 4.2.1.).

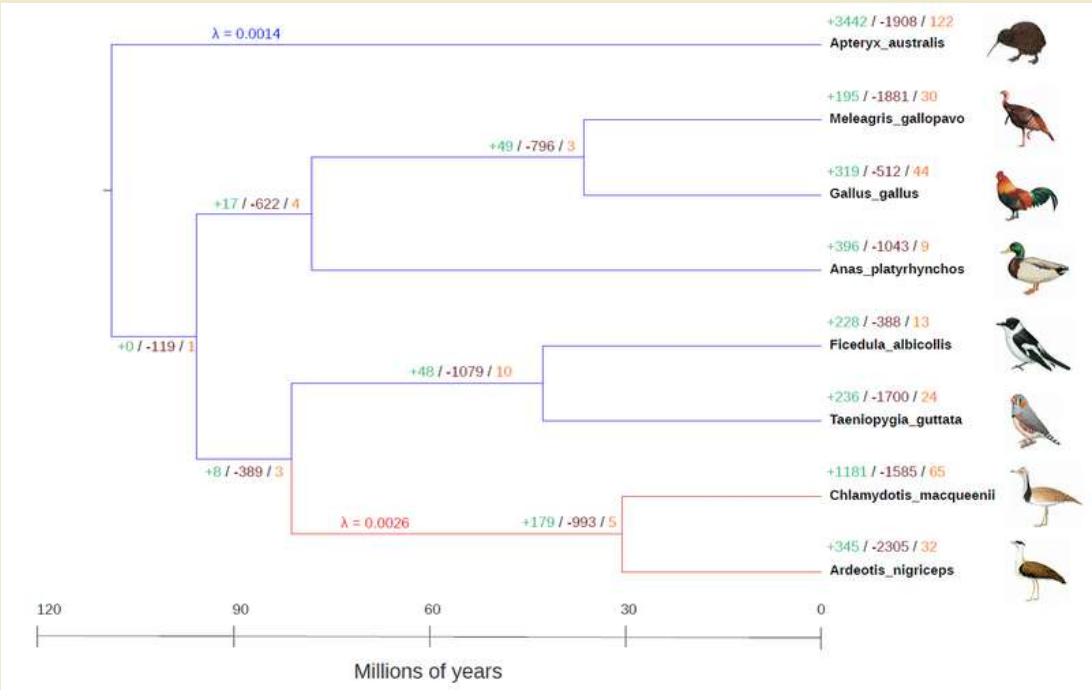


Figure 8 : Gene gain and gene loss in the eight bird species.

The number of gene gain (+; green colour) , gene loss (-; red colour) and rapidly evolving gene families (orange colour) are mentioned above in the species name (branches). CAFE was used to estimate death and birth rate (λ) using two lambda model with λ=0.0026 for bustards and λ=0.0014 for the rest of the species.

Mitochondria Genome Assembly and annotation: The assembled genomes of GIB were subjected to blastN against the published bird MT genomes to extract mitochondrial like contigs. Contigs having more than 90% coverage were selected and subjected to annotation using MITOS2 web server and the circular map of the mitochondrial genome was drawn using OGDRAW online tool. Total 14 protein coding genes, 22 tRNAs and 2 rRNAs were identified in GIB.

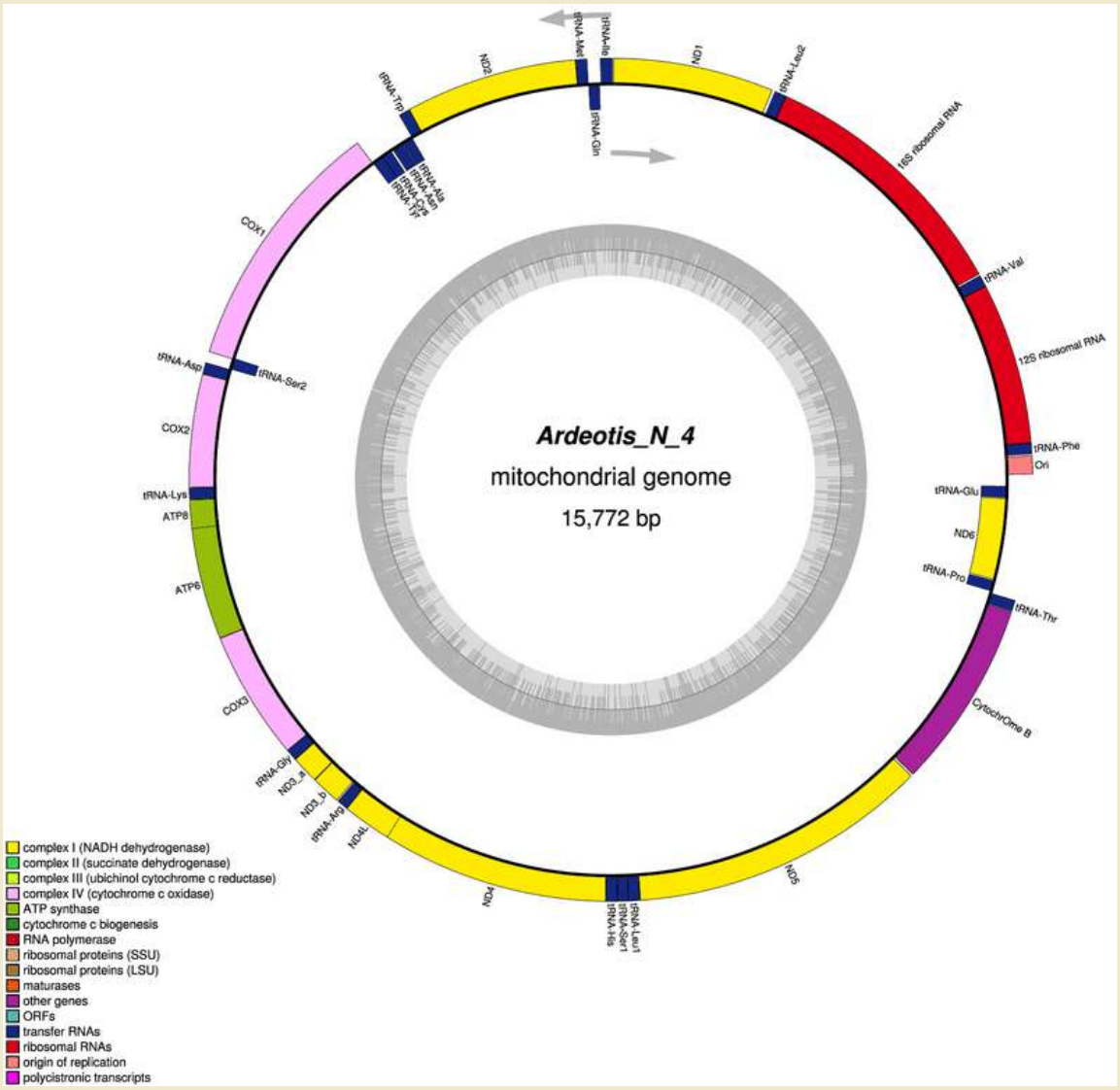


Figure 9: Graphical representation of GIB Mitogenome

Visualisation of the mitochondrial genome via Organellar Genome DRAW (OGDRAW). Many genes are represented with different colour blocks. The colour blocks outside the ring indicate genes that are located on the positive strand, and colour blocks within the ring indicate genes that are located on the negative strand.

Phylogenetic Analysis: The published bird Mitogenomes genome (downloaded from GenBank) along with assembled GIB MT genome was taken as input for the phylogenetic analysis. All MT genomes were aligned using MAFFT's auto algorithm at 1000 iterations and the tree was drawn using FastTree with GTR model to derive a newick tree at 1000 bootstraps. The newick tree was visualised using iTol v3 online tool, by ignoring the branch-lengths.

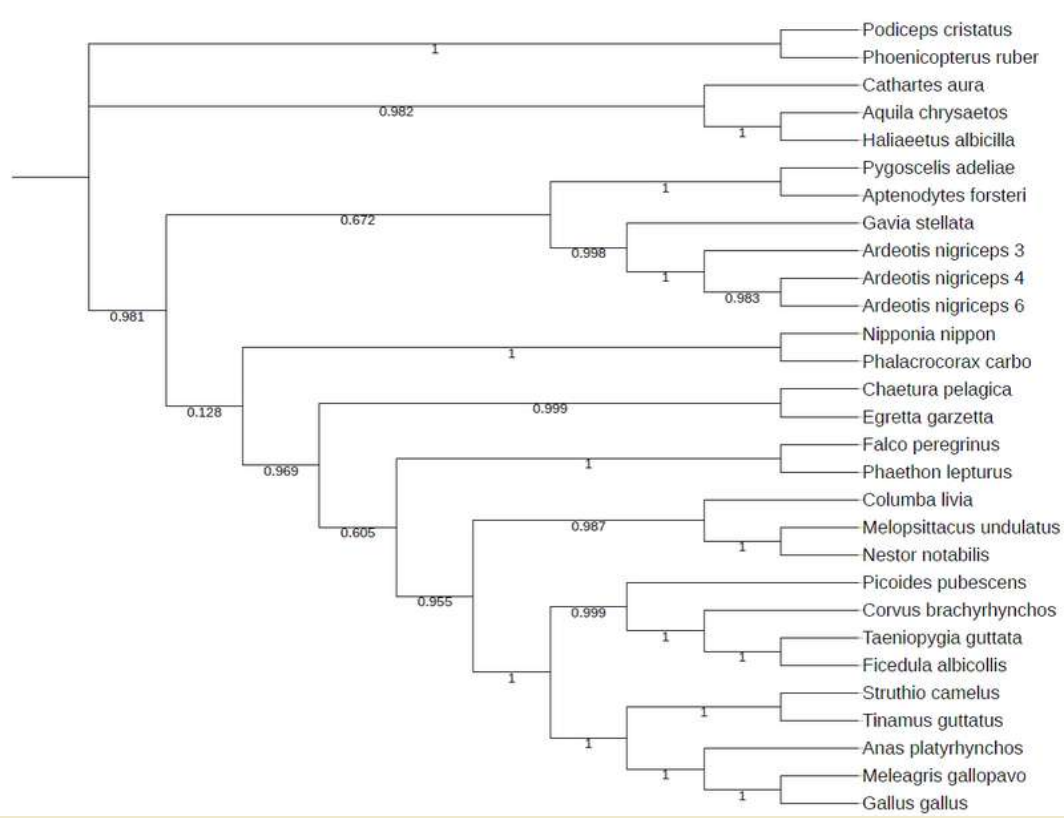


Figure 10 : Phylogenetic analysis of assembled GIB mitogenomes and published bird mitogenomes.

2.11. Arthropod assessment

For assessment of GIB habitat with respect to resource availability, the study was carried out inside and outside of different enclosures of Desert National Park from November 2020 to February 2021. Study points were selected randomly inside and outside of enclosures from satellite-telemetry data and previously known nesting locations. A transect of 50m was walked, and insects that were flushed within 1m on either side of the line were noted and identified up to order level. Vegetation sampling was also conducted in three 1m×1m quadrats laid within a 20 m radius of the selected point in three randomly selected cardinal directions. Dominant plants from each quadrat were noted.

A total of 336 transects for arthropod and 1,008 quadrats for vegetation were sampled. Seven orders of insect were found i.e., orthoptera, coleoptera, diptera, hemiptera, hymenoptera, odonata and lepidoptera. Six habitat types were found: agriculture, shrubland, barren (Flat land), grassland, stable dunes, and unstable dunes (Shifting).

In terms of land-cover, the density of total arthropod was highest in shrubland (8.56±0.99 individual/100sqm) and grassland (8.22±0.49 individual/100sqm) and lowest in stable dunes (3.5±0.5 individual/100sqm) (Figure 11). Order orthoptera density was highest in grassland (5.92±0.45 individual/100sqm) and lowest in stable dunes (0.5±0.5 individual/100sqm) (Figure 12). Order coleoptera density was highest in unstable dunes (1.2±0.96 individual/100sqm) and lowest in grassland (0.14±0.05 individual/100sqm) (Figure 13).

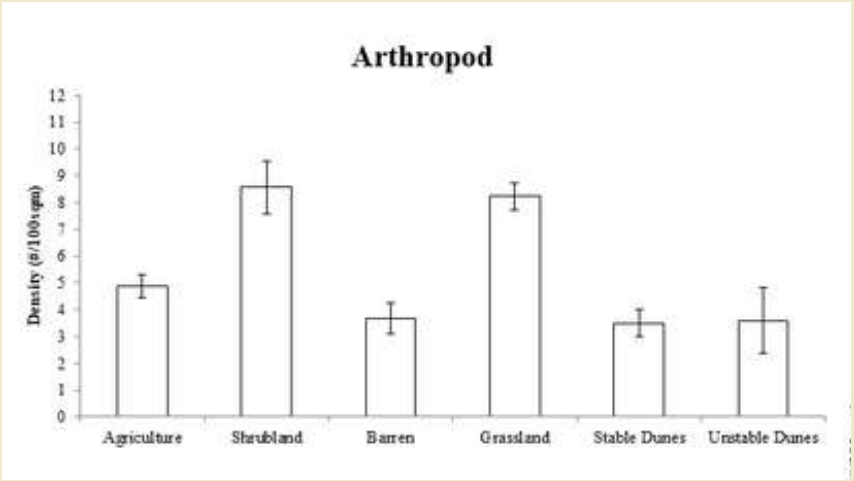


Figure 11: Mean and Standard Error of density of total arthropod across different habitat of Desert National Park during winter (2020-21).

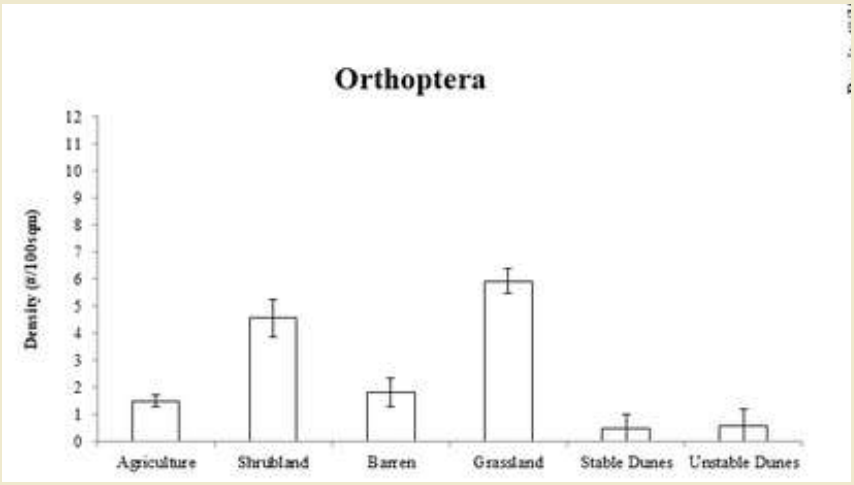


Figure 12: Mean and Standard Error of density of orthoptera across different habitat of Desert National Park during winter (2020-21)

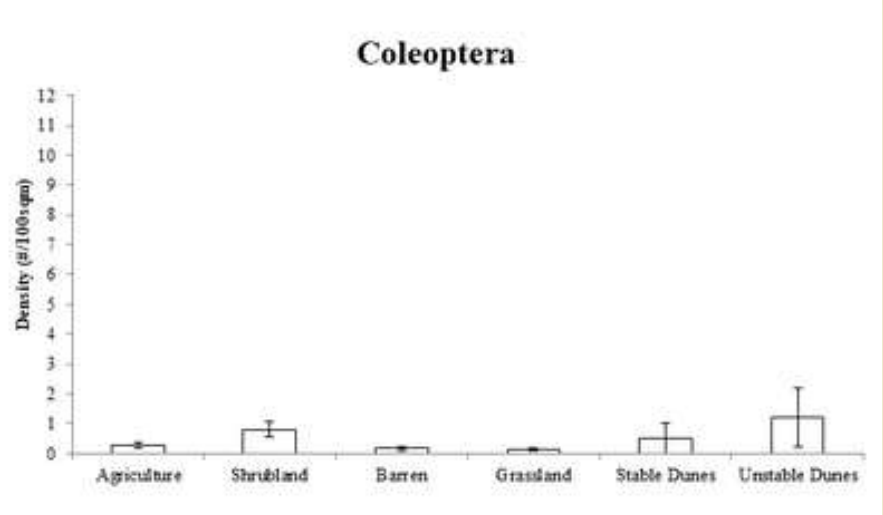


Figure 13 : Mean and Standard Error of density of coleoptera across different habitats of Desert National Park during winter (2020-21)

One of the habitat restoration measures for GIB involves creating and maintaining enclosures to regulate livestock grazing to improve vegetation production that are likely to increase invertebrate biomass and ultimately benefit bustards. However, the effectiveness of this action is largely untested. To investigate if GIB-centric habitat management, specifically fenced grassland to reduce livestock grazing, benefits invertebrate assemblages that act as one of the primary foods for GIB, spiders were used as target species to address this question because of their predatory functions and notable indicator roles. The study's primary objectives where assessment of spider community composition and finding habitat correlates of spider diversity and abundance in the Thar desert landscape.

The density and richness of spider families in different enclosures (as protected grassland/ungrazed land) and their surrounding areas (as non-protected grassland/agriculture land/grazed land) were assessed in the Thar landscape to generate baseline information on the spider diversity status and also to look at the effect of grazing on their density and richness. A total of 11 pairs of enclosures and surrounding areas were surveyed, namely Sudasari, Gajaimata, Chauhani PPC, Chauhani TFC, Sipla, Manihari, Miajlar, Ramdeora, Loharki, Guddi, and Rasla. Sampling was performed using hand-collection and pitfall trap methods in a systematic grid framework (1×1 km grid unit). A total of 4032 spiders were found belonging to 22 families from 680 points in 136 grids spread across the study area. Preliminary results indicate higher family richness (t 1.87, df 10, $p<0.05$) and density (t 1.87, df 10, $p<0.05$) per plot in enclosures (ungrazed land) compared to surroundings (grazed land).

The current finding indicates a positive effect of controlled or no grazing inside enclosures on the density and richness of spider families in the Thar landscape. This landscape has experienced GIB-centric conservation action by the Rajasthan Forest Department following MoEF&Cc's National Bustard Recovery Guidelines. Great Indian Bustard breeding habitats have been enclosed using chain-link-fencing to regulate livestock grazing, which has aided in vegetation recovery and a visible increase in vegetation

-biomass inside enclosures compared to the surroundings. Spiders are predatory invertebrates and a commonly used indicator of lower trophic level health/productivity. Greater diversity and abundance values of the spider inside enclosures perhaps reflect higher vegetation and invertebrate production resulting from fencing and grazing regulation. Thus, this study hints at a potentially positive effect of GIB-centric management on non-target taxa. This further justifies these conservation actions since bustards are projected as conservation flagships of arid ecosystems.

2.12. Habitat use and behaviour of Chinkara in Thar

Land-use change is a major driving force of habitat modification and has important implications for the distribution of wildlife and the maintenance of ecological processes. The Thar Desert which is one of the most heavily populated deserts in the world, is also undergoing these changes rapidly. These changes are known to disrupt the behavioural patterns of wild animals and influence the landscape of fear which may have fitness consequences. Habitat use and behaviour of Chinkara, *Gazelle bennetti* found in diverse land-use types of Thar Desert were examined.

The study was conducted in the Desert National Park, Jaisalmer and in an immediately adjoining unprotected area outside the national park. To understand the land-use effect, the study area was further classified into four different land-use classes Grassland, flat Scrubland, Agriculture and vegetated Dune blocks. Each class has four 10 sq.km. area blocks, the study covered a total of 16 sites (160 sq. km. area) and each block includes three 2 km line transects.

To estimate Chinkara density across land-use types, Distance sampling method during the past two seasons- monsoon (July 2021 - October 2021) and winter (November 2021 – February 2022) were carried out.

Result: A total of 84 km was surveyed using 42 line transects in the monsoon season and 90 km was surveyed using 45 line transects in the winter season. The densities (chinkara / sqkm) were 8.86 ± 2.01 in monsoon and 5.97 ± 0.96 in winter. The density in various land-use classes is given in Figure 17 .

To examine the seasonal activity budget of Chinkara and time allocation to different behavioral activities especially Foraging vs. Vigilance, behavior data were collected through scan sampling method for herds and focal method for individuals. In each habitat block three fixed observation points were chosen for behavior data collection. Scan sampling was for 1 minute and done at 10-minute intervals and focal sampling was for 5 minutes, period of sampling was from dawn to dusk.

Chinkara were found foraging for most of the time followed by vigilance, walking, resting, and others avtivities. Time allocation for foraging vs. vigilance varied considerably with land-use classes.

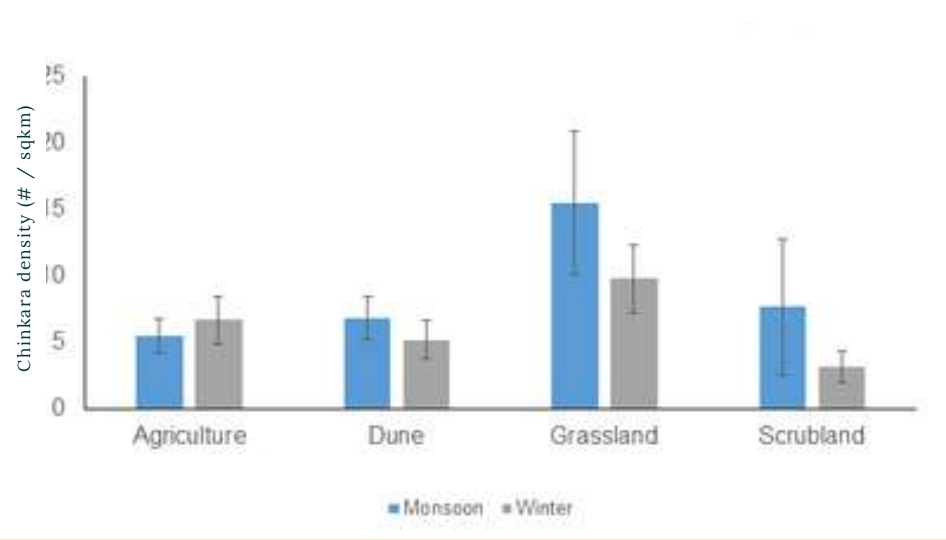


Figure 14: Seasonal densities of Chinkara in monsoon (July 2021- October 2021) and winter (November 2021- February 2022) season.

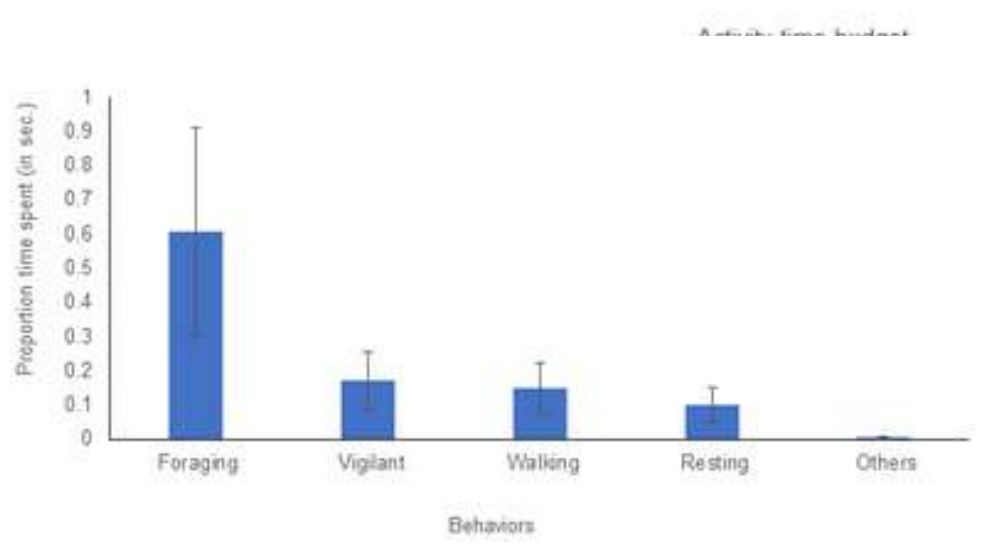


Figure 15: Activity time budget of Chinkara in monsoon (July 2021 – October 2021) and winter season (November 2021 – February 2022).

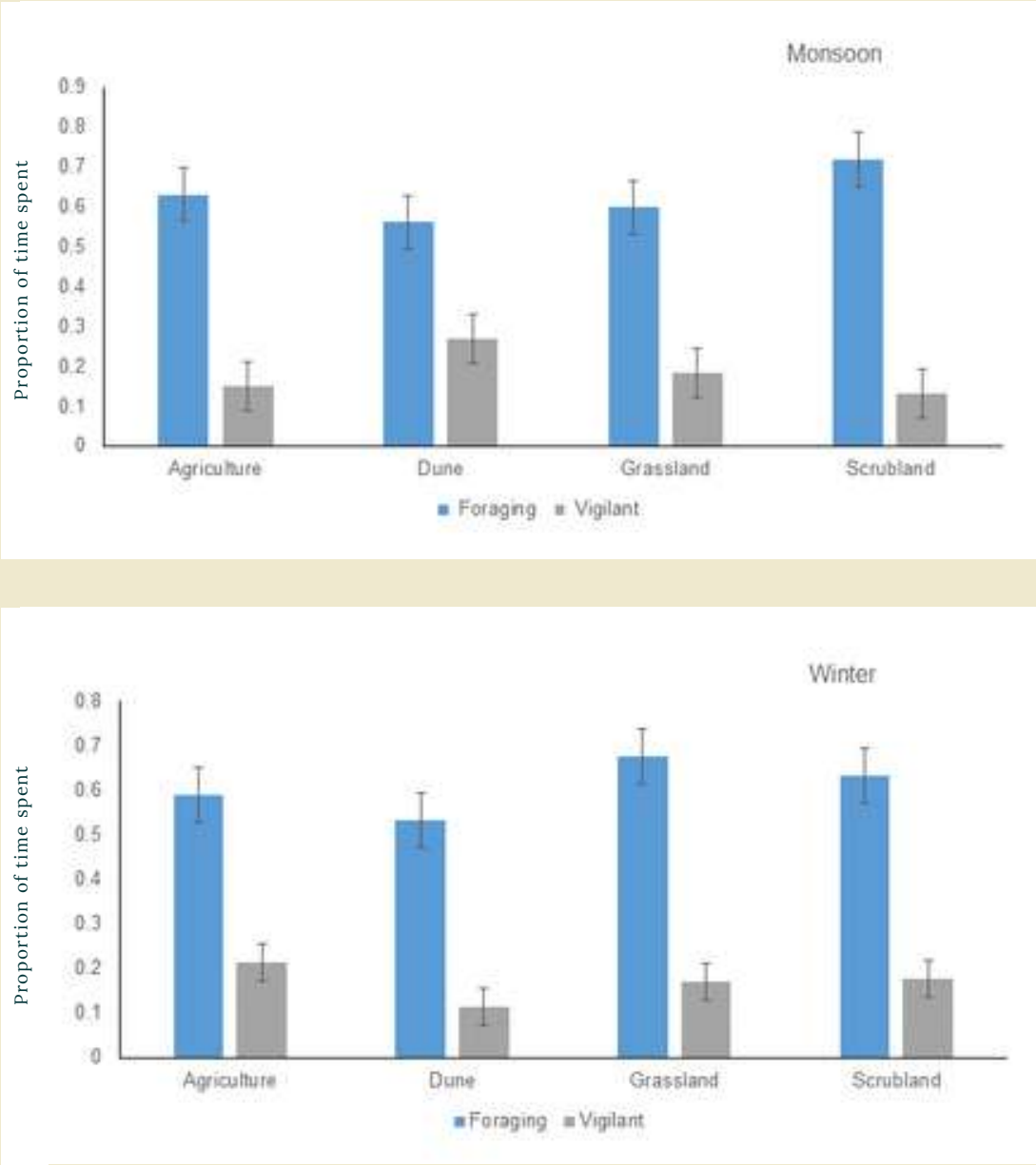


Figure 16: Time allocation to foraging vs. vigilance of Chinkara in monsoon (July 2021- October 2021)-top and winter (November 2021-February 2022) season.

The preliminary findings provide a quantitative understanding of factors influencing Chinkara behaviour and the role of land use in shaping their spatial distribution pattern which will aid in habitat management for the species.

2.13. Thermal ecology of Spiny tailed lizards

Lizards and other ectotherms survive within their thermal limits and have a well-defined range of body temperatures within which their performance is optimal. Hence, as climate warming accelerates, ectotherms like lizards become increasingly constrained. Spiny tailed lizard *Saara hardwicki*i survives in areas where environmental temperatures are already extreme. Therefore, they may be at the risk of extinction due to rising temperatures.

Data on field body temperatures and operative temperatures were collected in natural conditions to evaluate and quantify the degree of thermoregulation observed in the lizard and to evaluate changes in activity patterns over months. In the laboratory, preferred temperature, thermal thresholds and locomotor of the lizard were quantified. Using a combination of field and laboratory data, *S. hardwickii* use of burrows to thermoregulatewas investigated, and the impact of climate warming on locomotor performance and hours of activity in the future was evaluated.

Burrows provided an exceptional buffer to the lizards as the temperatures deep inside (~1 m) do not exceed the preferred temperature of the lizard, even in the worst-case climate change scenario (Representative Concentration Pathway (RCP) 8.5). Currently, the lizards are restricted to their burrows for six hours during their active period. In the model predicted in this study, by the year 2100, the lizards might get restricted to their burrows for 7 hours in the best-case scenario, and for 9 hours in the worst-case scenario. Additionally, the model suggested a decrease in locomotor performance by 2.1%, 9.5% and 28.3% in the best- (RCP 2.6), intermediate- (RCP 4.5), and worst- (RCP 8.5) case scenarios by the year 2100. Hence, the synergistic effect of loss of activity hours and decline in locomotor performance might result in decreased fitness of *S. hardwickii*, potentially leading to its extirpation.

Image 9: Spiny tailed lizard in its natural habitat of Desert National Park (DNP)

Training programs

- Training of Field staff of Desert National Park in survey techniques was conducted online in November 2020.

- Training of Field staff of Desert National Park in bird identification was conducted in February 2021.

- Training of Forest Department staff and volunteers in Bikaner on large-scale surveys and related field techniques

- ·Interim report on the status of migratory birds and key wildlife in Bikaner was prepared at the request of Hon. Minister of State for Heavy Industries & Public and Parliamentary Affairs- Government of India

- Residents of local villages in and around Desert National Park were briefed about the ongoing project activities in multiple meetings.

- Status of Wildlife in Bikaner and Power-line Mitigation Report II Edition was prepared and disseminated to various stakeholders.

- Preparation & distribution ofoutreach materials (posters, t-shirts, caps, books, bags & brochures

- Various interactive sessions have been conducted during wildlife week in the schools around Desert National Park enabling the kids to have a better understanding of the importance and significance of the desert eco system.

Meetings with stakeholders regarding GIB conservation

- Meeting convened by MoEFCC through video conferencing under the Chairmanship of Director General of Forest & Special Secretary on 05th May 2020 attended by Inspector General (Wildlife), Joint Secretary- MNRE, DIG (Wildlife), CWLWs of Rajasthan & Maharashtra, Additional Principal Chief Conservator of Forests (Wildlife) of Gujarat and Karnataka, officials from Ministry of Power, RVPNL, Gujarat Energy Transmission Corporation, Power Grid Corporation of India limited, National Highway Authority of India, Sprng Energy,other wind and solar farms/ projects agencies operating in Rajasthan and Gujarat to discuss on plans for protection and conservation of GIB in the country with emphasis on power line mitigation.

- A meeting and a site visit were organised in Jaisalmer on 22-23 February 2021 to discuss various aspects for formulating an action plan for GIB conservation regarding the Hon'ble NGT case inOA No 385 of 2019 as mandated by MoEF&CC. Critical GIB habitat delineation of priority & additional important areas through joint surveys of WII & RFD and finalised during this site visit by the officials of MoEFCC, RFD, WII & power agencies in February 2021.

- Correspondences with representative from General Electric- Mr. Dheeraj Jain, Regulatory Leader-Turnkey for mitigation of power lines to prevent bird mortality across India.

- Correspondences with - Mr. Amit Gupta, Head (ESG), Sprng energy for mitigation of power linesin Jaisalmer and Jodhpur.

- Meeting with Mr. Yash Arora (Environmental Specialist) International Finance Corporation, World Bank Group regarding GIB conservation and mitigation of power line impacts.

- Correspondences with Mr. Soumik Sarkar Dy. Manager- Project Skipper Limited, Bikaner (Rajasthan) during August 2020 regarding technical specifications & drawings of bird diverters to be installed in the upper conductor of 132 KV D/C Chhatargarh Loonkarnsar transmission line under forest area.

- Correspondence with Mr. Devesh Kumar Singh, Chief Manager, Power Grid Corporation of India Limited, regarding the identification of transmission line stretch infringing GIB habitats zones in Rajasthan during August 2020.

- Correspondence with Shri Dinesh Kumar, Chairman & Managing Director, Rajasthan Rajya Vidyut Prasaran Nigam Ltd during August- September 2020 regarding the design ofbird deflectors/ diverters and the span length & distance at which bird diverters are to be installed on the earth wire of transmission line passing through the forest area (other than DNP and GIB arc) and on all conductors of transmission line passing through DNP and GIB arc for fixing of bird diverters on RVPN transmission lines to avoid bird collisions.

- Correspondence with Ms. Emma Marsden, Senior Environment Specialist, South Asia Energy Division, Asian Development Bank, during September 2020 regarding mitigation measures for upcoming power projects in the GIB habitat in Rajasthan.

- Correspondence with Mr. Abhay Garg, Lead consultant INDUS Enviro- Environmental, Health, Safety, and Social (EHSS) consulting and auditing firm regarding setting up a Solar Power Project near Desert National Park.

- Correspondence with ERM consultants during October 2020 regarding GIB conservation pertaining to Adani Hybrid power project in Jaisalmer critical habitat assessment study.

- Mitigation measures for proposed transmission lines by Adani Power near the potential GIB areas in Rajasthan and Gujarat.

- Correspondence with Poonam Singh Green Enel regarding power line mitigation GIB areas in Maharashtra

LF conservation recommendations:

The LF is Critically Endangered, and the Shokaliya landscape in Ajmer is one of the remaining strongholds where the species visits during monsoon (July – October). This landscape also supported the critically endangered great Indian bustard until the last decade. A meeting was held on 14th October 2020, under the chairmanship of the Chief Conservator of Forest, Ajmer and involving the Bustard Recovery Project team of the Wildlife Institute of India (WII) and the Bombay Natural History Society (BNHS), to discuss the plan of developing a conservation reserve in lesser florican distribution area in Ajmer, in compliance with the directions of THE NATIONAL GREEN TRIBUNAL, PRINCIPAL BENCH, NEW DELHI in response to original application no. 135/2017 (CZ) (MA Nos. 499/2017, 11/2018, 106/2018 and I. A. No. 14/2020) in the matter of Rajputana Mines Owners & Mineral Merchants Association Vs. State of Rajasthan & Ors. Dated: 3rd March, 2020. The NGT has directed Rajasthan State Forest Department to issue a notification with regard to the Community Reserve for conservation of the great Indian bustard (GIB) and lesser florican (LF) within a period of six months. Subsequently, the Bustard Recovery Program team of WII studied the area from the species' perspective with the help of past surveys (range-level collaborative surveys carried out by WII with the State Forest Department and NGO partners in 2017 and 2018), telemetry data (2019-20), and current ground surveys, to identify areas for the conservation of lesser florican with the involvement of local communities.

Recommendation:

The lesser florican occupied area in the Shokaliya landscape is enclosed herewith (Figure1), wherein, multiple smaller areas may be identified and declared as community-based conservation areas with the direct consultation/participation of local communities. Within this larger area, the Forest lands of Arwar and Goyla villages along with their surrounding areas, are important breeding habitats of lesser florican. These forest lands can be declared as Conservation Reserve in the short-term. As per observations made during the joint visit of WII and Forest Department, and the species' requirements, the following areas are recommended for the Conservation Reserve, and have been digitised on Topo / Google Earth map (enclosed as Figure 20).

Table 4: Details of Forest Lands recommended for declaration of Conservation Reserve

Proposed Site	Area (Ha.)	Boundary (km)	Surrounding Villages	Dependent Villages
Arwar Forest land	271.3	7.4	Arwar, Badla, ganeshpura	Arwar, Badla and ganeshpura
Goyla Forest land	371.2	8	Goyla, Shergarh, Aathun Ganeshpura	Goyla
Kheeriya Forest Land	241.34	10.8	Kheeriya, Inderpura, Bherukhera and Atumb Ganeshpura	Kheeriya and Aathun Gaeshpura

These Forest lands require management practices to maintain the suitability of the habitat for the species. area wise management recommendations are as follows:

1) Arwar Bid:

- Prosopis removal: Seventy percent of the land is occupied by *Prosopis juliflora* (Vilayati Babool) which has to be removed for successive years to avoid regeneration and planted with native grasses to restore the required grassland habitat.
- Fencing: The area should be enclosed with chain-link fence to protect the restored habitat from undesirable activities. The perimeter of this block is 7.4 km out of which ~2 km has been protected by a stone wall and the remaining fencing work is pending.

2) Goyla Bid:

- Prosopis removal: Sixty percent of the land is occupied by *Prosopis juliflora* (Vilayati Babool) which has to be removed for successive years to avoid regeneration and planted with native grasses to restore the required grassland habitat.
- Fencing: Currently, this land does not have any protective boundary. It is recommended that the entire 8 kms perimeter be enclosed with chain-link fence to protect the restored habitat from undesirable activities.

3) Kheeriya Bid:

- **Prosopis removal:** Eighty percent of the land is occupied by *Prosopis juliflora* (Vilayati Babool) which has to be removed for successive years to avoid regeneration and planted with native grasses to restore the required grassland habitat.
- **Fencing**: Currently, this land does not have any protective boundary. It is recommended that the entire 10.8 kms perimeter be enclosed with chain-link fence to protect the restored habitat from unwanted activities.

It is critical that consultation of local communities be taken in declaring community or conservation reserves for better management and to avoid the persecution of the species.

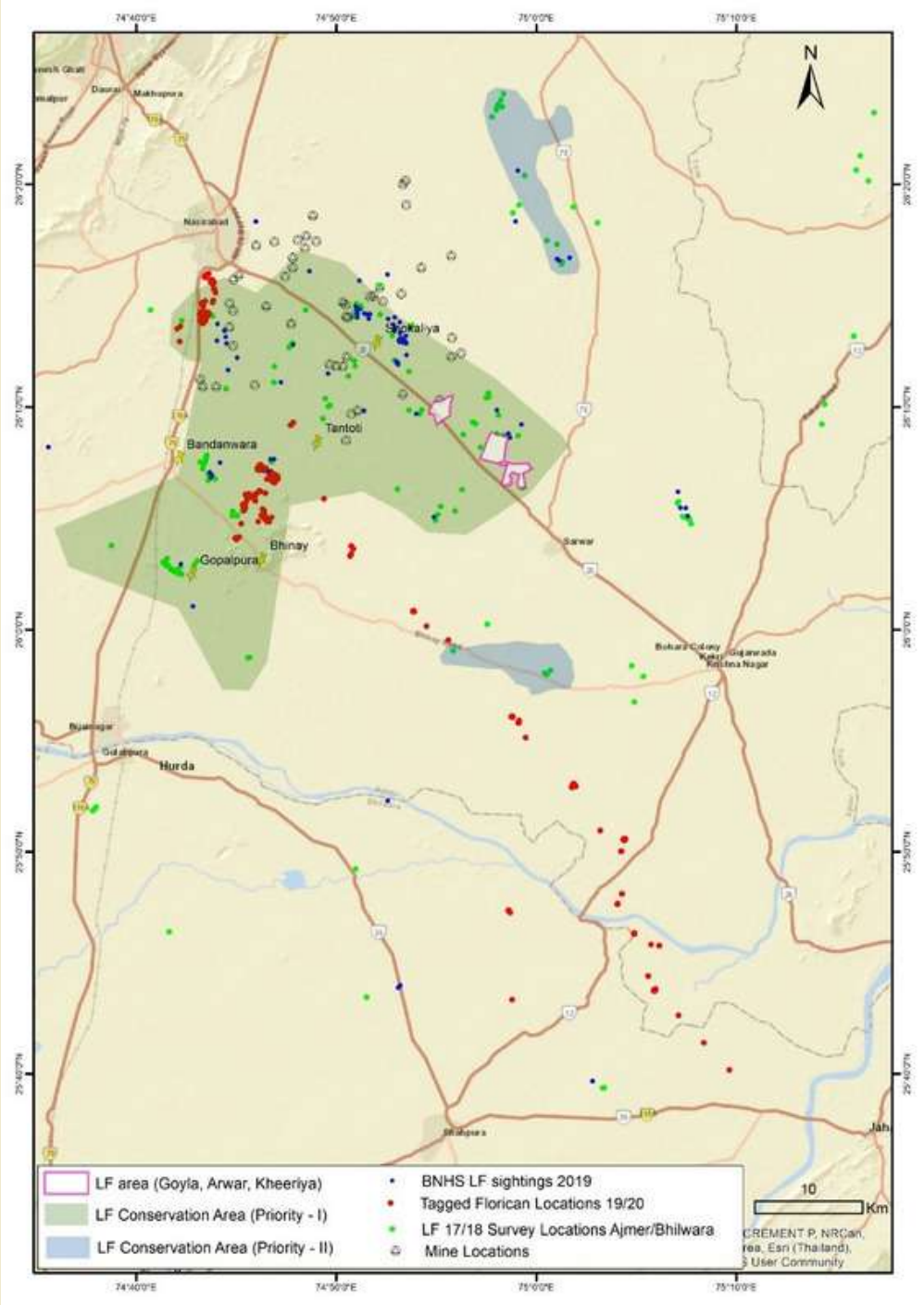


Figure 17: Map showing proposed are for Community Conservation Area in Shokaliya landscape

List of Publications

- **Peer reviewed Journal**

1. Uddin, M., Dutta, S., Kolipakam, V., Sharma, H., Usmani, F., & Jhala, Y. (2021). High bird mortality due to power lines invokes urgent environmental mitigation in a tropical desert. Biological Conservation, 261, 109262.
2. Dutta, S., & Jhala, Y. (2021). Devil is in the detail: behaviorally explicit habitat selection by the Critically Endangered great Indian bustard. Endangered Species Research, 45, 55-69.
3. Kher, V., & Dutta, S. (2021). Rangelands and crop fallows can supplement but not replace protected grasslands in sustaining Thar Desert's avifauna during the dry season. Journal of Arid Environments, 195, 104623.
4. Tripathi, R., Jangid, A. K., Siliwal, M., Dutta, S., & Sudhikumar, A. V. (2021). First record of Menemerus marginatus (Kroneberg, 1875)(Araneae: Salticidae: Chrysillini) from India. Peckhamia, 231, 1-7.
5. Tripathi, R., Jangid, A. K., Siliwal, M., & Dutta, S. (2020). The first report of matriphagy in Stegodyphus pacificus Pocock 1900. Acta Arachnologica, 69(1), 17-21.

- **Technical Manual**

1. Wildlife Institute of India 2018 Power-Line Mitigation Measures. Second edition 2020

- **Status Survey / Short study report**

1. Habitat improvement and conservation breeding of the Great Indian Bustard: An Integrated Approach: 2018 – 2020
2. Roy, A., Uddin, M., Dutta, S., Jhala, Y. 2021. Green Energy? Assessing the Impacts Of Wind Turbines On Birds In Thar Landscape (Ann I / 3.1)
3. Interim report on Status of migratory birds and key wildlife in Bikaner, Rajasthan 2020
4. Progress report of Project “Habitat improvement and conservation breeding of the Great Indian Bustard: An Integrated Approach” for Apr-Aug 2021
5. Status Survey of Migratory Birds and Key Wildlife in Bikaner, Rajasthan 2021

- **M.Sc. Thesis**

1. Aritra Roy, 2020. Green energy? Assessing the impacts of wind turbines on birds in thar landscape. Dissertation submitted to Department of Energy and Environment TERI School of Advanced Studies
2. Sumandrita Banerjee, 2020. Assessing threats to birds from wind turbines at thar and comparing visual & auditory senses of birds, to prevent collision. Master’s dissertation submitted to Bhavan’s college, Andheri
3. Saurav Jagtap, 2020. Effect of wind turbine installation on wildlife usage in the Thar desert. Master’s dissertation submitted to Bhavan’s college, Andheri
4. Idris Ahmed, 2020. Validating density estimation techniques for camera trap data using known population size. Master’s dissertation submitted to Bhavan’s college, Andheri
5. Tatu, A (2021) Thermal Ecology of Spiny-tailed Lizard and its Vulnerability to Climate Warming. Dissertation submitted to the Saurashtra University

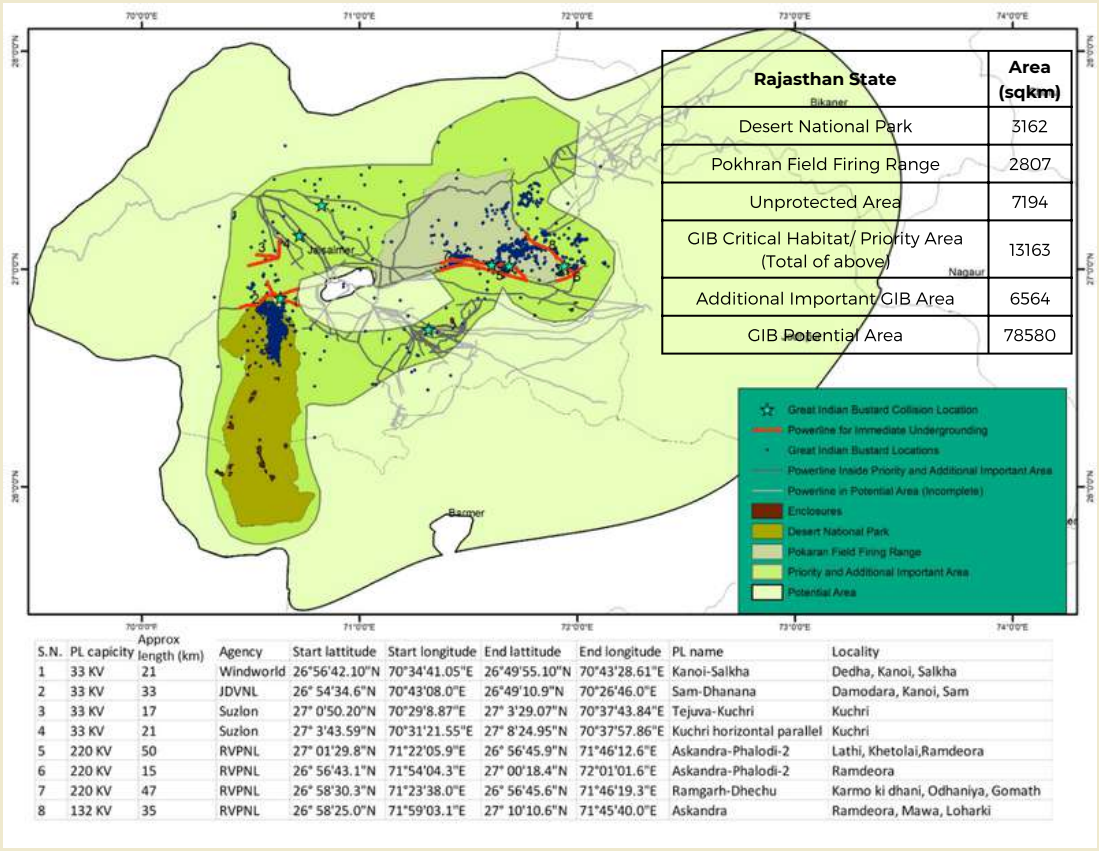
4. Pilot Habitat Management

4.1. Power line mitigation for Great Indian Bustard conservation

Power-lines are a leading cause of mortality for all big bustards including GIB, due to their poor frontal vision and fast, heavy flights (Collar etal. 2017). Ten fatal power-line collisions of GIB have been reported in the last eight years: seven in Jaisalmer (2017-22, with the latest casualty about a month ago), two in Kutch and one in Solapur; whereas, the actual mortality would be much higher as a majority of carcasses go undetected. The estimated GIB mortality (~16% of the population per year) due to power-lines is unsustainable and sufficient to cause the species' extinction within 15-20 years (Uddin et al 2021). According to population viability analysis, GIB can persist only if power-line induced mortality is curbed (no power-line mortality in critical habitats beyond two years and <10% mortality of dispersers outside critical habitats), which would require undergrounding of high-risk power-lines and installing Bird Flight Diverters on low-risk power-lines (MoEFCC's National Bustard Recovery Plan).

The MoEFCC, Rajasthan Forest Department (RFD) and WII have jointly advocated for mitigating the adverse impacts of power installations for the recovery of GIB since 2014. As mandated by MoEFCC and through collaborative surveys and consultation between RFD, WII and MoEFCC, **important areas for GIB** have been identified: a) the Priority / Critical Area covering 13163 sqkm area comprising Desert National Park (3162 sqkm), Pokhran Field Firing Range (~3000 sqkm) and intervening unprotected areas, and b) Additional Important Area covering 6564 sqkm area using more updated information on GIB occurrence/movements (2019 - 2021). These areas hold the majority of current GIB usage, are quintessential for their survival and safe movements, and can hold a viable population if power-line mortality is curbed in this area. Similarly, the Priority Area for Gujarat includes habitats that are most intensively used by GIB covering 477 sqkm area.

Within these important GIB areas, ~250 km of power-lines in Rajasthan (out of existing ~2300 km lines) and ~280 km power-lines in Gujarat (out of existing ~1000 km lines), that cut across the most intensively used movement paths and pose the maximum risk to GIB, were jointly identified for undergrounding on a priority basis. These important GIB areas and most critical power-lines were jointly proposed by RFD and WII in consultation with MoEFCC during the meeting to formulate an action plan for GIB Conservation on 22-23 February, 2021. Immediate undergrounding of these identified lines is critical to achieving the required reduction in power-line mortality, without which GIB would go extinct.



S.N.	PL capicity	Approx length (km)	Agency	Start lattitude	Start longitude	End lattitude	End longitude	PL name	Locality
1	33 KV	21	Windworld	26°56'42.10"N	70°34'41.05"E	26°49'55.10"N	70°43'28.61"E	Kanoi-Salkha	Dedha, Kanoi, Salkha
2	33 KV	33	JDVNL	26° 54'34.6"N	70°43'08.0"E	26°49'10.9"N	70°26'46.0"E	Sam-Dhanana	Damodara, Kanoi, Sam
3	33 KV	17	Suzlon	27° 0'50.20"N	70°29'8.87"E	27° 3'29.07"N	70°37'43.84"E	Tejuva-Kuchri	Kuchri
4	33 KV	21	Suzlon	27° 3'43.59"N	70°31'21.55"E	27° 8'24.95"N	70°37'57.86"E	Kuchri horizontal parallel	Kuchri
5	220 KV	50	RVPNL	27° 01'29.8"N	71°22'05.9"E	26° 56'45.9"N	71°46'12.6"E	Askandra-Phalodi-2	Lathi, Khetolai,Ramdeora
6	220 KV	15	RVPNL	26° 56'43.1"N	71°54'04.3"E	27° 00'18.4"N	72°01'01.6"E	Askandra-Phalodi-2	Ramdeora
7	220 KV	47	RVPNL	26° 58'30.3"N	71°23'38.0"E	26° 56'45.6"N	71°46'19.3"E	Ramgarh-Dhechu	Karmo ki dhani, Odhaniya, Gomath
8	132 KV	35	RVPNL	26° 58'25.0"N	71°59'03.1"E	27° 10'10.6"N	71°45'40.0"E	Askandra	Ramdeora, Mawa, Loharki

Figure 18: Important Great Indian Bustard (GIB) areas with critical power-lines identified for immediate undergrounding in Thar, Jaisalmer

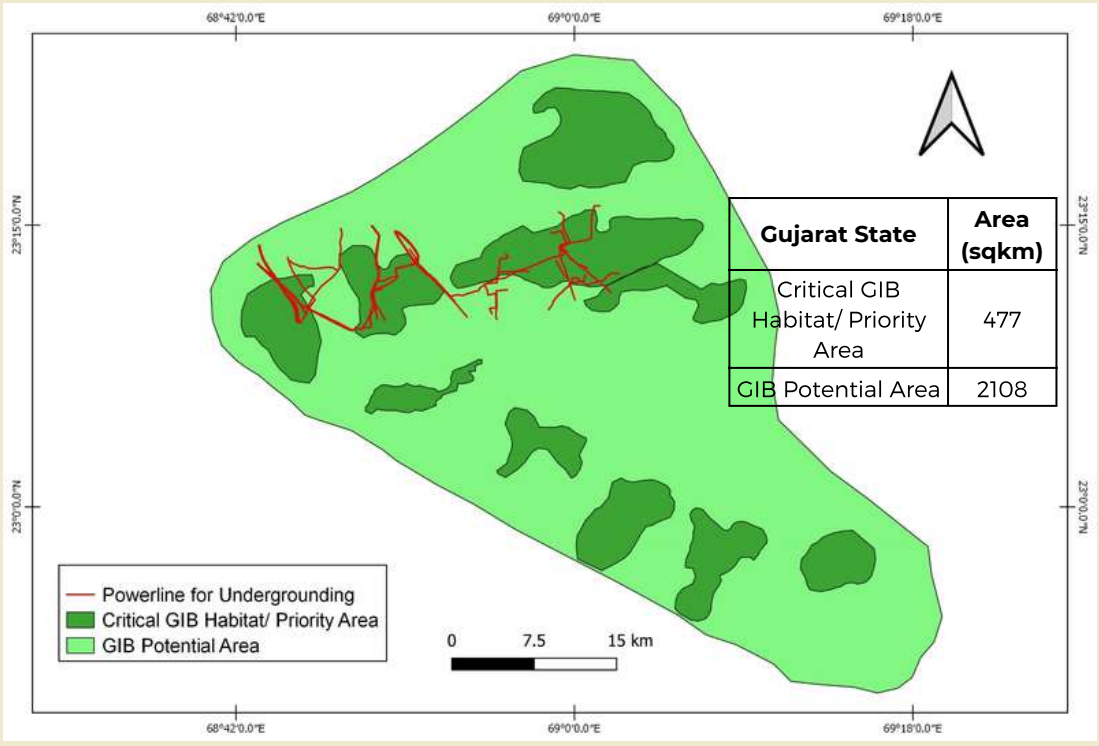


Figure 19: Great Indian Bustard Critical Habitat/ Priority Area with power lines identified for immediate undergrounding in Kutch, Gujarat

The Hon'ble National Green Tribunal (O.A. 385/2019 dated 23.12.2020) had ordered the installation of Bird Flight Diverters on all existing lines in the GIB priority area, and disallowed future lines in this area. Subsequently, the Hon'ble Supreme Court (W.P. (C) 838 of 2019 dated 19th April 2021) had ordered for undergrounding of all powerlines in the GIB priority and potential area, and directed power agencies to install diverters on these lines within 12 months until they are undergrounded. The court has also stated that if any powerline cannot be laid underground for technical reasons, the same can be referred to a constituted committee for ratifying overhead cable. The project carried out an exercise in April 2022, about 12 months after the Hon'ble SC order, to assess the status of powerline mitigation in important GIB areas of Thar. Total powerlines inside important GIB areas in Rajasthan was about 2112 km out of which about 1676 km was sampled. About 10% of lines (165 km) were marked with diverters, whereas the rest was not marked, and about 12% of installed diverters were non-functional / broken.

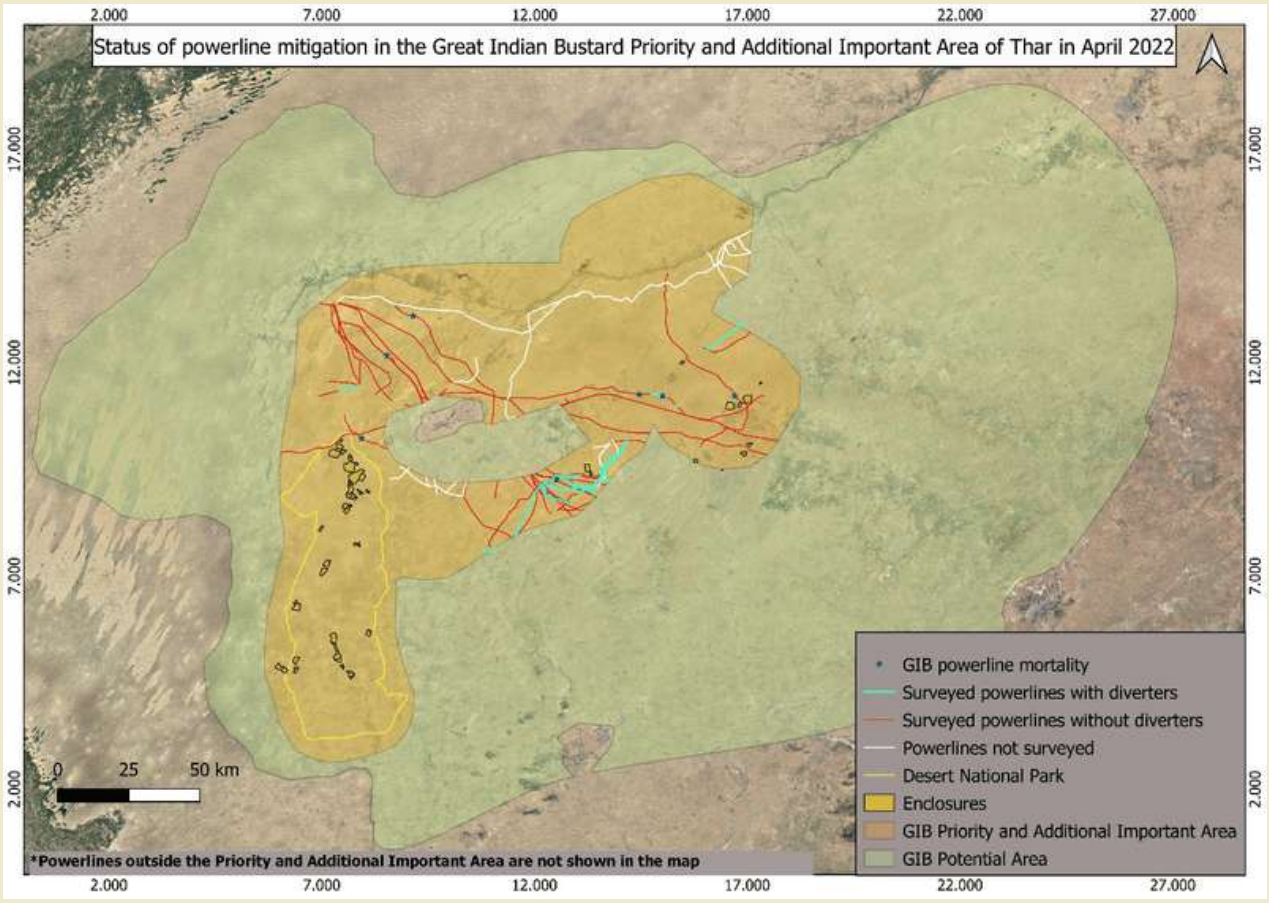


Figure 20: Distribution of marked and unmarked powerlines in Priority and Additional Important Area for GIB in Jaisalmer, Rajasthan as on April 2022

An incident of powerline induced mortality of GIB male was reported by RFD near Parewar, Jaisalmer, Rajasthan (27.2930 N, 70.8161 E) on 20/04/2022. The bird was found dead within 10-15 m of a high-tension power transmission line (RVPNL Akal to Ramgarh 400kV line with bundled wires and a large vertical distribution of cables), and the PME revealed electrocution/ collision as the cause of mortality.

Image 8: The location of Great Indian Bustard carcass close to the powerline.

4.2. Procurement and distribution of indigenous bird diverters for pilot installation on power-lines in Thar

Bird diverters designed based on the project team's technical inputs to local vendors for manufacturing indigenous low-cost bird diverters were procured and distributed to Suzlon energy ltd. for installation. These diverters were installed according to the design provided by WII on 250m segment of 33KV line near Mokla in July 2020. A total of 105 diverters were installed in this pilot step to examine their field longevity and efficacy. To this end, long-term studies are ongoing, since it requires many years and bird crossing/ collision events to detect the field life and effectiveness of these products in reducing crossings and/ or collisions. The project has distributed more than 300 bird diverters of different makes to various agencies during the project tenure.

4.3. Nest predator management

Prevailing nest predation rates are high. Hence, trapping and translocation of nest predators such as free-ranging dogs, foxes and monitor lizards are being carried out in

breeding enclosures of Jaisalmer from June 2020 onwards, with permission granted by the CWLW, Rajasthan. The captured predators were relocated at a considerable distance outside the enclosures. Till now, 213 free-ranging dogs, one fox and five monitor lizards have been removed.

4.4. Repairing of breeding enclosure in DNP

Radio telemetry and ecological monitoring of GIB haves shown that fenced enclosures inside DNP are important for breeding. Possible reasons for this are the low disturbance, high arthropod biomass and heterogeneous understory of these enclosures. Hence, it is important to minimise livestock grazing during the breeding season in this enclosures, as recommended by the National Bustard Recovery Plan Guidelines (Dutta et al. 2013). Fences are broken by local people to enable livestock to graze inside enclosures particularly during summer, when fodder is scarce. Thus, it is important to repair and monitor these fences before breeding season (monsoon) to ensure there is low grazing pressure on enclosures/ grasslands and so that vegetation and insect populations can recover which will benefit GIB recruitment. Surveys were carried out to identify these fence breaks in Sudasari and RKVY enclosures after consultation with Rajasthan Forest Department. These fence breaks were repaired between July and August 2021 when the recruitment of chicks was high. To ensure fencing is not damaged or broken at least till the end of the breeding season, adequate monitoring and patrolling are necessary.

4.5. Regeneration Monitoring

Extension of enclosures has been initiated by RFD in the year 2021. The new extension has been made for RKVY and Gajaimata enclosures. For regeneration monitoring in these areas, camera traps were deployed (January 2022) to check for the movement of animals including GIB.

4.6. Pesticides

Insect and faecal samples of GIB collected from GIB habitat in Kutch, Gujarat were analysed for pesticide presence. Several organophosphate pesticides were found in insect and fecal samples respectively. Though the concentration of these pesticides was within the permissible limit of LD50 concentration, the continuous exposure of such contaminated feed to birds could pose a severe threat in the near future. Locust samples were collected from the GIB habitat in Thar during July 2020 that are being analysed in the lab. As and when information on pesticide spraying in critical GIB breeding enclosures was reported, pesticide sprayed locusts were collected and removed to reduce their detrimental effect on GIB during 2020–21.

4.7. Plans for future GIB habitats in India

Mapping of grasslands in the country is being carried out to find suitable GIB and LF habitats and for future conservation planning.







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BUSTARD
RECOVERY PROGRAM












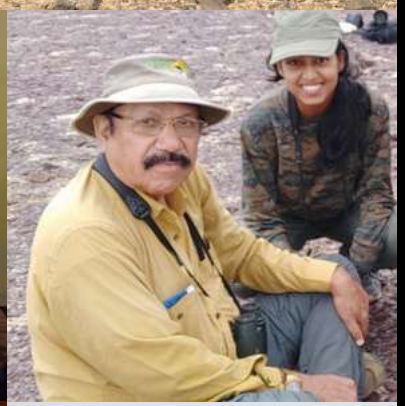


Vinit Bajpai

Designed by: Tanya Gupta

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BUSTARD RECOVERY PROGRAM

الصندوق الدولي للحفاظ على الحبارى
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