BUSTARD RECOVERY PROGRAM

ANNUAL REPORT

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 2021-2024

Project report period: April 2022- March 2023

Total sanctioned budget: 33.85 crore INR
Funds received: 4.53 crore INR (January 2023)
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: 27.57 crore INR

Project implemented by: Wildlife Institute of India

Funding agency: National CAMPA Authority

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
Bombay Natural History Society
Humane Society International
Jivdaya Charitable Trust
The Grasslands Trust

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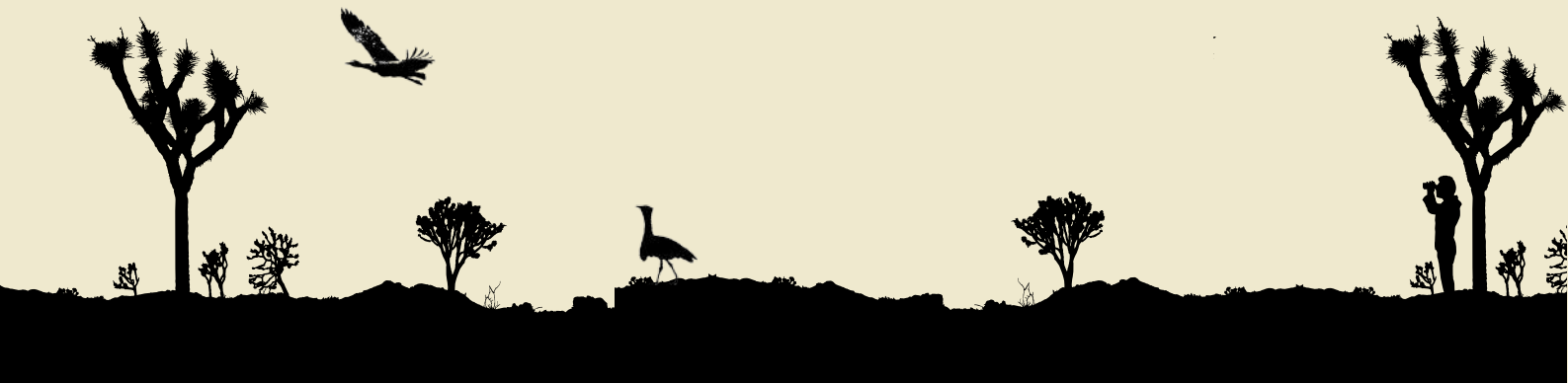

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Ashok Chaudhury

Background

The Great Indian Bustard (GIB) Ardeotis nigriceps and the Lesser Florican (LF) Sypheotides indica are Critically Endangered with less than 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. To conserve these flagship species of grasslands, National Bustard Recovery Plans (2013) was developed by the Ministry of Environment, Forest & Climate Change (MoEFCC) in consultation with scientists and managers, that recommend:
a) establishing and protecting enclosures to improve breeding success,
b) mitigating threats in intensively used areas 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

Bustard range state Forest Departments were mandated to implement these actions. However, the vast expanses of bustard habitats, multiple conflicting interests and partial control of the Forest Department over these lands, limited by the paucity of critical conservation information delayed the implementation of these actions. A workshop held in New Delhi (2014) to decide whether 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 as well as 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 was granted from 2021 to 2024. The project activities are being implemented in collaboration with MoEFCC, Rajasthan and other bustard range state Forest Departments, International Fund for Houbara Conservation (IFHC) 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

Project milestones (2016 – present)

Conservation Breeding

1. A tripartite Memorandum of Agreement was signed between MoEFCC, Rajasthan Forest Department (RFD) and the Wildlife Institute of India (WII) in July 2018.
2. Sites in Ramdevra and Sorsan in Rajasthan were selected for long-term conservation breeding facilities. Since the construction and operation of new facilities would require a few years, a temporary facility was established in Sam, Jaisalmer, in June 2019. A long-term facility has been developed at Ramdevra and has been made functional in August 2022.
3. These two facilities currently house 22 hand-reared captive GIB that were secured from 31 wild-laid and artificially incubated eggs.
4. The world's first captive-bred Great Indian Bustard chick hatched in March 2023 in Sam Conservation Breeding Centre (CBC) at Jaisalmer. This chick has been artificially hatched from an egg laid by a captive-reared bird via natural breeding.
5. Conservation Breeding of LF was commenced in a temporary centre at Bijainagar, Ajmer from 2020 which houses eight LF from wild collected artificially hatched eggs, which are being reared following similar approach.
6. A Memorandum of Understanding was signed between the WII and the IFHC for bustard conservation in September 2022.

Applied Research

1. The status of GIB, its associated fauna and habitat was assessed in Rajasthan and Great Indian Bustard (GIB) population was estimated at 128 ± 19 in 2018.
2. Two range-wide surveys for Lesser Florican (LF) were carried out that yielded a population estimate of 426 (174-805) males in 2017-18.
3. Bird mortality due to power lines was assessed using carcass surveys in Thar (2017-18) and Kutch (2018-19), that showed mortality of three GIB in Rajasthan, and an estimated death of ~21,000 birds (all species) annually per ~1000 km² area in GIB habitats of Rajasthan and Gujarat.
4. Ten GIB and nine LF were fitted with transmitters to understand their ecology, movement patterns. This information has since been used for spatial prioritisation and conservation planning.
5. Sociological surveys were conducted in/around Desert National Park (DNP) to understand livelihood issues and conservation perceptions of local people.

Capacity building and awareness

1. Series of awareness programs were carried out in Jaisalmer and Ajmer districts in Rajasthan, to sensitize school children, local people and tourists about bustards and biodiversity conservation.
2. Over 200 frontline Forest Department staff and numerous wildlife enthusiasts across bustard range states were trained on wildlife population assessment techniques in 2016-18.
3. Meetings & workshops were carried out jointly with RFD and MoEFCC to sensitize power agencies and regulatory bodies on the impact of power lines on bustards and the necessity of mitigation measures. Technical inputs to several power agencies & diverter developers were provided to implement power-line mitigation measures in Important GIB Areas.
4. Project team shared evidence-based recommendations on legal issues pertaining to GIB conservation in the Hon. Supreme Court, Jodhpur High Court, NGT Delhi and NGT Bhopal.
5. A documentary film on GIB conservation was developed (available at youtu.be/XR5Z_rA7xd0).

Pilot habitat management

1. Important GIB Areas in Rajasthan and Gujarat were delineated jointly with RFD, and a species conservation action plan was developed, as mandated by NGT in 2019-21.
2. Critical conservation area for LF in Rajasthan was identified for Rajasthan Forest Department in 2021.
3. Mapping of key threats — power lines and renewable infrastructure across 20,000 km² GIB landscape in Rajasthan was carried out. Existing power lines were prioritized for mitigation across GIB habitats in Rajasthan and Gujarat.
4. Bird flight diverters of various makes were procured and pilot installed to test their designs, durability & effectiveness (ongoing).
5. Chain-link enclosure fences in DNP were repaired and maintained in consultation with the Rajasthan Forest Department to improve GIB breeding success and recruitment in the wild.
6. Sterilization of 801 dogs from 23 villages in/around DNP in collaboration with Humane Society International (HSI) India in 2018-19.
7. Capture and translocation of predators such as monitor lizards, foxes and free-ranging dogs (~300) in key breeding areas of DNP.

Project Activities (April 2022 – March 2023)

Conservation Breeding of GIB

Background: The Sam Conservation Breeding Centre (CBC) has been operational since June 2019. This facility houses a founder population of 13 GIB that were collected as eggs from the wild and hatched artificially in this facility. The Ramdevra CBC has been under construction since 2019 and was made operational in August 2022. In 2022, nine eggs were collected from the wild, hatched at Sam CBC and then shifted to Ramdevra CBC. Currently, the founder population consists of seven males, 15 females and one chick.

Egg collection: All nine eggs collected from the wild were brought to the Sam CBC in a foam padded box or a portable incubator in a slow moving, good suspension and temperature-controlled vehicle. One egg was collected from a captive female in Sam CBC.

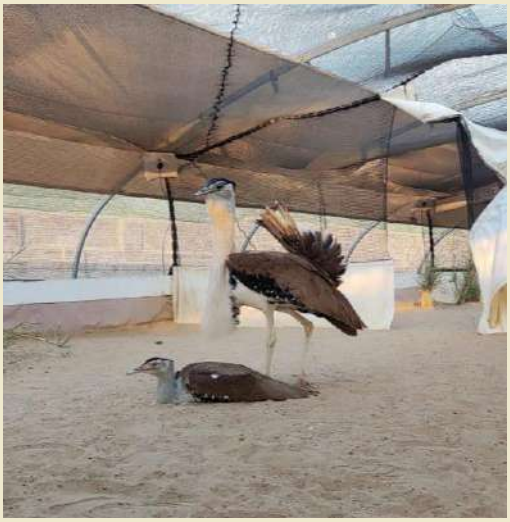
Artificial incubation: All eggs were incubated at the Sam facility. The incubation room was maintained between 20-25 ^{o}Celsius (C) and 30-40% Relative Humidity (RH). They were incubated in Brinsea Ovation Incubators at 37.5 ^{o}C. The humidity was regulated based on the egg's requirements. The eggs were monitored daily to check for signs of development and fertility. Once the external pip was noticed, eggs were transferred to the hatcher that was maintained at 37^{o}C and 55-65% RH. The eggs took 6-22 days from collection to hatch. Total incubation period was ~22 days.

Chick rearing**:** The chicks were kept in the brooder for 24-36 hrs after hatching. One day old chicks were then shifted to the chick rearing room which is maintained at 27-30^{o}C and 30-40% RH. Chicks were kept in transparent boxes with rubber mat as substrate and provided with heat lamps. They were kept individually or in pairs (if of similar age). They were imprinted on the keepers as imprinting is essential for close monitoring, handling for vetcare and assisted reproduction in captivity. They were reared on a balanced combination of Mazuri Omnivore diet, mealworms, crickets, mice, alfalfa, pomegranate, watermelon and were gradually introduced to dry balanced pellets containing 24% Crude Protein (CP). They were taken to the outdoor cage for exercise from the tenth day and were kept in the chick rearing unit till they turned 30 days of age.

Juvenile rearing**:** The nine birds that hatched in 2022 were shifted to the juvenile unit in Ramdevra and are currently housed there. These birds were trained for transport by performing short drills before the actual transport. Chicks were placed in foam padded plastic crates having a sandy substrate

and modified lid and transported in a temperature-controlled vehicle with good suspension. Vital parameters were monitored before, during and after transport by a veterinarian and the exercise was carried out along with a representative from RFD. The transportation was carried out at night to minimise stress and disturbance. It took 3-4 hours by road to travel 160 km between the two centres. The juvenile unit at Ramdevra CBC consists of an indoor unit with net cages connected to an outdoor cage. The birds are kept indoors at night and during inclement weather and in the outdoor holding area during the day. The birds gradually transitioned to eating dry balanced pellets containing 24% CP. Mealworms, crickets, mice, alfalfa, mustard and other seasonal fruits and vegetables are also provided. Vaccination and health monitoring is conducted regularly.

***Adult rearing*:** Adult birds in Sam are housed in individual net cages and are allowed to move between cages for a few hours every day. These birds are fed dry balanced pellets containing 14-18% CP along with live invertebrates produced at the centre and locally available fruits and vegetables. The birds are vaccinated against major diseases and their health is monitored regularly. Across the year, adult females weighed between 3.6-5 kgs and males weighed between 5-9 kgs.



Ramdevra centre construction: Establishment of Ramdevra Conservation Breeding Centre was continued and included the construction of staff quarters, a quarantine / PME unit, a research & communication unit, and additional bird cages. Defects in existing buildings were repaired by the Central Public Works Department (CPWD). External water connection work was carried out by the Public Health Engineering Department (PHED) during Oct 2021-Jan 2022. The centre was equipped with necessary equipment, appliances, electronics and furniture. Additional works included upgradation of transformers to make the existing solar plant functional, borewell and Reverse Osmosis

(RO) plant installation by CPWD, construction of additional bird cage, erection of inner predator proof fence around bird cages, and an upgradation of the outer fence of the centre. Veterinary equipment for three centres (x-ray, gas anaesthesia, surgical instruments etc.) were procured.

Image: Ramdevra juvenile unit - Outdoor and Indoor cage

Jumpstart: The project team attempted a novel jump-start technique where an egg collected from a wild female's nest was artificially incubated in Sam CBC and returned to the nest immediately prior to hatching. Along with this attempt, a remote CCTV setup was built and deployed on field which allowed live monitoring of the nest. This first attempt was successful and the chick continues to survive to this day. This technique was conceptualized to combat the high predation rates faced by GIB eggs in the wild.

Captive-breeding: In an important milestone for the Program, two females copulated with a male in Sam facility, and laid eggs. A chick hatched through artificial incubation of one of these eggs in March 2023. This is the first instance in the world wherein GIB have bred in captivity.

Image: The first GIB chick born from captive raised birds at Sam Conservation Breeding Centre, Jaisalmer in March 2023

Training: Four project personnel were trained in semen collection and insemination of poultry in Anand Agriculture University, Anand in February 2023. Three project personnel were trained in artificial breeding techniques at National Avian Research Centre (NARC), Abu Dhabi in 2022-23.

Image: Training at IFHC (International fund for Houbara conservation - International collaborators) for bird artificial insemination and semen collection

Image: Honourable Minister of Environment, Forest and Climate Change Shri Bhupendra Yadav visited the Sam Conservation Breeding Centre, Jaisalmer in April 2022

Collaboration

A Memorandum of Agreement between the WII and IFHC to undertake collaborative work aimed at the conservation of GIB and LF was signed in September 2022.

Conservation breeding of LF

The temporary LF breeding facility has been operational since 2020 at a private rental property in Bijainagar, Ajmer.

Nest search, egg collection and artificial incubation: The Project team found four nests during the breeding season (July to October 2022) from Shokaliya landscape in Ajmer district and collected ten eggs. These eggs were transported to the Bijainagar facility, where they were artificially incubated following a procedure similar to the GIB. At present there are seven birds, three males and four females.

Chick rearing*:* Chicks were shifted to first age unit after 24-36 hours of hatching, where they were kept in transparent acrylic glass boxes (dimensions 60 ×45 ×30 cm) on rust proof inox tables with padding of soft mats as the floor. Room temperature and humidity were controlled and chick boxes were provided with heat lamps in corners to provide required and voluntary heat use by chicks. Chick were hand fed on soft balanced diet pellets (SDS), mealworms, crickets, alfalfa (invertebrates and vegetables fed to birds are produced at the facility) and seasonal fruits. Feeding during the first age was mostly done by keepers by hand at regular intervals of one hour. When the chicks were 15 days old, they were gradually shifted to an indoor rearing cage with sand and gravel layering for exercise and acclimatisation. Subsequently, 20-day old chicks were taken to an outdoor cage for short periods of exercise. Chicks were weighed daily and measured on alternate days to monitor their health and growth.

Juvenile rearing: Birds were shifted to outdoor cages and kept in flocks at the age of 30-35 days (during October-November). Outdoor cages contained internal soft net layering (dimensions 3×4×3m), gravel with grass, alfalfa and small shrubs for cover. Birds were fed at regular intervals of 1-2 hours in morning (0700-1300 HRS) and evening shifts (1600-1800 HRS) with soft balanced diet pellets and dry balanced diet pellets, mealworms, crickets, alfalfa and seasonal fruits and vegetables. Chicks were weighed daily and measured twice a week to monitor their growth. Birds gained their adult weight, 450g (male) and 550g (female), within the first two months. Birds were kept indoor during nights till 60 days of age and were shifted to outdoor cages during day time.

Adult rearing: After two months of age, birds were completely shifted outdoors. During winter (mid November - February) when temperatures at night drop below 10-15^{o}C, birds are housed in indoor cages. They are shifted back to outdoor cages in March, when temperatures remain >17^{o}C. Individuals are kept in separate compartments inside the cage as these birds are territorial. Birds are weighed once a week, and timely vaccinations and health checks are conducted. Their body weights range between 460-480g (male) and 550-580g (female).



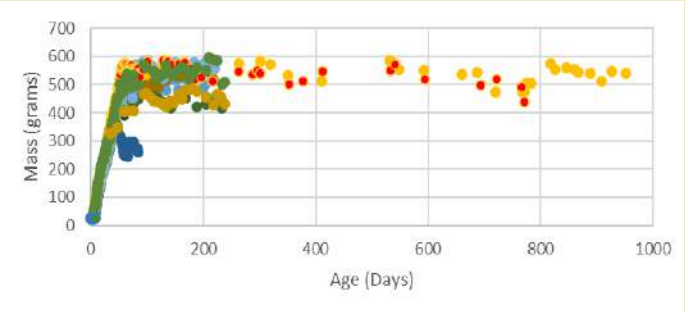


Figure: Growth pattern of captive Lesser Florican at the Lesser Florican Conservation breeding facility in Bijainagar, Ajmer

Image: Lesser Florican Conservation breeding facility in Bijainagar, Ajmer

Image: Lesser florican female (adult)

Image: Lesser florican male (adult)

Applied research

GIB population survey

Three seasonal surveys were conducted in April 2022, September 2022 and February 2023 respectively, to assess the current status of GIB and habitat in/around DNP — from Sam to Ramgarh (hereafter, western Thar landscape). The study area was divided into two sampling blocks — protected and non-protected (with renewable energy infrastructure). A total of 44 grids of 36 km² (6 × 6 km) were sampled to obtain information on GIB, its habitat and other co-occurring species. Surveys were conducted following a pre-established vehicle transect based survey protocol (Dutta et al., 2018). Data for GIB and other key wildlife species was recorded in an Occupancy and Distance sampling framework, and habitat features were recorded at every 2 km along the transect. These surveys yielded an abundance estimate of $31 \pm 11_{SE}$ for adult Great Indian Bustards. With additional recruits (sub-adults of more than 6 months age) of the current year, the total population size of western Thar population is approximately 40 individuals. Population estimates for all key wildlife species recorded during the survey are summarised in the table below.

Table 1: Summary of population estimates for all target species surveyed in the western Thar landscape.

Species	Detections	Occupancy	Density (per 100 sq.km)	Abundance Estimate
GIB (adult)	47	0.44 (0.22-0.93 CI)	$2.9 \pm 0.98_{SE}$	$31 \pm 11_{SE}$
Chinkara	617	0.99 (0.96-1.00 CI)	$170.2 \pm 14.7_{SE}$	$2757 \pm 238_{SE}$
Desert Fox	48	0.53 (0.15-1.00 CI)	$35.4.1 \pm 2.9_{SE}$	$212 \pm 48_{SE}$
Nilgai	35	0.26 (0.15-0.67 CI)	$8.1 \pm 2.3_{SE}$	$132 \pm 38_{SE}$

Our rapid assessment shows that suitable habitat ground vegetation for GIB exists in both protected (DNP) and non-protected (north of DNP) areas; with both areas dominated by grasslands ($0.64 \pm 0.04_{SE}$) and with vegetation of height 30-100cm ($30.32 \pm 2.57_{SE}$). The total cover of agricultural land (active and fallow) was also lower in the non-protected block (~43%) as compared to the protected block (~58%). However, despite suitable habitat, the density of GIB in this block was much lower than the density in protected areas. This could be largely explained by the widespread renewable energy infrastructure (particularly powerlines) in the unprotected northern block, which has been found to be a direct threat to the survival of the species as a result of collisions with power lines.

GIB ecological monitoring

In addition to telemetry-based monitoring, we conducted ground surveys to get a better understanding of GIB ecology. We recorded important life-history and demographic parameters of both tagged and untagged GIBs and estimated vital rates such as breeding success, chick survival and recruitment rate. Our monitoring of 84 eggs across three years suggests that hatching success of GIB eggs in the wild is 25-35% and first quarter chick survival rate is about 50-60%. However, in case a breeding attempt fails, a female GIB can re-lay up to 3-4 times in a breeding season. Given the ability

of the species to re-lay multiple times and the low wild nest survival, collection of eggs for conservation breeding is expected to have minimal effect on the recruitment and population size in the wild. Intensive monitoring of life history parameters has refined our understanding of the species' biology.

In the breeding season of 2022-23, 25 nests containing 32 eggs were detected (seven double clutch nests). Of these 17 nests were in DNP, five in Salkha and three in Ramdevra and Pokhran Field Firing Range (PFFR). Of these, 23 nests were monitored for estimating breeding success. Chicks of the five tagged birds were monitored to estimate chick survival. Additionally, a chick survey was conducted in December 2022 to assess first quarter chick survival and recruitment in the wild.

GIB telemetry and tracking

A total of eight Great Indian Bustards has been tagged in DNP between March 2019 and June 2021. Seven of these birds were tagged using GSM/GPRS PTTs (e-obs telemetry 42g Bird Solar tags) that collect data from inbuilt GPS and accelerometer sensors. One bird has been tagged using a GSM PTT from Microwave telemetry that collects only GPS information. Two of these tags had become dysfunctional prior to 2022. In 2022-23, no new birds were tagged and two more tags became non-functional at the end of the breeding season. Thus, we monitored six tagged birds during the breeding season of 2022 and the remaining four tagged birds in the non-breeding season.
The data from the tags was used to mainly monitor movement, life history and behaviour of the species. The GPS sensors provided information on ranging and movement; and accelerometers provided insights into behaviour of the species. All birds were ground-tracked and visually observed regularly to keep a log of life-history events.

Like previous years, tagged birds used old-growth grasslands in areas such as Sudasari, PPC Chouhani and Salkha during the breeding season; and agro-pastoral and regenerating areas such as RKVY, crop fields of Ganga, Jamra, Neemba, Chouhani, Kanoi, Barna, Bida, Salkha villages etc. in the non-breeding season. This information was used to assess effectiveness of management strategies and prioritise areas for upcoming in-situ conservation.

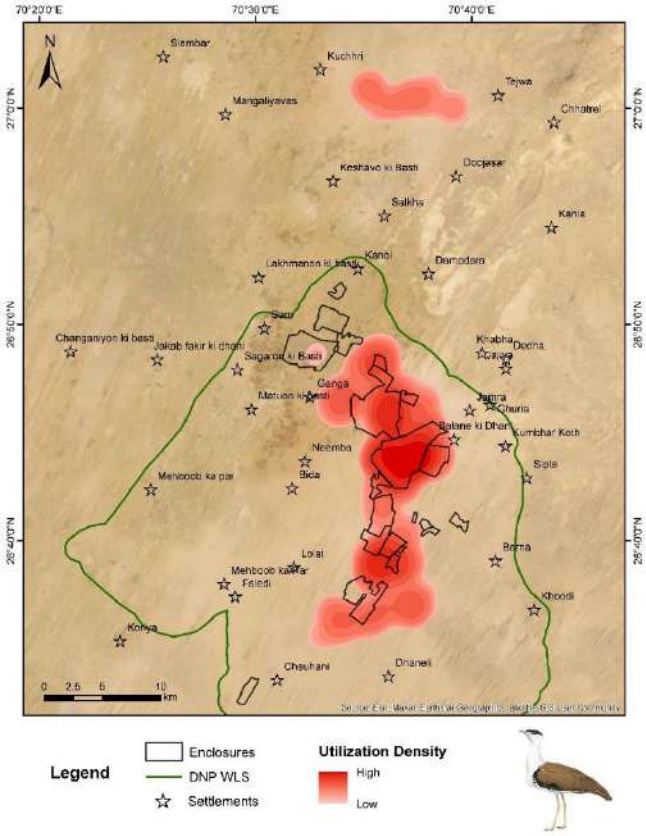


Figure: Tagged GIB use of the landscape obtained from telemetry data

Ranging patterns were assessed across demographic stages. Home range of a breeding female during the first six weeks of chick rearing is less than 2 sq.km and increases substantially afterwards, once the chicks undertake long flights after about week 10.

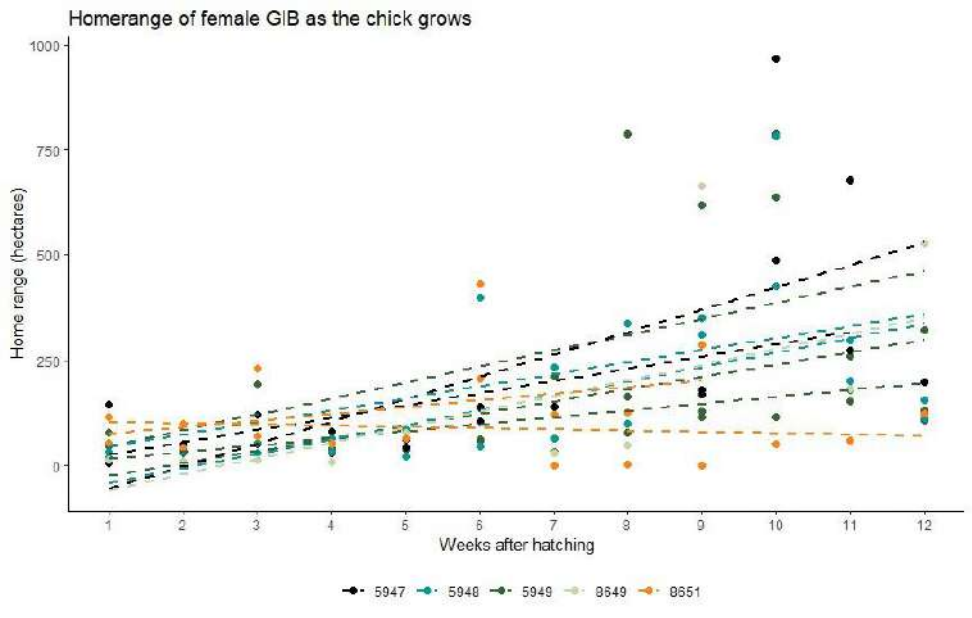
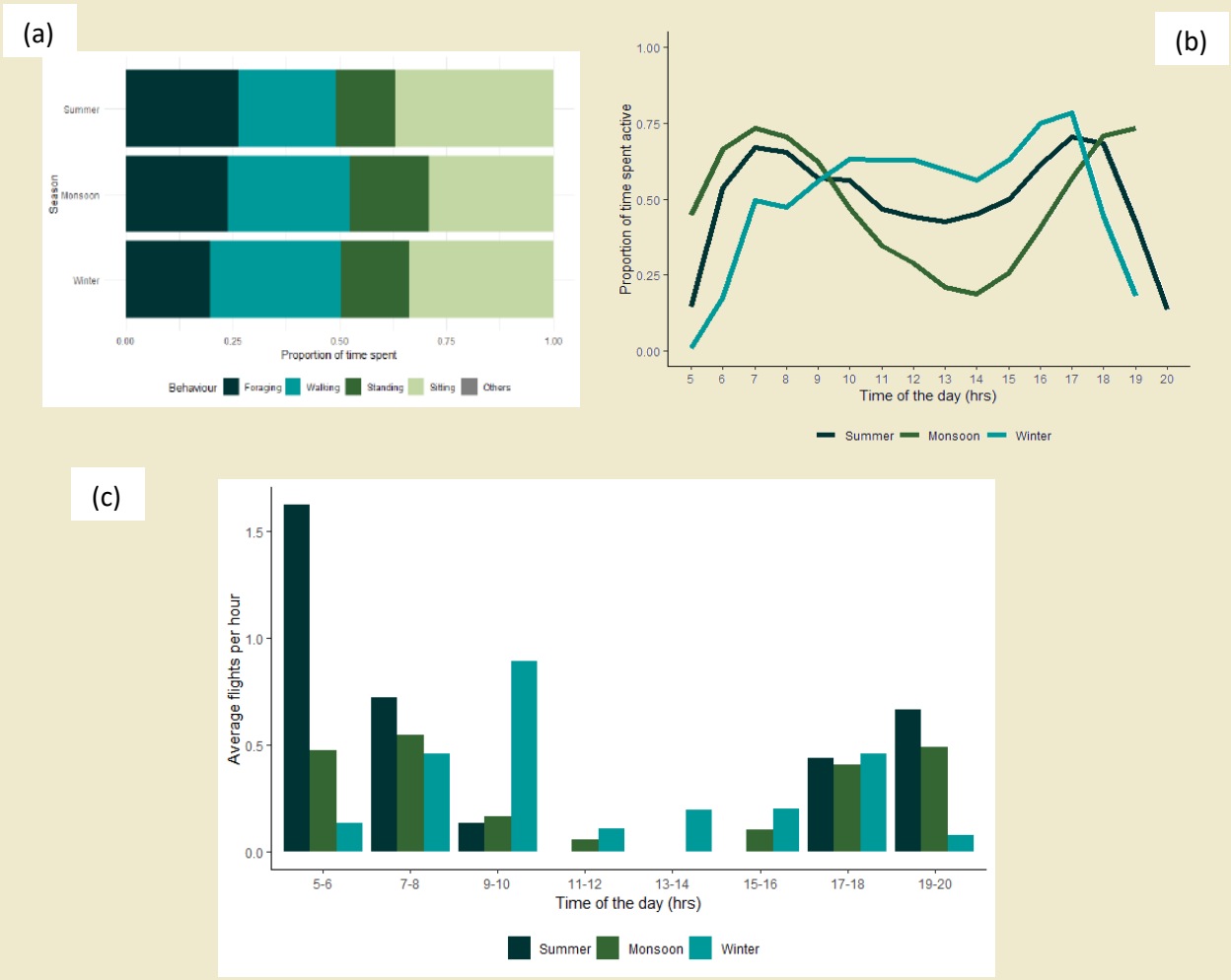


Figure: Home range of tagged GIB females with the progress of chick growth

The accelerometer sensors in PTTs record triaxial acceleration of the animal, which after calibration can be used to remotely identify target behaviours. We trained a random forest model (accuracy of 92.38%) using 421 time-calibrated video samples from wild and centre birds to classify accelerometer data into 5 behavioral classes of interest. This allowed us to estimate time activity budgets for GIB without the need of physical behaviour observations. Our results showed that, across different seasons the total time allocation between behaviours is similar but diel activity patterns change, with clear restriction of activity due to heat in summers. Accelerometers also allowed us to quantify frequency of flights, a rare behaviour of conservation importance. We found that female GIBs take 6.5 flights per day on an average and most flights are taken during the early morning hours. These results are preliminary in nature and we hope to refine our models and analysis in the time to come.



Figure(a) Proportion of time spent- season wise (b) Proportion of time spent- daily (c) Average flights per hour taken by GIB

Lesser florican telemetry and tracking

The team tagged four Lesser Floricans — two males and two females between August to September 2022. The birds were tagged near Bandanwara, Dhantol and Kalyanpura villages of Ajmer district. Their movements were tracked till they reached wintering grounds.

One female was tagged on 24th August 2022 at the nest after egg collection in Dhantol Area. The bird was fitted with Ornitela tag Model OT-103GC S/N 215636 weighing 10g. The female left the tagging site after one week and went to Pali, then moved to Patdi area of Gujarat, and then started moving

towards south India and reached Jangaon area in Andhra Pradesh towards the end of September 2022. All of winter was spent within 30 km of this area. Habitat sampling of the female's locations was carried out during November to December 2022. The tag is functional and transmitting till date. Since tagging the bird has travelled about 1400 km.

Another female was tagged on 6th September 2022 at the nest after egg collection and was fitted with a Milsar Radio-tag S9 weighing 10g. The female moved out of the tagging site to Bandanwara area after which it started its journey back towards south India and reached Bidar area of Karnataka towards the end of September 2022. The bird spent winter in fallow and active agricultural fields of Bidar. Ground tracking and habitat sampling of its locations is being carried out. The tag is functional and has been transmitting data till date.

One male caught on 25th August, 2022 in Kalyanpura was fitted with Ornitela OT-103GC tag weighing 10g. Post-tagging, the bird remained close to the tagging location for the rest of the breeding season (till 14th October 2022). By then, most of the agriculture fields were harvested in the locality, and it moved 3.5 km away near Tantoti area where it stayed till 19th October 2022. After that, it started moving out of the area, taking stopovers for 2-3 days at locations near Satolao, Bogla, Jahazpur, Baroda, Jakholi Kalan villages, following which it reached an area near Jalindri village close to Bhimlat Mahadev area on 5th November 2022. It was localized there for three weeks in a scrubland habitat. On the night of 22nd October 2022, the transmitter started giving erroneous positions, and when tracked on ground, it was found to be a case of natural death, evidence suggesting as a result of predation. The bird travelled for 220 km and lived for 89 days post tagging.

Another male was tagged on 24th August 2022 in Dhantol area and was fitted with an Ornitela tag Model OT-103GC weighing 10g. Post-tagging the bird displayed from the same field for next 2 weeks, and began moving out and exploring other sites in Nagola, and Shahpura area. The male reached Khatpa Kireka village of Neemuch district of Madhya Pradesh and last transmitted on 24th October 2022. The tag malfunctioned at this point and is currently non-functional.

The ongoing tracking and monitoring of Lesser Florican is improving our understanding of the species' non-breeding ecology, threats, and behaviour.

(a)

(b)

(c)

Images a & b- Tagged LF females with backpack harnessing, (c) Lesser florican nest in crop field of Jowar at Dhantol, Ajmer in August 2022.

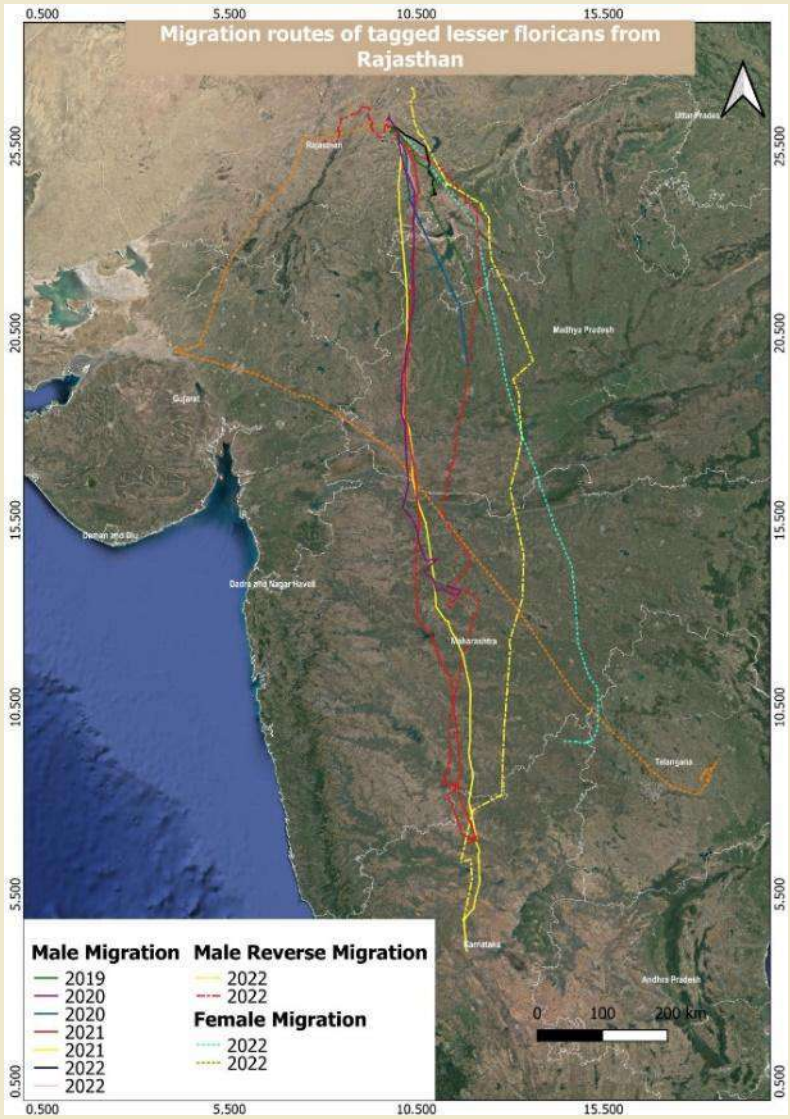


Figure: Migration routes of tagged lesser florican

Threat assessment

Previous studies have shown that power lines are a key current threat for GIB and associated birds. Surveys conducted in 2017-2018 in the Thar landscape have estimated that about 88,000 birds die every year due to power line related mortalities. Power lines span a distance of about 2000 km in the landscape and have increased multifold in the last few years. More recently, power lines are being marked with bird flight diverters as per the Hon. Supreme Court's directives. This situation provides an opportunity to monitor mortality rates due to power lines and evaluate the effectiveness of ongoing mitigation measures. Carcass surveys were conducted in March and April 2023. Observers searched for carcasses from a slow-moving vehicle and searched a belt of 30m on either side of the power line. Carcasses were identified to the species level or to their finest discernible taxonomic grouping. Data on diverter installation, type and their placement was also recorded for these power lines. The survey covered a distance of 156.33 km and a total of 35 carcasses were found. Results show that the majority of deaths were within 5m of the power line pylons. All carcasses were large bodied birds (size class > 1000 g) and primarily raptors (eagle and vulture spp.). The mortality rate was estimated at 0.29 (95% CI 0.097 - 0.486) carcasses per km per day. It is likely that smaller birds were

missed during the survey, and the method will be refined, by incorporating imperfect detection, and continued for large-scale monitoring of bird mortalities and effectiveness of powerline marking.

Image: Power line caused bird mortality in Thar

Technological innovation for conservation monitoring

A species classification tool was developed to automatically classify camera trap images based on image features. The tool was based on a Convolutional Neural Network model that used a transfer learning approach. Our multi-class species classification model had a macro-averaged F1 score of 0.95 and overall accuracy of 94%. The precision score for the critically endangered Great Indian Bustard was 99%. A graphical user interface was also developed to facilitate running of complex CNN models.

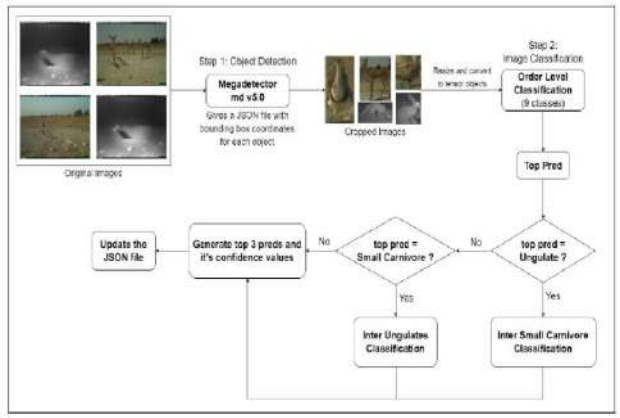


Figure: Flowchart representing the end-to-end pipeline for image classification

GIB nest habitat sampling

In the year 2022, 26 nest locations were surveyed for land cover, insect abundance, vegetation and anthropogenic disturbance. Two 50m × 2m belt transects were laid in two cardinal directions for arthropod abundance estimation. Arthropod numbers were counted visually with distinction between Orthoptera, Coleoptera and other insect classes. Vegetation was sampled in five 2m × 2m quadrats inside the arthropod sampling belt. The ground cover and height class of understory plant species was

quantified by visual estimation. Infrastructures and anthropogenic disturbances were noted in a 200 meter radius around the nesting location.

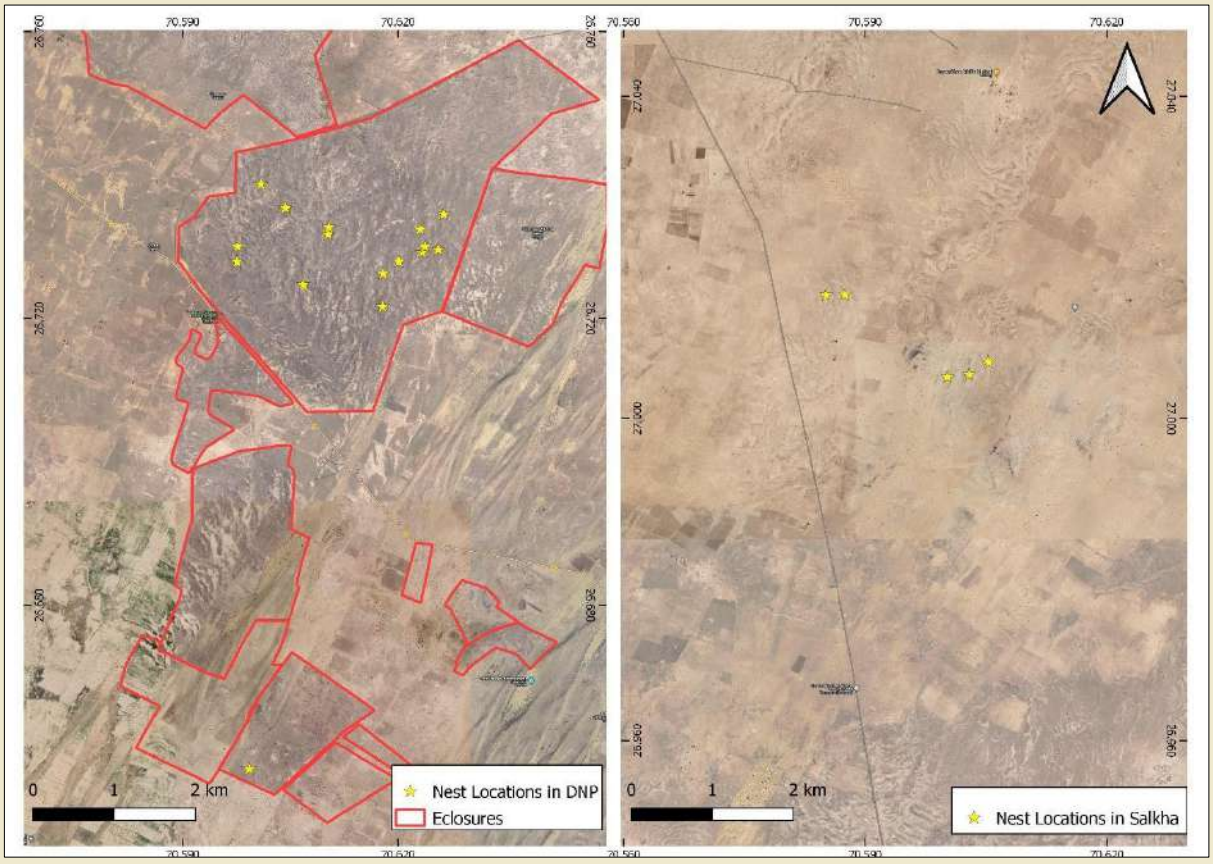


Figure: Nesting location surveyed in 2022 in and around DNP

Habitat assessment of GIB usage area in Western Thar Landscape

A 520 km² area in and around the northern part of DNP was identified for habitat assessment of GIB. The objective was to understand seasonal habitat use of GIB with respect to ground vegetation, disturbance and resource availability. The study area was delineated based on a 95% Minimum Convex Polygon generated using telemetry data for five birds over three years. This area was divided into 520 cells (one km² each) and 110 cells were randomly selected for sampling. Each selected cell was sampled for vegetation structure, land cover, human disturbances, arthropod abundance, and availability of plant-based food resources for GIB. In each cell, two 0.25 km² sub-cells were randomly selected for sampling during a season (Summer: mid-March to mid-June, Monsoon: mid-July to mid-October and Winter: mid-November to mid-February). In each sub-cell, data was collected for land use, land cover (in 50 m and 200 m radius), vegetation structure, vegetation composition, insect abundance, anthropogenic disturbances, grazing pressure and other food resources. Two belt-transects of 50m × 2m were sampled to estimate insect abundance. Trees (height above 2 meter) and shrubs (height above one meter but less than two meter) were sampled on belt-transects of 200m × 50m and 200m × 20m respectively. Within each 200-meter belt, nine quadrats of 2m × 2m were laid to estimate understory structure and composition. For each understory species (herb and shrub under one meter), height was measured using a stick marked at every 10 cm and ground cover corresponding to each height class was estimated visually. Cattle dung and goat/sheep pellets were counted within

a belt of 25m × 2m. A total of 110 cells were surveyed across three seasons in 2022-23. The data collected during the survey is currently being analysed.

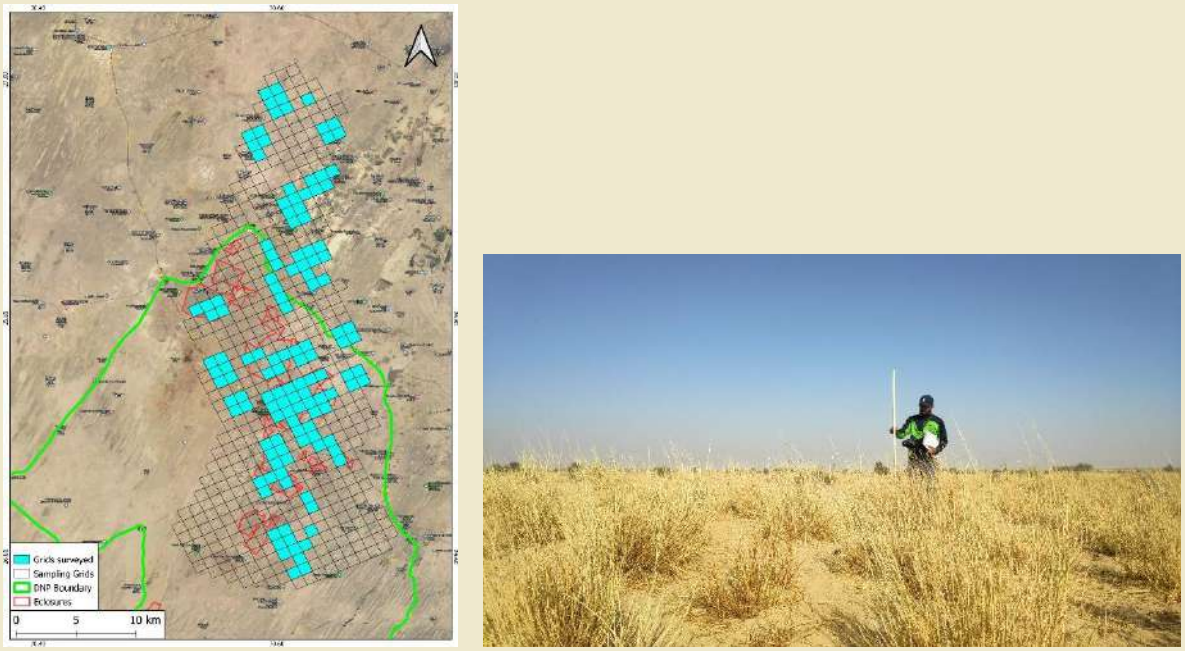


Figure : Sampling grids for habitat assessment study

Arthropod assessment

A detailed arthropod survey was also conducted alongside GIB habitat assessment (described in the previous section). Sweep netting using a standard approach of 100 strokes was conducted in 50 × 4 sq.m. belt transects and samples were collected after every 20 strokes. The samples were preserved in 70% ethanol (wet preservation) and a jar containing ethyl acetate (dry preservation). Dead insects were pinned and kept in a storage box for drying. Orthopteran insects were identified up to genus or species level with the help of a stereoscopic microscope using a suitable morphological key. Vegetation sampling was conducted using the quadrat method. Quadrats of 1m × 1m dimensions were laid within a 20m radius of the selected sampling point in three randomly selected cardinal directions. In each quadrat, the genus of the dominant plant was recorded. All the data analysis was carried out using Microsoft Excel 2007 and R programming environment (Version 3.0.2).
A total of 23 Orthopteran species were found in the study area. Among these, twelve were found in summer, eight in winter, and all 23 were found in monsoon. *Ochrilidia gracilis* was found to have the highest density during the GIB breeding season and in GIB nesting habitats.

Six vegetation clusters from indicator species analysis were identified: 1) Cenchrus + Indigofera 2) Cenchrus + Lasiurus 3) Dactyloctenium 4) Dipterygium + Dactyloctenium 5) Fagonia + Dactyloctenium + Aristida + Cyamopsis 6) Lasiurus + Dactyloctenium.

Order Orthoptera density is highest in vegetation clusters of Cenchrus + Indigofera (7.27 ± 1.54SE) and lowest in vegetation cluster Fagonia + Dactyloctenium + Aristida + Cyamopsis (1.74±0.20SE). The analysis also indicates that Orthoptera density was highly dependent on vegetation clusters. Results suggest that grass species have the highest potential for insect density.

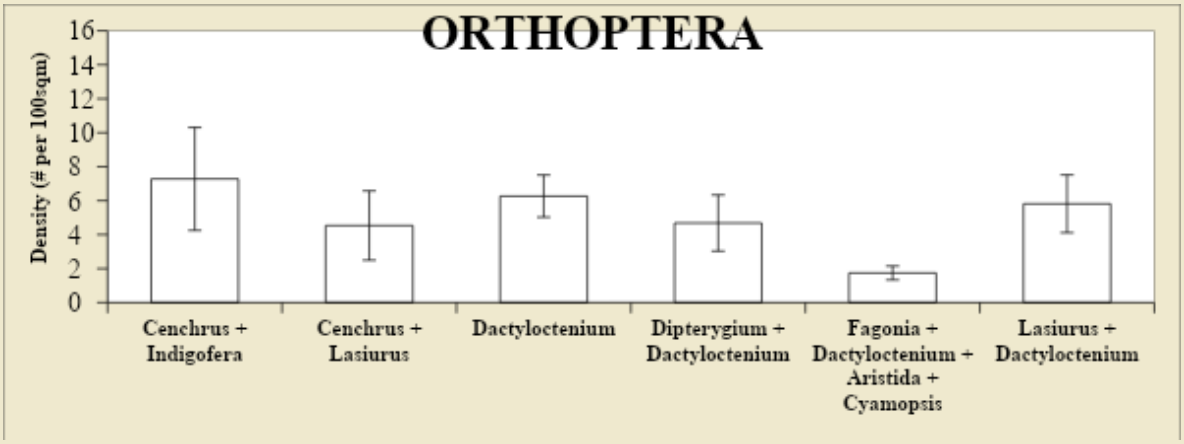


Figure: Mean and 95% confidence interval of density of Orthoptera across vegetation clusters in Desert National Park during winter (2022-23)






Image: Insect abundance assessment in GIB habitat Thar

Capacity building and outreach

Posters, brochures and other outreach materials (banner, brochure, t-shirt, badges, pamphlets) were prepared and distributed to support stakeholder engagement activities in GIB and LF conservation landscapes.

First phase of school nature education programmes was conducted in Jaisalmer during 2022-23 and over 4197 students in 15 schools across 13 villages were made aware about GIB and native biodiversity in their area. Information on the GIB, their threats and conservation issues was shared with the help of a documentary film. Subsequently, Phase 2 of nature education programmes (make your own bag) was carried out in February 2023. Over 822 students in three schools from different villages in Jaisalmer District participated in this interactive event. Students participated by block printing bags with images of GIB and chinkara in traditional Rajasthani style. In this activity the kids were provided with one t-shirt/bag, few wooden blocks and different coloured dyes. The children were encouraged to print these animals on their bag as per their own choice of colour and block and design their personal bags. The purpose of this activity was to make nature education joyful, entertaining and interactive. Beyond school programs, villagers were informed about the importance of Bustard conservation through informal meetings and conversations at social gatherings.

Image: GIB conservation awareness programs in schools, Jaisalmer

Similar to Jaisalmer, awareness programs on LF conservation in several schools in Shokaliya , Rajasthan and Bidar, Karnataka were conducted that were attended by ~1000 students from four schools during February-March 2023. Posters with information on LF and other outreach materials (bags, caps, notebooks, bookmarks and badges) were distributed in these schools. Local villagers in Shokaliya landscape (prime breeding habitat of LF) were sensitized to LF conservation through informal meetings and were also provided with outreach material. They were also rewarded for sharing information on nesting of the species.

Image: GIB conservation awareness programs in schools, Jaisalmer

In addition to the targeted awareness sessions, display stalls on GIB and LF conservation were set up at Desert Festival, Jaisalmer (February 2023) and Pushkar Festival, Ajmer (November 2022). These stalls were visited by approximately 2000 people respectively and were set up in collaboration with Rajasthan Forest Department and Bombay Natural History Society (BNHS) respectively. Similarly, interactive sessions were conducted in the schools around DNP, Jaisalmer and Bidar, Karnataka to sensitize the students on the occasion of Environment day.


Image: Lesser Florican conservation awareness stall in Pushkar, Ajmer






Image: GIB conservation awareness programs in schools, Jaisalmer

The project was represented at the 2nd Environment and Climate Sustainability Working Group meeting- G20 from March 27–29, 2023, in Gandhinagar, Gujarat. An exhibition on the theme-ecosystem restoration through species conservation was set up in which the GIB was showcased to generate awareness about their plight and conservation efforts. The project team also participated in the inaugural Indian Conservation Conference (ICCON) on wildlife research, conservation, and management, held in Mysuru, Karnataka, from April 9 to 11, 2023, where they highlighted the conservation efforts to recover GIB population.

A high-quality video documentary on Critically Endangered bustards and project activities is being developed, as mandated by MoEFCC, in technical collaboration with The Grasslands Trust and Talescope Pictures.

Pilot habitat management

Powerline bird flight diverter assessment in prioritized GIB area

Power lines are a critical threat for the Great Indian Bustard, as their heavy body, fast flight, low aerial manoeuvrability and poor frontal vision restrict their ability to avoid fatal collisions. In 2022-23 alone, we recorded three GIB mortalities due to power lines collisions in the Thar landscape. Taking cognisance of this threat, the Hon. Supreme Court of India (2021) has directed powerline agencies to underground power lines inside priority and potential GIB habitats and install bird flight diverters where undergrounding is exempted on technical grounds, ratified by a Court appointed committee. The Hon. Supreme Court has additionally directed power agencies to install bird flight diverters as a temporary mitigation measure on all power lines until then.

To monitor the adherence to these directives, our team carried out an assessment of diverter installation on power lines in important sections of the GIB Priority Area in April, 2022. The team sampled 1676 km of power lines out of a total of 2112 km in Salkha, Khetolai and Rasla-Degrai areas. Information such as tower height, number of wires, voltage capacity of the lines, number of diverters installed and the number of dysfunctional diverters was recorded. About 10% (~165 km) of power lines were marked with diverters, as of April 2022. Out of this, 12% of the total diverters were either broken or non-functional.

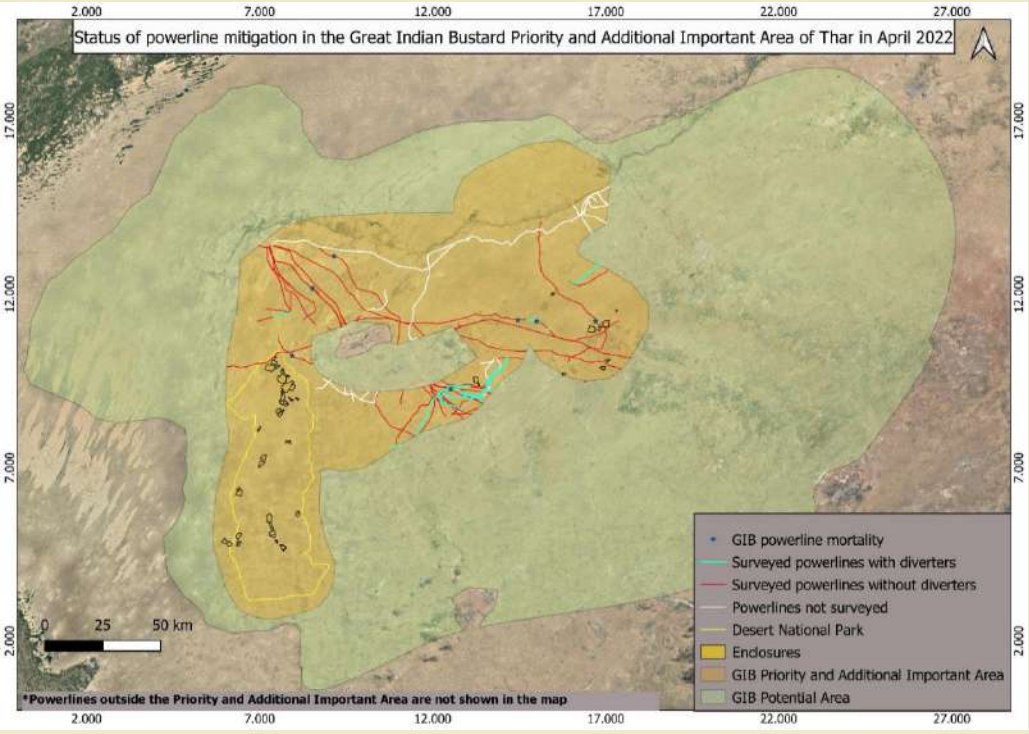


Figure: Power line bird flight diverter assessment in prioritized GIB area

Nest Predator Management

The high incidences of GIB nest predation necessitate immediate action which includes trapping and relocation of all nest predators. The Thar landscape houses a large population of free-ranging dog which not only hunt native wildlife but are also predators of GIB nests. Nets, leg hold traps or dart guns were used to capture and immobilise mammalian nest predators. Caught animals were then

translocated at a safe distance from GIB breeding enclosures. In the year 2022-23, 71 free ranging dogs and one Indian fox were captured and relocated in this manner. Additionally, a few individuals of *Varanus spp* were caught and translocated to areas away from GIB breeding enclosures.

Image: Nest predator management in GIB habitat in Thar

Staff engagement

To implement the above activities, engagement of existing contractual project personnel was continued or refilled; additionally, one junior veterinarian (from Rajasthan funding), one consultant veterinarian (surgery specialist), two Project Associates, seven Project Assistants, and more local support staff were engaged and trained to meet manpower requirements of three conservation breeding facilities during this reporting period.

Rohit Kolhatkar

Designed by: Tanya Gupta

भारतीय वन्यजीव संस्थान
Wildlife Institute of India

BUSTARD RECOVERY PROGRAM

الصندوق الدولي للحفاظ على الحباري
International Fund For Houbara Conservation

Rajasthan State Pollution Control Board

BNHS India

The Corbett Foundation

HUMANE SOCIETY INTERNATIONAL
INDIA

Rajasthan Forest Department