

Habitat Improvement and Conservation Breeding of

Great Indian Bustard



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Bustard Recovery Program

Wildlife Institute of India



Ratnakar Hiremath, The Grassland Trust &
Bustard Recovery Program Team

Project title: Habitat Improvement and Conservation Breeding of Great Indian Bustard

Project duration: April 2016 - 2021 and no-cost extension 2021 - March 2024

Project report period: April 2023 - March 2024

Total sanctioned budget: 33.85 crore INR
First instalment (Released in December 2015): 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
Fifth instalment (Released in January 2023): 4.53 crore INR
Sixth instalment (Released in May 2023): 3.59 crore INR
Seventh instalment (Released in November 2023): 2.69 crore INR

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Bombay Natural History Society
Humane Society International
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The Grasslands Trust

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Project team

Dr. Sutirtha Dutta – PI

Prof. Qamar Qureshi, Dr. Vishnupriya Kolipakam and Dr. Lallianpui Kawlani – Co-PIs

Dr. Tushna Karkaria, Dr. Vipul Bishnoi & Dr. Sonika CK (Project Veterinarians), Mr. Bipin C. M. (Project Associate), Mr. Pravesh Sakhlani, Mr. Mohib Uddin, Mr. Sourav Supakar, Ms. Tanya Gupta, Ms. Hrishika Sharma, Ms. Hemlata Joshi, Mr. Indranil Paul, Ms. Anjali Nagar, Mr. Varun Kher, Mr. Anshuman Pati, Ms. Shimontika Gupta, Ms. Nikhila Purohit, Ms. Swapna Lawrence, Mr. Ashish Kumar Jangid, Ms. Sweta Bhattacharya, Mr. Mahesh Gujar, Mr. Mohana Krishna, Ms. Mayuri Moitra, Ms. Maithali Sawant (Researchers), Mr. Sohan Lal, Mr. Jograj Singh and Mr. Amrit Ram (Assistants)

Ms. Binya Sagar & Mr. Pradeep Dobhal (Office assistants)

Dr. Shashikant Jadhav (Consultant)

Collaborating officers

CWLW, Rajasthan

DCF Jaisalmer

DCF (WL) Jaipur Zoo

Advisors

Dr. G. S. Bharadwaj, MS NTCA, Dr. Asad Rahmani & Dr. Yadvendradev Jhala

Project interns & volunteers

Mr. Swayam Thakkar, Mr. Yashwant Gowda, Mr. Atharva Togattiwar, Ms. Kajal Tanwar, Ms. Chandralekha Lochan

PhD & Dissertation Students

Ms. Ruchika Verma, Mr. Yudhajit Kundu, Mrs. Krishnapriya, Ms. Krishnapriya, Mr. Mihir Jadhav

Support staff

Mr. Haru Ram, Mr. Harish Genwa, Mr. Chanesar Khan, Mr. Rashid Khan, Mr. Aradin Khan, Mr. Amin Mehar, Mr. Kamal Solanki, Mr. Devendra Genwa, Mr. Musa Khan, Mr. Rahamat Ulla, Mr. Keshab KC, Mr. Salakh Khan, Ms. Rekha Mali, Mr. Purushottam Prajapat, Mr. Chandan Prajapat, Mr. Sahdev Prajapat, Mr. Chandraprakash Prajapat, Mr. Vinod Mali, Mr. Jamaldin, Mr. Jagdish, Mr. Mohammad Salim, Mr. Srawan Kumar, Mr. Arsad Khan, Mr. Govardhan Mali, Mr. Vishnu, Mr. Tikuram, Mr. Saawan Khan, Mr. Ramzan Khan, Mr. Rahim Khan, Mr. Saddam Khan, Mr. Vivekanand, Mr. Prakash Parihar, Mr. Jam Khan, Mr. Parasram Meena, Ms. Krishna Sharma, Mr. Saale Khan, Mr. Dhanraj, Mr. Kularam, Mr. Hingora Khan



BACKGROUND

The Great Indian Bustard (GIB *Ardeotis nigriceps*) and Lesser Florican (LF *Sypheotides indicus*), two resident bustard species of India are Critically Endangered (IUCN Red list; Birdlife International, 2018; 2021) and facing severe population declines due to hunting and habitat loss. The long-term conservation of these flagship species requires the protection of its remaining grassland habitats and the restoration of degraded habitats. For the conservation of these species, the Ministry of Environment, Forest & Climate Change (MoEF&CC) developed the National Bustard Recovery Guidelines (2013), that recommended creating protected grassland enclosures, to enhance in-situ breeding success, minimising threats in important areas, and conservation breeding as an insurance against extinction in the wild and for population augmentation.

The Bustard Recovery Project, launched in 2016, focuses on conservation breeding, applied research, capacity building, and pilot habitat management. Collaborating authorities and organisations include MoEF&CC, Rajasthan Forest Department (RFD), International Fund for Houbara Conservation (IFHC) and NGO partners. These conservation activities require continuous long term efforts (15-20 years) to secure a stable captive population, assist augmentation of wild populations and aid habitat improvement through scientific inputs.

Within the project scope, significant efforts have been made in Rajasthan since 2019 to breed and conserve both species. This has resulted in the establishment of ex-situ populations, including 29 captive GIB and 10 captive LF. Additionally, measures to protect these species in their natural habitats have been undertaken, such as managing nest predators, addressing threats, and sensitising key stakeholders and decision-makers in conservation efforts.

OBJECTIVES OF THE PROJECT:

- **Conservation Breeding:** Securing ex-situ populations of GIB and LF.
- **Applied Research:** Prioritising conservation areas, characterising threats, monitoring populations and habitats, understanding livelihood issues and population genetics.
- **Capacity Building, Awareness, and Advocacy:** Enhancing protection measures, sensitising stakeholders and decision-makers, raising public awareness, and promoting bustard-friendly land uses.
- **Pilot Habitat Management:** Demonstrating effective interventions for habitat management, replicable by range State Forest Departments and conservation agencies



CONSERVATION BREEDING



Great Indian Bustard

Husbandry

The Bustard Recovery Program initiated conservation breeding for the Great Indian Bustard in 2019 to secure a captive population of these Critically Endangered birds. The project has established two conservation breeding facilities in Rajasthan, the first smaller facility in Sam (in Desert National Park) and a larger facility in Ramdevra.

Table 1: Number of captive GIB with respect to age in Sam and Ramdevra Conservation Breeding Facilities

Conservation Facility	Age(year)	No of Female	No. of Male
Sam CBC	4-5	7	-
	3-4	3	1
	2-3	2	-
	<1	-	3
Ramdevra CBC	1-2	3	5
	<1	3	2

The conservation breeding program has managed to establish a captive population of 29 GIB, of which 13 are adults and seven are breeding (one male, six females) (Table 1). Of these, 28 individuals are hatched from eggs collected from the wild while one is the offspring of two captive individuals. The program has been successful in establishing a part of the founder population and its probability of converting an egg into an adult is ~0.60 which for other international bustard conservation breeding programs is between 0.33-0.48 (Fig. 1).

Table 2: Information on the collection of eggs and chick survival over the last five years (2019-2023)

Year	Eggs collected	Chicks Hatched	Survived over a year	Current numbers
2019	10	9	9	7
2020	7	7	5	4
2021	5	4	2	2
2022	9	9	8	8
2023	9*	9	8**	8

*Out of the nine eggs of 2023, two were laid by captive females after natural breeding at Sam CBC

**One of the two captive bred chicks survived

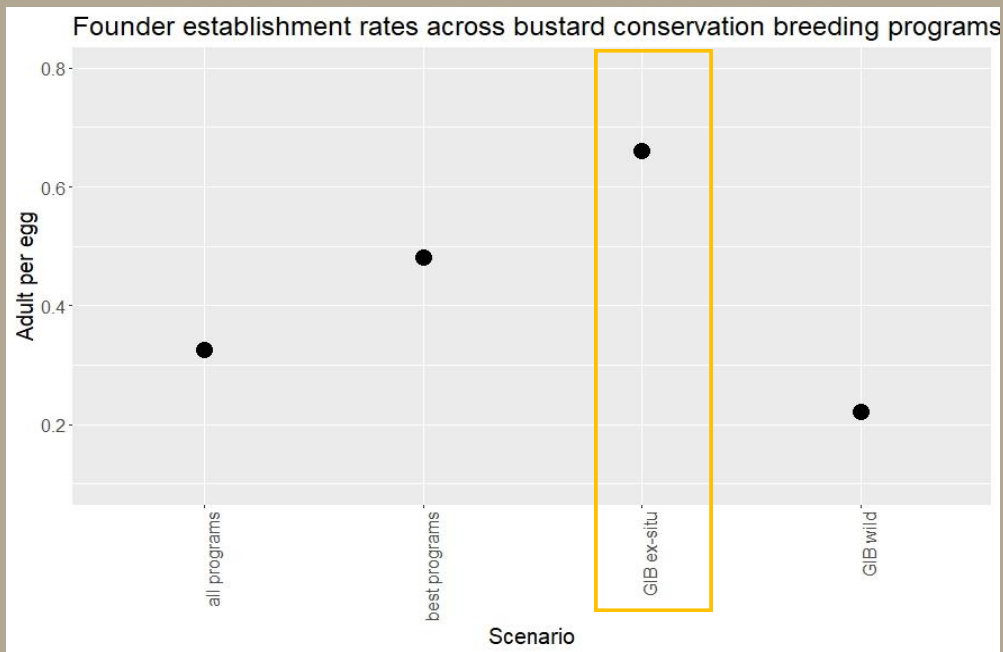


Figure 1: Probability of a collected egg reaching adult stage for GIB CBC compared to other bustard conservation breeding programs across the world and recruitment in wild

Artificial Incubation

Eggs were collected from wild and captive GIB females. 38 GIB eggs were collected from the wild (DNP, Ramdevra and surrounding area) from June 2019 to March 2024. The wild eggs are collected and brought to the Sam CBC in a foam-padded, insulated box (for short distances) or a portable incubator (for long distances) in a slow-moving, good suspension vehicle. The external and internal ambient temperatures are monitored during the transport. The external temperature in the vehicle is maintained between 20-25°C and the internal temperature of the box is maintained between 35-37°C. Once the eggs reach the centre, they are cleaned, measured, weighed, and checked for fertility by candling, checking for a pulse and other signs of embryo development. The incubation room is maintained between 20-25°C and 30-40% RH. All eggs are incubated in Brinsea Ovation Incubators at 37.5°C. The humidity is regulated based on the egg requirements. The eggs are monitored daily to check for signs of fertility and to track the development of the embryo in fertile eggs. Once the external pip is seen they are transferred to the hatcher which is maintained at 37°C and 55-65% RH. The eggs collected were artificially incubated for 1-22 days depending on their age when they were collected.

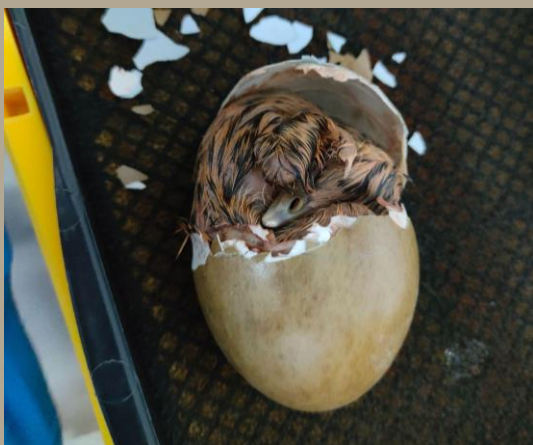


Image 1: A GIB chick hatched from a wild egg in Conservation Breeding Centre, Sam (left); Chicks in Conservation Breeding Centre, Sam (right)

Additionally, one egg was collected for a novel jumpstart attempt from a tagged female who had nested in Salkha, an unprotected area. The egg was collected and artificially incubated while a dummy egg was placed in the nest. After artificially incubating the egg for seven days, the egg was returned to the nest immediately prior to its hatching. The egg hatched successfully in the wild and the chick was successfully raised and recruited to the wild population. This intervention can be scaled up to try and combat the high predation rates of wild eggs and increase hatching success.

Chick Rearing

Chicks, after hatching, are kept in the brooder for 24-36 hrs. The brooder allows maintenance of a strict range of temperatures and environmental conditions, required by the newly hatched chick. One-day-old chicks are shifted to the chick-rearing room maintained at 27-30°C temperature and 30-40% RH. They are kept in transparent boxes with rubber mats (as substrate) and heat lamps. They are kept individually or in pairs (if similar in age). They are imprinted on the keepers at an early stage as it is essential for closely monitoring birds in captivity and reduces the stress of husbandry and veterinary practices for animals in captivity. For exercise and muscle growth chicks are taken to the outdoor cage for a few hours daily. Chicks are gradually shifted from indoors to the second-age juvenile cage, at around 30 to 35 days, where they are kept in individual cages. After 90-120 days birds are shifted to the adult cages (tunnels).

Housing

Sam CBC, started in 2019, is fully equipped and well-developed. It has a functional incubation and chick-rearing unit, one juvenile cage with two adult tunnels, and a vet unit for emergencies. In Sam CBC, seven birds are showing signs of sexual maturity. All adult birds are housed in individual net compartments within each tunnel. All compartments have sewan/grass patches to provide shade. During the harsh summer, coolers and sprinklers are installed near the cages.

During the breeding season, adult birds are allowed to move between cages for a few hours during the day so that adult females can have access to displaying males (to encourage natural breeding).



Image 2: Juvenile cage in Sam Conservation Breeding Centre (left); Adult tunnels in Sam Conservation Breeding Centre (right)

The Ramdevra CBC has been functional since August 2022. 14 birds, that hatched in Sam CBC in 2022 and 2023, were shifted to the juvenile unit in Ramdevra when they were two weeks to two months of age and are currently housed there. The birds were trained for transport by performing short mock transport drills before the actual transport. Chicks were transported in foam-padded plastic crates, with a sandy substrate and a modified lid, in a temperature-controlled vehicle with good suspension. The vital parameters were monitored before, during, and after transport by a veterinarian, and the exercise was carried out along with a representative from the Forest Department. The transportation was carried out at night to minimise stress to the bird. It took 3-4 hours for the birds to be transported from the facility in Sam to Ramdevra.



Image 3: Transportation crate with lid (left); Keepers travelling with chicks during chick transportation (right)

The Ramdevra Juvenile unit consists of an indoor unit with net cages connected to an outdoor cage. Initially, the birds were carried in and out and later trained to walk on their own. The frequency of jumps at night in the indoor unit is much less than that observed in the outdoor units, so the birds are currently being kept indoors at night (and during inclement weather) and outdoors during the day (7:00 - 18:00 hrs).

Adult tunnels in Ramdevra have a similar structure to the adult tunnels in Sam, that is, smaller net partitions within each tunnel to house birds individually. These tunnels have been modified slightly, such as increased overall height, based on learnings from Sam CBC.



Image 4: Juvenile unit in Ramdevra CBC (left); Adult tunnel in Ramdevra Facility (right)



Image 5: Birds in Ramdevra juvenile cage (left); Birds in Ramdevra adult tunnels (right)

Reproduction

Adult GIB females weigh between 4-4.5 kg and males between 7-11 kg (Fig. 3). Birds reach their maximum weight immediately before the breeding season and reaching a certain minimum weight may be a trigger for the start of breeding activity. Males began showing signs of breeding display from one year of age, with the proper breeding display starting at 2-3 years of age. Females started showing signs of sexual maturity from three years of age, usually indicated by shorter, less complex displays and laying eggs. As mentioned above, females are given access to displaying males to encourage mate choice and natural breeding. Two females in 2023 showed signs of mating and were shifted to the adult male's cage. This resulted in successful copulations and subsequently fertile eggs. The females laid eggs 2-4 days after mating and most eggs were laid right after sunset. The females naturally stopped incubating the eggs (usually within 12 hours of laying), at which time the eggs were collected and moved to the incubation unit to be artificially incubated.

Some copulations were unsuccessful, which could be due to the young age of these birds, resulting in infertile eggs. To circumvent this issue, male birds are also being dummy-trained for semen collection to allow assisted reproduction through artificial insemination of females.



Image 6: Adult male and female during natural breeding event in Sam CBC.

Diet

Bustards are omnivorous species and to fulfil their nutritional requirements, captive birds are given a balanced diet of dry pellets, fruits, vegetables and live feed (Fig. 2). The pellets are formulated specifically for bustards by IFHC / Reneco and contain 14-24% crude protein. Live feeds such as mealworms and crickets are produced in-house. Plants like alfalfa, mustard and pomegranate are organically grown at the centres and seasonal fruits and vegetables are also provided to the birds. The protein and fibre percentage in the diet is changed according to age. In the chick stage, a high protein diet is fed, and then it reduces gradually by transitioning from 24% to 14 % over the year. Immediately prior to the breeding season, the total protein content of the diet is increased to meet the breeding requirements (eg. for egg laying).



Image 7: Diet of captive GIBs

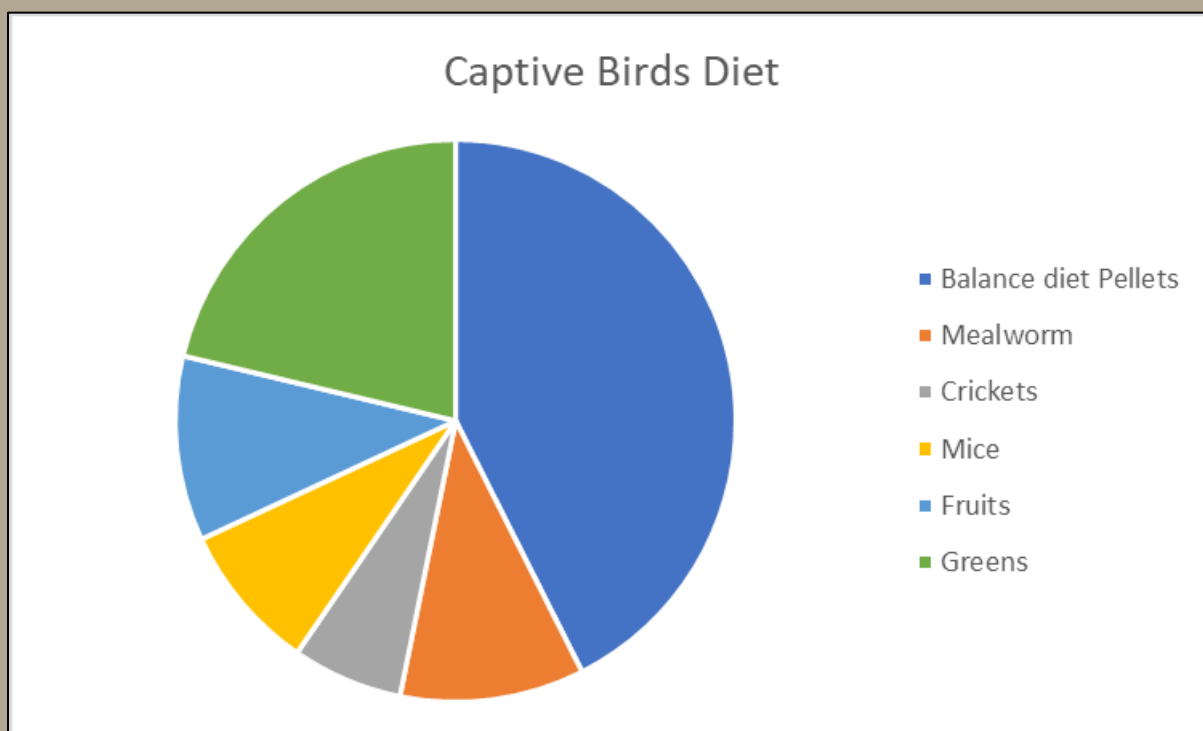


Figure 2: Proportion of diet for captive GIB in Conservation Breeding Centres

Growth of birds at different stages

Table 3: Average weights of males and females in different age groups

Age	Average Female Weight (in grams)	Average Male Weight (in grams)
30 days	873	927
90 days	2624	3581
180 days	3894	6572
360 days	4132	6855
2 years	4500	8500
3 years	4575	11590
4 years	5070	11960
4.5 years	4800	N/A

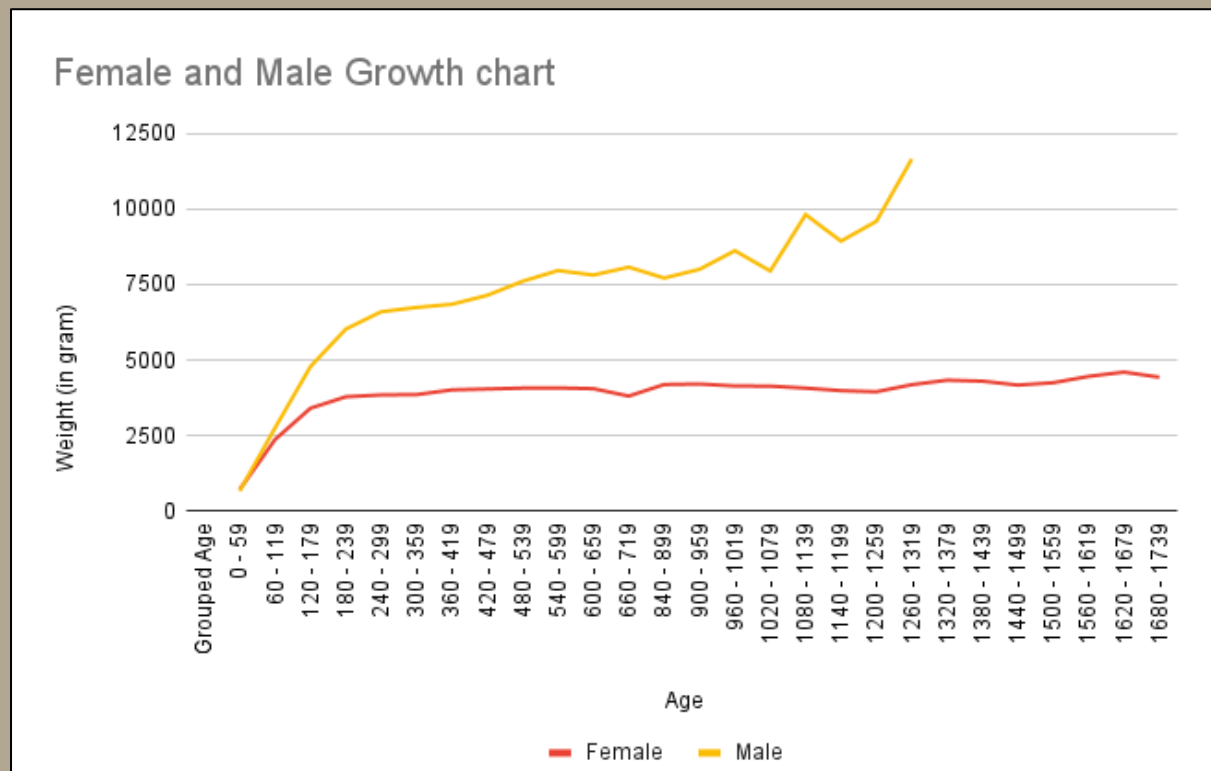


Figure 3: Weight differences in captive male and female GIBs

Veterinary Care

All birds are vaccinated for Newcastle disease (ND) and Fowl Pox (pigeon pox/canary pox vaccine). Birds are monitored intensively and any injury or illness is reported quickly. The veterinarians along with the keepers check the general health of the birds daily. Apart from daily monitoring, the birds are examined three times a year and blood collection for biochemistry is done.

Veterinary interventions:

Chick stage:

- Chicks are initially vaccinated for ND at one month and a booster is given at two months of age. At three months, they are vaccinated against Fowl Pox and a booster is given at four months of age.
- Angel wing is common in the first age (one month) and develops around 10 days of age. The wings are bandaged using a vet wrap for one day and the bandage is changed every alternate day till the condition persists. The wings generally recover from this condition within a week.
- Rotation of legs is rare and has been observed in one chick in 2023. Slight rotation when observed has been corrected by giving a harder substrate and exercise.
- Dehydration has been seen in some chicks that do not consume water and it was corrected by providing additional water with food or in severe conditions an oral DNS+NS+RL mixture is given using a 1 ml syringe.
- Genetic deformities: One chick that hatched from an egg collected near Pokhran showed cloacal prolapse after defecation, which was put back in place a few times after cleaning and applying cold water. The condition continued for two weeks during the chick stage but healed by maintaining minimum handling and preventing any contamination.
- Pox lesions have been observed in five juvenile birds which were shifted outdoors and kept with vaccinated birds. The pox lesions are mostly observed on the beak and legs. The lesion gradually dries and falls off. The lesion is cleaned daily with 5% betadine and betadine ointment is applied.



Image 8: GIB chick with bandage to rectify angel wing

Adult stage:

- Fractures of wings are the most common injury in the CBC birds. The fractures are corrected and pinning is done when necessary. Some birds that have had wing fractures cannot fully open their wings and are more prone to future injuries when they jump as they cannot balance and land badly.
- Air sac rupture was recently observed in two birds in the Ramdevra juvenile unit. The birds were observed to be in pain for 2-3 days. Radiographs confirmed the diagnosis and the affected birds were given Meloxicam and easily digestible food. Their movement was restricted by keeping them indoors for two weeks. The birds recovered and showed no further signs of discomfort.
- Two females were observed having nodules on the underbelly which on further examination appeared to be growing. X-rays did not reveal any findings, so experimental surgery was done to check and remove the growth. Fatty abdominal tissue was found through a hernia in one individual. No intervention was performed after that as it did not pose any discomfort or threat to the bird.
- Two adult birds (one female in Sam CBC and one male in Ramdevra CBC) were coughing frequently in winter 2023. Oro-tracheal and faecal swabs were taken for testing. The female tested positive for *Streptococci pneumonia* but the condition improved and coughing stopped as the temperature increased. Birds were provided lukewarm water to drink during this period and the male was given treatment with Azithromycin for 10 days. The birds are healthy now and showing no symptoms.
- Blood biochemistry is performed routinely to form baseline data for the species and to intervene when necessary.
- Faecal samples are tested routinely for parasitology.



Image 9: A GIB male with wing injury (left); Abdominal air-sac rupture in a subadult GIB male (right)



Image 10: Bird keepers with birds at Ramdevra and Sam CBCs

Live Feed Unit

Invertebrates such as mealworms and house crickets are produced in-house in separate units, to supply live feed to the birds. This reduces the cost of purchasing live feed and reduces the risk of contamination during transportation. The sanitation process while entering the live feed unit is followed strictly. Every unit has separate staff that maintains the weekly workflow and all units are cleaned daily. The microenvironment of these rooms, such as temperature and humidity, are logged daily to maintain optimal ambient conditions for the desired production of live food. Weekly production data for each unit is maintained in an excel sheet.

Cricket Production Unit

House crickets (*Acheta domesticus*) are reared in plastic crates (height around 1.5-2 feet) with room temperatures maintained at 30-35°C and relative humidity of 60-90%. Cello tape is attached inside the crate on the upper side to prevent crickets from coming out. Crickets are provided with wheat bran, apple, cabbage/lettuce for food. The temperature of the room is controlled by an air conditioner and during winter an additional heater is provided. Cleaning is done weekly for all crates. The weights of the crickets in every box are recorded weekly. Adult crickets (above six weeks) are provided with organic potting soil in bowls to lay eggs. This soil is washed with clean water and treated in a hot air oven before use, to avoid contamination. The egg bowls are removed after 3-4 days and kept in separate crates where the eggs start hatching after 6-7 days of incubation. Egg bowls are regularly sprayed with water to maintain optimum humidity for incubation. Baby crickets are then transferred to separate boxes. Egg trays are kept in every box to provide substrate for the crickets to move on and crates are sprayed with water regularly (twice a day) to maintain humidity. Water is provided in a feeder for all adult crickets. Adult crickets of 9-10 weeks old are fed to the birds and others are kept for further production. On average 6-10 kg of feeding crickets and 15-20 kg of breeding stock along with baby crickets are produced monthly.



Image 11: Cricket production unit at Ramdevra conservation breeding facility (left); Soil bowls filled with cricket eggs (right); Adult cricket crate with soil bowl (middle down)

Mealworm Production Unit

Larva of the darkling beetle (*Tenebrio molitor*) are reared in shallow plastic crates and given a diet of wheat bran, apples and potatoes. Air conditioners and dehumidifiers help maintain the temperature of the mealworm unit at 25°C and relative humidity below 40%. The four stages of mealworm (egg, mealworm, pupa and beetle) are kept in separate crates. Beetles mate and lay eggs in the wheat bran which is then kept separately for hatching. Eggs hatch after 7-12 days. The mealworm larvae change into pupae after 7-10 weeks and pupae turn into beetles after 7-10 days. Mealworms of different sizes are separated weekly and wheat bran is changed at the same time. It takes around 7-8 weeks for producing larva that are fit for feeding birds. On average 40-50 kg adult mealworms (feeding stock), 150-180 kg of breeding stock, 5-6 kg pupa and 10-15 kg beetles are produced every month.



Image 12: Mealworm production unit in Ramdevra conservation breeding facility



Image 13: Different life stages of mealworms: Pupa stage (left); Beetle stage (middle); Adult mealworms (right)

Training of Project Personnel

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



Image 14: Training at IFHC (International Fund for Houbara Conservation - International collaborators) for Artificial Insemination and semen collection

Lesser Florican

Husbandry

The Lesser Florican conservation breeding facility is currently operational at a temporary rental facility (since July 2020), at Bijainagar, Ajmer in Rajasthan. The facility currently houses 10 captive floricans. The facility has a small incubation, chick rearing and vet unit, and indoor and outdoor cages to house adult floricans. It also has a small live feed unit to keep mealworm and cricket stock. All these facilities are maintained with biosecurity protocols and sanitation is done once daily to avoid any infection risk to the captive birds. A substitute long-term hatchery with these facilities has been developed in Arwar Forest Block near Shokaliya and construction of a permanent Conservation Breeding Center at Sorsan has also commenced.

Collection, transportation and artificial incubation of Lesser Florican eggs:

All eggs collected from the wild are transported to the LF breeding facility by slow-moving and good suspension vehicles. Eggs are kept in a foam-padded shockproof box during transport. On arrival at the facility, eggs are first cleaned with lukewarm water and then kept in incubators at 37.5°C and required humidity (according to egg water loss calculation). Eggs are monitored daily throughout the incubation period to track the developmental progress of the eggs. The eggs are incubated for approximately 22 days and are moved to the hatcher after the internal pip. Once the chick hatches, it is weighed and betadine is applied at the navel opening. It is kept in the hatcher for 6-10 hours before being shifted to the brooder for the next 24 hours.



Image 15: Monitoring of Lesser Florican eggs at LF facility, Bijainagar

Chick stage:

After keeping chicks for 24 hours in the brooder and/or depending on signs of hunger (it takes 24-30 hours after hatching), chicks are shifted to the first age unit where they are kept in transparent acrylic glass boxes (dimensions 60×45×30 cm) with soft mat padding at the bottom. Room temperature and humidity are controlled and chick boxes are provided with heat lamps in the corners. Chicks are fed soft balanced diet pellets (SDS), mealworms, crickets, alfalfa and seasonal fruits. In the first age, they are mostly hand-fed by keepers at regular intervals of one hour. Chicks are gradually shifted to an indoor rearing cage with sand and gravel layering for exercise and acclimatisation from 15 days of age. At 20 days chicks are taken to an outdoor cage for short periods to encourage play and exercise for good muscles and bone growth. During the exercise time, massage and playful interactions are done by

keepers to encourage imprinting. Chicks were weighed daily and measured on alternate days to monitor their health and growth.

Juvenile stage:

Birds are introduced to outdoor metal cages with internal soft net layering (dimensions 3×4×3 m) and are kept in flocks from the age of 30-35 days (during September-October). These cages have a gravel substrate with grass, alfalfa and small shrubs for their cover. Birds are fed at regular intervals of 1-2 hours in morning and evening shifts. They are given soft and dry balanced diet pellets, mealworms, crickets, alfalfa, pomegranate and watermelon and are gradually introduced to dry balanced pellets containing 24% Crude Protein (CP). Chicks are weighed daily and measured twice a week to monitor their growth. Birds gained their adult weight of 450 g (male) and 550 g (female) within the first two months. Keepers continue handling and spending extended time with the bird to continue habituation to humans. Till the age of 60 days, these birds are kept outdoors during the day and are shifted indoors during the night till they acclimatise to the outside environment.

Adult stage:

After two months of age, birds are completely shifted outdoors with indoor cages, in a portable container, made available for winter use. Birds are housed in indoor cages for ~3 months during winter (temperature <15°C) and inclement weather conditions, and shifted back to outdoor cages in March when night temperatures reach ~17°C. As they are territorial, all birds are kept separately in individual compartments. At this age, they start becoming independent and start eating by themselves. Weighing of all birds is done once a week, and vaccination, and bird health check-ups are done routinely. Bird weights range from 460-480g for males and 550-580g for females with weights varying by 30-40g between summer and winter (Fig. 4). One-year-old males showed only partial breeding plumage during mid April 2023. From this age, birds start avoiding keepers and hence bird-keeper interactions are kept minimal.



Image 16: Lesser Florican egg during incubation period at Bijainagar LF conservation breeding facility (left); Lesser Florican chick at Bijainagar LF facility (right)





Image 17: Lesser Florican chicks at the age of four days in transparent boxes at Bijainagar LF facility (left); A 3-week-old Lesser Florican chick in the outdoor cage at Bijainagar LF facility (right)



Image 18: Adult female Lesser Florican in outdoor cage at Bijainagar LF facility (left); Subadult male (with partial breeding plumage) at the age of 11 months at Bijainagar LF facility (right)

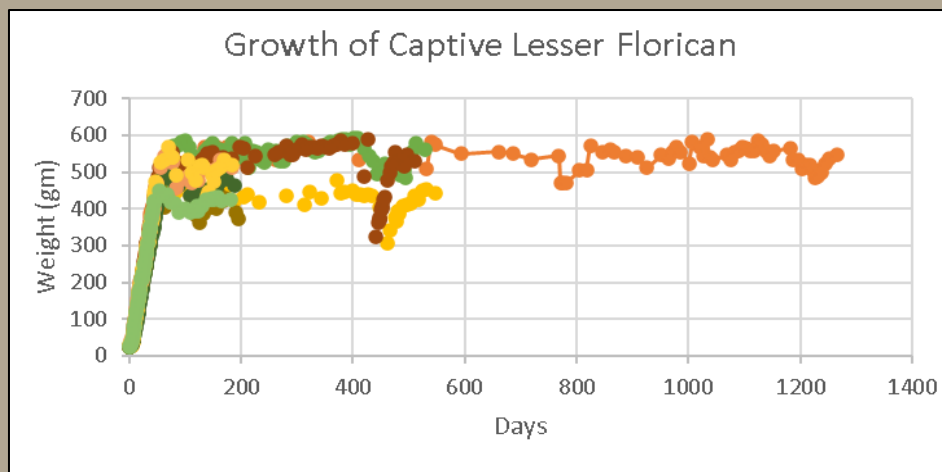


Figure 4: Growth pattern of captive Lesser Floricans at LF conservation breeding facility in Bijainagar

Veterinary Care

- Liver function test values (Aspartate transaminase) of all the florican birds were high in October 2023; hence, the diet was reduced (pellets and live feed), and the birds were shifted indoors in October 2023. All of the birds were supplemented with multivitamins weekly in water. All birds consumed more greens (alfalfa), and vegetables (cucumber, ridge gourd, bottle gourd) that were offered post-dietary restrictions.
- Birds were vaccinated along with boosters for New Castle and Pox.
- In the past year, the breeding facility proactively addressed the potential threat of *Clostridium* infection among the captive birds. To prevent the spread of the bacterial infection, all birds received a calculated dose of antibiotics, and oral and cloacal swabs were collected for diagnostic purposes. A thorough physical examination was conducted for each bird, providing a baseline for ongoing health monitoring. Subsequently, proactive husbandry changes were implemented throughout the facility to prevent further spread of the infection. These adjustments were made using best practices in avian health management, ensuring a healthier environment.
- Two juvenile birds sustained minor injuries at the shoulder joint due to jumping in their enclosures. The wounds were diligently cleaned, dressed every five days, and secured with figure-eight bandages to restrict wing movement. Both birds received standard doses of antibiotics and anti-inflammatory medications, resulting in successful healing of the wounds.
- One adult female bird had a left leg hock joint dislocation (open) due to jumping and landing with a bad angle in the enclosure. Radiographs were taken, and a veterinary surgeon performed surgical correction under gaseous anaesthesia. Dressing with an external splint was applied for additional stability. The bird is recovering with antibiotic and anti-inflammatory supplementation and routine wound dressings.



Image 19: Lesser Florican undergoing veterinary examination at the Bijainagar CBC.

Centre Infrastructure

Sam GIB Conservation Breeding Centre

The Sam conservation breeding facility includes an incubation and chick-rearing room, commissary room, juvenile cage, two adult tunnels, a veterinary unit and a live feed rearing unit. In the last year, the old live feed unit was modified with a permanent roof to avoid rainwater percolation and to help maintain proper temperature. The inside and outside walls were fitted with wall tiles to avoid ants and to maintain cleanliness. An existing container was modified into a veterinary unit with all veterinary equipment installed and ready for use in case of emergencies. Two toilets and a bathroom were also constructed at the facility for staff use.

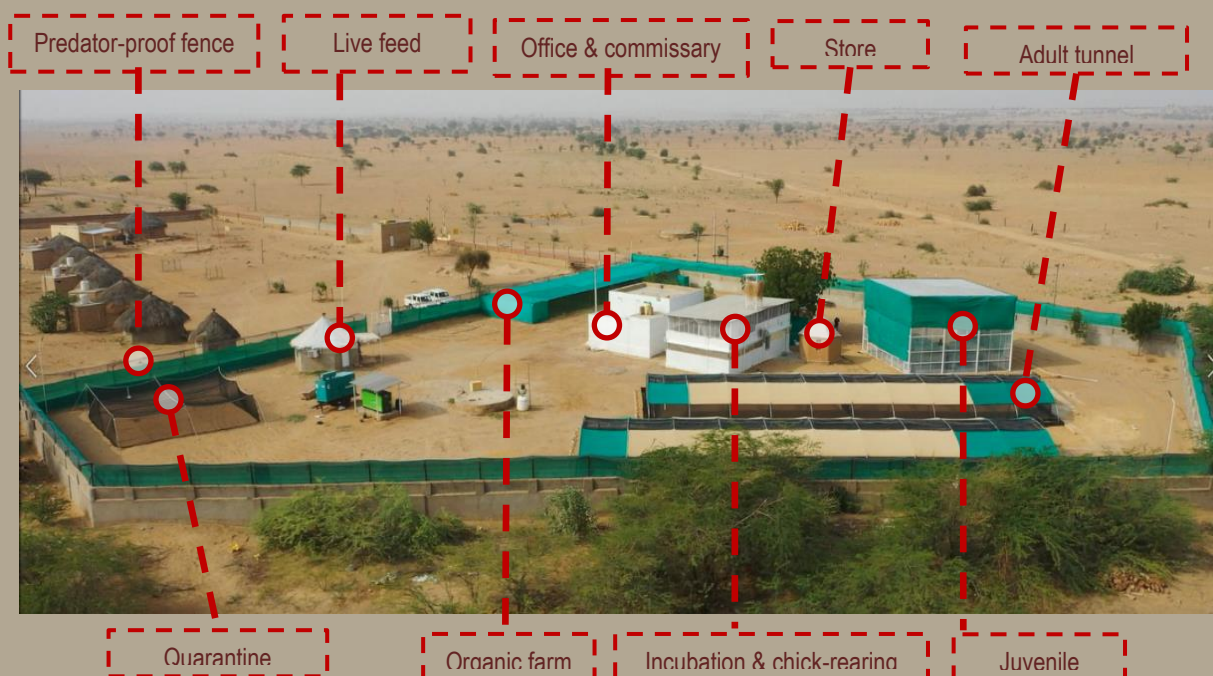


Image 20: Infrastructure of Sam GIB Conservation Breeding Centre

Ramdevra GIB Conservation Breeding Centre

Ramdevra GIB CBC construction was majorly done by Central Public Works Department (CPWD) Jaisalmer. The majority of work was completed by 2022. A few necessary modifications and upgradation were later done by the project team through a local construction agency. In 2023, a 9 ft tall predator-proof fence with 1×1 inch mesh size and barbed wires was constructed around the juvenile cage. The chain-link was also connected to a solar electric wire to avoid predators such as monitor lizards that can climb. Another larger predator-proof fence with similar specifications was constructed around the adult tunnels. One indoor-outdoor cage to house juveniles was constructed within the periphery of the predator-proof fence. The adult tunnels at the facility were modified, and their soft net cages were repaired and updated with current bird requirements. A container of 7×9 m in size was shifted in front of an adult tunnel and was connected to the tunnel gate by providing a platform in between. Soft net cages were constructed inside this container to keep birds indoors during the night and inclement weather. These indoor cages were made with PVC pipe frames, with soft net layering and fine sand as the substrate.

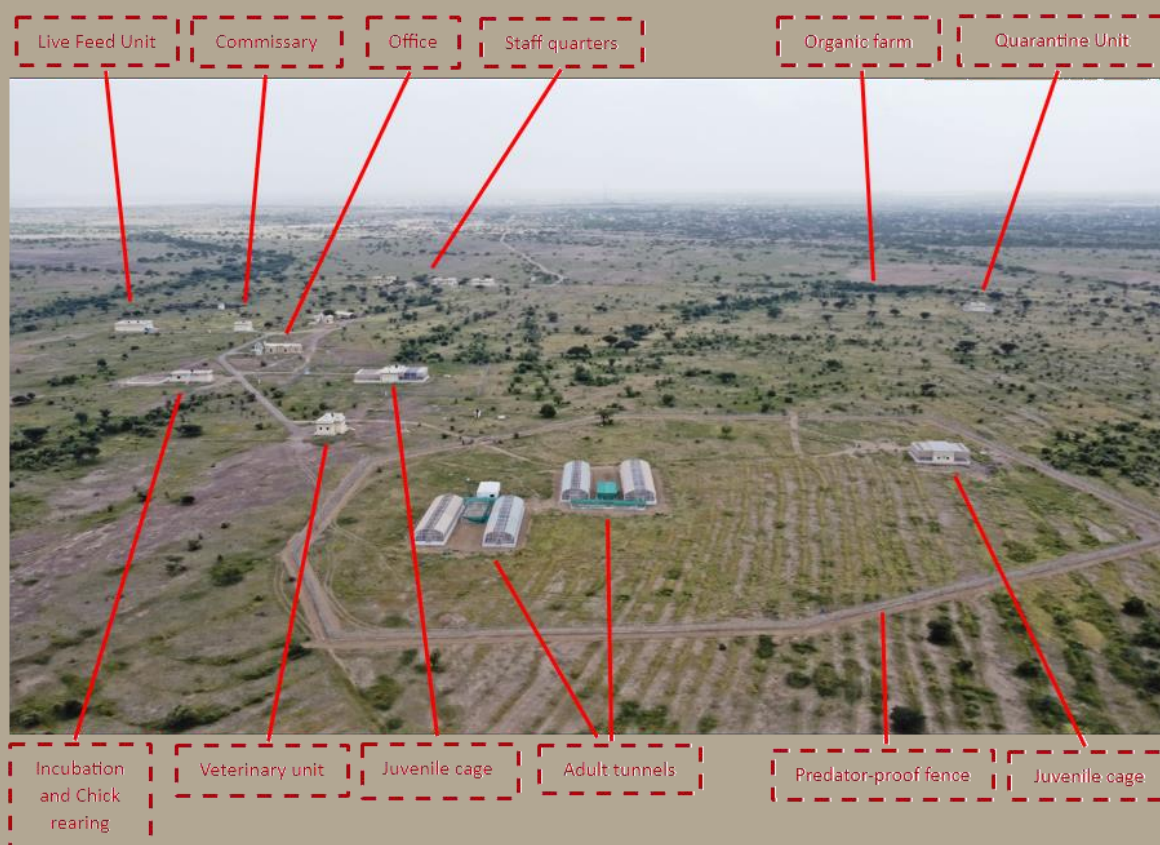


Image 21: Infrastructure at Ramdevra GIB Conservation Breeding Centre

Bijainagar LF Conservation Breeding Centre

A container of 7×9 m size was brought to the Bijainagar LF facility. This was connected to the existing cage enclosure at the facility. Indoor cages were constructed to house LF chicks during winter. The indoor cages have a PVC pipe frame and nylon net and individual cage sizes were kept as 1.5×2×2 m. Reinforcement and predator-proofing of existing enclosures were also carried out.

Arwar LF Conservation Breeding Centre

The LF facility is currently being run at a rental property. To provide a long-term safe space for the captive floricans in Ajmer, the Arwar forest area was mutually selected by the RFD and Project team. Two old *chowkis* at the Arwar block were handed over to the Project by RFD which were modified for conservation breeding. One of the *chowkis*, which was very old and in very bad shape, was fully repaired and converted into staff accommodation, a store and a live feed stock rearing room. The second *chowki* which was more recently constructed was repaired and modified, and converted into an incubation, chick rearing, veterinary room and office space. A metal cage for outdoor housing of adult LFs with dimensions of 32×12×5 m was constructed in the facility and its internal soft net cages are currently being constructed. All these buildings were interconnected and provided with water, electrical and sewage line connections.



Image 22: Ongoing construction of Arwar LF Conservation Breeding Centre

Sorsan CBC

Construction of a permanent facility in Sorsan, as initially planned in the Project, was reinitiated through a joint visit of the Project team, CPWD engineers and Forest Department during May 2023 and a timeline for construction of first phase buildings was mutually decided. The first phase of construction would include five buildings, namely, an incubation and chick-rearing unit, a veterinary unit, a bird food production (live feed) unit, an adult indoor/outdoor cage and a security outpost. The CPWD commenced the work on the ground in December 2023 and the work is currently in progress with the foundation for all buildings already constructed. Completion of this work will require continuation of funding in the coming year.



Image 23: Site for Sorsan Bustard Conservation Breeding Centre



APPLIED RESEARCH



GIB monitoring and population estimation

Reliable and accurate estimates of wildlife populations are key to *in-situ* conservation management, especially for threatened and rare species (Dutta *et al.* 2018; SolB 2023). As the GIB is a cryptic species with patchy distribution and very small numbers, detections are low, and obtaining reliable and precise abundance estimates is very difficult. Hence, three different methods were used to estimate numbers to improve accuracy and examine their convergence. These were vehicle-based line transect distance sampling, density surface modelling and camera trap based mark resight techniques. All three methods converged to give similar mean abundance estimates of 33-38 individuals in the Western Thar landscape (in / around Desert National Park; excluding Pokhran Field Firing Range).

Estimation using Distance Sampling Framework

Regular surveys to monitor the status of GIB and other key fauna (chinkara, nilgai, desert fox, Indian fox and desert cat) have been conducted in the larger Thar landscape since 2014. Between 2022 and 2024, six intensive surveys were conducted across multiple seasons (two surveys each in summer, winter and monsoon), covering an area of 1080 sq.km between Mokhla (north) and Khuri (south) (Fig. 5). The sampling area was divided into 30 grids of 36 sq.km each and was split into two sampling blocks — a) protected areas falling within DNP and b) non-protected areas outside DNP (with renewable energy infrastructure). This stratification was carried out to understand the influence of protection on species abundance. Surveys were conducted following a pre-established vehicle transect-based survey protocol (Dutta *et al.* 2018). Each grid was sampled to obtain information on GIB and other co-occurring species where data was recorded in Occupancy and Distance sampling frameworks. Additionally, at every 2 km interval, a rapid habitat assessment was conducted to record features like land cover, vegetation structure and composition, and active and passive disturbances.

Data from all surveys was pooled for the analysis (reasons mentioned earlier) to get an accurate overall density estimate for this period. Single species multi-season occupancy models were run to estimate the occupancy of all target species. Data was analysed in R programming software.

In each grid, 2-3 transects of a minimum sum of 10 km were sampled and an average of 54 transects were sampled in a survey. The survey effort, across six surveys, was 2045 km (Table 4).

Table 4: Details of seasonal landscape surveys for GIB and associated fauna in Western Thar landscape

Season	Number of transects	Survey effort (km)
February 2024 (winter)	55	329.4
October 2023 (monsoon)	55	300.28
February 2023 (winter)	56	357.74
April 2022 (summer)	55	366
June 2023 (summer)	51	341.93
September 2022 (monsoon)	53	349.14

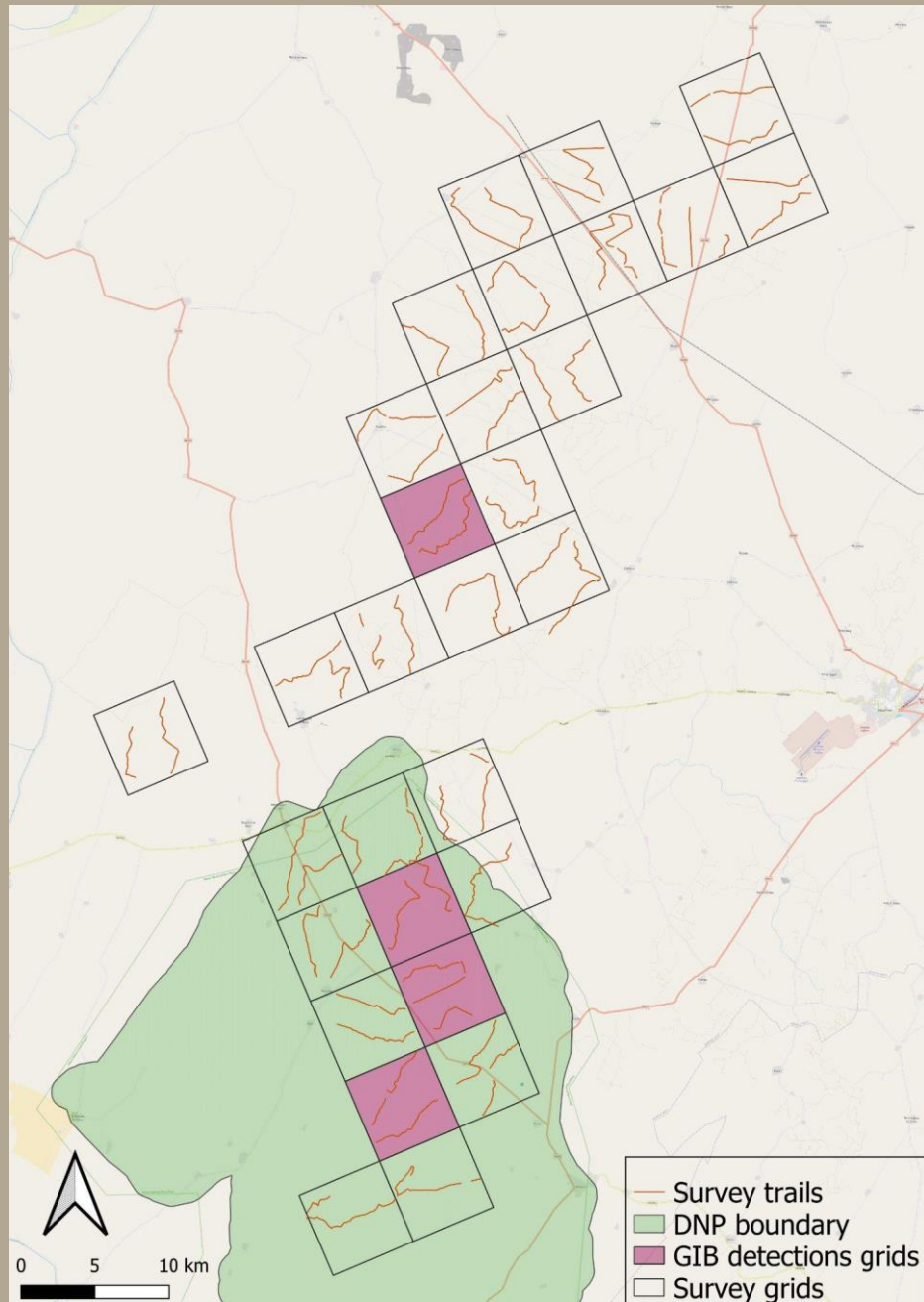


Figure 5: Vehicle survey trails for seasonal landscape GIB surveys in Western Thar landscape

For the GIB, data was best explained by a half-normal detection function, with sex as covariate, that estimated effective strip width at $564.3 \pm 74.5\text{SE m}$. GIB density was estimated at $3.3 \pm 1.1 \text{ SE animals}/100\text{km}^2$, yielding an abundance estimate of $35.3 \pm 12.07 \text{ SE birds}$ in the Western Thar landscape (Table 5). As hypothesised, GIB was found to have a higher abundance in the southern block as compared to the northern block.

Population estimates for all key species recorded during the survey are summarised in Table 5 below. For Indian foxes, only occupancy could be estimated as detections were too few to get reliable density estimates. Estimates for desert cats could not be analysed as there were very few detections ($n=4$). Overall, the densities of all target species was found to be higher in the southern block.

Table 5: Distribution and population estimates of GIB and associated fauna in Western Thar landscape, collected during seasonal landscape surveys during 2022-2024

Species	Detections	Encounter Rate (SE)	Occupancy (SE)	ESW (m) (SE)	Density/100 sq.km (SE)	Abundance Estimate (SE)
GIB	73	3.4 (1)	0.17 (0.07)	564.3 (74.5)	3.3 (1.1)	CDS 35.3 (12.07) DSM 37.60 (14.11)
Chinkara	2250	107.33 (8.91)	0.9 (0.09)	410.3 (9.6)	201.89 (17.61)	2180.44 (190.14)
Desert Fox	72	3.44 (0.53)	0.75 (0.10)	393.2 (34.7)	10.95 (1.94)	118.24 (20.94)
Indian Fox	11	NA	0.22 (0.10)	NA	NA	NA
Nilgai	148	6.94 (1.69)	0.35 (0.09)	535.6 (27.6)	10.79 (2.68)	116.57 (28.9)

Habitat assessment showed that the dominant land cover in the northern and southern block was grasslands followed by fallow agriculture (Table 6). Landcover types and vegetation structure was found to be roughly similar between both the blocks. *Capparis decidua* and *Zizyphus nummularia*, both a food source (fruits) for GIB and other fauna, were among the most dominant trees in both blocks. *Calotropis procera*, an invasive species, was found to be the second most dominant upperstory plant. The four most dominant understory species were *Dactyloctenium* sp. and *Lasiurus indicus* (grasses), *Crotalaria burhia* and *Fagonia cretica* (shrubs/ herbs). These four species are characteristic of grasslands and fallow lands, respectively, the dominant landcovers of the area. Occurrence of most active and passive disturbances were also roughly similar between both blocks. The presence of infrastructure, such as wind turbines and power lines, were found to be significantly higher in the northern block. Farm huts were higher in the southern block with slightly higher human occurrence, indicating more human presence in the protected area. The results indicate that even though habitat variables are similar between both blocks, the significantly higher incidence of infrastructure and lack of protection in the northern block have led to reduced species densities and displacement of the GIB.

Table 6: Descriptive statistics for anthropogenic disturbance, land cover, vegetation structure and composition in the Western Thar landscape

Feature	Units	Habitat Variable	Mean (SE)		
			Overall	Southern block (protected)	Northern block (unprotected)
Disturbance	Occurrence in 500 radius of point	Active Disturbance			
		Human	0.46 (0.03)	0.49 (0.07)	0.42 (0.07)
		Machinery	0.27 (0)	0.27 (0.06)	0.27 (0.06)
		Passive Disturbances			
		Farmhut	0.42 (0.1)	0.52 (0.07)	0.33 (0.05)
		Settlement	0.06 (0.01)	0.06 (0.03)	0.07 (0.03)
		Powerline	0.36 (0.21)	0.15 (0.06)	0.58 (0.09)

		Windmill		0.19 (0.16)	0.03 (0.03)	0.36 (0.08)
		Fence		0.37 (0.04)	0.41 (0.09)	0.33 (0.07)
		Road		0.12 (0)	0.12 (0.04)	0.12 (0.03)
Landcover	Frequency occurrence in 100m radius of point	Grassland		0.59 (0.06)	0.53 (0.07)	0.65 (0.06)
		Barren		0.12 (0)	0.12 (0.05)	0.13 (0.04)
		Shrubland/Scrubland		0.21 (0.06)	0.28 (0.06)	0.15 (0.05)
		Woodland		0.05 (0.02)	0.03 (0.03)	0.07 (0.02)
		Fallow Agriculture		0.35 (0.04)	0.4 (0.08)	0.31 (0.07)
		Active Agriculture		0.1 (0.01)	0.11 (0.05)	0.09 (0.04)
Vegetation Structure	Percent cover in 20m radius of point	Vegetation between 0-30cm		32.03 (3.56)	28.47 (3.77)	35.59 (3.51)
		Vegetation between 30-100cm		27.51 (1.81)	29.32 (3.98)	25.69 (3.27)
		Vegetation between 1-2m		9.12 (1.04)	10.16 (1.52)	8.08 (1.1)
		Vegetation>2m		9.51 (0.79)	8.72 (1.43)	10.31 (1.35)
Vegetation Composition	Occurrence in 100m radius of point	Dominant Upperstorey Vegetation (1=most dominant)	<i>Capparis decidua</i>	0.83 (0.03)	0.8 (0.06)	0.85 (0.04)
			<i>Calotropis procera</i>	0.37 (0.05)	0.42 (0.07)	0.33 (0.07)
			<i>Zizyphus nummularia</i>	0.36 (0.06)	0.3 (0.05)	0.42 (0.08)
			<i>Leptadenia pyrotechnica</i>	0.3 (0.05)	0.25 (0.06)	0.34 (0.06)
			<i>Acacia tortilis</i>	0.08 (0.03)	0.05 (0.03)	0.1 (0.05)
		Dominant Understorey Vegetation (1=most dominant)	<i>Dactyloctenium sp</i>	0.83 (0.04)	0.79 (0.05)	0.87 (0.04)
			<i>Crotalaria burhia</i>	0.46 (0.04)	0.41 (0.07)	0.5 (0.07)
			<i>Fagonia cretica</i>	0.34 (0.07)	0.27 (0.08)	0.4 (0.08)
			<i>Lasiurus syndicus</i>	0.26 (0.01)	0.27 (0.06)	0.26 (0.06)
			<i>Aerva sp</i>	0.17 (0.07)	0.24 (0.05)	0.1 (0.04)

Estimation using Density Surface Modelling

Density Surface Model (DSM) in Distance sampling framework was used to understand the spatial distribution of GIB population in the Western Thar landscape (Hedley and Buckland, 2004; Miller *et al.* 2013). The density curve was fitted with the Generalized Additive Model by merging the data from all six surveys.

For density, a total of ten candidate models with half normal and hazard rate detection functions (cosine and hermite adjustments) were fitted to the data. Three sets of variable effects (sex, season and sex+season) on scale parameters were tested against the null model (no effect). It was assumed that the occurrence of enclosures in every grid would positively influence the abundance of GIB. These enclosures largely indicate the presence of protected grasslands with greater insect and cover resources where bird usage tends to be high. According to the best-fit model (half normal cosine with season covariate), GIB abundance was estimated to be 37.61 (14.11 SE; 37.52% CV; 52.1% deviance explained).

Estimation using Mark Resight Method (pilot exercise)

A combination of marking (tagging and ringing) and passive resightings using camera traps, at their regular usage areas, offers the scope of more reliable and precise abundance estimates using the well developed Mark Recapture framework. The mark-resight method was used on the ratio of tagged to untagged GIB females in photo captures from camera traps deployed at water guzzlers in the summer (June - August 2023) when usage of guzzlers by GIB is the highest. 22 guzzlers were selected across eight enclosures within DNP, which included Ganga, RKVY, Sudasari (ACD, B and EF), Gajaimata, New Gajaimata, and PPC, from north to south (Fig. 6). This method is particularly useful in small populations that are closed to birth and death during the sampling period.

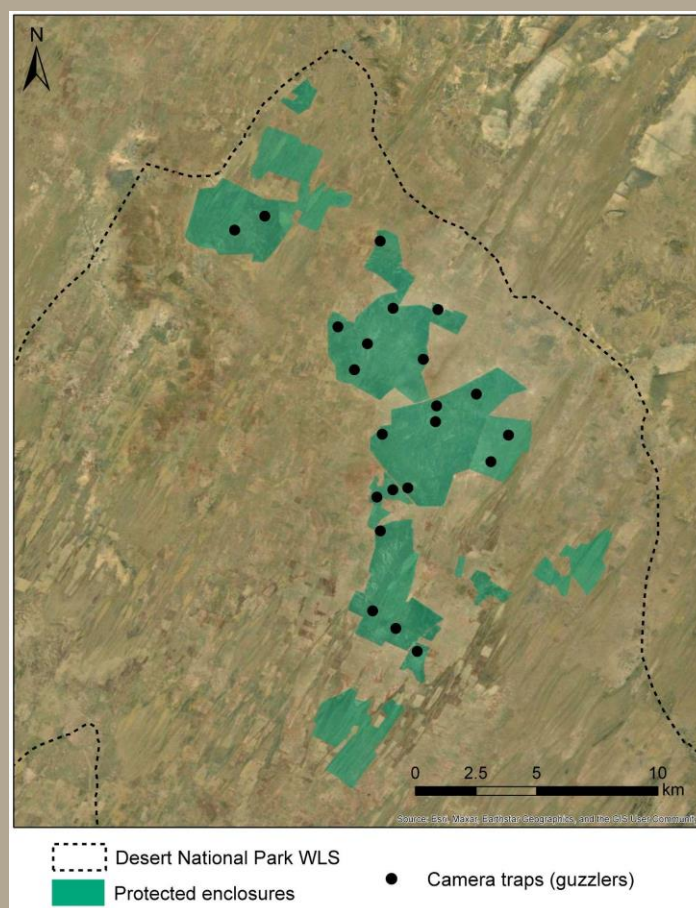


Figure 6: Locations of deployed camera traps at guzzlers in protected enclosures in DNP



Image 24: Camera trap image of tagged female (GIB 2054) at D2 guzzler of Sudasari ACD enclosure

This selection of sites and sampling period was informed by monitoring the frequent movements and regular guzzler usage by tagged female GIBs in the northern areas of DNP (n=5). Camera trap data from July 01 to 15, 2023 was analysed focusing on daylight hours aligning with GIB movements to guzzlers. Photos collected were segregated using a customised deep learning algorithm based on ResNet and Megadetector approaches, combined with manual identification of tagged GIB individuals. Unclear or unidentifiable photographs were excluded from the analysis. We analysed the sighting frequency of tagged and untagged birds using the Poisson Mark Resight estimator, suitable for sampling with replacement and individually identifiable marks, in Program MARK (McClintock, 2008). This analysis accounted for individual heterogeneity and the unmarked population size.

Pilot findings based on a small dataset yielded a preliminary female GIB abundance (in GIB core use area of northern DNP) of 17.81 (8.44 SE, 7.38 - 43.02 at 95% CI), with resighting rate of marked females at 6.04 (2.93 SE, 2.45 - 14.87 at 95% CI) and a detection probability of 0.82 (0.18 SE, 0.3 - 0.98 at 95% CI). This estimate is slightly lower when compared with CDS analysis which yielded female abundance estimate at 22.9 (10.2SE) individuals.



Picture Credit: Ratnakar Hiremath

Demographic monitoring of wild GIB population

GIB populations are monitored intensively during the breeding season to understand aspects of their breeding ecology such as male lekking, female nesting, and chick-rearing. Nest searching and monitoring is carried out to estimate nest success rates and better understand the causes of hatching failure in the wild. It also helps find eggs to collect for the Conservation Breeding Centre. Additionally, chick recruitment surveys are conducted at the end of every breeding season to estimate recruitment rates in the wild. Both these activities are critical to monitoring GIB demographics as population viability analysis shows that GIB populations are extremely sensitive to adult mortality followed by breeding failure.

Nest Monitoring in 2023

Nest search is carried out in all known breeding areas from March to September/October using a combination of vantage and vehicular observations. Any female found is observed for signs of nesting such as extreme site fidelity, sitting (that is incubating) for long durations, etc. Suspected nest sites are monitored from a distance for 2-3 days after which a joint visit of Project and Forest Department staff is made to confirm the nest. During the 2023 breeding season, 16 nests were found, of which one was a double clutch. 13 nests were found in DNP, one in Salkha and two in Ramdevra. Seven eggs were collected for the CBC. All seven eggs collected for the CBC hatched successfully. Of the eight eggs left and monitored in the wild, only two hatched successfully, five were predated and one was not viable (infertile or early embryonic death). The last nest detected was laid in July end. Males too stopped displaying by mid-August and all birds moved into flocks by September. Thus, the breeding season ended earlier than usual, likely due to the sporadic and sparse rainfall in monsoon.

Nesting events for tagged females can be detected by a characteristic star-like pattern (radiating from one location) in their movement data. These nests provide accurate estimates of egg hatching and predation rates in the wild as there is 100% detection and the egg can be monitored from the day of laying. The six tagged females being monitored in the 2023 breeding season nested 13 times and laid an average of 2.3 eggs per female. The average interval between two different clutches was found to be 16.5 days. Five out of the eight eggs left in the wild were predated, making the rate of egg predation for monitored eggs 62.5%. Only two of the tagged females' eggs hatched successfully in the wild and showed an incubation period of 22-23 days.



Image 25: Double clutch of tagged bird 8649 found in 2023 (left); Team member during nest search (right)

Chick recruitment survey in 2023

The chick survey was conducted in the northern part of Desert National Park, covering areas between Salkha to Hattar, as this area is known to be the primary breeding ground for the GIB population in Western Thar. Polygons were overlaid on previously recorded breeding and wintering grounds used by GIBs and vehicle transects were laid on pre-existing trails in each polygon. Additionally, one or more vantage points at strategic locations were chosen in each polygon and a combination of vehicle and stationary surveys was conducted.

A total area of 227 sq.km was surveyed along 202 km of vehicle transects (Fig. 7). In total nine males, nine females (including five tagged), and two chicks were recorded. Thus, the recruitment rate for 2023 was found to be 0.22. Chick survival was estimated from tagged birds as the tags allow monitoring of every nesting attempt. In 2023, only two out of five tagged birds nested successfully (8649 and 8650), thus two chicks hatched in the wild. However, both chicks were predated/died within 20 days of hatching.

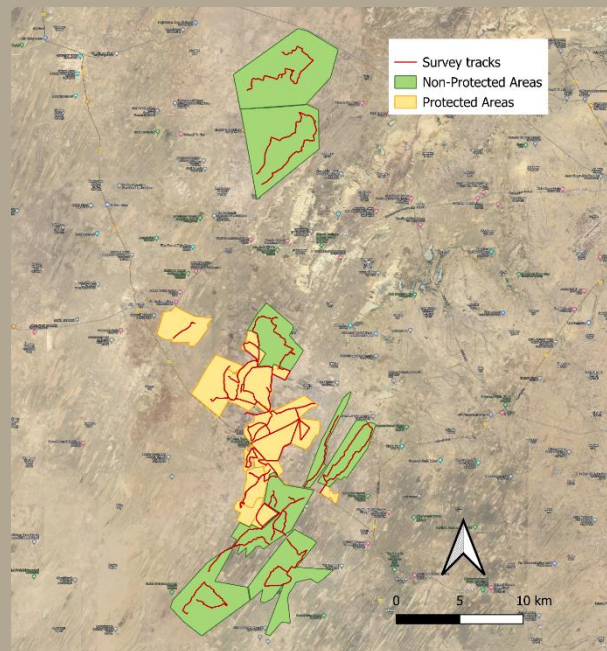


Figure 7: Vehicle survey tracks for chick survey in protected enclosures and non-protected areas outside enclosures of Desert National Park



Image 26: A female GIB with chick seen in Sudasari ACD enclosure

Summary of GIB demographics

GIB demographics have been monitored closely since 2019. Over the last four years, 97 nests have been detected. Three main breeding areas have been found in the Western Thar landscape, three protected enclosures within DNP - Sudasari (61% of nests), RKVY and PPC, and an unprotected grassland habitat in Salkha. Additionally birds breed in enclosures around Ramdevra and inside Pokhran Field Firing Range. The GIB breeding season lasts from March to August with most nests detected in June and July. In years with good rainfall, the breeding season has been found to continue until September, more overall nests have been found, and 10 double clutches have been detected, most likely a consequence of resource abundance.

Among the tagged birds, 39 nests of nine tagged females were monitored in the wild to estimate nesting success, the realised egg relay rates, and the chick survivorship till the 1st and 2nd quarters (Results summarised in Table 7). This allowed estimation of the overall recruitment probability per female per year, which was 0.35 (0.34 SE).

Table 7: Demographic summary for GIB

Demographic parameter	Estimate
Probability of female laying at least one egg every year	0.96
Probability of at least one egg hatching	0.79
Recruitment probability (per female per year)/ Probability (per female) of at least one chick hatching & surviving till six months	0.35

Thus it is observed that there are very high egg predation rates (57%) and high chick mortality rates (47%) in the first quarter with most mortalities occurring within the first month of hatching. The 2nd quarter mortality rates are low, indicating that once chicks make it to three months of age, they most likely survive till adulthood. As a consequence of these high predation rates at the egg and early stages, only 35% of all breeding attempts result in an individual recruiting every year. Thus, predator management in the main breeding enclosures (mentioned above) and scaling up of jumpstart strategies are critical conservation activities for improving wild GIB recruitment rates.

GIB Telemetry

Since 2019, 10 GIB females have been tagged in the wild with GSM/GPRS PTTS (Nine e-obs telemetry 42g Bird Solar tags and one 50g Movetech Flyway-50 tag) (Table 8). These tags have an average lifespan of 2-3 years and some of the tags have stopped functioning since the time of deployment. On average, the e-obs tags have transmitted for 24.7 months with one tag (5949) functioning for 60 months since the time of deployment. Two tagged birds were predated in 2023 most likely by foxes or dogs. The tags on two birds got displaced/malfunctioned so, the birds were recaptured and the tags removed. In 2023, one female was fitted with a Flyway-50 Movetech tag for the first time and it has been functioning smoothly since deployment. At present, there are three functional tags and it has been demonstrated that tagging birds (males and females) provide highly valuable ecological and conservation information and can be continued in small numbers annually.

Table 8: Summary of all tags deployed in Phase 1

Bird Id	Tag type	Population (tag site)	Tagging date	Tag status	Remarks	Tag months
5949	e-obs	West (DNP Kali Mali)	31-03-2019	Functional		60.5
5946	e-obs	West (DNP Sudasari)	11-04-2019	Non-functional	Tag stopped transmitting	2.47
5947	e-obs	West (DNP RKVY)	15-04-2020	Removed	Displaced tag removed, bird ringed	44.97
5948	e-obs	West (DNP Chouhani)	21-06-2020	Non-functional	Bird predated	26.33
865	e-obs	East (Didhoo)	05-07-2020	Non-functional	Tag stopped transmitting	19.03
8649	e-obs	West (DNP Sudasari)	24-04-2021	Functional		35.33
8651	e-obs	East (Ramdevra ABC)	29-04-2021	Non-functional	Tag stopped transmitting	28.43
8652	e-obs	West (DNP RKVY)	28-06-2021	Removed	Malfunctional tag removed, bird ringed	13.77
8650	e-obs	West (Sudasari)	12-05-2023	Non-functional	Bird predated	7.13
2054	Movetech	West (Salkha)	10-06-2023	Functional		9.37

From these tagged birds the information obtained on the species' ecology, movement and behaviour has been critical in improving the understanding of this critically endangered bird and has helped inform conservation action like delineating a GIB priority area within the Thar landscape where mitigation measures like undergrounding of powerlines can be targeted.



Image 27: Team at GIB tagging in 2023

Space use and movement ecology of GIB

A 95% Minimum Convex Polygon (MCP) of GPS fixes from eight tagged birds yielded an average home range estimate of 192.81 ($\pm$ 52.85SE) sq.km (ranging from 114.36-465.25 sq.km) (Fig. 9). Additionally, Kernel Density Estimation was used to understand the intensity of area utilisation within these MCPs (Fig. 8). The KDE maps show that although birds range widely, using grassland enclosures, agricultural lands as well as the non-protected area of Salkha-Kuchri in the north, the maximum usage falls within grassland enclosures (in DNP) or inviolate areas (of Pokhran Firing Range).

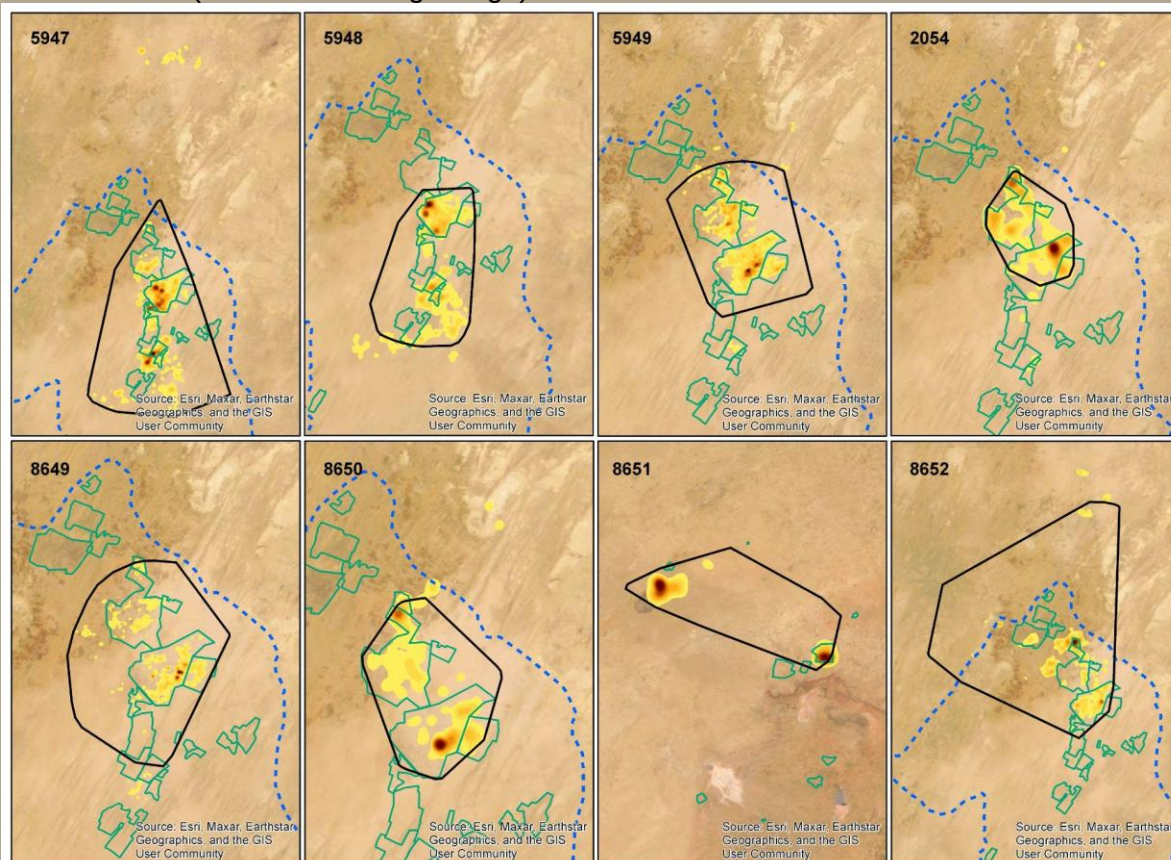


Figure 8: 95% MCP and utilisation density (kernel density) for tagged GIB females in northern DNP and Ramdevra, Jaisalmer

Habitat use and selection

For preliminary understanding of relative utilisation of grasslands and agricultural areas by GIBs, Ivlev's Electivity Index was calculated using telemetry data (Ivlev 1961). This index measures the utilisation of a resource in relation to its availability in the environment. The index has a possible range of -1 to +1, with negative values indicating avoidance or inaccessibility of resources, zero indicating random selection from the environment, and positive values indicating active selection. A land use/cover (LULC) map was prepared using Sentinel-2 satellite data, with a high spatial resolution of 10 metres. A 95% MCP was generated using telemetry data of seven birds from 2019-2024. The available grassland and agricultural area within each MCP was calculated for every tagged female and the proportional use of grassland and agricultural areas was measured through Ivlev's Index.

Additionally, from telemetry data, it is known that GIB ranging changes between seasons, with more usage of grassland enclosures in summer and monsoon (their breeding season) and usage of agricultural lands during the winter. Hence, Ivlev's index was calculated for each season to understand how habitat selection changes with seasons.

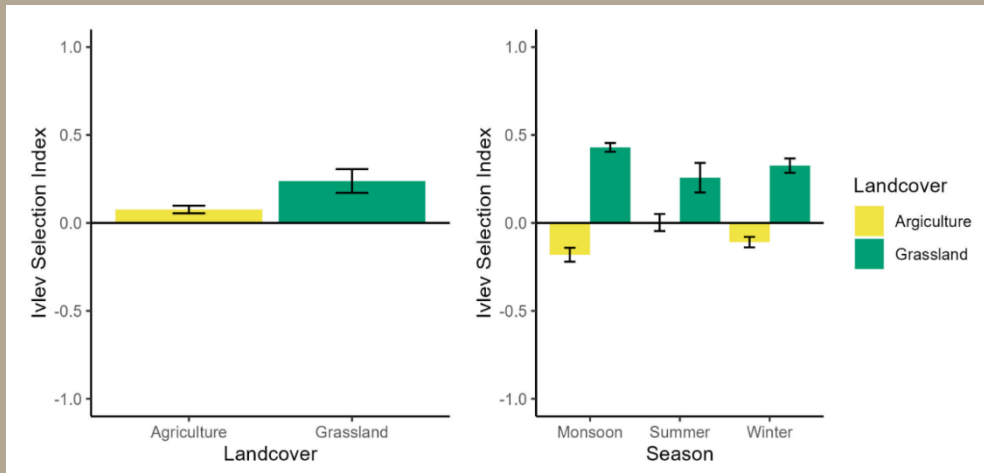


Figure 9: Comparing Ivlev selection index for GIB in agriculture and grassland land covers

GIBs show a positive selection for grasslands in all seasons, with the strongest selection for grasslands in monsoon (Fig. 9). However, they showed a weak negative selection (avoidance) for agricultural land in monsoon and winter. This is contradictory to the previous understanding of GIB space use from telemetry data, especially winters, and could be due to a smaller sample size of females and because seasonal movement data from only one year was used. Ivlev's index gives a very basic understanding of the land cover preferences for the GIB. Factors such as flatness of terrain, presence of enclosures, grazing pressure, man-made disturbances, and infrastructure along with resource availability also influences habitat preference or intensity of habitat use and these factors will be looked into.



Lesser Florican Ecology

Nest Monitoring in 2023

The Lesser Florican breeding season starts in June-July with the arrival of monsoon. The team started locating males and females in mid-June in Ajmer landscape. Males established territories by the second week of July and female sightings increased after that. The nest search efforts were focused in Bandanwara, Shokaliya, Kalyanpura, Madhopura, Dhantol, Dadiya and Bahera areas of Ajmer.

In these areas, at first, breeding male territories were located. These displaying males were monitored throughout the day to find male and female movements. Any female spotted was then visually followed by a team of observers from different vantages to narrow down on potential nesting areas. If the female was seen leaving and returning to the same area multiple times, this was considered a potential nesting site. A team of 4-6 searchers then conducted a nest search by thoroughly combing the entire vicinity of the suspected area. If a nest was found, its location was recorded and the site was left immediately to avoid disturbance. A nest with only one egg was left undisturbed to allow the female to lay more. Once the clutch size reached two or more eggs, few of the eggs were collected for the conservation breeding program and replaced with dummy eggs to encourage the female to incubate other eggs of the same clutch.



Image 28: The project team while searching for display males and nesting females during Lesser Florican breeding season of 2023.

The main nesting area recorded during this season was in Kalyanpura. A total of four nests with 13 eggs were found here, all within 100m of a displaying male's territory. A total of six eggs were collected and seven were left in the wild. All the eggs left in the wild were lost to predation or other unknown causes.



Image 29: A Lesser Florican nest found during 2023.



Image 30: A Lesser Florican female incubating eggs in the wild.



Image 31: The nest search team combing agriculture fields in Kalyanpura, Ajmer in 2023.

Lesser Florican Telemetry

One female Lesser Florican was tagged on 4th August, 2023 on her nest after the collection of eggs. She was equipped with Ornitela OT-E103G (weighing less than 2% of the bird's body weight) (Fig. 11). She moved within 500m of the tagging location for three days post-tagging and then started moving out of the breeding area slowly. She moved out of Rajasthan by the end of August and stayed for three weeks in Kumbharaj in the district Guna, Madhya Pradesh. On 20th September, she moved to Satpura Tiger reserve and hasn't transmitted since then (Fig. 11). Ground tracking and habitat data collection of this individual and previously tagged individuals was carried out from August 2023 to February 2024 in Rajasthan, Madhya Pradesh and Telangana.

Our preliminary observations show that these birds intensively use areas with dense vegetation during the non-breeding season which does not allow the tag to charge enough and transmit on a regular basis. Further, these birds frequently use remote areas without mobile network coverage which causes delays in the transmission. When tags are non-

functional for long durations, due to large data storage and low battery, they can malfunction. However, some tags have recently re-transmitted after months of communication loss, which indicates that these birds with malfunctioned tags may still be alive.

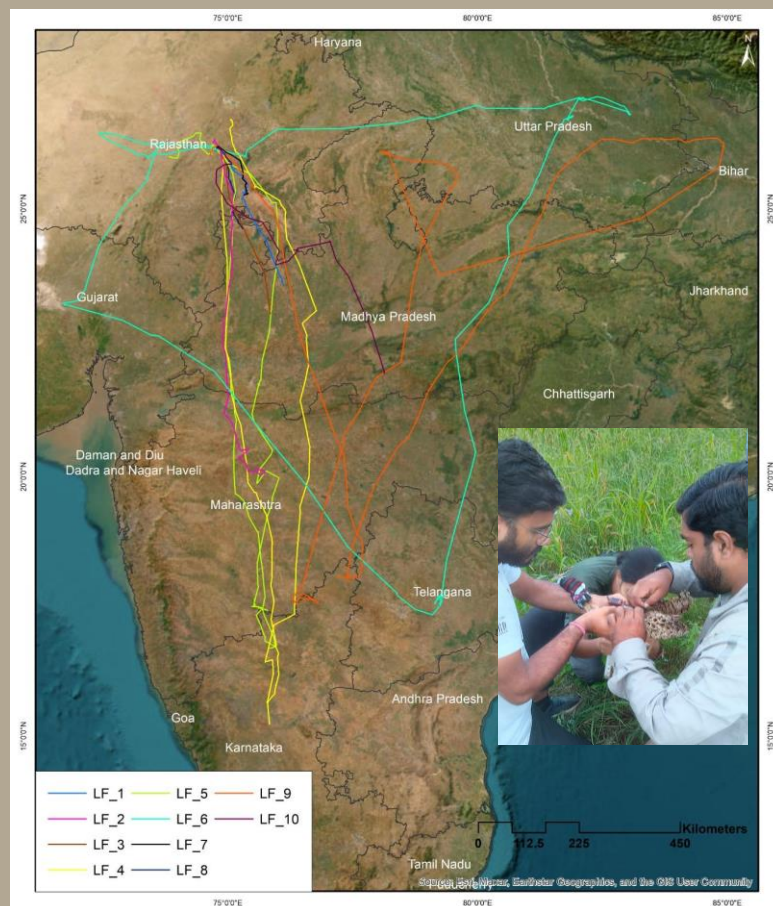
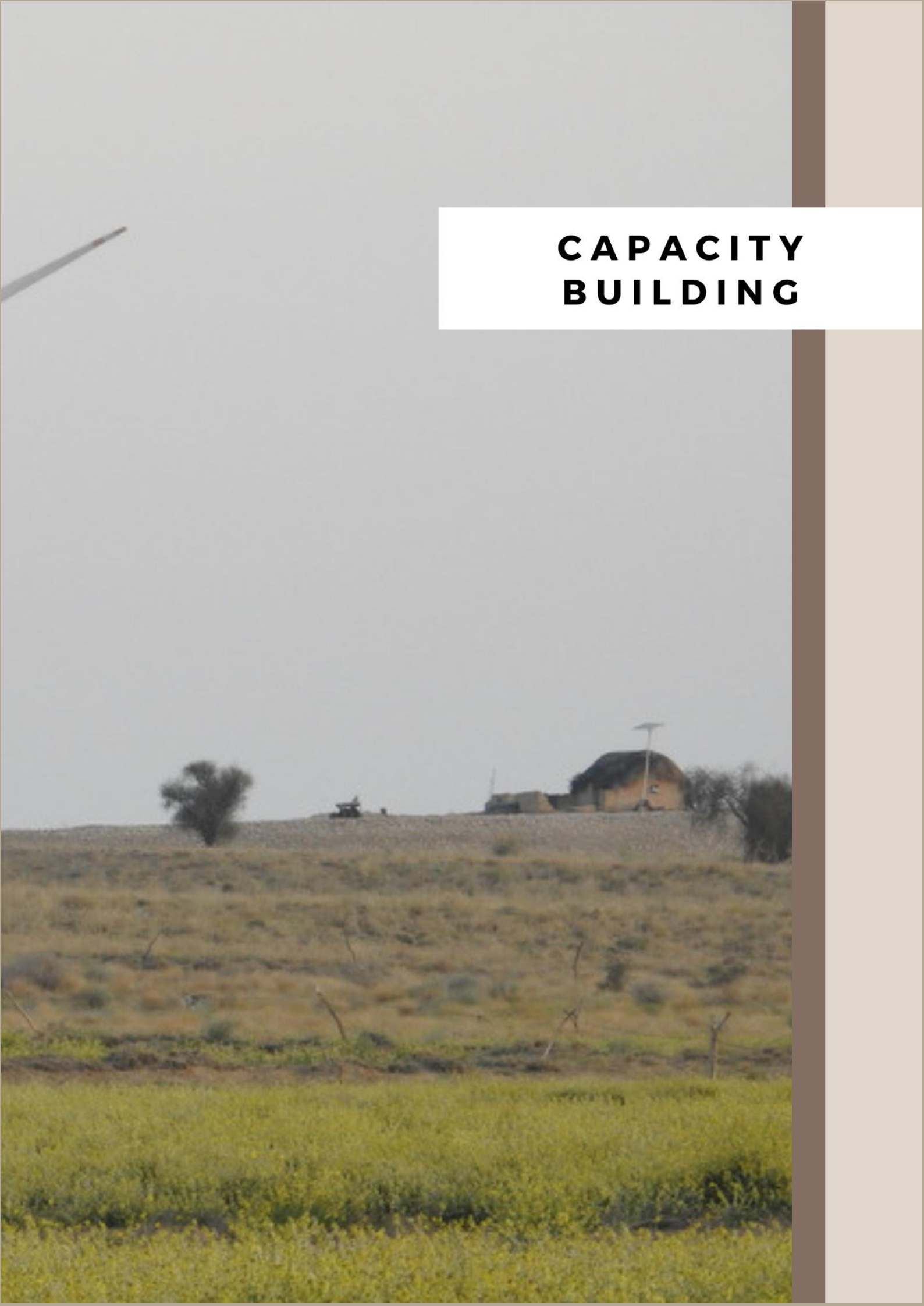


Figure 11: Movement of tagged Lesser floricans (up). Tagging a female Lesser Florican in Kalyanpura, Ajmer landscape during August, 2023 (inset) & tagged male Lesser Florican (down)



A landscape photograph showing a rural scene. In the foreground, there is a field of bright yellow wildflowers. Behind it is a grassy hill with some sparse vegetation. On the crest of the hill, there is a small, round building with a thatched roof, possibly a traditional dwelling. To the left of the building, there is a small, dark, bushy tree. The sky is a pale, overcast grey. On the right side of the image, there are vertical decorative bars in shades of brown and beige. A white rectangular box is overlaid on the upper right portion of the image, containing the text 'CAPACITY BUILDING' in bold, black, sans-serif capital letters.

CAPACITY BUILDING

Most GIB habitats in the country are agro-grassland mosaics occurring within human dominated landscapes. Many of these areas do not have any significant protection status and face tremendous pressures from anthropogenic activities like agriculture and unplanned infrastructure development. Consequently, GIB conservation involves multiple stakeholders, ranging from government executives, development agencies, regulatory authorities, armed forces, farmers, agriculturalists and local communities. Thus, popular awareness about the species and its habitat is crucial for augmenting support for its conservation. At the same time, it is important to understand the perception and attitude of local people towards grasslands and GIB.

Given this context, a significant component of the project is to engage with local people who live in and around prime GIB habitat, to form a buy-in and create goodwill for the long-term success of species conservation efforts. Outreach programs in the Desert National Park are essential for the conservation of the Great Indian Bustard, as they help raise awareness, educate communities, reduce grazing pressure, encourage participation in conservation efforts, and preserve the desert ecosystem's ecological balance. To encourage a sense of ownership and responsibility for the Great Indian Bustard, outreach programmes should be customised to the particular needs of the target population.

Some outreach activities conducted were:

1. **Education and Awareness Programs:** Wildlife conservation is reliant on future generations as they shape the future of wild species and their habitats. The purpose of this activity was to make nature education joyful, entertaining and interactive through various games, field visits and interactive sessions. Students were given an opportunity to learn about and identify the biodiversity in their backyard and their role in the desert ecosystem. During these sessions, kids were given notebooks and bookmarks illustrating the flora and fauna of DNP. Customised nature education programmes were conducted and through these programmes over 4475 students in 17 schools across 16 villages were sensitised from April to September 2023 in Jaisalmer District.



Interactive sessions such as ‘make your own bag’ involving block painting of animals on bags, were carried out in multiple schools and over 400 students participated in these sessions. Also, furniture for setting up a library was sourced and books related to wildlife conservation were provided.



Image 42: Outreach programs conducted in schools across Jaisalmer district

Awareness programs on Lesser Florican conservation were conducted in several schools and villages of Lesser Florican habitat in Rajasthan and Karnataka. Around ~800 students and ~500 villagers were sensitised about the species and its habitat. Posters with information on LF and other outreach materials (bags, caps, notebooks, bookmarks and badges) were distributed in these schools and villages.



Image 43: Awareness programs conducted in Ajmer



Image 44: A board with information on Lesser Florican installed outside a school in Shokaliya by the project, Ajmer, Rajasthan

2. **Field Visit for school students:** A nature excursion program for Rajkumari Ratnavati Girl's School was conducted in Desert National Park in association with the Rajasthan Forest Department. The students were introduced to the GIB conservation breeding program. They were also given a demonstration of wildlife research equipment. These visits are expected to inculcate an appreciation for nature in students and ultimately instil a sense of connection, responsibility and desire to partake in conservation efforts going on in their area.



Image 45: Field visit for students of Ratnavati Girls' School

3. **Wall-painting/mural:** To showcase the activities of GIB conservation to a wider audience, walls in the Sam Conservation Breeding Centre and a government school in Neemba were painted with relevant caricatures. The CBC wall depicted the bond between GIB and their keepers in the conservation breeding centre, whereas the school wall depicted important flora and fauna of the Thar desert.



Image 46: Wall mural in Sam CBC (left) and Neemba School (right)

4. **Wildlife week and Wildlife Day celebration:** Various interactive sessions were conducted in schools around Desert National Park, during the wildlife week of 2023. As part of Rajasthan Forest Department's Wildlife Week 2023 celebration, students from 12 schools of Jaisalmer visited Desert National Park and were given a demonstration of wildlife research equipment. Similarly, the team held an awareness programme with the Meghwalon ki Basti school's teachers and children as part of the celebration of World Wildlife Day 2024.



Image 47: Wildlife week celebration in DNP

5. **Awareness campaign at Desert Festival, Jaisalmer:** A stall was set up at the recently held Desert Festival, Jaisalmer 2024 to spread awareness amongst locals and tourists visiting Jaisalmer. More than 5,000 visitors (locals and tourists) were sensitised during this event and informed about the conservation of the GIB and its grassland habitats.



Image 48: Stall set up during Desert Festival in Jaisalmer

6. **Sensitization of dignitaries at conservation breeding centres:** Many dignitaries and government officials were sensitised about the need and process of GIB conservation during their visits to conservation breeding centres in Sam, Ramdevra and Bijainagar. The delegates were briefed about the ecology of GIB, threats they face, conservation actions in the field and conservation breeding activities being conducted

by WII. The dignitaries included Hon. Chief Justice of India, Hon. Forest Minister of Rajasthan, District Magistrate and Superintendent of Police Jaisalmer, Indian Army officers, IFS trainees, media executives and more.



Image 49: Visitors at Ramdevra Conservation Breeding Centre

7. **Presentations at meetings and conferences:** The project team presented the work being done under the program at various meetings and conferences. A detailed list is provided below:

- a. 'Multi-stakeholder Meeting to Discuss Wildlife Conservation in the Thar - A Community-Based Conservation Approach' conducted by WCS-India at Jodhpur between September 8, 2023.



Image 49: Members from different conservation agencies present at the stakeholder meeting

- b. A stall was set up in the exhibition for Country Led Initiatives in the United Nations Forum on Forest conference organised at the Forest Research Institute (FRI), Dehradun.

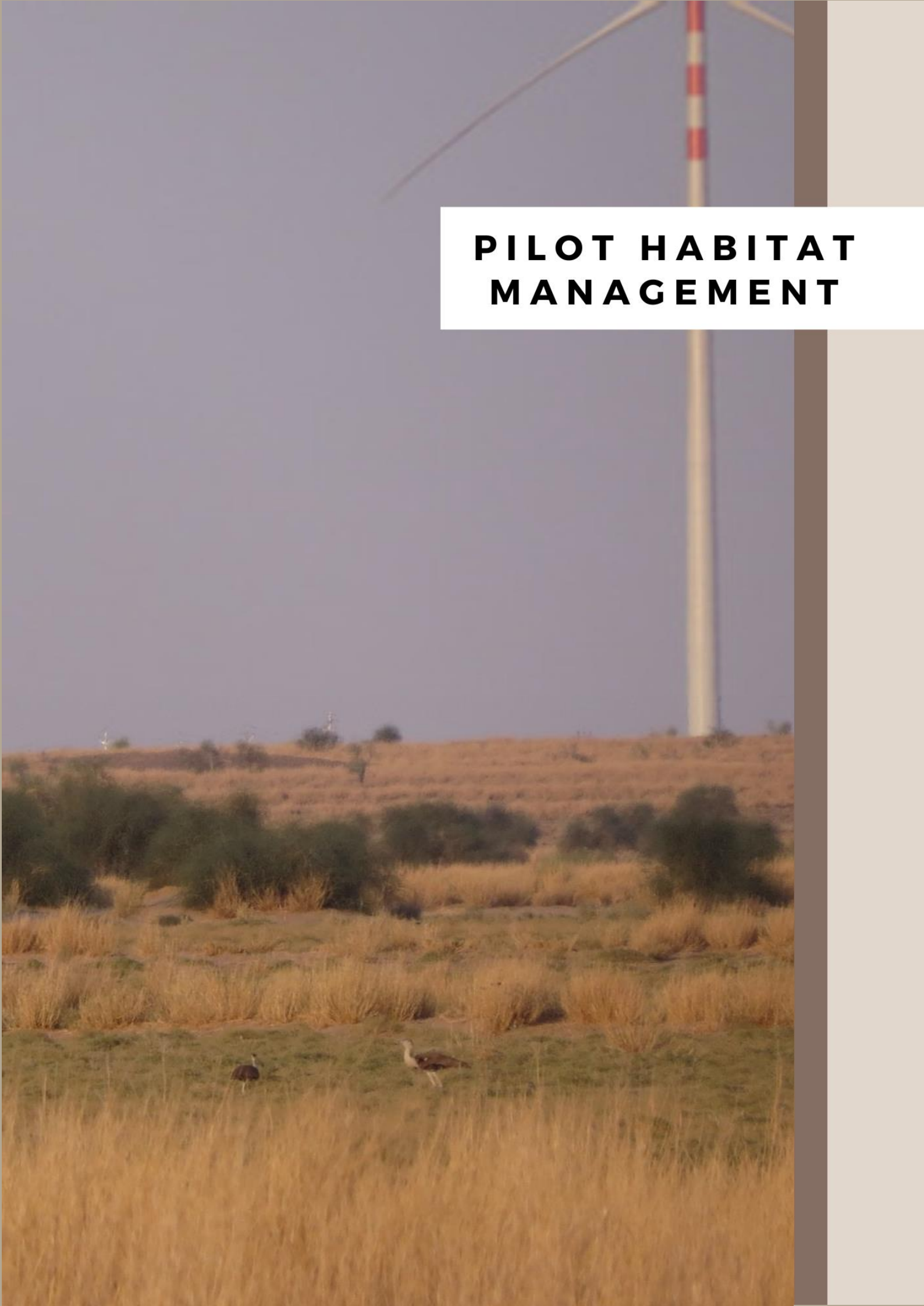


Image 50: Stall set up at the United Nations Forum at FRI, Dehradun

- c. Ongoing conservation actions for GIB were presented in CMS COP 14 meeting at Samarkand, Uzbekistan through online presentation by the Project Investigator.
8. **Documentary:** A video documentary on Critically Endangered bustards and project activities is being developed, as mandated by MoEF&CC, in technical collaboration with The Grasslands Trust and Telescope Pictures.





The image is a full-page background photograph. It depicts a dry, hilly landscape under a clear sky. In the foreground, there is a field of tall, golden-brown grass. Two ostriches are visible in the lower-left quadrant of the foreground. The middle ground consists of rolling hills covered with sparse, dry vegetation and some small, dark green shrubs. In the background, a tall, white wind turbine with a red-and-white striped section near the top is visible. The sky is a pale, clear blue. A white rectangular box is overlaid on the upper right portion of the image, containing the title text.

PILOT HABITAT MANAGEMENT

Assessment of food resource (Arthropods)

Arthropods, particularly grasshoppers, are the primary prey of GIB, particularly during the breeding season. Therefore, understanding differences in insect communities across different habitat gradients is essential for managing habitats for GIB. Thus a study looking at effects of grazing regulation and vegetation recovery on arthropod abundance was carried out in Desert National Park.

For insect sampling, grids of 0.25 sq.km were overlaid on the entire study area composed of both protected (enclosures) and unprotected areas (areas outside enclosures). To allow comparison between the enclosures and areas outside, a 2 km² buffer was placed around the enclosure boundary. The study focused on the Orthoptera family (mainly grasshoppers) as they are the primary food of GIB and an important indicator of the grassland ecosystem. Sampling grids were selected randomly and a transect in any direction was placed from the centroid of the grid. To get the total count of insects, sweep net sampling was done on 50 x 4 m² transect.



Image 32: Insect sampling fieldwork being carried out

The results indicate that the grasshopper density is much higher in protected grasslands during monsoon with no significant difference between areas in summer and winter (Fig. 12). This shows that in monsoon, increase in ground vegetation biomass and food abundance in protected grasslands leads to a rapid increase in insect numbers. In areas outside, insect densities do not increase to this extent during the wet season. This is of significance to the GIB as these protected grasslands (enclosures) form the primary breeding ground for the bird and high insect densities are required for breeding activities like nesting and chick rearing.

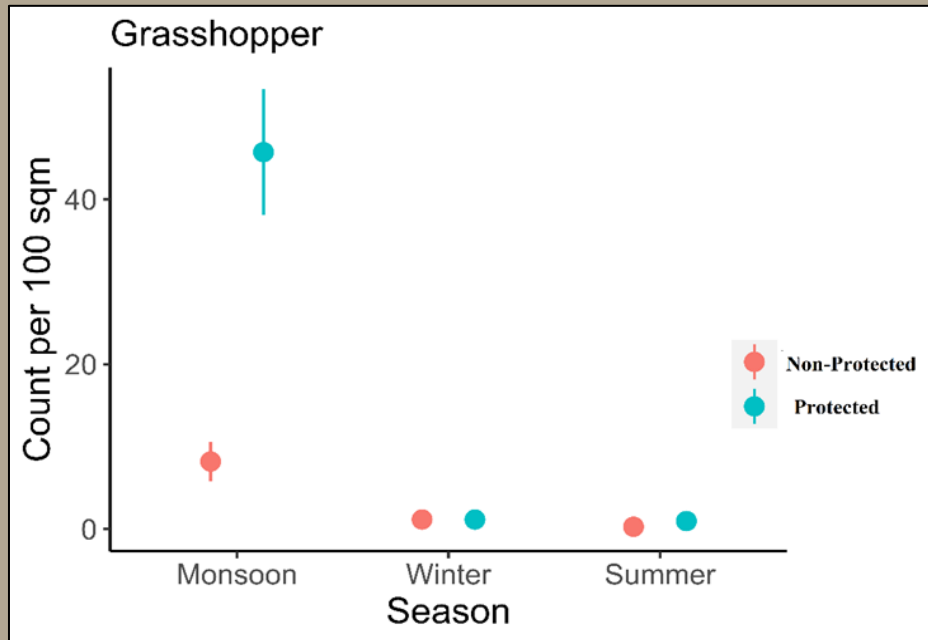


Figure 12: Seasonal density of grasshoppers in protected and non-protected areas of DNP. Note the large difference in count during Monsoon.

Threat Assessment

Powerlines

Power lines pose a significant threat to birds globally, leading to the mortality of millions of individuals every year (Ferrer *et al.* 2020). Within the Thar landscape, the distribution of power lines in the priority area of the Great Indian Bustard is a major cause for concern. Between 2017 to 2023, eight GIBs have died due to collisions with power lines. According to previous studies, the current mortality rate of GIBs due to power lines could lead to the extinction of the species within the next 15 to 20 years (Uddin *et al.* 2021). Assessing the magnitude of the situation, the Honourable Supreme Court of India ordered power line agencies to underground power lines within the critical habitat of the GIBs and install bird diverters on power lines as an immediate mitigation measure. Thus, power line surveys are conducted to estimate mortality rates of GIBs and other important bird species in the landscape and assess the effectiveness of the bird diverters.

Three surveys were conducted between 2023 and 2024 in the western Thar landscape within the Priority GIB Area of Rajasthan (Fig. 13). Vehicle transects were conducted along transmission lines and observers searched for carcasses within a 30m width on either side of the power line. Carcasses were identified to the species level or their finest discernible taxonomic group. They were also classified into three different size classes - small (<100g), medium (100g - 1000g) and large (>1000g). To assess the durability of diverters, information on the number of diverters was collected in the first four pylon segments at the start of each line. Survey efforts were 156 km in March 2023, 69.7 km in September 2023 and 142.8 km in January 2024.

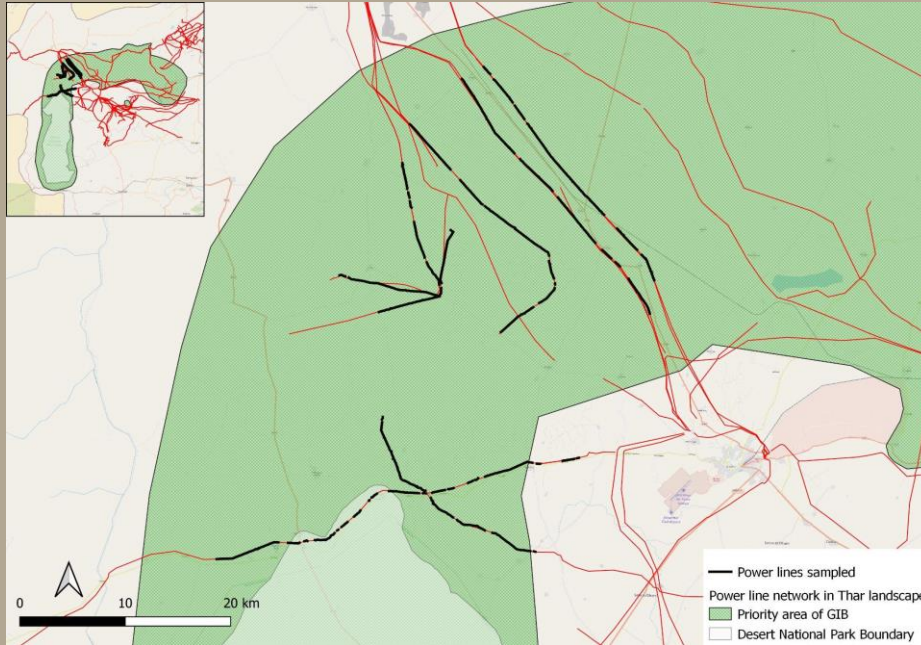


Figure 13: Surveyed power lines within the priority GIB areas in Thar landscape

A total of 107 carcasses were encountered during these surveys. Encounter rates of carcasses were estimated for each survey and size class separately (Table 9). These estimates will be refined using bias correction factors that account for imperfect detection and removal of carcasses before detection, following Uddin et al. (2021).

Table 9: Encounter rates of bird carcasses due to power lines

Survey	Small (<100g)	Medium (100g - 1000g)	Large (>1000g)
Jan 2024	0.06 (0.03)	0.18 (0.04)	0.11 (0.03)
Sept 2023	0.012 (0.012)	0.11 (0.05)	0.05 (0.04)
Mar 2023	0	0	0.18 (0.03)



Image 33: Carcasses of Steppe eagles (left) and Indian Eagle owl (right) found under power lines during the surveys

Studies have shown that bird diverters are effective in reducing power line mortalities. However, the number and placement of diverters affects the extent of mitigation. The surveys conducted found that diverters were placed randomly along most lines and at different intensities. The average reduction in diverter numbers every year was found to be 23%. More surveys need to be conducted to cover a larger network of power lines within the priority area of GIB and to conduct studies on bird crossings to examine the effectiveness of diverters.

Wind turbines

Wind turbines can adversely impact birds through collision mortality as they collide with turbine blades or get drawn into the wind vortices. The Thar desert is a hotspot for wind energy because of suitable wind resources, availability of land, and large wind power potential (5050 MW). In continuation, wind projects here have expanded from 16 to 2820 MW between 2002 and 2014.

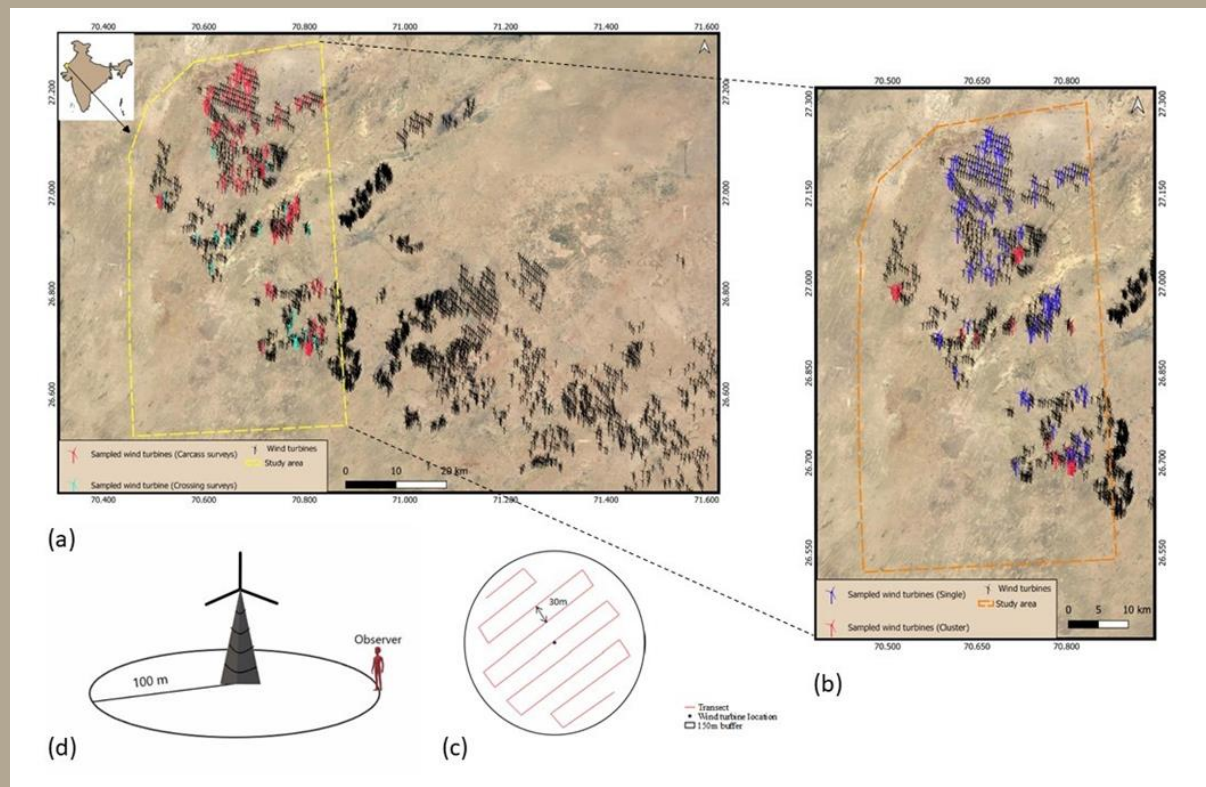


Figure 14. Map of Thar desert showing (a) the study area in yellow polygon, (b) population of wind turbines in black, sampled single turbines in blue and clustered turbines in red, (c) diagrammatic representation of bird carcass survey around sampled turbines, and (d) diagrammatic representation of bird crossing survey around sampled turbines during 2020–21

To estimate wind turbine induced bird mortality, 90 out of ~900 turbines (that were installed before the study) were randomly sampled (Fig. 14). Bird crossing observations at 16 wind turbines were conducted to examine bird usage of turbine areas, and to identify vulnerable taxa. Vulnerability index for each bird family was also calculated. The influence of turbine and habitat characteristics on bird mortality was estimated to plan evidence based mitigation strategies. Furthermore, collision-to-crossing rates vis-à-vis flight patterns of bird families was studied to identify relatively vulnerable taxa.

A total of 124 bird carcasses were observed in 630 turbine searches. Out of these, 93 carcasses belonged to nine families and 19 species, whereas 13 carcasses were of unidentified raptors and another 18 could not be identified. Bias adjusted mortality rate was estimated as 1.24 (SE 0.18) bird turbine⁻¹ month⁻¹, comprising 0.23 (0.13) small birds, 0.87

(0.12) medium size birds, 0.02 (0.01) large birds, 0.09 (0.01) raptors and 0.04 (0.02) unidentified birds. This yielded an annual mortality estimate of 13,359 (95% CI 11426 - 15293) individuals for all birds and 953 (95% CI 801 - 1104) raptors for the entire study area containing 900 wind turbines.

Wind turbine collision rates differed between habitats (Fig. 15). Collision rates were greater in single turbines compared to clustered turbines and showed a weak positive relationship with hub height (Fig. 15). Vulnerability was highest for Falconidae > Accipitridae > Columbidae > Ardeidae > other families (Fig. 16).

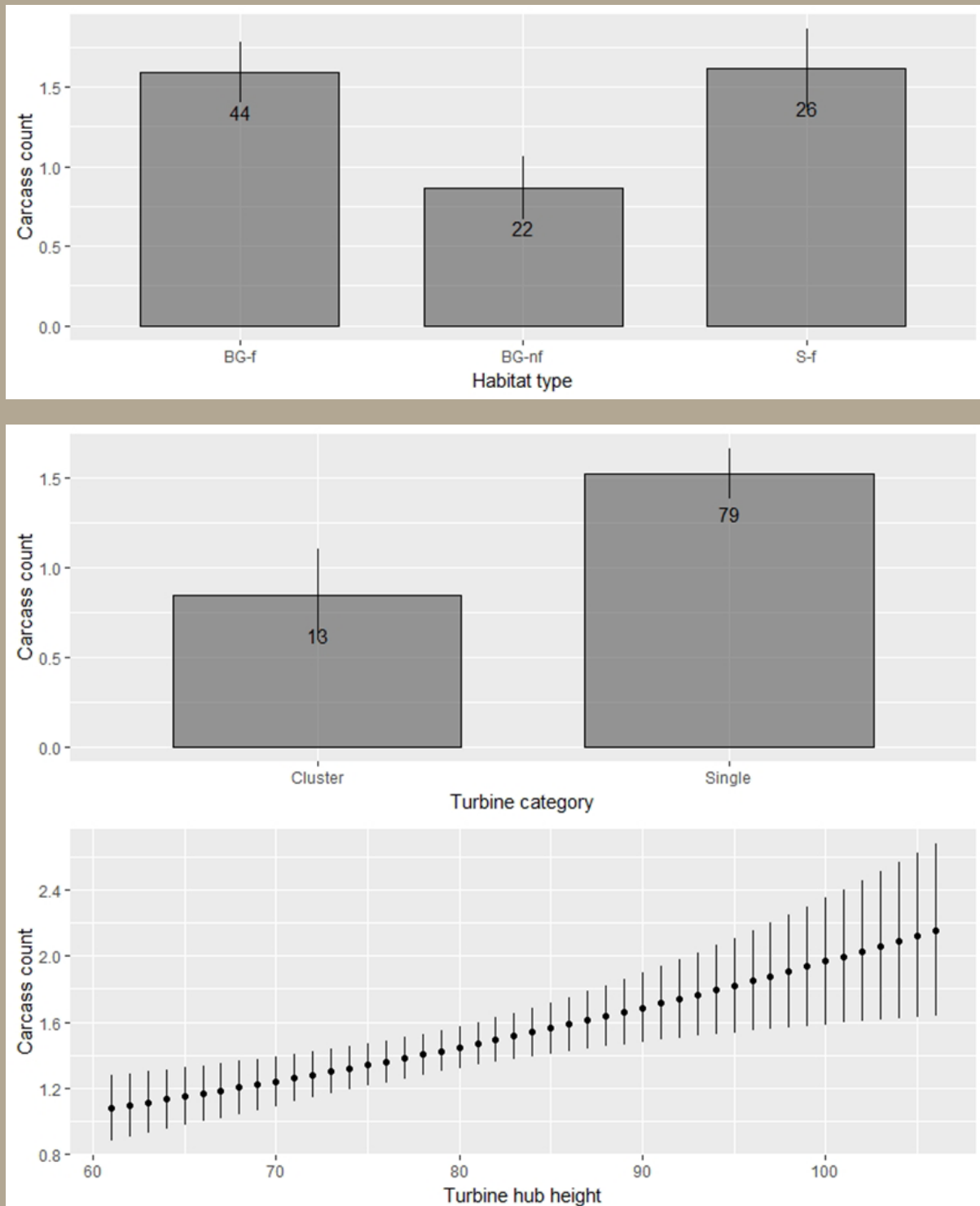


Figure 15. Comparison of model estimated mean (SE) carcass turbine⁻¹ survey⁻¹ against habitats (BG-f: Flat grassland; BG-nf: undulating grassland; S-f: flat scrubland), single vs. clustered turbines and turbine hub height (m) [top to bottom] in Thar desert during 2020–2021

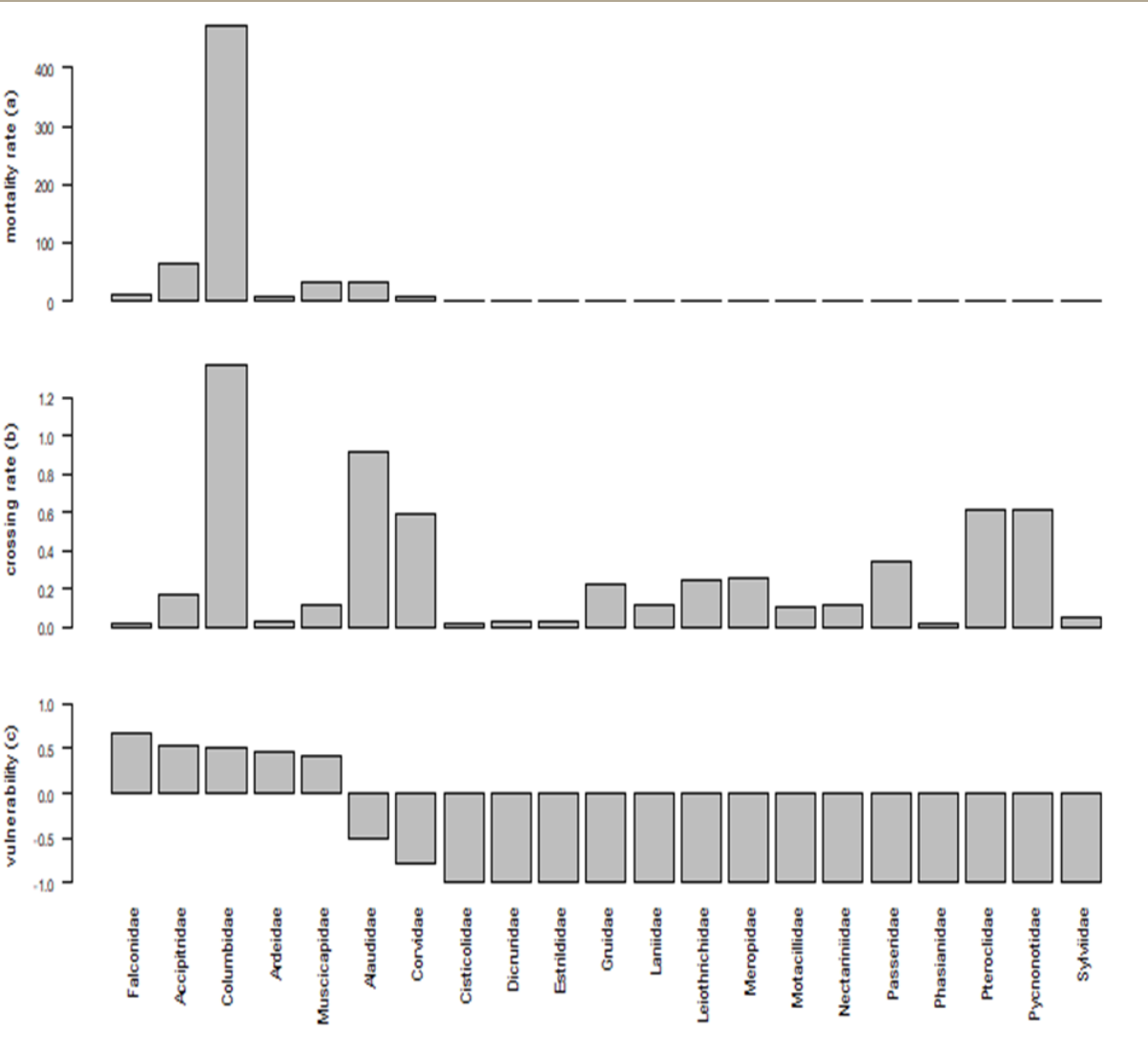


Figure 16. Vulnerability index of bird families (c) computed as the ratio of proportional bias-adjusted mortality (a) and proportional crossings (b) of bird families in Thar desert during 2020–21



Assessment and management of nest predators

Quantification of nest predator densities using camera traps

Desert National Park, which is a critical conservation area for one of the last few viable populations of the Great Indian Bustard, is also home to other iconic xeric species like the desert fox, Indian fox, desert cat, chinkara, and spiny-tailed lizard. In the past few decades, animals like the Indian fox, nilgai, wild pigs, mongooses and even free-ranging dogs have dispersed into this landscape due to changing land use patterns. Cohabitation with some of these species, like the Indian fox, inside the fenced enclosures of DNP is detrimental to GIB recruitment because most of these meso-carnivores predate GIB eggs and chicks. Mitigating this threat requires a better understanding of the population of these predators that reside inside the enclosures. A camera trap based predator density estimation study was conducted inside nine enclosures of DNP representing present and past breeding areas of the GIB, namely- Sudasari, RKVY, Kanoi, Gajaimata, Chouhani TFC, Chouhani PPC, Ramdevra, Rasla and Myajilar (Fig.17). Three areas outside these enclosures were also included in the study to see the contrast, if any, in predator populations.

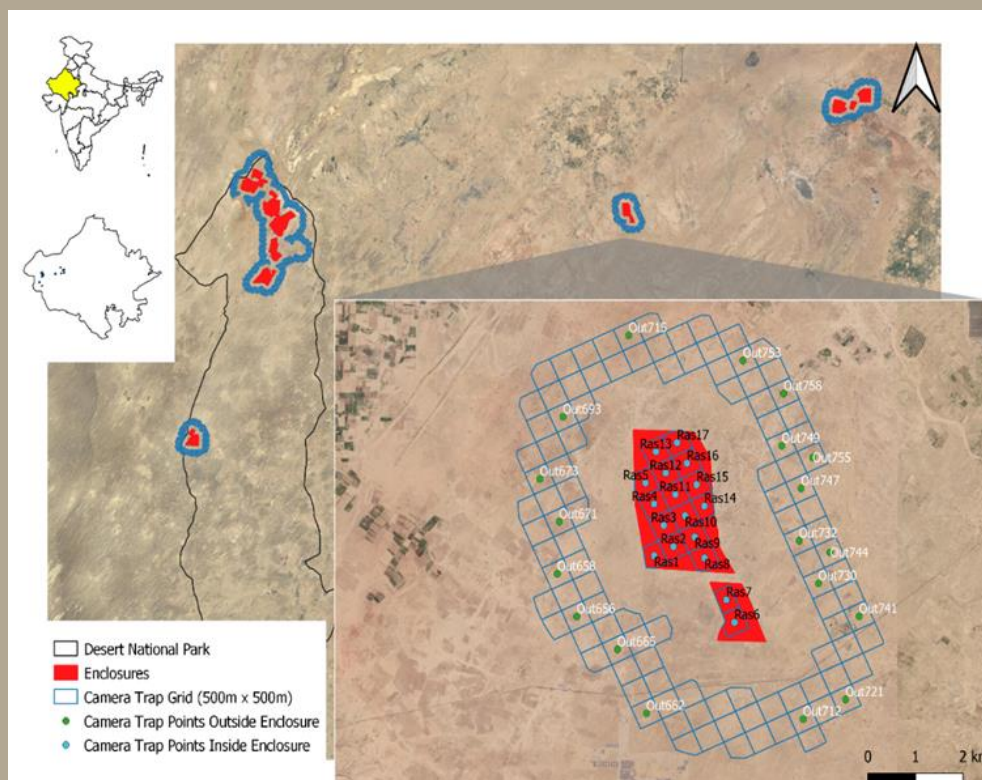


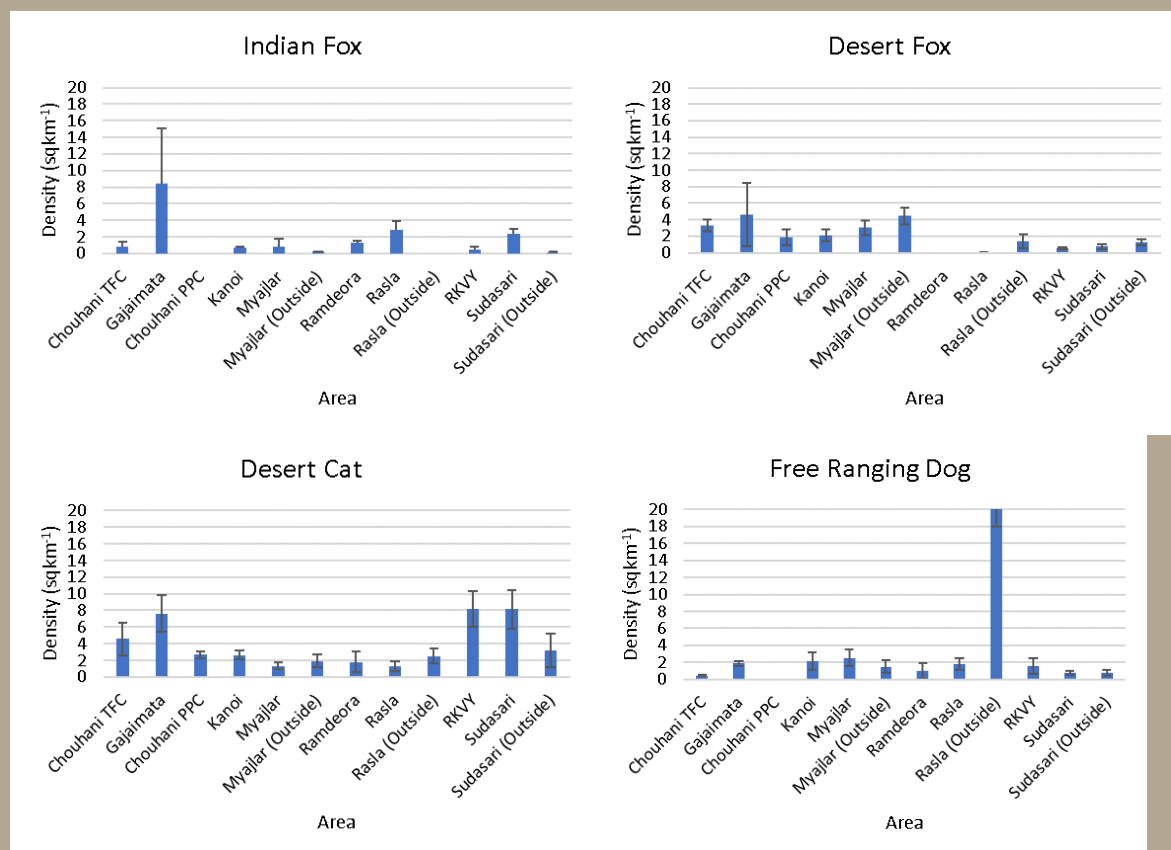
Figure 17: Locations of deployed camera traps in and around protected enclosures in DNP

Since the study comprised species of varying sizes and different temporal behaviours, camera traps were thought to be the best mode of conducting the survey. Camera Trap Density estimation (CTDS) was selected as the survey technique where the density of the species is calculated based on the detection probability of the species at different distances from the camera and the encounter rate of the species. The target enclosures were split into 500×500 m grids using GIS tools. Grids with comparable dimensions were also drawn outside the enclosures, with a buffer of one kilometre left from the perimeter (Fig 17). At or within a 50m radius from the centre of these grids, camera traps (Reconyx HC500 Hyperfire Semi-covert Passive Infrared Camera-traps) were placed using a standardised methodology methodically. The cameras were placed inside specially designed mounts 18–23 cm above the ground. When triggered by an animal crossing, the cameras were set to take a burst of 10 pictures. To determine animal distance, calibration exercises were conducted where pictures were taken

of a pole, of 100 cm height, positioned at known intervals of 2, 4, 8..., and 20 metres at the centre and on both sides of the camera's field of vision. These pictures were used to characterise the camera viewing frames to then generate the triaxial location and distance of the animal from the camera. As an alternative, sticks with various heights and markings were placed at predetermined distances (2, 4, 8, 12, and 20 m) to act as distance markers. Cameras were deployed on field for 30-40 days, with periodic monitoring (every four to five days) to assess the cameras' condition and make necessary adjustments.

This field sampling was conducted in 2016-2018 during which a total of 307 unique camera trap locations were sampled. Each image obtained was tagged with the name of the species, number of individuals and distance class using the software ExifPro. A proprietary software 'Animeter' was used to get the distance class in images where distance classes were not demarcated using sticks. Our target species for the study were nest predators like Indian fox, desert fox, desert cat, free-ranging dogs and other important animals like chinkara, nilgai and wild pigs.

Density of seven species of animals across 12 areas was estimated using this method. The densities of animals (per sq.km) in different enclosures are shown in Figure 18. Indian foxes, desert foxes, desert cats and wild pigs were found to be in high densities inside most enclosures. Desert cat density was highest inside Sudasari, the primary breeding enclosure in DNP. Thus this study reinforces the need for nest predator management from the main breeding enclosures in DNP.



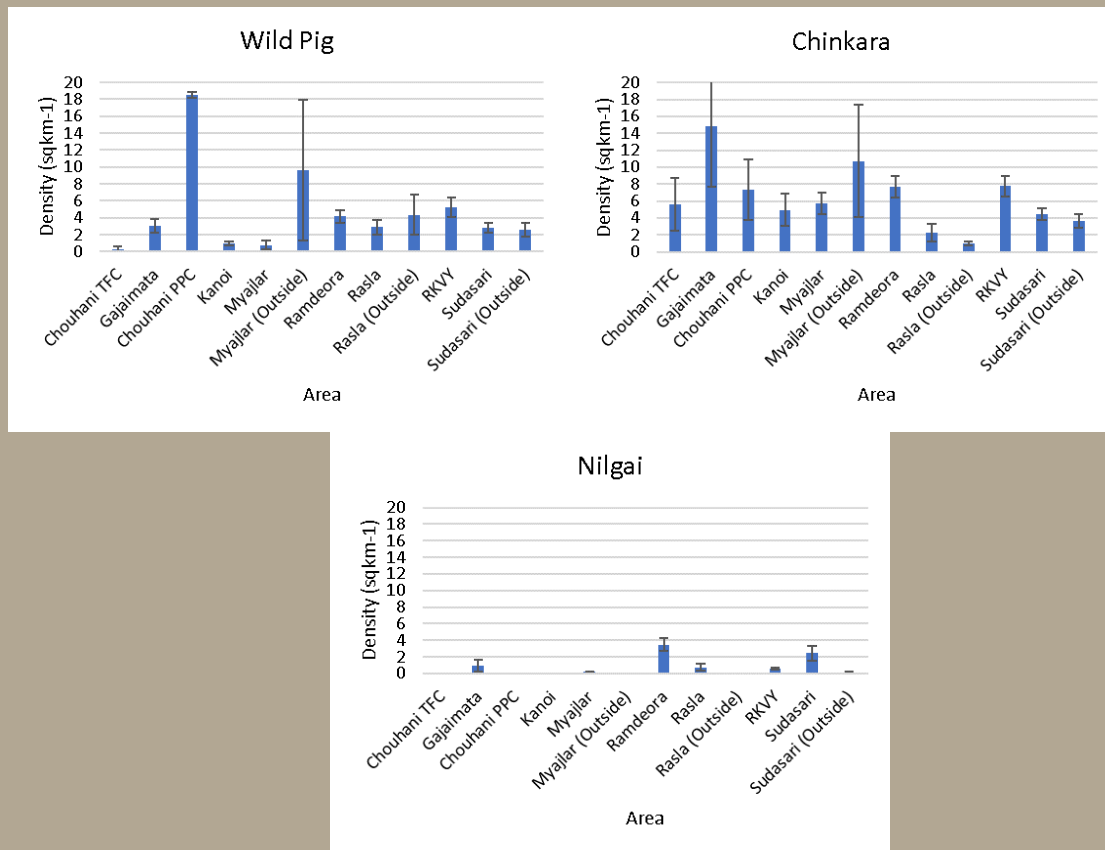


Figure 18: Density of species (per sq.km) in and outside different DNP enclosures

Short study on the breeding ecology of Desert Fox

The desert fox *Vulpes vulpes pusilla* is a common yet understudied carnivore of the Thar desert. A short-term study was carried out to understand some aspects of its breeding ecology in an unprotected area of 150 sq.km outside Desert National Park in Jaisalmer. 2x2 sq.km grids were overlaid on the study area and fox dens were searched for intensively on vehicle and foot in an attempt to detect all dens in the area (Fig. 19). Detected dens were classified as either active or inactive depending on the presence of fox activity signs such as scats and pugmarks. Active dens were further classified into resting and breeding dens (for the ones where sightings or signs of pups were seen). The breeding population size was estimated from the total number of breeding dens found, assuming 100% detection. To determine the number of pups in each breeding den, camera traps were placed at each den for 2-15 days. The litter size was estimated from the maximum number of pups sighted in a frame over multiple trap days across dens ($n = 18$) using Royle's N-mixture model. Using ground truth points, a land-use land-cover map was generated and locations of settlements and carcass dumps within the study area were recorded. The count of dens within each 2x2 sq.km grid was modelled with land cover, distance from settlements, carcass dumps, roads and water using a Poisson generalised linear model to assess the effect of these variables on den density. Breeding pair density in the site was found to be 0.11 / sq.km, yielding an abundance of 36 foxes in a 150 sq.km study area. The detection corrected litter size was estimated to be 3 (± 0.5), similar to what is already known for the species. Breeding den density was higher in scrublands than other land-covers and densities were highest at an optimal distance of 2km from settlements and carcass dumps which may be acting as resource/ food subsidies. This study provides some basic information on the species' breeding ecology, while many aspects of it remain to be studied.

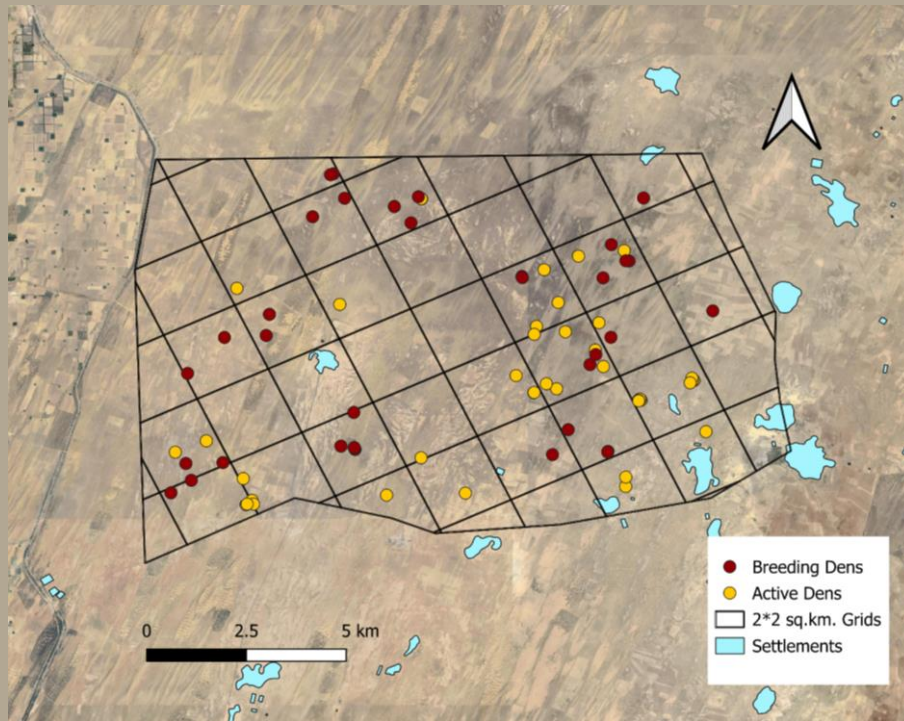


Figure 19: Map showing locations of all active and breeding dens found in the study area



Image 34: Female desert fox nursing pups at night (left); Desert fox with four pups outside den (right)

Den search in Sudasari

Sudasari, a 15 sq.km enclosure in Desert National Park serves as one of the main breeding grounds for the GIB with ~70% of the nests detected here. Moreover, the nest predation rate in this enclosure is very high (~60%). Foxes are known to be a major nest predator, based on the presence of scat at predation sites and a dummy egg experiment conducted in 2016-17. Hence Sudasari is a prime area for nest predator management (National Bustard Action Plan), where foxes need to be strategically translocated to suitable non-breeding areas. To prioritise areas for fox capture, an intensive den search was conducted.

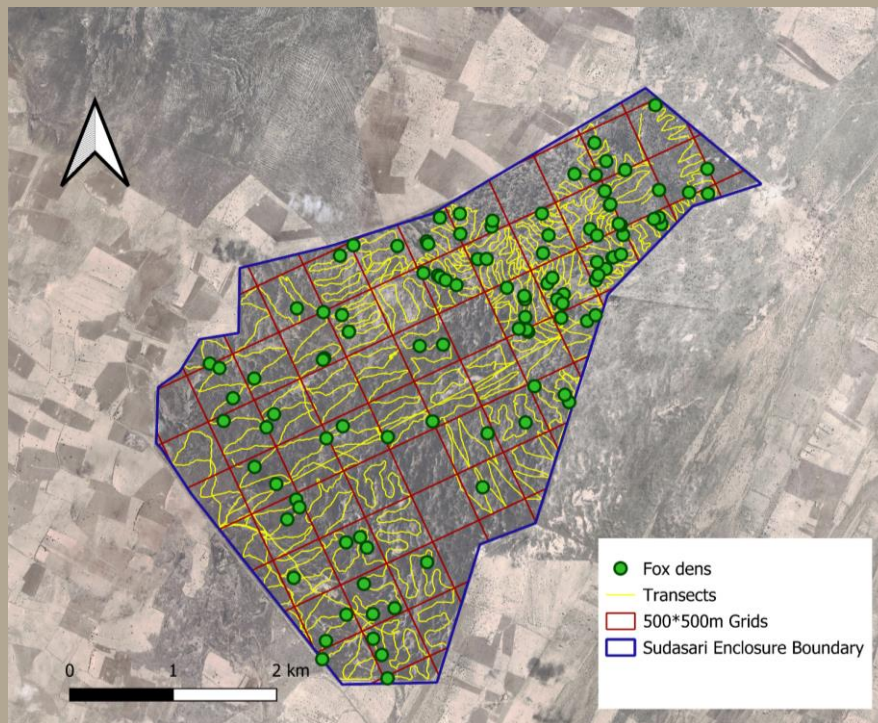


Figure 20: Map of all fox dens detected in Sudasari.

For den search, 500×500m grids were overlaid and transects of an average length of 1.78 km were walked in a zig-zag manner to ensure maximum coverage of each grid (Fig. 20). 113 fox dens were found of which only 16 were found to be active at the time of detection. All dens will be monitored periodically to detect activity, especially during the GIB breeding season, and active dens found near GIB nesting areas will be targeted for future translocations.

Translocation of GIB nest predators from breeding enclosures in DNP

Predation of nests is a demographic hindrance to the rapid recovery of GIB populations. GIB nests are mere scrapes on the ground and do not contain any nesting material. This makes them extremely vulnerable and prone to predation. Life-history monitoring has shown that ~60% of GIB nests get predated by predators such as foxes, mongooses, cats, monitor lizards and pigs. To deal with this problem and increase GIB hatching success in the wild, the program steering committee had decided that nest/ chick predators such as dogs, wild pigs, cats, fox, mongoose, and monitor lizards should be excluded from important GIB breeding enclosures using a combination of predator-proof-fencing and regular translocation.

Additionally, predator density needs to be assessed, and translocated predators need to be tagged/marked to monitor the effectiveness of management interventions. Permissions were granted to trap, mark and release Indian fox, desert fox, desert cat, wild pig, monitor lizard and mongoose. Predator translocation exercise was initially attempted on a pilot basis in 2020 and 2022, and three foxes were translocated from two important GIB breeding enclosures (Sudasari and Chouhani) to other less important GIB areas of Desert National Park (DNP). At the same time, multiple dogs were translocated out of enclosures in GIB breeding habitats of both the Sudasari and Pokhran ranges. In May 2023, 15 dogs were removed from Khetolai, near Pokhran. The removal was carried out by the team, along with a veterinarian, by using dart guns and trap cages. These dogs were translocated 50km away.

From December to January 2023, a predator translocation exercise was carried out in PPC (Chouhani) and the adjoining areas of DNP. This was done based on a request of the local forest administration in response to a GIB mortality found in the PPC Chouhani enclosure of DNP on 19/12/2023, prima facie predated by a canid, likely a fox as per genetic investigation. Based on the learnings of all the trapping sessions thus far, a more focused predator

translocation exercise will be carried out in the next season. The exact methodology of the entire process is given below.

For capturing small predators such as foxes, cats and mongoose, padded foot-hold traps and Tomahawk cages were set up at sites where predator movement was previously observed. The traps were baited using animal entrails and, in some cases, whole chicken. Traps were checked every two hours to detect any trapped animal. As this method was not suitable for free-ranging dogs in the area, the area was surveyed using vehicles and dogs found were darted. Once captured, the animal was chemically mobilised using a mixture of xylazine, ketamine and medetomidine. Vital parameters such as heart rate, respiration, and rectal temperature were monitored continuously during the immobilisation process and a heat source was provided to prevent hypothermia. Few of the captured animals were tagged using Telonics VHF collars whereas others were marked with dog collars. All animals were measured, weighed, and scored for body condition and samples of hair and ectoparasites were collected. All animals were released >35 km of aerial distance from GIB breeding enclosures within 24 hrs of capture. Additionally, 11 dogs were captured using dart guns and were handed over to the Forest Department to be translocated to a suitable area.

All collared animals were intensively tracked by the team for 2-3 weeks post-release after which the intensity of tracking was reduced to once a week. Two foxes and one cat could not be traced post-release while four foxes returned to the PPC enclosure within two months of release. These four foxes were released within 100km of the site of capture. During the next fox translocation exercise, foxes will be released at further distances so that they are unable to return. Additionally, the fences are to be checked by the Forest Department to find areas that foxes and other predators might be able to cross through. Some foxes and cats will be collared with GSM/GPRS collars which will allow tracking the animal more precisely post-release. Additionally, a camera trap predator estimation was conducted in PPC prior to the translocation exercise (results yet to be analysed) and the same study will be repeated six months later to look at the effectiveness of predator removal from these enclosures.



Image 35: Desert cat with VHF collar





Image 36: Captured desert fox with VHF collar



Image 37: Collaring of desert fox



Image 38: Predator translocation team with a captured desert fox



Image 39: Release team with the captured animals



Image 40: Two desert foxes before release at Dav enclosure in Desert National Park



Image 41: Camera trap image of collared fox back inside PPC enclosure

List of predators captured, marked and translocated (during 2023-24):

In total, 14 foxes, three desert cats, two mongooses and one monitor lizard were captured, marked and translocated. Details of capture and release are given below in Table 10.

Table 10: List of animals captured and released with relevant details during 2023-24

Sl. No.	Species	Capture site	Capture Location		Release site	Release Location		Sex
			Latitude	Longitude		Latitude	Longitude	
1	Indian Fox	Chouhani PPC	26.6616	70.5990	Dav	26.4509	70.4494	Female
2	Desert Cat	Chouhani Silvipastoral-2	26.6517	70.6072	Dav	26.4187	70.5130	Female (died / predated later)
3	Desert Fox	Chouhani PPC	26.6557	70.6046	Dav	26.4108	70.4965	Male
4	Small Indian Mongoose	Chouhani PPC	26.6663	70.6113	Hatar	26.6125	70.5566	Male
5	Small Indian Mongoose	Chouhani PPC	26.6556	70.6031	Dav	26.4109	70.4963	Female
6	Desert Fox	Chouhani PPC	26.6674	70.6119	Dav	26.4109	70.4963	Female
7	Desert Fox	Chouhani PPC	26.6674	70.6119	Dav	26.4109	70.4963	Male
8	Monitor lizard	Chouhani PPC	26.6558	70.6046	Dav	26.4377	70.4429	Unknown
9	Desert Fox	Chouhani PPC	26.6674	70.6119	Dav	26.4108	70.4963	Male
10	Desert Fox	Chouhani PPC	26.6675	70.6009	Dav	26.4108	70.4963	Male
11	Desert Cat	Chouhani PPC	26.6550	70.6042	Myajlar	26.2767	70.4064	Male
12	Desert Fox	Chouhani PPC	26.6675	70.6009	Myajlar	26.2767	70.4064	Male
13	Desert Fox	Chouhani PPC	26.6633	70.6136	Myajlar	26.2767	70.4064	Female
14	Desert Fox	Chouhani PPC	26.6639	70.6136	Dhanana	26.7091	70.1914	Male (Recapture)
15	Desert Fox	Chouhani PPC	26.6639	70.6136	Dhanana	26.7091	70.1914	Female
16	Desert Fox	Chouhani PPC	26.6639	70.6136	Dhanana	26.7091	70.1914	Male
17	Desert Fox	Chouhani PPC	26.6674	70.6120	Dhanana	26.7091	70.1914	Female
18	Desert Fox	Chouhani PPC	26.6674	70.6120	Longewala	26.3814	70.0883	Male
19	Desert Cat	Chouhani PPC	26.6678	70.6110	Longewala	27.3950	70.1158	Male
20	Desert Fox	Chouhani PPC	26.6675	70.6000	Longewala	27.3950	70.1158	Female



Picture Credit: Rajasthan Forest Department

References:

- BirdLife International. 2018. *Ardeotis nigriceps*. *The IUCN Red List of Threatened Species* 2018: e.T22691932A134188105. <https://dx.doi.org/10.2305/IUCN.UK.2018-2.RLTS.T22691932A134188105.en>. Accessed on 20 March 2024.
- BirdLife International. 2021. *Sypheotides indicus*. *The IUCN Red List of Threatened Species* 2021: e.T22692024A199959007. <https://dx.doi.org/10.2305/IUCN.UK.2021-3.RLTS.T22692024A199959007.en>. Accessed on 20 March 2024.
- Dutta S, Bipin CM, Anoop KR, Uddin M, Shekhawat RS and Jhala YV (2018). Status and trend of Great Indian Bustard, associated wildlife and threats in Thar. Wildlife Institute of India, Dehradun and Rajasthan Forest Department, Jaipur. Available at: https://wii.gov.in/images/images/documents/publications/rr_2018_GIB_Thar_Survey_Report.pdf.
- Ferrer, M., Morandini, V., Baumbusch, R., Muriel, R., De Lucas, M., & Calabuig, C. (2020). Efficacy of different types of “bird flight diverter” in reducing bird mortality due to collision with transmission power lines. *Global Ecology and Conservation*, 23, e01130.
- Hedley, SL and Buckland, ST (2004). Spatial models for line transect sampling. *Journal of Agricultural, Biological, and Environmental Statistics*, 9, 181–199. <https://doi.org/10.1198/1085711043578>.
- Howe, E. J., Buckland, S. T., Després-Einspenner, M. L., & Kühl, H. S. (2017). Distance sampling with camera traps. *Methods in Ecology and Evolution*, 8(11), 1558-1565.
- Ivlev, V.S. (1961) *Experimental Ecology of the Feeding of Fish*. Yale University Press, New York, 302.
- McClintock, B. (2008). Mark-resight models. In: *Program MARK: A Gentle Introduction* 13th edition (Cooch, E.G. and White, G.C. eds.). Pp 18.1-18.33.
- Miller, DL, ML Burt, EA Rexstad, and L Thomas (2013). Spatial models for distance sampling data: recent developments and future directions. *Methods in Ecology and Evolution* 4(11): 1001–10. <https://doi.org/10.1111/2041-210X.12105>.
- SolB (2023). *State of India's Birds 2023: Range, trends and conservation status*. Available at: https://stateofindiasbirds.in/wp-content/uploads/SolB-2023_report.pdf.
- 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.



The Bustard Recovery Program is supporting local livelihoods and skill development as residents around Conservation Breeding Centers in Rajasthan have been engaged and trained to execute bird rearing, food production, center maintenance, caretaking and sanitation works, forming a dedicated team of support staff for this specialised Program.



Designed by: Tanya Gupta

