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# A Study on Ecology and Migration of the Lesser Florican (*Sypheotides indica*) in Western India Using Satellite Tracking Techniques



## Principal Investigator

Dr. K. Sivakumar

## Co-Investigators

Dr. Y. V. Jhala

Dr. G. S. Bhardwaj

## Junior Researcher Fellow

A. Mohan

Final Report

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Title of the Project: A Study on Ecology and Migration of the Lesser Florican (*Sypheotides indica*) in Western India Using Satellite Tracking Techniques

Project Investigator: Dr. K. Sivakumar, Scientist-F

Co-investigators: Dr. Y.V Jhala, Scientist-G  
Dr. G.S. Bhardwaj, Chief Conservator of Forest-  
Jodhpur, Rajasthan.

Research Fellow: A. Mohan & Omkar Dhavale

Volunteers: Rupesh Gomes and Ashish Jangid

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Mr. Rathod, RFO, BNP.

Mr. Mathruja sikh Forest Range Officer, Dahod.

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- **Project Team**

1. The Lesser Florican *Sypheotides indica*, a species endemic to the Indian subcontinent, is largely seen during the monsoon season in north-western India, where it breeds. Its population and range is believed to be decreasing at an alarming rate due to breeding habitat loss and threats in the non-breeding habitats, believed to be in south and south-east India. In this connection, to understand the present status, distribution and non-breeding habitats of Lesser florican in the north-western India i.e. in Gujarat, Madhya Pradesh and Rajasthan, this study was initiated in the month of August 2010, which is a part of breeding season of this species, when most of males display in the grasslands.
2. In 2010, a total of 84 individual Lesser floricans (83 male and 1 female) were sighted in three states of north-western India, which is less than 65% of the sightings reported in 1999. It was found significantly fewer sightings than reported in 1999 in all grasslands surveyed ( $t=2.81$ ,  $df=14$ ,  $p<0.05$ ). Of the 169 potential grasslands available for floricans in the north-western India, 91 grasslands were surveyed, which include grasslands surveyed during 1999. Of the surveyed grasslands, Lesser floricans were found in 24 grasslands as against 37 grasslands in 1999.
3. At Shokhaliya, two male floricans (Florikin I and II) were tagged on 10th of August, 2014 with PTT transmitters that are solar-powered Platform Terminal Transmitters (PTTs: Microwave Telemetry, Inc., Columbia, MD, USA) weighed less than 3% of body mass of birds.
4. FLORIKIN-I: The male florican that was tagged with 18g Agros PPT-100 (Platform no.125812) had spent 112 days in breeding site and then left the site (Shokaliya) on 11th November 2014. The bird moved for 94 km towards south direction and settled down in grasslands/croplands of north of the Bhilwara, Rajasthan. The bird covered this distance in 5 days and 8 hours (including stopover

times) with four stopovers. Each stopover last for one to two days. All the stopovers were in the croplands or fallow lands. Florikin-I flew at the speed of 0.73 km/hr which includes stopover days. The transmitter was active until May 2015. PTT lost the signal when the bird just started moving towards Ajmer from Bhilwara in the month of May, 2015.

5. FLORIKIN-II: He was tagged with 22g GPS/Argos PTT had transmitted data for 35 days after that it failed to function, the reason remained unknown, but it provided much more precise insight into the lekking behavior of this species. The available data shows that the Florican can shift the displaying territory within an arena during a breeding season. Three times this bird had shifted his territory and spent considerable time in each territory. All these three territories of Florikin-II were within the home range of 6.8 sq.km area (MCP100%). The same kind of territory shifting behaviour was observed in Florikin-I as well.
6. Both Florikin I and II, left their territory and moved to a different site after a week of tagging. Total days spent in breeding season/area by Florikin-I were 122 days. During that period the home range of Florican-I was estimated as 12.46sq.km when 5% locations excluded (MCP 95%) and 30sq.km when all location were included (MCP 100%). Similarly, the home range of Florikin-II was within 6.8 sq.km (MCP 100%)
7. Territory shift within Lek Arena was observed in Floricans. Both the tagged floricans could shift the displaying territory but within the arena. Agricultural activities such as weeding, pesticides applications and growth of crops (like Millet) might have also influenced this short distance territory shifts.
8. After the breeding season, one of the tagged florican i.e. Florikin I which had active PTT left the breeding ground on 11<sup>th</sup> November 2014 to non-breeding grounds. It reached the non-breeding grounds on 15<sup>th</sup> November 2014 which was 87 km (aerial) 94 km (polygon)

away from the breeding ground. During this 87 km long migration, it stopped at four places (nearby villages Goyla (26° 60' 54" N, 74° 55' 36" E), Keriya kurd (26° 03' 43" N, 74° 53' 42" E), Peepaliya (25° 59' 17" N, 74° 49' 52" E) and Sardarpura (25° 49' 21" N, 74° 49' 51" E). All these stopovers were near the water bodies with grasslands. In each stopover that last for one to two days. This bird flew at the speed of 0.73 km/hr which include the stopover time.

9. Habitats of the migratory route of Florikin I were mostly comprised of croplands (Cotton and Millet) with mosaic of grass/herbs cover at least 40% to 50% of the total land cover.

10. Non-breeding habitat of Florikin I was located at Bhilwara, Rajasthan, largely comprising agricultural crops with mosaic of scrub forests consists of *Prosopis juliflora*. At Bhilwara region, this bird stayed for first 17days at one place where the home range was 6.1 sq.km (MCP 100%) and then moved into another place and stayed for 177 days till 29<sup>th</sup> March 2015 where the home range was 2.9 sq.km (MCP 100%). The distance between these two non-breeding areas was 9.53 km.

11. General habitat of non-breeding area of florican was *Prosopis juliflora* (34.18%) followed by Agriculture land with crop and without crop (19.47%), grassland (18.93%), water logged but this land dried during the summer 10.29%), Barren land (8.28%) and human built (6.61%).

12. Though the sample size was low, our study indicate that the all floricans won't migrate a long distance from the breeding areas. Their non-breeding grounds probably near to breeding areas within distance of 200 to 300 km and gather during the breeding season in the breeding ground.

13. In 2014, the population of floricans was estimated using both traditional (Area Search method) and 'Occupancy Modelling with Distance Sampling' methods. Using the Occupancy Model, it was estimated that the population size

of floricans was 1091 floricans (689 to 1729) (Uniform cosine function  $x^2$   $p=80.8$ ,  $AIC=659.6$ ) and estimation the ESW at 213.7 m ranging 185.3–246.4). Detection probability=0.56 (0.48 to 0.65). The generated global density estimate is 1.19 Floricans per sq.km. However, sightings of floricans in the breeding grounds from 2010 to 2014 were varied between years.

14. Sightings of male floricans from 2010 to 2015 in Rajasthan, Gujarat and Madhya Pradesh

Sate	District	Key Villages	2010	2011	2012	2014	2015	
Rajasthan	Amjmer	Shaunkhaliya	3	62	71	---	---	
		Bhilwara	Shahpura	5	7	7	11	0
		Prathapgarh	Sidpura	0	1	0	0	NS
MP	Ratlam	Sailana	1	1	6	6	9	
		Amba	1	0	0	1	3	
		Dhar	Sardharpura	2	4	3	0	1
		Jhabua	Petlawad	2	2	5	3	5
		Dhahod	Rampua	5	0	2	2 R	0
Gujarat	Bhuj	Naliya	23	10	2	3	NS	
		Bhavnagar	Velavadar NP	22	26	27	26	49
		Total	66	113	126	94		

14. Maximum individuals of breeding floricans reported from the agricultural landscape mixed with mosaics of grasslands at Shokaliya region. Presence of larger populations of floricans in the agriculture landscape is cause of concern as these landscape uses heavy amount of pesticides that kills of larger number of insects which were fed by floricans.

14. National Policy on Grasslands Management - It is important to have a National Policy on Grasslands Management in India appreciating the ecological services provided by this ecosystem. Currently, grasslands are by and large considered as waste lands due to lack of understanding about their ecological services. The practice of tree plantation by the forest department in grasslands or grass *birs* should be avoided. Under the umbrella of Joint Forest Management/ Eco-development or social forestry schemes tree plantations were carried out in a major scale which is harmful to floricans and their habitats as well as associated species in the grasslands especially in Shahapura and Naliya areas.

15. Moreover, current practise of looking grasslands as source of only fodder for cattle needs to be reconsidered. Sustainable use of grassland resources without harming their ecological services needs to be emphasised in the National Policy. The Policy is also required to be suggesting the wildlife especially bustards friendly grassland management in India. Inclusion of more florican habitats in the existing Wildlife Protected Area Network -

16. Less than five protected areas (grasslands) are existing exclusively for the conservation of florican/bustards in the north western India. These include Sailana Kahrnor Sanctuary and Sadarpur Florican Sanctuary both in Madhya Pradesh and the third is Velavadar WLS. Former two are exclusively notified for Lesser Florica while the third one is for Black Buck in Gujarat. There is also one sanctuary the Great Indian Bustard WLS, which is chiefly for GIB but it is also a habitat of Lesser Florican. Less than 5% of globally endangered Lesser florican habitat is protected by Wildlife (Protection) Act, 1972. Since the protected florican habitats are comparatively better than non-protected grasslands, it would be better to bring more grasslands under the Wildlife Protected Areas of India by declaring more grasslands as „Conservation or Community Reserves“. It is urgently required to bring some of the grasslands in

Nalliya region in the protected area network. Similarly, some grasslands in Gonda and Rajkot districts as well as in Ratlam and Dhar districts. Grasslands around Sailana are also need to be declared as „Community/Conservation Reserve“ with consensus of local communities. And then the grasslands in the protected areas are need to be managed to fulfil the habitat requirement of bustard in general and lesser florican in particular. Management of Invasive Species -

17. Eradication of *Prosopis juliflora* and other invaded tree species from the selected grasslands in the north-western India should be taken up immediately. Eradication and monitoring of invasive species in the grasslands should be a continuous programme following the guidelines of IUCN- Invasive Species Specialist Group.

18. Floricans prefer pure but undisturbed grass patches with mosaic of last year grasses to settle down at the beginning of breeding season. Therefore, it is recommended to leave mosaic of old grasses during harvesting for floricans as well as other grassland wildlife. Instead of leasing out grasslands for grazing it would be better if the grasses are manually cut after the monsoon season that will prevent trampling of cattle on florican nests as well as spreading of invasive tree species in the grasslands. Pesticides use in adjoining agricultural fields found to be detrimental for the survival of floricans, therefore, local communities need to be advised the ill effects of pesticide use and they should be compensated if they incur any loss due to non-use of pesticides around florican habitats.

19. Florican watch and community involvement in florican conservation  
- The financial incentive scheme of Madhya Pradesh Forest Department for rewarding the villagers for giving the information of the presence of bird in their agricultural land needs to be thoroughly reviewed and it may be started in others states of Rajasthan and Gujarat, if it is found be worth. An awareness and sensitisation

programme for the conservation of Lesser Florican and its habitat should be initiated by all the state forest departments in the states of Rajasthan, Madhya Pradesh and Gujarat. This should be further supplemented with eco-tourism and sensitive florican watch activities. Local communities need to involve in the management of grasslands and they need to be told the reason behind the decline of florican as well as deterioration of their grasslands. There was an initiative in Naliya, where grasslands grazing/harvesting were regulated with the help of local communities. Because of this some grasslands in Naliya region were not disturbed during the breeding season of florican. This initiative was implemented in collaboration with Forest Department, Revenue Department and Local community. If this model works successfully then the same may be tried elsewhere in the country.

20. Apart from declaring some of important grasslands as conservation/community reserves, it would also be requiring to modify the current use of grasslands in the north-western India. Instead of allowing livestock grazing all over grasslands, certain portion of grasslands need to be protected at least for a year period. Next year, these protected grass patches may be used as fodder but protecting other parts of grasslands for another year use. This kind of practice would help the floricans to settle down and to breed.

21. The Lesser Florican (*Sypheotides indica*), a species endemic to the Indian subcontinent, is largely seen during the monsoon season in north-western India, where it breeds. Its population and range is decreasing at an alarming rate due to breeding habitat loss and threats in the non-breeding habitats, believed to be in south and south-east India. Their breeding habitats have sharply declined in north-western India, which is believed to be a major cause for the decline of this endangered species, and there is hardly any information its non-breeding habitat which is supposed to be in Central and South India. A number of studies have been carried

on its population status, habitat-use and behaviour in the breeding grounds, but there is practically no information about their habitats, ecology and behaviour in non-breeding habitats, the knowledge of which is crucial for their comprehensive conservation plan preparation. It is important to know the status of non-breeding habitat of florican using satellite tracking techniques, understand the migration pattern/movements, and investigate its current status and distribution in north-western India, which could lead to data on the species in other areas. There is also need of continuous monitoring of Lesser Florican and its habitat in the states of Rajasthan, Madhya Pradesh, Gujarat and Maharashtra. Studies on impact assessment of mega and even so called eco-friendly projects like wind mills on the Lesser Florican should be initiated. A study on the effects of pesticides and insecticides on Lesser Florican is still lacking. There should be a study on this issue.

## Chapter-I

### Introduction

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Six species of bustards (Otididae) occur in the Indian subcontinent. The Great Indian Bustard *Ardeotis nigriceps*, Lesser Florican *Sypheotides indica* and Bengal Florican *Houbaropsis bengalensis* breed in India, while the Great Bustard *Otis tarda* and Houbara *Chlamydotis undulata* are occasional or common winter migrants (Grimmett *et al.*, 1998). The Lesser Florican and the Great Indian Bustard are endemic to the Indian subcontinent, while a subspecies of the Bengal Florican is found in Cambodia, and Vietnam as well (Osborne *et al.*, 1984).

The Lesser Florican is amongst the smallest bustards of the world with 510-740 gm adult body weight. It occurs largely in grasslands and is an endangered species. It breeds during the southwest monsoon, which normally begins by the end of June (Jerdon 1864, Baker 1921, Dharmakumarsinhji 1950, Ali and Ripley 1969, Sankaran *et al.* 1992, Sankaran 1997a). During



this period, a distinct movement into Gujarat, eastern Rajasthan and western Madhya Pradesh, where it congregates in areas of good rainfall, has been documented (Jerdon 1864, Sankaran *et al.* 1992). Its primary breeding habitat are grasslands where sufficient grass cover is available during the breeding season. In western India, these

grasslands are fragmented and patchily distributed and the majority of habitat available to the Lesser Florican is now a mosaic of grassland and cropland (Sankaran 1997).

The most recent surveys in 1999, have an estimated population of 3530 birds (Sankaran, 2000).



The breeding success of the Lesser Florican depends on the quantum and distribution of monsoon, which is highly uncertain across all its breeding range (Sankaran, 1994) and availability of sufficient grass cover (Ali and Ripley 1983). Undisturbed grasslands with mixed vegetation

cover appears to be of the greatest importance in habitat selection during the breeding season of the Lesser Florican (Sankaran, 1997a).

Several studies (Jerdon 1864, Baker 1921, Dharmakumarsinhji 1950, Ali and Ripley 1969, Sankaran et al. 1992, Sankaran 1997a&b, Sankaran 2000) have been carried out and gathered information on habitat use, population status and breeding behavior of this species during the breeding season.

Loss of breeding sites is believed to be a major cause for the declining of this endangered species. More than 620 sites have been brought under protected area network in India but



grasslands are very poorly represented (Rahmani and Manakadan, 1988; Rodgers and Panwar, 1988). There has been a considerable loss of private owned grasslands, and also grass patches in between crop fields (Rahmani 1987, Shankaran, 1994). In addition, most of the grasslands, either pure or mosaic are under excessive pressure of grazing due to livestock. Unlike

the breeding areas, there is hardly any information about the non-breeding habitat of this species, which is crucial for their comprehensive conservation plan preparation. In this context, this three year study is proposed with following objectives.

### **1.1. Historical Distribution**

The Lesser Florican is virtually endemic to India, although there were some records from Pakistan, Nepal and one unconfirmed historical report from Myanmar (Birdlife International, 2001). The scatter of historical records shows a fairly even distribution across all of modern-day lowland India, with the exception of the Brahmaputra valley in the north-east; thus the species appears once to have occurred from Gujarat and central Rajasthan east to West Bengal and Orissa and from Sahranpur in north-west Uttar Pradesh south to Trivandrum in southern Kerala (Baker 1922–1930, Ali *et al.* 1986, Sankaran 1995b, Birdlife International, 2001). There was a one record from Punjab (Birdlife International, 2001). The main breeding areas were apparently in the districts of Nashik, Ahmednagar and Sholapur of Maharashtra, eastern Haryana and the Kathiawar Peninsula (south-central and south Gujarat) (Goriup and Karpowicz 1985), but are now in southern Rajasthan, southern and eastern Gujarat, and

western Madhya Pradesh (Sankaran 1991, 1994b). The species believed to be winters in dry, grassy areas throughout much of India, mainly east of the Western Ghats, and south and east of the Godavari river (Ali *et al.* 1986, Sankaran 1995b), however, in the recent past their sightings in India other than during breeding season is become rare.

Early in the twentieth century, breeding florican were also sighted in southern Sind and the grassy plains of Lasbela district, Baluchistan, Pakistan, these birds might be the spill over of breeding dispersal from the near by Gujarat in India (Ticehurst 1922–1924, Roberts 1991–1992). The Lesser Florican also reported in the eastern part of Coastal Mekran (Ticehurst. 1926–1927.

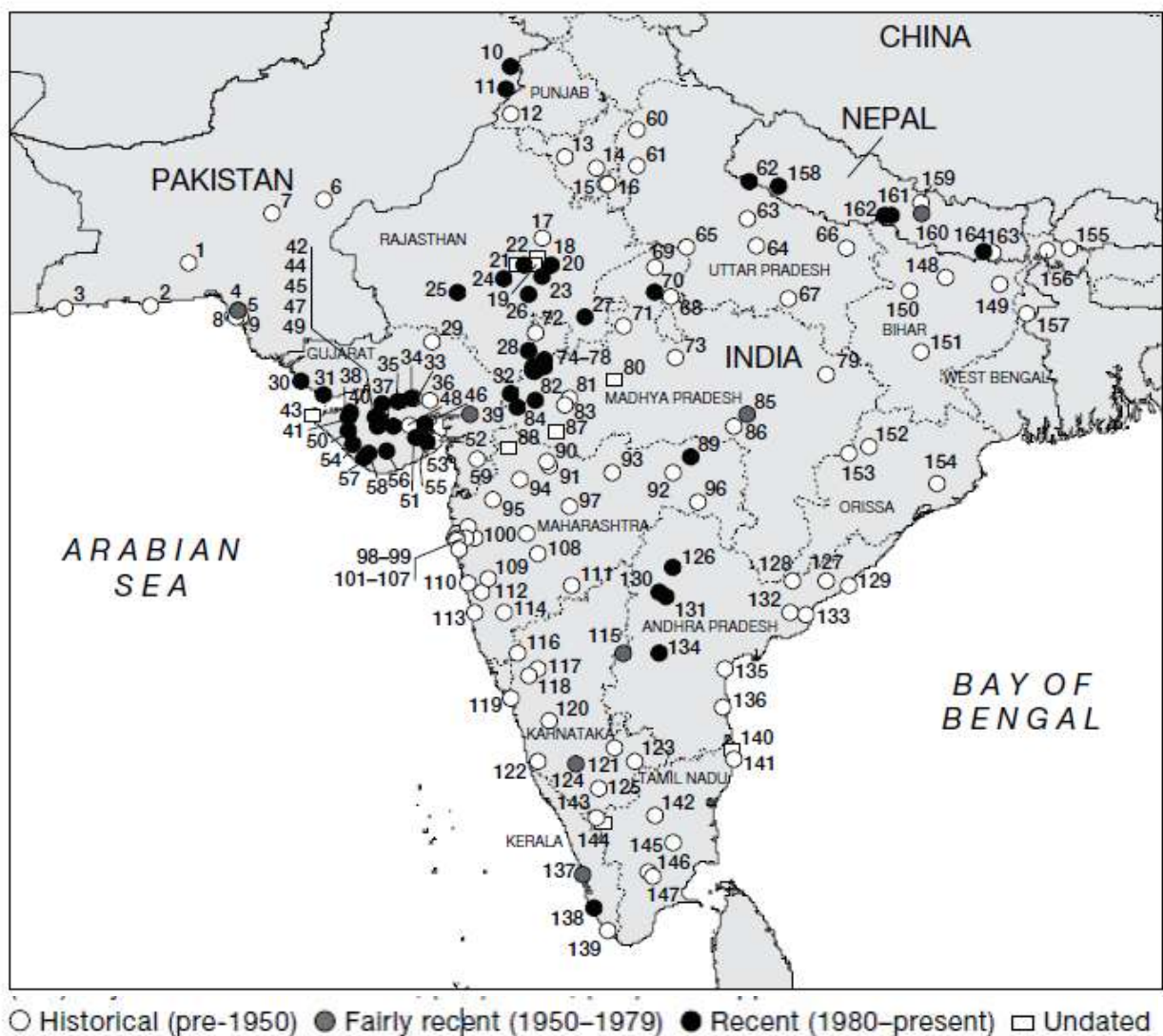


Fig1. Present and historical distribution of Lesser florican (Source: Birdlife International, 2001)

## **Project Objectives:**

The reports of decline in the population and possible extinction of Lesser Florican in next 50 years was even mentioned in the late 19<sup>th</sup> (Hume and Marshall, 1879-1881) and in first quarter of 20<sup>th</sup> (Baker, 1921-1930) centuries. It was observed that there was a drastic reduction in its population by 60% from an estimated number of 4374 individuals in 1982 to 1672 in 1989 (Sankaran et al. 1992; Sankaran, 1990, Sankaran and Rahmani, 1990a). The most recent surveys in 1999, have estimated a population of 3530 birds (Sankaran, 2000) which shows a population increase of 62%. For last 10 years there was no systematic study for assessing the status and distribution of this species. Due to ever increasing anthropogenic pressures, continuous change in the land use pattern especially in grassland areas, natural resource management practices by different agencies, other developmental activities and possible climate change might have dragged the dwindling population of Lesser Florican to minimum level. Being an indicator of high grass productivity (Magrath et al. 1985, Sankaran, 1997c), the jumping display of Lesser Florican is like the pulse of the grassland ecosystem. With this background a rapid survey aimed to assess the present status of Lesser floricans and their habitat in north-western India was carried out. It was also aimed to train the local staff and bird watchers towards florican count and also create awareness among locals;

- To study the migration and movement pattern of the Lesser Florican to identify their non- breeding habitats using satellite tracking techniques.
- To assess the status of non-breeding habitat of the Lesser Florican using previous sighting records.
- To assess the current status and distribution of breeding Lesser Florican in north-western India to study the habitat and breeding ecology of Lesser Florican in north-western India and
- To prepare a comprehensive conservation plan to covering both breeding, non-breeding ranges including migration pathways of the Lesser Florican.

### Study Area

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#### 2.1. Introduction

The study has done during this project complimented and expanded to research earlier done by Sankaran in 1991 & 1994 and Bhardwaj in 2010 (Bhardwaj 2011). Especially the study concerned about post breeding movements, breeding habitat and status of Lesser Florican. Therefore we selected the potential breeding sites where the previous studies extensively carried. These principle breeding grounds of the species are located in north-western states of India which are southern Rajasthan, western Madhya Pradesh and Gujarat. The areas fall into semi-arid region of India which fed with southwest monsoon from July to October, the average rainfall varying from 400 to 1000 mm (Kesava Rao *et al.* 2013). Lesser Florican breeds in different kinds of semi-arid grassland habitats, the area comprises of pure grasslands, mosaic grasslands, savannah grasslands, sure Croplands, mosaic croplands which are characterised by *Sehima-Dichanthium* type with scattered bushes and where breeding habitats ranges from 0.02 to 30 sq.km in area (Sankaran 1997 and Bhardwaj 2011). The predominant grass species in this habitat are *Dichanthium annulatum*, *Sehima nervosum*, *Bothriochloa pertusa*, *Chrysopogon fulvus*, and *Heteropogon contortus* (Sakaran 1997 and Sing et al 2014). The most common shrub species are like *Zyzipus*, *Acacia*, *Butea* and *Calotropis* and trees like *Accasia nilotica*, *Prosopis cinerea*. *Lantana camara* and *Prosopis juliflora* are the invasive plant species causing habitat distraction except in Malwa Plateau habitats. All these florican reserves are surrounded by cropland. All the though the species recorded from various places from western India during breeding period including Maharashtra, our study restricted to only potential breeding grounds of the species in three states Rajasthan, Madhya Pradesh and Gujarat. We have not surveyed in Maharashtra and Andhra Pradesh where some outstanding population breeds.

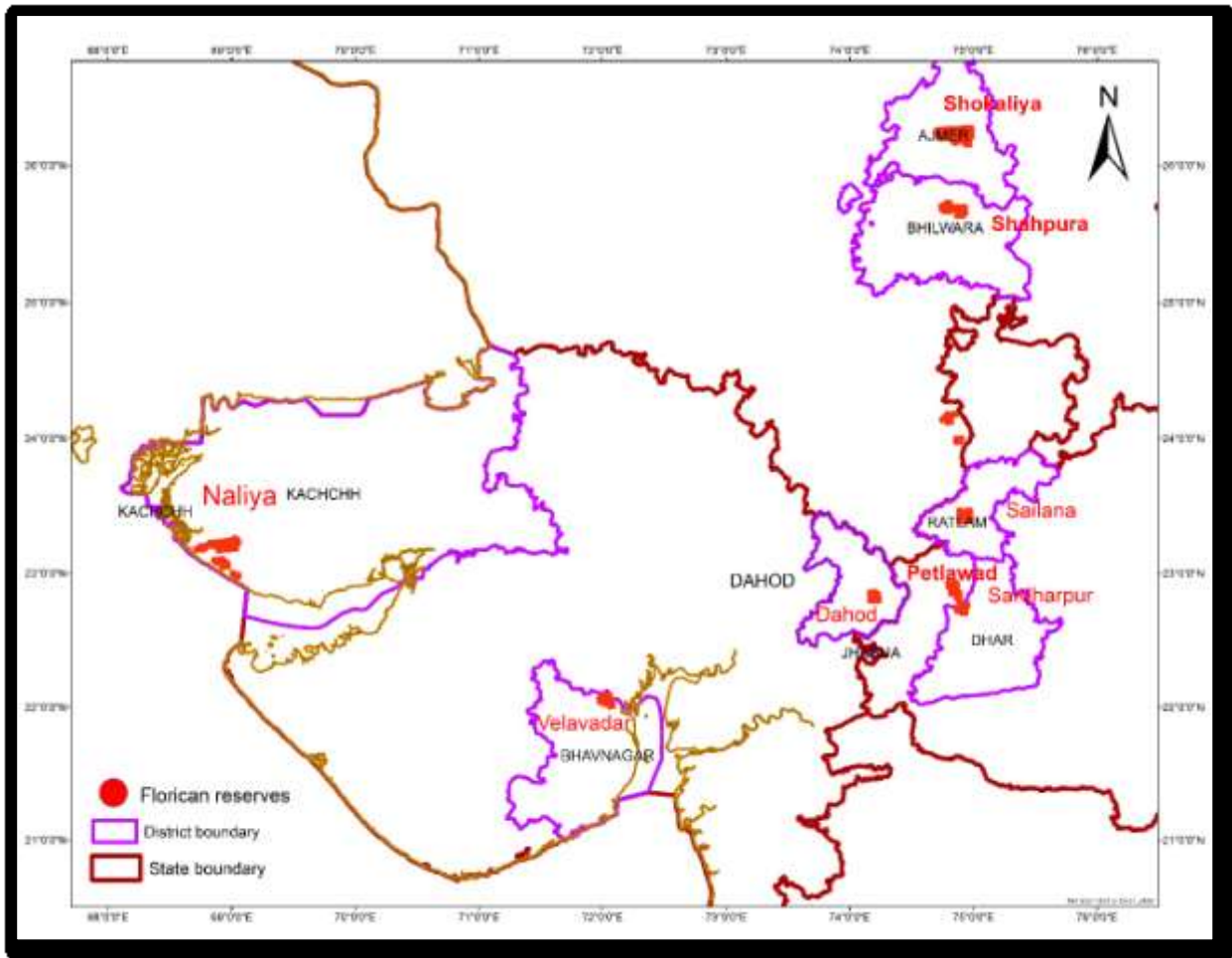


Figure 2.1. The distribution of Lesser Florican breeding sites in western India (Gujarat, Madhya Pradesh and Rajasthan).

## 2.2. Rajasthan

**2.2.1. Shokaliya:** Shokaliya (village) landscape well known for the Lesser Floricans, assumed that currently the landscape holds largest breeding congregation of Lesser Florican than any other breeding sites. The centre point of the breeding landscape lies  $26^{\circ}16' 41''$  N  $74^{\circ} 59' 32''$  E to  $26^{\circ}09'14''$  N,  $74^{\circ}46'15''$  E which is 35 km of aerial distance from Ajmer city spread over to eastern side of central *Aravalli* mountain range in Ajmer district of Rajasthan. Approximately 360 sq. km of area holds scattered Floricans throughout landscape (Bhardwaj 201, WII progress report 2014). The habitat elevation ranges from 360 to 410 m to mean sea level. As the area being located semiarid zone of India (Kesavarao et al 2013) the annual rain fall ranges from 500 to 600 mm (Koteswaram 1978). The average temperature ranges  $33^{\circ}\text{C}$  to  $25^{\circ}\text{C}$  in the month of August,  $21.7^{\circ}$  to  $7.9^{\circ}$  C in December and  $39.6^{\circ}$  C to  $24.6^{\circ}$  C in May. As the region is rain fed the landscape was

dominated by semi-arid grasslands *Chrysopogon fulvus*, *Heteropogon contortus* grass species is common and locally abundant along with this *Aristida-dichanthium*, *Aristida-Oropetium* and *Sehima-Apluda* characterised grass patches mixed with non-woody herb specs are also present. *Accasia nilotica*, *Prosopis cinerea*, *Accasia senegal* are common tree species scattered among the grasslands/croplands composes savannah type vicinity. Invasive species *Prosopis juliflora* is dominant shrub or mall tree species has spread and occupied most of the places created scattered patches between crop fields. *Capparis decidua*, *Zizipus mauritiana*, *Calotropis* and *Senna alexandrina* are predominant shrub species throughout the landscape. At present most of the grasslands have been converted into forming lands are under the cultivation with the *Kharif* crops *Sorghum*, Pearl millet (*Pennisetam glaucum*), Black gram (*Vigna mungo*), Green gram (*Vigna radiata*) Cotton (*Gossypium herbaceum*), Soybean (*Glycine max*) etc. Sowing starts after initial rains of monsoon then harvesting starts in first week of October. Following *rabi* crops are wheat (*Triticum vulgare*), chickpea nut (*Cicer arietinum*), and mustard (*Brassica nigra*) in small irrigated areas with well and bore wells. The site was also potential sight for Great Indian Bustards *Arditis nigricepse*, before 1990 nearly 36 were used sighted but now currently due to complete degradation of grasslands and increase in disturbance there is not even single sighting record since past five years (personal comm. Rajendra Singh). Along with the Lesser florican mammals, mammals like Nilgai *Boselaphus tragocamelus*, and Jackal (*Canis aureus*) Grey wolf (*Canis pulas*) also found in the landscape. As the majority of landscape's people depend on the animal husbandry the livestock grazing pressure is high. Livestock includes cow, buffalo, sheep and goat. During the rainy season (from the beginning of crops sowing till the harvesting) usually the livestock grazes in open lands where partially barren with small pastures and *Prosopis juliflora* patches where the grassy pastures are available. As soon the harvesting of *Kharif* crop the livestock moves to harvested fields for feeding on leftover glean and leaves of harvested crops. In winter and summer the majority of the fields would leave without growing crop as fallows.

**2.2.2. Shahpura:** The site located in Bhilwara district of Rajasthan, outskirts of Shahpura where the florican are breeding is in, the site lies between 25° 50' 44" N, 74° 39' 21" E to 25° 39' 26" N, 74° 59' 51" E terrestrial comprises with dry arid agricultural lands, thorny shrubs patches. Majority of the forest and revenue department lands dominated by is *Prosopis juliflora*, *Prosopis cineraria* and thorny shrubs etc. Cultivated major *Kharif* crops are Millets, Blak gram, Green gram Cotton, Soybean and Maize etc. And *Rabi* crops

are as follows Wheat, Gram, Mustard and Barely etc, Most of the croplands are fenced with cactus (live-fence) to overcome the crop raiding from Nilgai (*Boselaphus tragocamelus*) as well from cattle. Usually cattle graze in open areas where thorny bush patches with grass in mid of croplands.

### 2.3. Madhya Pradesh

M.P Florican reserves and including Dhahod site falls in Malwa plateau (north-central India) which in western Madhya Pradesh and eastern Gujarat. Topography structures, gently undulated slopes and average elevation of the plateau is 500 m. Receives southwest [monsoon](#) rains, and average rainfall ranges from about 800 mm in the west to about 100.5 mm in the east. The area is dominated by tribal communities like Bheel and Bhilala depend agriculture and animal husbandry. *Echinochloa crus-galli*, *Lagascea mollis*, *L. camara* and *P. hysterophorus* are invasive species having high harmful to local vegetation.

**2.3.1. Sailana:** Administratively the site comes under Sailana range, Ratlam Forest Division. Area falls in latitude 23°26'11.48"N and longitude 74°56'8.89"E elevation ranges from 532 to 554m above mean sea level. Mainly it is a grazing pasture, due to found that Florican breeding, Madhya Pradesh Govt. declared an area of 354 hectares as an exclusive protected area in June 1983 named "Sailan Kharmor Wildlife Sanctuary" only during the breeding season of Floricans the area prohibited from grazing. Comprised of grasslands and grazing land and crop fields on the area is owned by surrounding village's people. Within this 250 hectares area is pure grassland supporting floricans and maintained for the production of hay. Same kind of habitat nearby Amba village which 12 km aerial far from Sailana reserve is also a breeding habitat for floricans records every year. The areas are with open slopes and undulated, before monsoon remains barren with *Butia monosperma* and *Lantana camara* bushes as bare land after rains as grass grows converts in to grassland (Rahmani & Sankaran, 1986).

**2.3.2 Petlawad:** Slope and undulated grasslands under Jhabua Forest Division, Petlawad range, located between 22°53'45" N 74°51'02" E to 22°51'32' N 74°48'51" E is also a potential site for floricans. It is a pure grasslands habitat has been created enclosure with barbed wire fencing to protect strictly from grazing. Floricans territories mainly found in enclosures, according to past records every year it supporting 5 to 10 male individual

(Mohan sing per.com.). Vegetation composition composes of grass with scattered *Butia monosperma* bushe

**2.3.3. Sardharpur Kharmor Sanctuary** was established for the protection of the Lesser Florican *Sypheotides indica* in 1983 by the Government of Madhya Pradesh. Approximately 348 sq. km area also an exclusive protected area for Lesser floricans during breeding season. Lies between 22°46'21"N, 74°54'50"E to 22°43'53" N, 74°53'38" E topography of the grassland are mainly slopes and undulated falls in to the same stretch with Petlawad florican site. In this site the vegetation dominated by same like Sailana wildlife Sanctuary and Petlawad predominant grass species *Sehima nervosum*-*Chrysopogon fulvus* type. Trees and shrub species like *Prosopis chilensis*, *Zizyphus jujube*, *Acaciacatechu* and *Butea monosperma* are found in scattered.

## 2.4. Gujrat

**2.4.1. Dhahod:** Approximately 18 sq.km under Dhahod Forest Division, Rampuara Range holds slope and undulated grasslands, which give refuge to Foricans as breeding grounds. It lies between 22°50'38" N, 74°12'27" E to 22°48'25"N 74°09'40" E in Malwa Plateau. *Boswellia* is detected dominant tree species in pure grasslands along with *Acacia* and *Butia* bushes.



**Plate 2.1. Grassland at Rampura, representative a typical Malwa plateau.**

**2.4.2. Velavadar National Park:** The area is well known as “Paradise for Lesser floricans” located in Bhavanagar district along the costal of [Gulf of Khambhat](#), Arabian sea (22° 3'28.61"N, 72° 1'46.23"E). .It is situated over coastal saline alluvial plains having an average height of two meters above mean sea level. Total area of national park covers 34.08 sq.km within that 9.79 sq.km area occupied by grasslands. The park has four different kinds of habitat grasslands, shrublands, saline lands and tidal flats with in these the major habitat is which grassland dominated by *Diacanthium annulatum* and *Sporobullus* sps. Shrub species *Prosopis juliflora* and tree species *Acacia* create savanna structure to grassland. The area is well managing habitat throughout year for the different kind of species to conserve like [blackbuck](#) *Antelope cervicapra*, [wolf](#) *Canis lupus pallipes* and [Lesser florican](#). It is also world’s largest communal roosting site for Harriers major herbivores fauna Nilgai. Adjacent crop lands also give refuge for floricans.



**Plate 2.2. Typical habitat in Velavadar National park, grassland with scattered *Prosopis juliflora* bushes.**

**2.4.3. Naliya:** The site recognised as Important Bird Biodiversity Area (IBA). The patchily distributed grasslands over vast 50,000 hectares long costal of Arabian Sea in Abdasa and Mundra talukas of kutchch district in Gujrat, lies on 23°13'4.20"N, 68°57'13.38"E and elevation ranges from 10 to 70 m to mean sea level. In 1992 a small portion that is 203 ha was declared as a sanctuary (Lala Bustard Sanctuary) for the Great Indian Bustard *Ardeotis nigriceps* which also breeding ground for Lesser Florean and winter ground for MacQueen's

bustard (*Chlamydotis macqueenii*). Due to these bustards which are facing high risk of extinction, the site is given high value in sight of conservation and along entire belt along the coast line is covered with grasslands and marginal crop fields, ideal for bustards. The grasslands comprises of dominant grass species *Cymbopogon*, *Chrysopogon*, *Dicanthium* and *Aristida*, and scattered bushes of *Zizyphus*, *Prosopis chilensis*, *Acacia spp.*, *Prosopis juliflora*, *Prosopis cineraria* *Salvadora spp.*, and *Capparis spp.* The site also considered as largest known aggregation breeding area for Lesser florican (Sankaran 2000 and Bhardwaj 2011). Mammal species like Chinkara *Gazella bennettii*, Bluebull *Boselaphus tragocamelus*, Golden Jackal *Canis aureus*, Indian Fox *Vulpes bengalensis*, Hyena *Hyaena hyaena* and Wolf *Canis lupus* also found. In all areas mentioned above a rapid survey conducted during the August-September of year 2014 and during 2015 only in Rajasthan which Shokaliya and Shahpura sites to assess the current status/density of Lesser florican in each particular area.



**Plate 2.3. Typical the grasslands in Naliya area.**

## Migration patter of Lesser Florican

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### 3.1. Introduction

When the South-West monsoon rains break in south and central parts of India, the birds tend to migrate towards their principle breeding grounds in north-western of India. Generally it begins from May to August and continuing till September to November. Sighting records confirms that, the birds disperse into south and eastern range of the Indian subcontinent after their breeding period and spend their non-breeding season in grasslands of Maharashtra, eastern Madhya Pradesh, Telangana, Andhra Pradesh, Karnataka, Tamilnadu, *Terai* region of Utter Pradesh and Odisha (Sankaran 1994, Birdlife International 2015). However there is lack of information on contemporary non-breeding range and its habitat distribution. The seasonal movement pattern of birds and connectivity/linkage between populations is also not known (Dutta et al. 2013). Therefore we have endeavoured to fulfil this research gap, which is helpful in preparing conservation strategy for non-breeding habitats.

### 3.2. Methods

During the breeding season (from July to September) the male birds establish territories and display in grasslands/croplands hence the birds more conspicuous due to their congregation and lekking than the non-breeding season. When the breeding season gets over birds starts dispersing from breeding grounds. To understand the post-breeding season movements of the individuals, customary technique satellite-telemetry was recommended as an ideal for these species. Satellite telemetry involves Platform Transmitter Terminal (PTTs) which is tagged to bird externally on the back (Wilson et al. 2002). In this procedure, birds have to be captured and fitted with the tracking device PTT and released to the wild. The movements of that bird can be monitored for extended periods of time without recapturing the birds. The PTTs then communicate via radio signals to orbiting satellites, which localize the PTT's signal and give the geographical position of bird location in a format of latitude and longitude. The signals transmitted by the PTTs are received by the US National Oceanic and Atmospheric Administration (NOAA) polar-orbiting satellites, which are at an altitude of 850 km and circle the earth around every 100 min. The French aerospace affiliate, Service

Argos (Toulouse, France), estimates the PTT locations from Doppler shifts in frequency. The locations are subsequently relayed to ground stations in USA and France, and users can either retrieve their data directly from Service Argos website via electronic mail.

### **3.2.1. Capture and tagging**

Since only two transmitters were available for the year 2014, we selected only one breeding site as our study area that is Shokaliya breeding site. On the 10th of August 2014, two males were located and captured using leg noose snares. In the event of capturing, snares were placed at their displaying site in their respective territories in the Sorgam crop fields and waited for 20 to 40 m to get entangled the birds. Birds were removed immediately after entangled in the snares and placed in cloth bags proceeded to take necessary morphological measurements. Following birds were tagged with solar-powered Platform Terminal Transmitters (PTTs: Microwave Telemetry, Inc., Columbia, MD, USA) on their back (Osborne et al, 1997) with harness of 4-mm width and 91 cm length of Teflon ribbon with internally ribbed crimping ring (Falconry electronic, Backpack Refit Kit, UK), whole PTT packages weighed less than 3% of body mass of birds. Lastly, individuals were released within 15-20 minutes at the exact location of their displaying site where they have been captured. This operation is done separately for each separately. Both the PTTs were programmed to transmit their location at every 5 hr followed by a break of 48 hr. The movements of that birds were monitored through online system “Argos - Worldwide tracking and environmental monitoring by satellite” for the periods of time without recapturing the birds.

To understand the seasonal movement pattern and habitat requirements of these two individuals, the locations were visited for the ground-truth evidences, abstained photographs of habitat, vegetation composition, crop pattern, disturbance and grazing pressure.

### **3.2.2. Mapping the movement of tagged birds**

By using the ARGOS data regarding movement, stopover and speed of the movement have been calculated. Hawth's tools and TRM tools were used in ArcGIS software. Home range maps for the breeding period and non-breeding period were generated separately. The home ranges of birds for a period of time estimated using the minimum convex polygon method (100% and 95%). And males are territorial during the breeding season especially in the peak period of displaying. To answer the questions like

whether the males shift their territory during displaying period or permanent? Previously the birds observed in displaying site for an approximately period of one week and not found at the same place, so we assume that birds could shift their territory as the disturbance from farming activity in this agriculture-dominated landscape. Therefore a weekly period of locations used to plot the polygons as MCP and calculated their each week area of the extent which is explored by individuals per a week, observed their habitat preference in this particular site.

### **3.2.3. Habitat classification**

In order to understand the habitat use of floricans using tagged individuals, the Landsat images data was used., Cloudless images were downloaded to classify the study area (images of 19th September 2014 and 18th January 2015 are matching with the period when PTTs were functional with tagged floricans) from <http://earthexplorer.usgs.gov>. ERDAS-IMAGINE 2015 and ArcMap 10.1 were used to process the downloaded images. Land use/cover classification was carried out using unsupervised classification method with maximum likelihood algorithms and applied in the ERDAS imagine 2015 software. Ground verification done with ground truthing data that were collected during the same period of images date. Miss-classified areas were corrected using option recording in ERDAS imagine 2015. First, the raw data classified into 50 classes then later merged into seven land use/cover types namely agriculture, grassland, human habitation, *Prosopis juliflora* cover, water body, water logged. The result of this process is a proportion of areas in each class and their extent it reflects the habitat using by tagged individuals (Praveen et al. 2015).

## **3.4. Results**

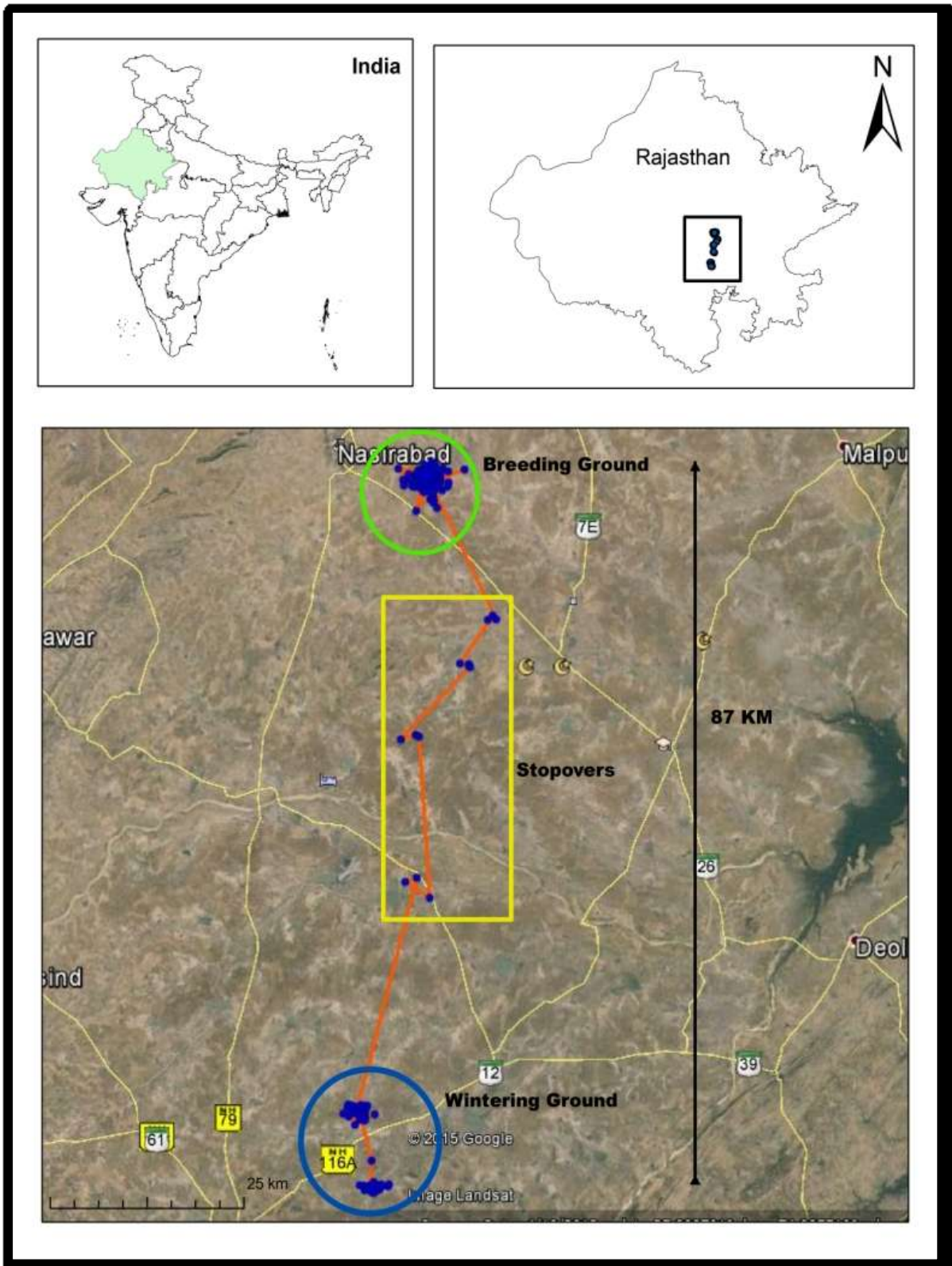
### **3.4.1. Brief about of tagged individuals**

**A. FLORIKIN-I:** The birds was tagged with 18g Agros PPT-100 (Platform no.125812) had spent 112 days in breeding site and left the site (Shokaliya) on 11th November 2014. The bird moved for 94 km towards south direction and settled down in grasslands/croplands in the north of Bhilwara, Rajasthan. The bird covered

this distance in 5 days 8 hours (including stopover times) with four stopovers. Each stopover last for one to two days. All the stopovers were in the croplands or fallow lands. Florikin-I flew at the speed of 0.73 km/hr which includes stopover days. The transmitter was active until May 2015.

**B. FLORIKIN-II:** It was tagged with 22g GPS/Argos PTT had transmitted data for 35 days after that it failed to function, the reason remained unknown, but it provided much more precise insight into the lekking behavior of this species. The available data shows that the Florican can shift the displaying territory within an arena during a breeding season. Three times this bird had shifted his territory and spent considerable time in each territory. All these three territories of Florikin-II were within the home range of 6.8 sq.km area (MCP100%). The same kind of territory shifting behaviour was observed in Florikin-I as well.

In order to describe the movement pattern of tagged individuals during changing circumstances like during crop, post-harvesting, winter and summer. The periods can broadly be divided into three; they are breeding season, stopovers and non-breeding season. Since the Florican-II is limited to the breeding area only, this is applicable for only Florican-I (Figure 3.1). The whole landscape including breeding area, stopovers, and the non-breeding area where the Florikin-I roamed is similar in terms of the climate condition and crop cultivation pattern. Yet there is the dissimilarity in the composition of surrounding vegetation and disturbance. During breeding period, agriculture fields remain green and land fully covered with vegetation. In this period the male birds mostly devote time to finding a mate which involves owning territory and displaying (Sankaran 1991). After crop harvesting birds start finding suitable dwelling place and they would confine to that territory where mostly vegetation comprises grassy/scrubby land that can be secure and suitable for them. When the other disturbance starts prevailing in the area birds have to leave their breeding areas. During stopovers, the bird (Florikin-I) landed in places where less disturbance and suitable vegetation covers like grass, failed crops and fallow lands. Finally, the bird settled at a locality where entire winter and until mid-summer.

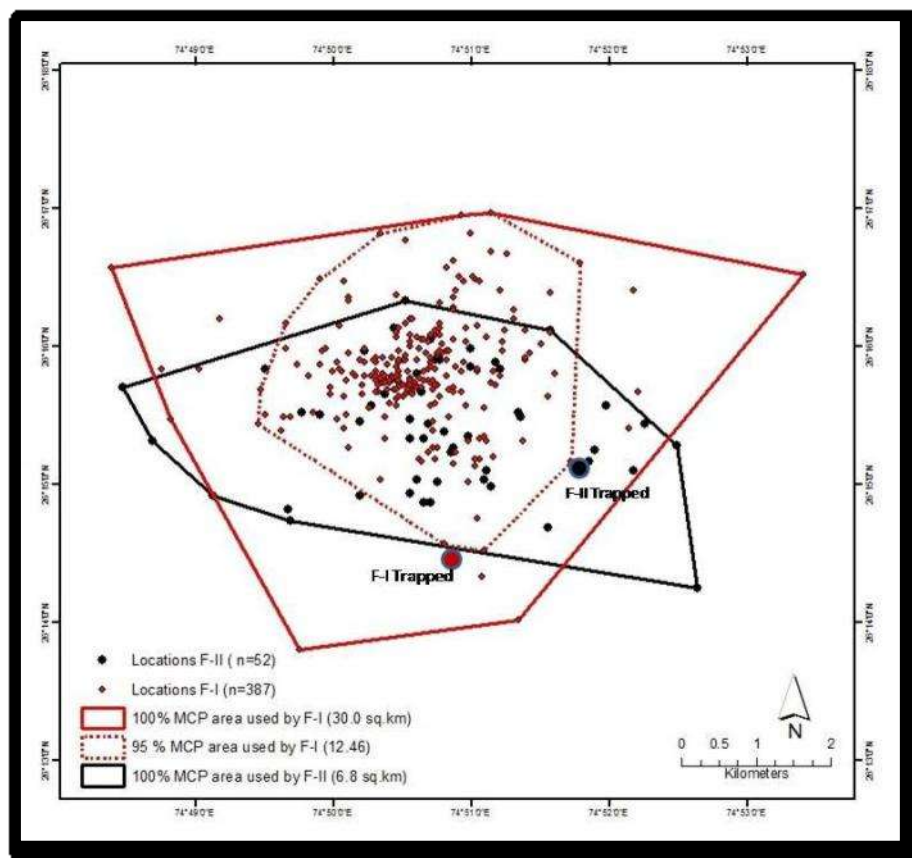


**Figure 3.1. Movement pattern of Floriki-I, shows breeding, stopovers and non-breeding areas.**

### **3.2.2. Breeding season**

#### **A. Florikin-I & Florikin-II in breeding habitat and their home ranges**

Sighting of birds in the breeding area was started after a week of initial rains that is 22nd July onwards, following displaying individuals in various sites. On 10th August 2014 tagging was done for both the birds, the distance between trapping locations of the two individuals is 2.1 km. After a week both individuals left their territory and moved to a different site. This could be a single available/suitable habitat for them which is closed by where both birds shared the same place. In this way in the breeding ground, home-ranges of both individuals are overlapping around 90%. Total days spent in breeding season/area by Florikin-I are 122 days (22th July onwards, calculated from the day when the first Florican was sighted in the breeding area in that year). Within these days, total explored area by Florican-I is estimated as 12.46sq.km when 5% locations excluded (MCP 95%) and 30sq.km when all location were included (MCP 100%) to plot the minimum convex polygon. Total explored area by Florikin-II is 6.8sq.km (MCP 100%), since very fewer locations are available, we didn't exclude any locations but used all location to plot the MCP (Figure 3.2).



**Figure3.2. Map shows both tagged individuals' home range during breeding season**

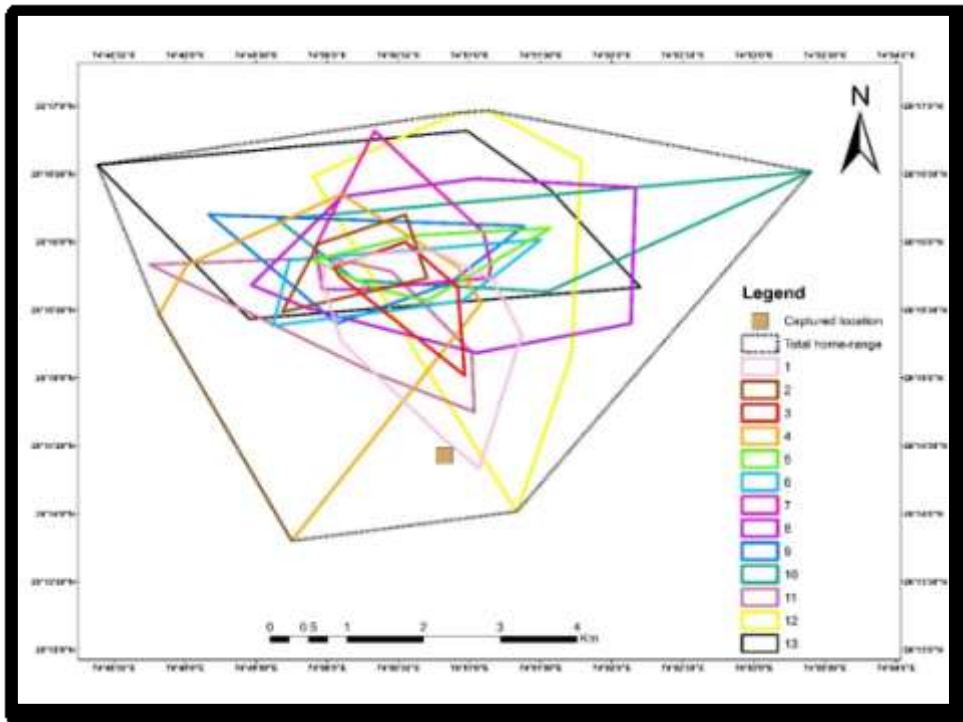
FLORIKIN-I	Activity	Days Spent	Area insq.km MCP 100%	Area in sq.km MCP 95%
	Home range in Breeding area	112	30	12.46
Home range in non-breeding area-I	17	6.1	*	
Home range in non-breeding area-II	118	2.9	*	
FLORIKIN-II	Home range in Breeding area	35	6.8	*

**Table 3.1. Home ranges in of Florican-I and Florican-II with area.**

**B. Territory shifting behaviour of displaying individuals:**

In agriculture-dominated breeding grounds like Shokliya observed that the territories of male individuals are not permanent for the entire breeding season. Satellite tracking data of tagged males, reveals that they change their territories, approximately once for a week. In following maps (Figure 3.3) the data analysed as every one week of location plotted as minimum convex polygon (MCP) to understand their territory shifting behaviour. From the day it has been tagged the Florikin-I spend 13 weeks, in the case of Florikin-II 5 weeks. All these locations of a week have been plotted on a map which conveys the birds had shifted their territory as time passes within their breeding home ranges (Florikin-I 30sq.km and Florikin-II 6.8 sq.km area). Our assumption is that agricultural activities in crop fields like weeding, applying pesticides and over-height growing crops (like Millet) would influence on maintaining the territories. The bird spent 13 weeks in the breeding ground from 10 August to 10 November 2014. Results show that birds used in one place without leaving throughout the breeding season. The birds moved in various places but made one area as permanently.

### A. Florikin-I



### B. Florikin-II

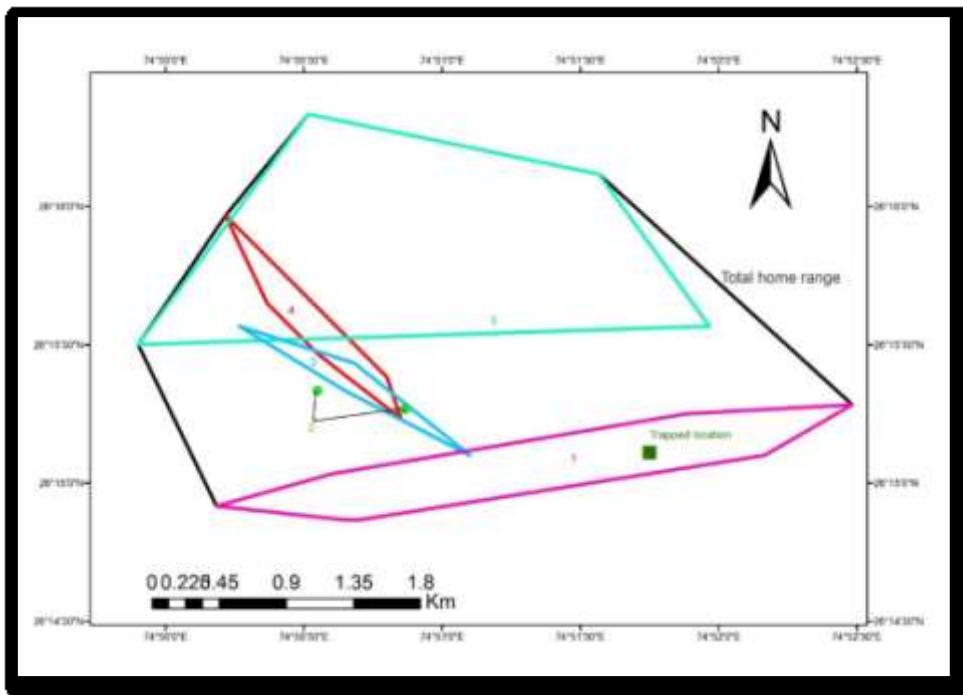


Figure 3.3 Florikin-I and Florikin-II weekly movement polygons shows that changing their territory for a period.

### C. Habitat in breeding area

Here an area (127.08 km<sup>2</sup>) which was taken as base for the breeding area to look over the habitat composition where the tagged Floricans have spent their breeding season. The Landsat images classification describes that, in that area dominant land cover is agriculture (55%), following *Prosopis juliflora* (28%) and barren (8.5%) and rest water bodies, grassland, human habitation and waterlogged make 8.3% land cover. The barren land, the most time of the year remains in barren with patchily distributed and grass patches which trampled by cattle. Based on the short distance stopovers we understood the birds need connected grasslands or open agriculture lands to wander.

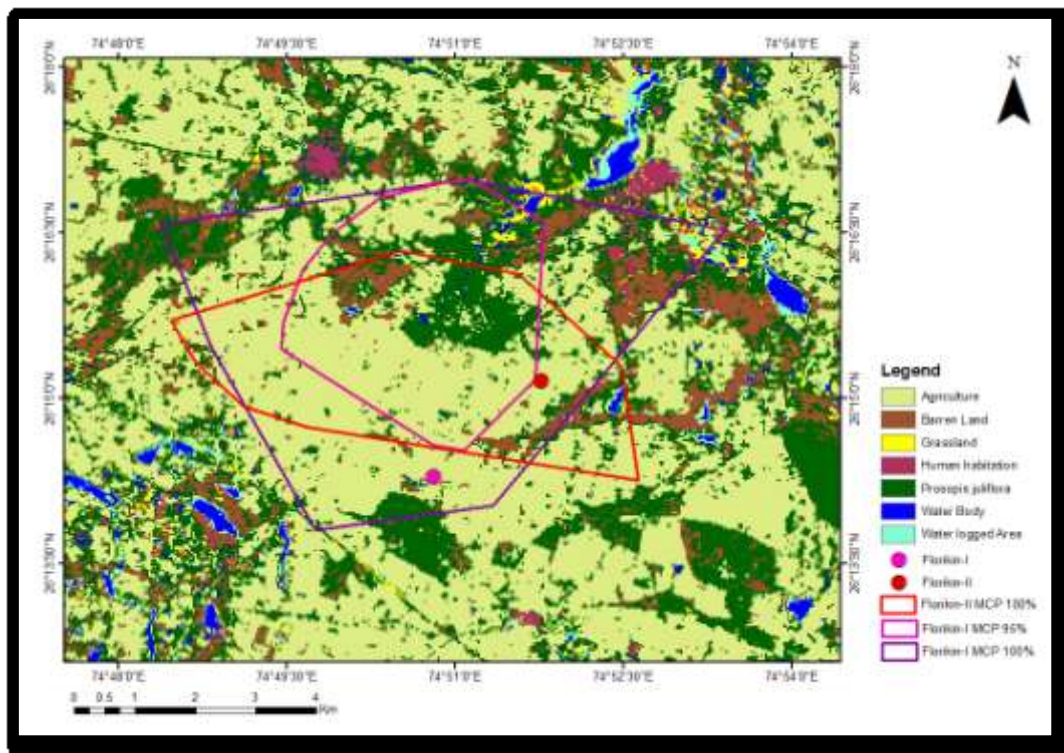
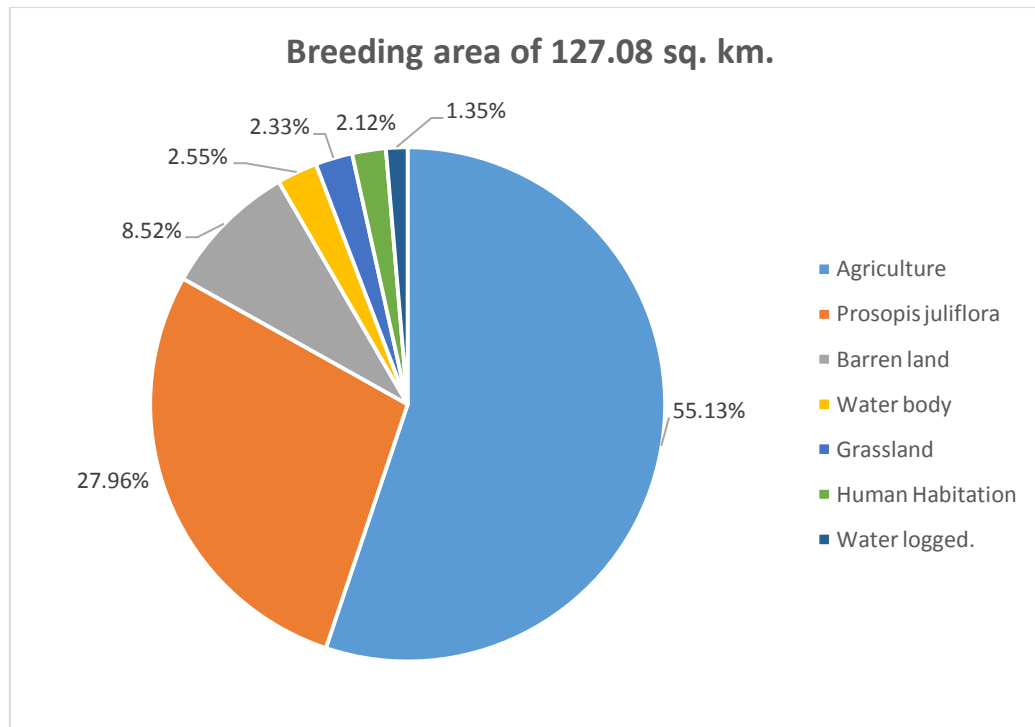


Figure3.4 Land covers in breeding area of Florikin-I and Florikin-II



**Figure3.5. Proportion of area in the habitat which was explored by both tagged birds during breeding period at Shokaliya.**



**Plate3.1 The images is of a core area where the Florikin-I and Florikin-II extensively used.**

Both the polygons are overlapping and falling in the same habitat. The first image shows Millet and cluster bean (*Cyamopsis tetragonolobus*) (mixed crop) crops were failed due to an uncontrolled weed growing, and it was abandoned crop and remained undisturbed entire season. That habitat is explored by tagged individuals. The second image is of a fenced land which is owned by government organization as goat breeding center, where the vegetation composition is prosopis and understory cover is grass. The intensively explored area habitat vegetation type is mixed with grass and herbs with 1 to 1.5 m. height. Which adjacent to patch comprised with approximate 50% Prosopis

juliflora and 50% grass. All the surrounding area does not look like this but agriculture lands with crop or without crop.



**Plate 3.2. Images represent that unused habitat inside the home range of tagged bird.**

September onwards the circumstances were started getting hot males were stopped displaying. Last sight of displaying male was seen on 18<sup>th</sup> September after that not seen any displaying males in this breeding arena. The first harvested crop was Green grams/black gram its started harvesting form second week of October. After harvesting the crops FLORIKIN-I was started using un-weeded and failed crop for residing (Above figure). Millet (*Sorgam valgare*) crops were stared harvesting third week of October (after 15th) while harvesting millet (*Sorgam valgare*) crops there was a heavy rain on 17<sup>th</sup> November that was after nearly one and half month from rains were stopped. Because cause this this we were expected to see some individuals display but we have not seen.



**Plate 3.3. After harvesting the immediate-harvested lands were occupied by cattle like sheep, cows and buffalo to feed on leftover crops straw /grains.**

In this time FLORIKIN-I moved to the place called “Goat breeding centre” (Plate 3.1) the area is 3.04 sq.km comprised with grass and *Prosopis juliflora* and surrounded with crop lands, used at one corner of area which adjacent crop lands. Due to low grazing pressure and 75 to 100 cm height grass Florican certainly can refuse in this patch. It is assumed that FLORIKIN-I had shared both areas grass patch and harvested crop land simultaneously for refusing and feeding respectively. These crop lands have been visited just after 6-7 days when the FLORIKIN-I left from this place, it observed that the crop lands were found freshly ploughed. May be this could be a reason why the Florikin-I left the area.



**Plate 3.4. Typical vegetation composition of Goat breeding centre.**

### **3.4.3. Stopovers**

When the ambient temperature had started dropping down, the FLORIKIN-I left the breeding ground on 11<sup>th</sup> November 2014 to non-breeding grounds. Florikin-I had reached his non-breeding ground on 15<sup>th</sup> November 2014, which was 94 km (polygon) from Shokaliya. The bird stopped at four places before reaching to reach non-breeding ground (nearby villages Goyla (26° 60' 54" N, 74° 55' 36" E), Keriya kurd (26° 03' 43" N, 74° 53' 42" E), Peepaliya (25° 59' 17" N, 74° 49' 52" E) and Sardarpura (25° 49' 21" N, 74° 49' 51" E). Distance between one flight to another as follows 18.6km, 6.75km, 12km, 18km, 28km and 9.4km. Florikin-I crossed this distance in 5 days 8 hours. Each stopover last for one to two days and flew at the speed of 0.73 km/hr which include the stopover time. Stayed one or two days and was heading to wintering places. These habitats mostly comprised with croplands (Cotton and Millet) and with approximate grass/herbs cover at least 40% to 50%. While the Florican heading to non-breeding areas the cotton crops were

with cotton-bolls and under harvesting and millet crops were harvested but in some parts the failed crops due to insufficient rains were still remained in some fields. And mustards crops were started growing with one feat of height and wheat crops fields were under sowing in well irrigated lands/fields. And some fields were ploughed and without any crop.



**Plate3.5. Stopover locations with Cotton and Millet crops.**

#### **3.4.4. Non-breeding season**

##### **A. Non-breeding habitats of Florikin-I:**

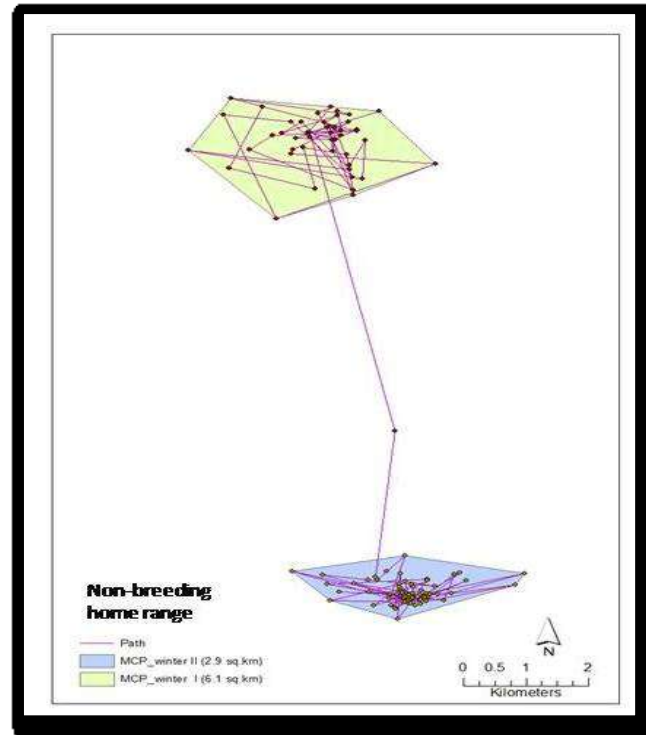
Though the non-breeding area not much different in terms of surrounding vegetation, geographical features and temperature but it holds much winter (Rabi crops) and irrigated crops lands. Florikin-I settled down at north of Bhilwara, Rajasthan where he spent whole winter in two places. 17days at one place where the home range is 6.1 sq.km (MCP 100%) and another place 177 day till 29<sup>th</sup> March 2015 where the home range is 2.9 sq.km (MCP 100%) distance between the two non-breeding areas is 9.53 km.

- I. Non-breeding Territory-I (17days):** The habitat vegetation is comprised of fallow lands, wetland with grass and cotton crops. The mustard and wheat were growing crops; all these crops lands are fenced with cactus (*Euphorbia caducifolia*). (See following figure)



**Plates 3.6. These are fallow land, wetland with grass, cotton crop and cactus fencing (*Euphorbia caducifolia*) which were used by Florikin-I spent in 17 days.**

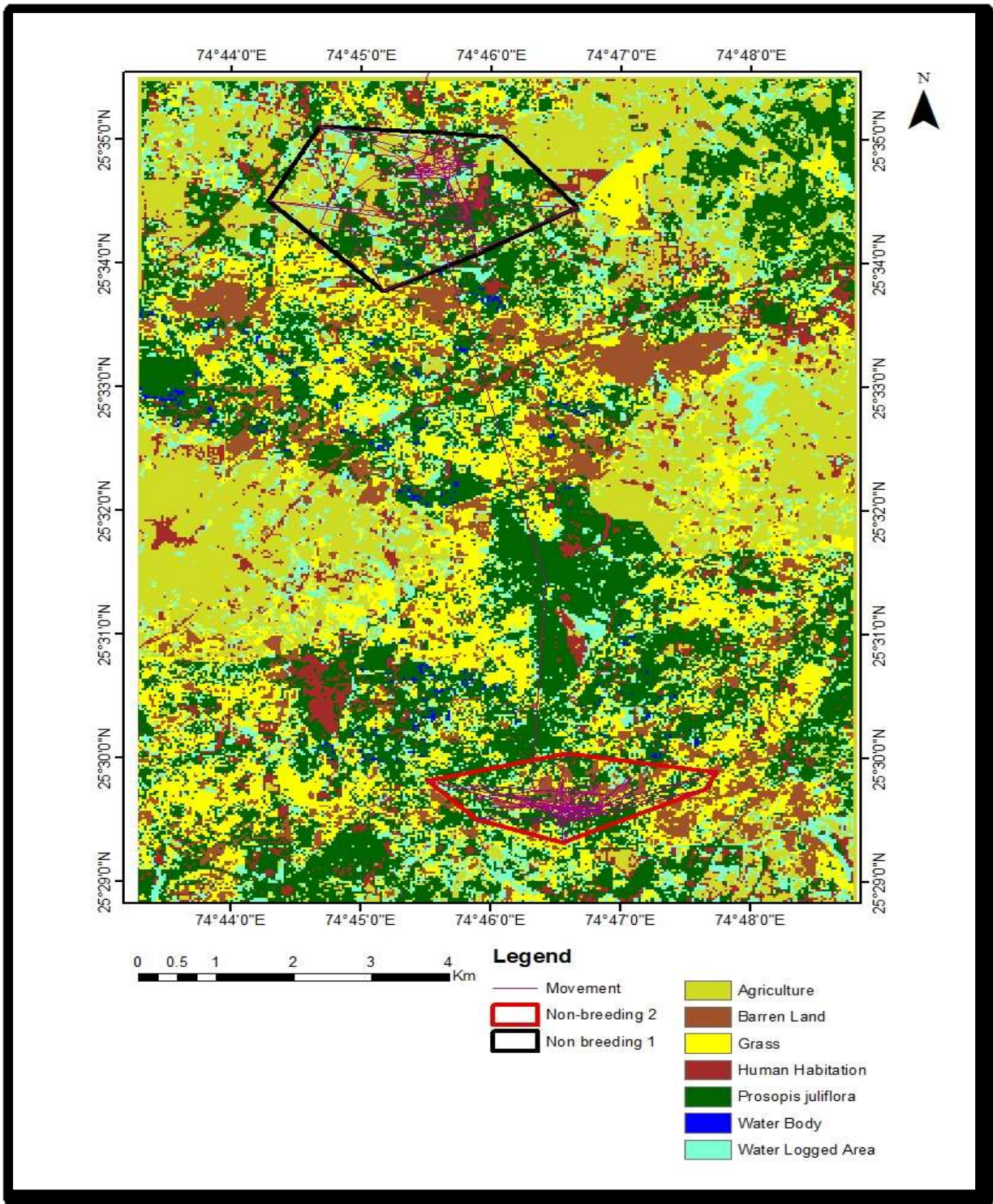
- II. Non-breeding territory-II (117 days):** Habitat comprising with crop lands of wheat, mustard, grams and lucerne (*Medicago sativa*) etc. and adjacent waste land comprising with *Prosopis juliflora* and grass cover/herb 10cm to 75cm height. Based on the data which provided by **Argos** the bird explored both areas crop lands and waste land same like in breeding area.



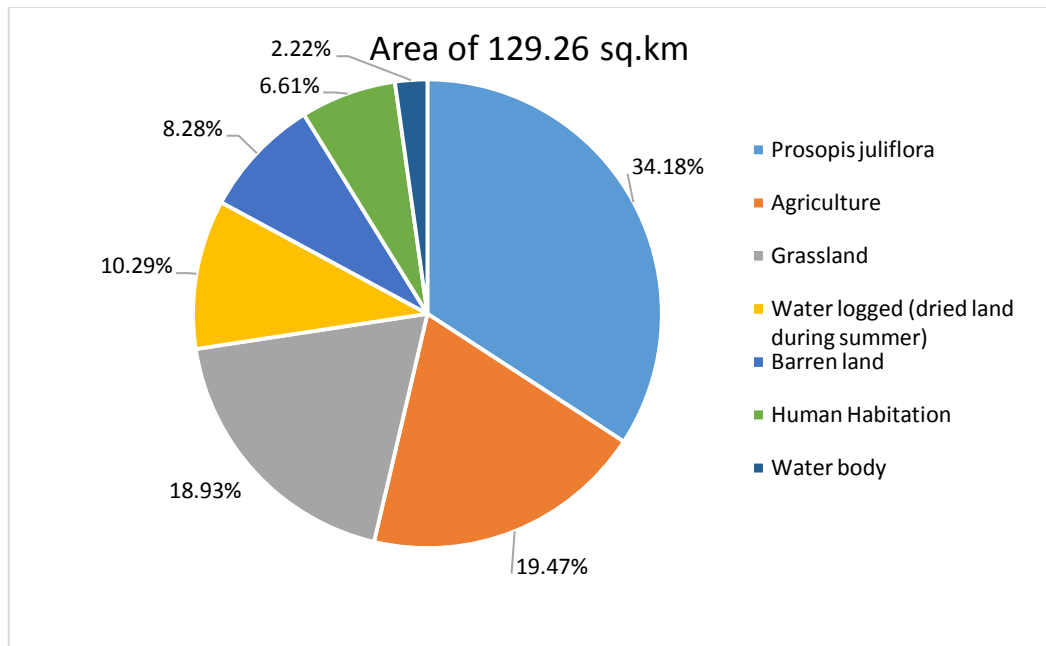
**Figure3.7. Florikin-I home ranges in non-breeding area.**

### **3.4.5. Habitat in non-breeding area**

Here an area (129.26sq.km) which was taken as base for the non- breeding area to look over the habitat composition where the tagged Florikin-I had spent. Within 129.26 sq.km extension of land where Florikin-I spent during winter and summer the land cover dominated by *Prosopis juliflora* (34.18%) followed by Agriculture land with crop and without crop (19.47%), grassland (18.93%), water logged but this land dried during the summer 10.29%), Barren land (8.28%), human built (6.61%), and least cover during summer water bodies like lakes and ponds (2.22%) (Figure3.7).



**Figure 3.7. The habitat which was used by the Florikin-I in 117 days till 29<sup>th</sup> March 2015.**



**Figure 3.8. Proportion of area in the habitat which used by Florikin-I during non-breeding season.**

### **3.4.6. Current Non-breeding range of Lesser Florican:**

In recent past, due to various developmental activities, there was a huge loss of grasslands habitat across the peninsula of India which is mostly part of Lesser Florican habitat, this led to shrinkage in species occupied range. To estimate the current distribution range of the species and its shrinking rate in last 30 years, the sighting records of birds during the non-breeding season were used. These sightings are during winter and summer (November to June) from various parts of Indian peninsula which gathered from literature citation and personal communication. This collection of sighting records is an addition to Ali and Rahmmani 1985 report. With the available sighting record locations of past 30 years, we plotted a minimum convex polygon using for ArcMap and we have compared 15+15=30 year data to understanding the shrinkage of species non-breeding range. In recent past there have been sighting in Uttar Pradesh (Ranjan 2014, Gopi Sunder 2006), Maharashtra (Kasambe *et al.* 2010, Narwade *et al.* 2015 and Sanjay Nafdey 2015), Andhra Pradesh (Sankaran & Manakadan 1990, Manakadan 2014) Karnataka (Raghavendra 2011) and Kerala (Monnappa 2012). The current non-breeding rage expands overs most of the peninsular India, Utter Pradesh, Maharashtra, Karnataka, Andhra Pradesh and Kerala. Some individuals remain their breeding range to spend winter and summer (Dharmakumarsinghji 1950)



**Table3.2 Sighting records of Lesser Florican during non-breeding season since 2000 to 2015**

S. No.	Place/area	No. of birds	No. of obs. days	Date and time	Habitat characteristics	Threats	Reference
1	Ambap, Kolhapur district, Maharashtra	1 female	Once	30 <sup>th</sup> Oct. 2002 14:15:00	Not available	Hunting	Kasambe <i>et al.</i> 2010
2	Etawah and Mainpuri, Uttar Pradesh	1 Male & 1 female	Once	15 <sup>th</sup> June 2005	Foraging in an uncultivated agriculture field with low grass	No data	Gopi Sunder 2016
3	Bourgav dam, Akhola, Maharashtra  (20° 43' 0" N, 77°09' 0" E)	1 female	Once	29 <sup>th</sup> April 2010 09:20:00	A good patch of grassland	No data	Kasambe <i>et al.</i> 2010
4	Little Rann of Kutch, Gujarat	1 female	Once	06 <sup>th</sup> Nov. 2011	Grassland with <i>Prosopis juliflora</i> .	No data	Rajesh Shah
5	Hesaraghatta, Bangalore	1 female	For a week	18 <sup>th</sup> Dec. 2011 06:00:00	Grassland with bushes	Land conversion into plantation, intensive, photography and vehicular movement.	Raghavendra 2011
6	Coorg	1 female	2 days	19 <sup>th</sup> March 2012 18:48:00	In abandoned paddy fields with wild grass at waist height	No data	Bishan Monnappa
7	Warora & Chadrapur, Maharashtra	2 Sex, not conformed	Once	22 <sup>th</sup> March 2013	Fallow lands, 0.9-1.5 m height of tall grass patches.	Developmental activities, Settlements of villages, roads constructions, industrialization, quarries and crushers, invasive species, electrocution and coal	Narwade <i>et al.</i> 2015.

						mining.	
8	Dadri, Ghaziabad	1 Male	Once	18 <sup>th</sup> July 2014 16:00:00	Dadri wetlands, in mid of tall grass near wetlands. (Displaying)	No data	Rajiv Ranjan
9	MIHAN (Multi-modal International Cargo Hub and Airport) Nagpur, Maharashtra.  (21° 4'10.82"N, 79° 0'27.41"E)	1 female	Once	25 <sup>th</sup> April 2015 16:00:00	Grassland comprised of 2 to 4 ft height, it is fallow land was acquired by industrial company, hence low disturbance allowed to grow abundant grass, no green grass but dry and fallen grass partially grazed by cattle was seen. The area has about 20 wells.	The land is acquired by MIHAN and currently witnesses a lot of blasting, digging and construction activity.	Sanjay Nafdey 2015.
10	Kuno	1 Male	only once		Grassland midst of forest	not known	Y. V. Jhala Per. Comm.
11	Rollapadu Wildlife Sanctuary	Several	September to January	2015	Grassland with scattered bushes and small trees are grazing-free enclosures	Probably these grasslands are threat free for the florican.	<b>Gosh. Per. Comm.</b>

**Table 3.3. Sighting records of Lesser Florican during non-breeding season since 1984 to 1999**

<b>S. No</b>	<b>Place/area</b>	<b>No. of birds</b>	<b>No. of obs. days</b>	<b>Date and time</b>	<b>Habitat characteristics</b>	<b>Threats</b>	<b>Reference</b>
1	Hyderabad, TN, Telangana	1 female	Caught & kept for few days	01-10-1984	Near to Residential	overhead wire	Pittie et al 1998.
2	Rollapadu Wildlife Sanctuary, AP	Several	For 7 months	October 1987 to June 1987 1988.	Grassland with scattered bushes and small trees are grazing-free enclosures	Probably these grasslands are threat free for the florican.	Sankaran, R. & R. Manakadan (1990):
3	Dudwa Tiger Reserve	no data	not known	May/June 1988	Bengal Florican' habitat tall grasses		
4	Mararithottam, Karunagapally, Kerala.	1 female	Kept for 50days at nearby Muruga Temple.	14.01.1989 to 6th of March Kept at nearby Muruga Temple.	Paddy fields	No data	Omkar G. Krishnan, 1999
5	Shukla Phanta	no data	not known	Summer 1989	not known	not known	B. B. Thapa pers. Comm. 1989 Sankaran,

							R., et al. (1992):
6	Rollapadu Wildlife Sanctuary , AP	3 Females	2 months	January, Feb, May 1993	Grassland with scattered bushes and small trees are grazing-free enclosures	Probably these grasslands are threat free for the florican.	Manakadan, R. & A.R. Rahmani (1999):
7	Rollapadu Wildlife Sanctuary , AP	9 males & 1 Female	For 6 Months	1994	Grassland with scattered bushes and small trees are grazing-free enclosures	Grassland with scattered bushes and small trees are grazing-free enclosures.	Manakadan, R. & A.R. Rahmani (1999):
8	Dubak Mandal, Medak district, TN	1 & Sex not mentioned	Caught & kept for few days by villages	01-02-1997	not known	not known	Pittie et all (1998):
9	ICRISAT, Patancheru, Medak. 17° 30' N, 78° 15' E. 79° 0'27.41"E)	1 Sex not mentioned	For 7 days	31.March 1997	Agriculture fields with crops Bajra ( <i>Pennisetium glaucum</i> ) Jowar ( <i>Sorghum bicolor</i> ) Ground nut ( <i>Arachis hypogea</i> ) Chikpea ( <i>Cicer arictinum</i> )	As bird taking flight it hit an overhead wire and scattered few feathers. Expansion of agriculture and overhead wire (electricity)	Pittie el al (1998):
10	Dudhwa	1 Female	only once	01-06-1998	Grassland midst of forest	not known	Rahmanni et al 1988, Javed and R

<b>11</b>	Sisa, Akola 26.699508 N, 77.115043 E.	1 Female	Near about for 50 days	27th Sept, 3rd Oct, 17th Nov 1998	Grassland	Hunting from Pardhis.	Narwade et al 2015.
<b>12</b>	North Lahore near Ravi river	no data	not known	Summer	not known	not known	T. J. Robert pers. Comm. 1989. Sankaran, R., et al. (1992):

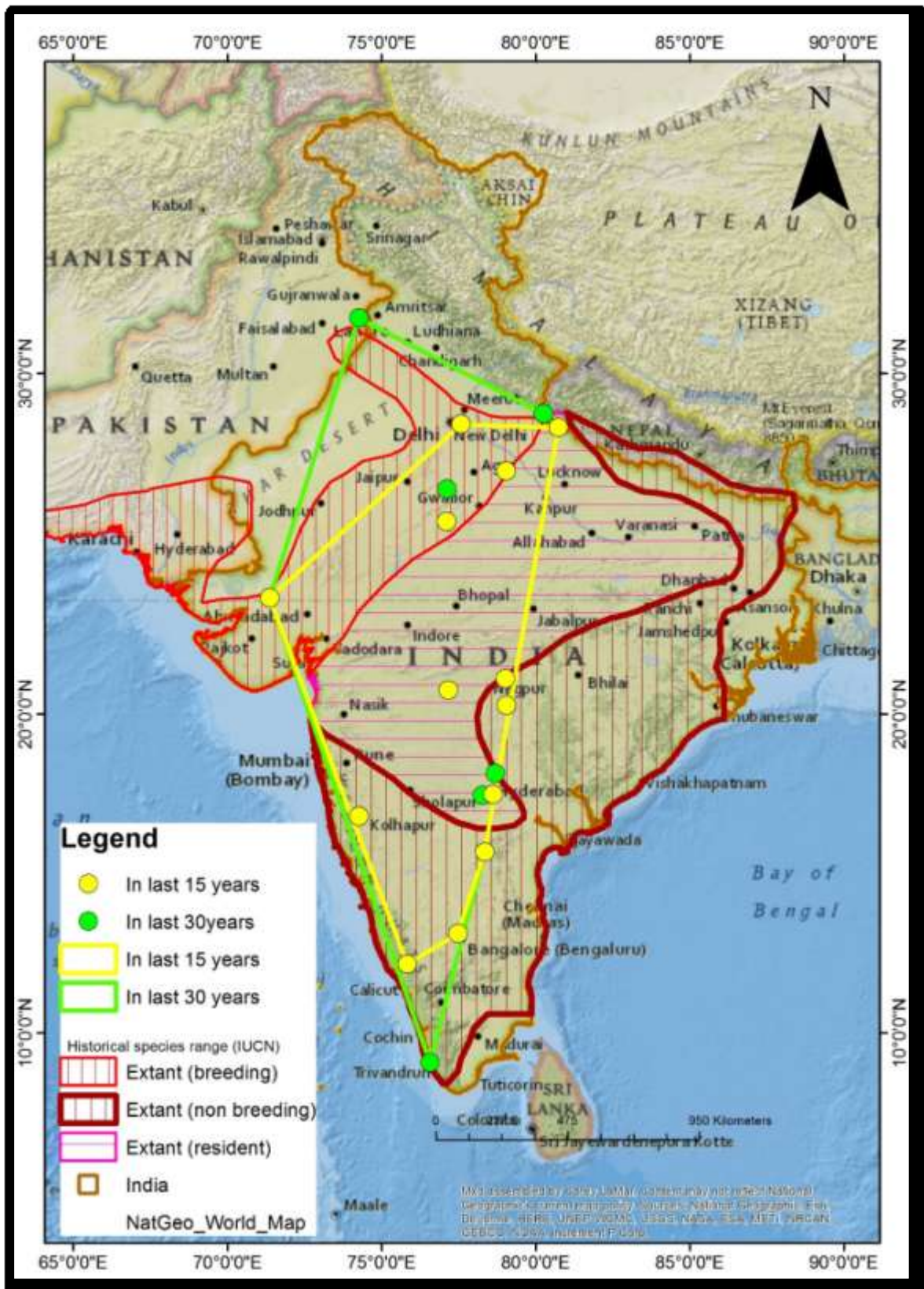


Figure 3.9. Distribution range of Lesser Florican during non-breeding season, data collected from literature and compared with IUCN data (Birdlife International 2014).

**Note:** There is limitation to this assumption is that, this is only based of sighting information that is available till now since last 30 years since 1985 this is after Ali and Rahmmani's collection (Ali et al. 1985). We assume that there must be other inaccessible and undisturbed areas using by the species. Over last 30 years the available area was 1540542.21 Km<sup>2</sup> (100%), and over last 15 years the available is 1140140.09 Km<sup>2</sup> which makes 74%, means 26% of area got shrunken. This is can be consider as nan-breeding range of the existing population. It shows that suitable non-breeding areas of Lesser Florican are shrinking at alarming rate.

### **3.5 Discussion**

Lesser Florican is one of the elusive bird species and difficult to sight during it non-breeding period. This made ornithologist to study their migration and movement patterns as a challenge. Little information is available on the migration pattern, movement pattern and non-breeding habitat. This is a first attempt study on migration pattern of Lesser Florican using satellite tracking techniques. There were two attempts to understand their migration pattern by earliest methods ringing. In the first attempt between 1943 to 1947 there were 489 Floricans ringed in Kathiawar region (that is Velavadhhar grasslands). In which, the study could discover only site fidelity behaviour in subsequent breeding season, that too which is confined only Kathiawar peninsula that is Sourashtra part in Gujarat in (Dharmakumarasighji 1950). In second attempt two males in 1984 and one male in 1985 were ringed at Amba village adjacent to Salina breeding site (Ali et al. 1985). Those birds were seen in that same breeding season after that there no information was available what had happed to those birds.

In this present study, the movement pattern of Lesser Florican in breeding area somehow understood, earlier used to think the breeding males don't change their breeding territory, but here the tagged males have changed their territory. Since the breeding site is dominated by agriculture in fact the birds breed in crops, the data conveys territories of males individuals are not permanent for the entire breeding season. Satellite tracking data of tagged males, reveals that they change their territories, approximately once for a week (Figure 3.3). From the day it has been tagged the Florikin-I spend 13 weeks, in the case of Florikin-II 5 weeks. All these locations of a week have been which are plotted on a map conveys the bids had shifted their territory within their breeding home ranges as time passes. Our assumption is that agricultural activities in crop fields like weeding, applying

pesticides and over-height growing crops (like Millet) would influence on maintaining the territories. The same kind of behaviour was observed in previous study. Where in initial days of arrival of males, the grazing was responsible for the movement of males from one place to another place (Ali et al. 1985).

Habitat used by tagged individuals in breeding area is dominated by agriculture (55%), following *Prosopis juliflora* (28%) and barren (8.5%) and rest water bodies, grassland, human built and waterlogged make 8.3% land cover. Since there are no pure grasslands left, birds are adopted to breed in crops. Breeding home range polygons of both birds are overlapping in same patch of habitat, where there was abandoned crop which was failed due to an uncontrolled weed growth and it remained undisturbed entire season. This information conveys that birds prefer the least disturbance patches to breed for males as well as females. At the times of crop harvesting it seems birds move to grass patches where they can hide. The tagged bird Florikin-I preferred fenced land which is owned by government organization as goat breeding center, where there is moderately low disturbance when comparing to surrounding area and the vegetation consists with upperstorey *Prosopis juliflora* and understory cover is grass. The intensively explored area habitat vegetation type is mixed with grass and herbs with 1 to 1.5 m. height (Plate 3.3) approximately 50% *Prosopis juliflora* and 50% grass.

When the temperature started falling down to winter and the Florikin-I left the breeding ground on 11<sup>th</sup> November 2014 to non-breeding grounds. Based on results yielding from satellite tracking species would not prefer to take long distance flights rather prefer with small distance. The distance between stopovers (One flight to another as follows 18.6km, 6.75km, 12km, 18km, 28km and 9.4km). We understood the grasslands connectivity plays a major role in movement of the Lesser florican. The species requires connected grasslands or agriculture/fallow lands to migrate. We have not observed crossing any barriers like mountains or water bodies. Bird preferred crops and grasslands as stopovers in plain areas with least disturbance approximate grass/herbs cover at least 40% to 50% (Plate 3.5 & Plate 3.6).

Florikin-I settled down at north of Bhilwara, Rajasthan where he spent whole winter in two places. Preferred the area is not much different from breeding area in terms of surrounding vegetation, geographical features and temperature but it holds much irrigated and winter (Rabi crops) crops than the breeding area. 17 days at one place where the home range is 6.1 sq.km (MCP 100%) and another place 177 days till 29<sup>th</sup> March 2015 where the home

range is 2.9 sq.km (MCP 100%) distance between the two non-breeding areas is 9.53 km. In 17 days place birds must be in search of better place to find to spend the non-breeding season, because the 17 place significantly larger (6.1sq.km) than the second 117 days place which is 2.9 sq.km. Floriki-I preferred the habitat comprising with crop lands of wheat, mustard, grams and lucerne (*Medicago sativa*) etc. and adjacent waste land comprising with *Prosopis juliflora* and grass cover/herb 10cm to 75cm height. Bird explored both areas crop lands and waste land same like in breeding area. It explains that the species required quit insect and grains available.

Our preliminary observations on one of Florikin-I, which could retain the functional PTTs till 15th June 2015 revealed that the florican did not migrate longer distance. They seem to be migrating to nearby grasslands soon after their breeding seasons located about hundred kilometres away. However, this needs to be confirmed after tracking some more floricans. If the floricans do not migrate long distance and restrict to other parts of semi-arid grasslands during the nonbreeding seasons then the importance of semi-arid grasslands goes up several folds with respect to long term conservation of Lesser florican in the country.

Regarding the non-breeding range of the Lesser Florican, the sighting records during non-breeding from literature shows that, the range is shrinking. Over last 30 years the non-breeding range was 1540542.21 Km<sup>2</sup> and over last 15 years the range is 1140140.09 Km<sup>2</sup> which makes 74% means 26% of area got shrunken (Fifure3.9). The individual recently has been sighted from Hessaragatta near to Bengaluru (Raghavendra 2011) is might be dispersed form Rollapadu wildlife sanctuary which is only nearest breeding as well as non-breeding site. Grassland patches which are far from cities or in remote areas where the human accessibility is difficult there are also birds might be taking refuse as non-breeding areas. Sighting in Coorge district in Western Ghats shows that birds might be using part of Maharashtra where the grassland has with plane areas can found. Species may percent in same kind of areas like where previous sighting had happened. Predicting their possible non-breeding sites is crucial for their future conservation and to extend protection and monitoring at their non-breeding sites. Species habitat suitability model may helpful to frame the prioritised sites for Florican in breeding and non-breeding range to safe guard species.

## **Status of Lesser Florican**

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### **4.1. Introduction**

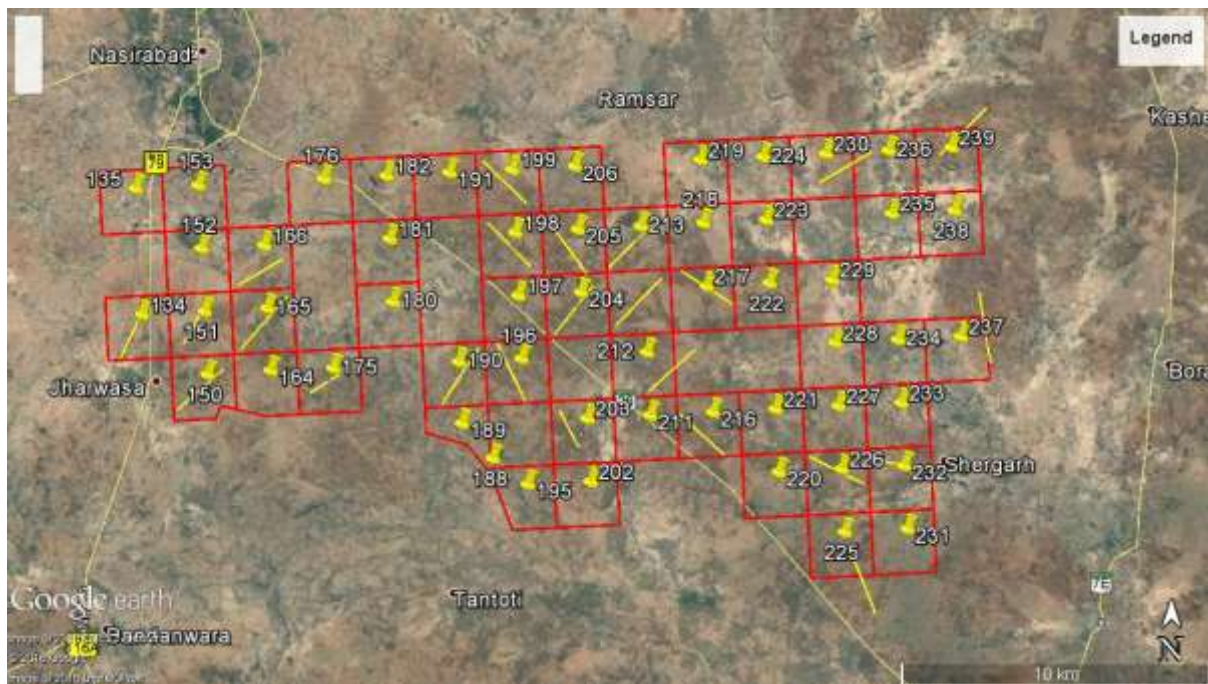
The species drawn attention even early since 1879 due to their habitat loss and as well as massive hunting by sportsman. Hume and Marshal projected its extinction 1950 to 2000. Nonetheless as a result of result of conservation efforts by the (Heme et al. 1879) government and species' adaptation like breeding in croplands species still surviving at edge of critically endangered status this population can be re-established as viable population.

Estimation of breeding population of species has been carried out 1981 onwards, initially attempted made by Gourip and Karpowicz in 1981, after that, Magrath in 1982 (Magrath et al. 1985). Based on this results the species categorised in 1988 as a threatened species by IUCN. In 1989 estimated population is 2206 individuals as result species listed as critically endangered (CR) in 1994 (Sankaran, 1991, Sankaran, 1994). Increasing population from 2206 to 3530 (1989 to 19999) made to list as endangered (EN) by year 2000 IUCN red list. However the population fluctuation are directly correlated with amount of rain fall. BNHS stated that there might be less than 2500 mature individuals are surviving by 2008. The latest survey carried by Bhardwaj et al. 2011 during 2010 monsoon; however the survey did not come up with global population but estimated density and encounter rate in potential breeding sites. Presently "BirdlifeInternational-2015" assumed that around 1500 mature individuals might be surviving. As continuous changes in habitat certainly there would be influence in status of species as the species is sensitive to human disturbances. Continuous population monitoring is necessary to ensure the conservation status of this species. Here we attempted to estimate density in potential breeding sites across three states Rajasthan, Madhya Pradesh and Gujarat and recent sighting information from south and western parts of India.

### **4.2. Methods**

In all sites mentioned above (chapter II) field work was undertaken during the August and September to assess the current status/density of Lesser florican in each particular area. During the breeding season of the birds (from July to September) the male birds establish territories in grasslands areas and display during better part of the morning and evening within their territories. Two deferent survey methods were used, first one is line transect method in large areas where grasslands/croplands widespread and total counts methods

followed in smaller areas where whole grassland/patch is under eye vicinity. And sighting records from various sites form reliable sources like forest department official and regular bird watchers with personal communication to prepare table for future planning. Line transect survey was followed in contiguous area, rather than sampling non-contiguous location (Sankaran 1994, Bardwaj 2011, Santangeli & Dolman 2011). Length of transect is varied from 1 to 2.5 km which were walked in grasslands/croplands when males are active for display between 06:00 to 09:00 and 16:00 to 18:30h. During the transect course along transect GPS location of sighting bird, sighting distance, sighting angle and walk-direction angle recorded to get perpendicular distance as well as vegetation sampling at every 250 m.



**Plate 4.1. Showing an example of transects laying in divided grids at Shokaliya site.**

#### **4.2.1. Analysis:**

The collected line transect data like number of transects, length of each transect, number of detected individuals per transect, perpendicular distance of detected individuals from line etc. are employed to estimate the density by using program DISTANCE (version 6.2) (Buckland et al. 1993). The following estimators were specified as a prioritised models: uniform (adjusted with cosine series and polynomial series), half normal (adjusted with hermit polynomials), and hazard (adjusted with cosine series). Akaike Information Criterion (AIC) is used to select the best-fit model. Encounter rate is the number of male individuals observed per kilometre of transect. Later, abundance was estimated by extrapolating density to the potential landscape area inclusive of sampled and non-sampled cells (Dutta 2014).

During the year 2014 monsoon all the sites (Shokaliya, Shahpura, Sailana, Petlawad, Sardharpra, Dahod, Velavadar, Naliya) were surveyed. However During 2015 monsoon only Shokaliya site was surveyed. Therefore the two years data of Shokaliya site collectively analysed for years 2014 and 2015 and computed a pooled density estimation. Census survey was carried out in these grassland sites to obtain an estimate of the male density. In all respected areas the sex ratio 1:1 is assumed and thus the population of males is multiplied by two to obtain an estimation of the entire population including females. Data collection from forest department officials who conducted total count survey in at a time in various grass patches, each patch covered with more than two observers, which is not used for density modelling rather to give general view on potential of habitat.

### **4.3. Results**

#### **4.3.1. Density estimation in contiguous areas of all potential sites during 2014.**

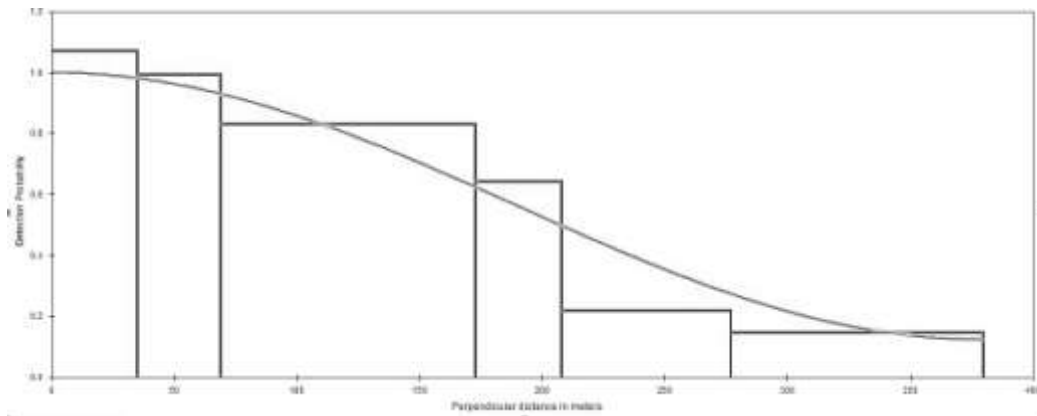
We laid totally 58 transects which makes 91.9 km walk effort in seven sites of three states, overall 57 Floricans were observed during the transect course. Sampling analysis shows that uniform co-sign functions best fitted to data. (Uniform cosine function  $\chi^2$  p=80.8, AIC=659.6) and estimation the ESW at 213.7 m ranging 185.3–246.4. Detection probability=0.56 (0.48 to 0.65). The generated global density estimate is 1.19 Floricans per sq.km of contiguous area (0.75 to 1.88) and abundance of **1091** Floricans (689 to 1729) in contiguous habitat of floricans in three states.

#### **4.3.2. Density estimation Shokaliya 2014 and 2015**

During the year of 2014 and 2015 monsoon, totally 47 transects were laid, 89 km walk effort was made in which 56 Lesser Foricans were detected along transects at encounter rate of  $0.5 \pm 0.4$ . The sampling pooled data analysis shows that Half-normal hermit. Polynomial function fitted the data best with Akaike Information Criterion (AIC) is 658.8 ( $\chi^2= 0.48$ ,  $df=3$ ,  $p=2.4$ ), estimating detection probability  $0.51 \pm 0.04$  and Effective Strip Width is  $225 \pm 9.3$ . Species densities estimated at Individuals/sq.km.

Area	Number of transects	Total length of transect	Number of birds detected	Density	95% confidence interval
Dahod	4	5	0	-	-
Naliya	7	12	2	0.37±0.37	0.17-3.83
Velavadar	5	9.6	6	1.46±0.56	0.53-4
Sailana	4	7.2	6	1.9±1.8	0.15-23
Petlawad	5	8.5	3	0.82±0.49	0.17-3.83
Shapuara	10	14.2	0	-	-
Shokaliya	23	34.8	40	2.68±0.61	1.68-4.2
Total	58	91	57		

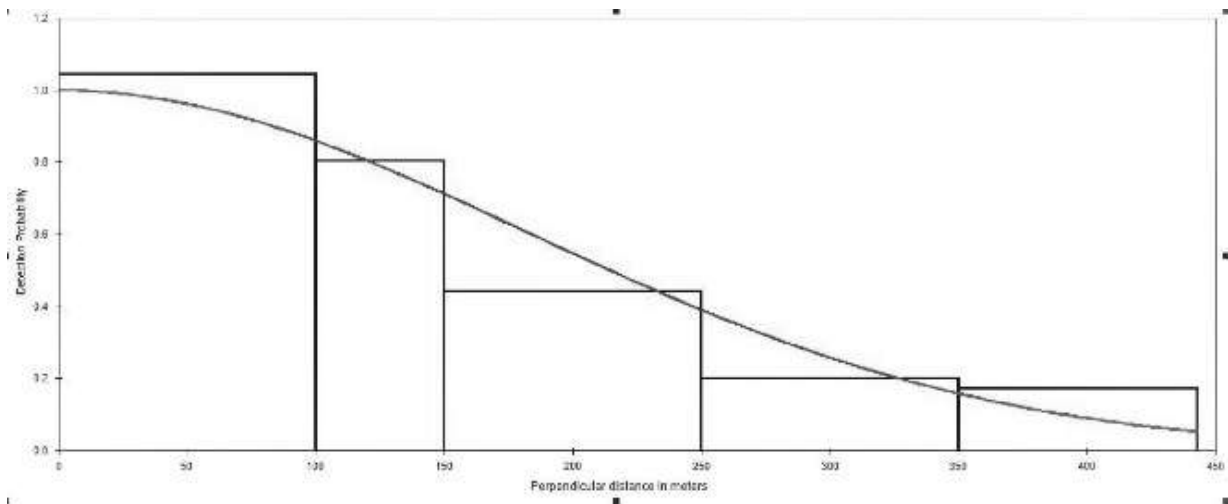
**Table 4.1. The results obtained by line transect analysis for males during 2014 monsoon in all Florican sites (Note: Here 4 females also included for Shokaliya, see 5.2)**



**Figure 4.1 Histograms and estimated detection functions derived from DISTANCE software for line-transect distance-detection data for male Floricans during 2014 monsoon in all potential Florican reserves.**

Year	Effort (km)	No. of transects	Individuals detected	Density of $\pm$ SE/km <sup>2</sup>	95% confidence Interval	Encounter rate/km	95% confidence Interval	Detection probability	95% confidence intervals	Effective strip width	95% confidence intervals
<b>2014</b>	34.8	23	36	2.29 $\pm$ 0.51	1.46-3.59	1.034	0.68-1.56	0.508	0.42-0.61	225	186-271
<b>2015</b>	54.85	27	20	0.9 $\pm$ 0.25	0.42-1.52	0.36	0.197-0.672	0.508	0.42-0.61	225	186-271

**Table 5.2. The results obtained by line transect analysis for males during 2014 &15 monsoon at Shokaliya site.**



**Figure 4.2.** In 2014&2015 number of Floricans sighting at different distance from transect and its histograms and estimated detection functions derived from DISTANCE software for line-transect distance-detection data for male Lesser Floricans at Shokaliya Florican site.



**Plate 4.2.** Distribution of Lesser Florican in Shokaliya breeding site.

State	District	1982	1989	1994	1999	2010	2014
Gujrat	Bhavnagar	0	2	35	19	27	6
	Amereli	0	NV	0	0	0	NV
	Junagarh	21	0	4	4	0	NV
	Jamnagar	34	NV	1	2	0	NV
	Rajkot	21	NV	27	42	0	NV
	Surendranagar	NV	NV	2	NV	NV	NV
	Kutch	NV	8	36	67	22	1
	Punchmahal	NV	20	6	11	5	NV
Madhya Pradesh	Ratlam	36	28	25	55	8	7
	Jhabuva	5	9	3	1	2	3
	Dhar	14	11	13	7	2	0
Rajasthan	Bhiwara	NV	NV	NV	3	5	0
	Tonk	NV	NV	NV	2	2	NV
	Ajmer	NV	NV	NV	4	3	40
	Chittaurgadh	NV	NV	8	25	8	NV
Total males seen		65	90	161	303	84	57
Total		4374	1672	2206	3530	NC	NC
		131	78	160	242	84	57

**Table 4.3. Number of male detected in large scale survey during transect course.**

Sate	District	Key Villages	2010	2011	2012	2014	2015
Rajsthan	Amjmer	Shaunkhaliya	3	62	71	---	---
	Bhilwara	Shahpura	5	7	7	11	0
	Prathapgarh	Sidpura	0	1	0	0	NS
MP	Ratlam	Sailana	1	1	6	6	9
		Amba	1	0	0	1	3
	Dhar	Sardharpura	2	4	3	0	1
	Jhabua	Petlawad	2	2	5	3	5
Gujarat	Dhahod	Rampua	5	0	2	2 R	0
	Bhuj	Naliya	23	10	2	3	NS
	Bhavnagar	Velavadar NP	22	26	27	26	49
		Total	66	113	126	94	

(Note: During 2014 and 2015 at Shokaliya site the no. of individuals not mentioned because direct count is not possible in such a large area)

**Table 4.4. Number of males sighted in last 6 years of period (2013's data is not available) the survey conducted by forest department officials.**

Sn	Place	Year	No. Individuals	Reference
1	Juna Sawr, Amreli, Gujrat	2014 Monsoon	4to 5	Pers. comm. Ms. Devanshi
2	Rollapadu WS, Andhra Pradesh	2015 October	6to 8	Pers. Com.
3	Pali District.	2014 August	4 to 5	Pers.com.
4	Kadera, Ajmer, Rajasthan	2015 Monsoon	10 to 15	Pers. Comm. With Mr. Rajender Sigh.

**Table 4.5. Information received from various places within range of species principle**

#### 4.4. Discussion.

Since 1981, the breeding populations of Lesser floricans in western India were assessed 12 times. All these years, the populations were highly fluctuating and many grasslands have lost their floricans due to degradation. However, newer florican habitats have also been discovered especially in the agricultural landscape. Surveyed areas as follows in **1981:** Kathiawad peninsula in Gujarat, Ajmer district, Rajasthan, some areas around Nagpur in Maharashtra central India (Goriup and Karpowicz 1981, 1985), **1982:** Three districts of Kathiawad peninsula in Gujarat (Magrath *et. al.* 1983, 1985) and, some part of central India and Malwa plateau (Yahya 1982), **1984:** Rajasthan and Malwa Plateau (Sankaran 1992), **1986:** Rajasthan and Malwa Plateau (Sankaran 1992), **1989:** Katiawad, Kutch and Malwa Plateau (Sankaran 1991), **1994:** Malwa Plateau, Kathiawad Peninsula and Rajasthan (Sankaran 1994), **1999:** Malwa Plateau, Kathiawad Peninsula and Rajasthan (Sankaran *et al.* 1992), **2010:** Rajasthan, Madhya Pradesh and Gujarat (Bhardwaj *et al.* 2011), **2014:** Rajasthan, Malwa Plateau and Kathiawad in Gujarat study (present study), **2015:** Ajmer district Rajasthan (present study).

Consistently Florican population used to estimate by using total count method, which involves counting all individuals in a grassland and extrapolated to whole area (Gourip and Karpowicz 1981 and 1985; Magrath *et al.* 1983, 1985; Yahya 1982, 1990, Sankaran, 1994, 2000). Estimated population 4374 in 1982, 1672 in 1989, 2206 in 1994 and 3530 in 1999. Unlike past study, we didn't attempted to estimate whole population instead only density in all respected areas. Therefore the results can be compared only with density and number of individual sighted against to earlier surveys which were done in 1994, 1999 and 2010. This present study followed distance sampling based on line transect method (Buckland *et al.* 1993). In this method it is assumed that the animals on the line certainly detected with certainty, and a detection function, representing probability of detection as a function of distance from the line. This allows estimation of the proportion of animals missed within surveyed strips, extending a specified distance from the line or point. Suitable survey design allows the resulting animal density estimates to be extrapolated to the full survey region, to come up with animal density. (Buckland 2007). In large and open croplands like in Shokaliya, Shahpura and Naliya breeding sites, because satellite tracking of Lesser Florican in Shokaliya breeding site reveals that displaying individuals' territories are not permanent due to disturbance from agricultural activities.. Due to this reason there is a chance of overestimating by making double counting.

Moreover Florican occupied places are numerous over the landscape. To visit every areas and counting every single individuals is time consumes, needs lot of effort and cause disturbance to displaying males and females. To avoid this kind of issues, distance sampling method based on line transect is selected as ideal for the species to estimate the male density in breeding sites.

Since our study could cover almost all areas where earlier surveys were done by Sankaran in 1994 and 1999 and Bhardwaj in 2010. Our comparison can be done with number of sighting individuals in previous survey. During 1994 breeding season 147 males and 20 females, 1999 breeding season 223 males 17 females (Sankaran 1994, 2000) and 2010 breeding season 83 males and 1 female (Bhardwaj et al. 2011) were sighted. In this present survey during 2014 breeding season 53 males and 4 females were sighted. It is 36% against to 1994, 23% against to 1999, and 63% against to 2010. Number of males sighted during 2014 is significantly decreased when comparing to earlier studies in western India.

**4.4.1. Rajasthan:** During 1999 survey 6 males (Shokaliya=4, Malpura=2) 2010 very 5 males (Shokaliya=3, Malpura=2) were sighted in this connected breeding landscape (Shokaliya and Malpura), but during 2014 survey 40 individuals (36 males and 4 females) and 20 males in 2015 were sighted. During 2015 only 55.5% males sighted comparing to 2014, it is significantly lower than 2014. In Shahpura breeding site during the 1999 three males, in 2010 five males were sighted, during peak season of 2014 more than 8 males were seen (pers. comm. Mr. Shathrujeetsingh and Mr. Mahendrasing) but till the time we visited rains were topped and weather getting hot that is October first week of 2014, males also stopped displaying this was the main reason for why we could not detect even single bird. During 2015 we visited during peaks season after good rains and grass/crops grown up even this time also we could not see the floricans. However in Shahpura region rains were too late while the surrounding areas received better and early rains fall than shahpura sites in the year. After few weeks we were informed as the Florican been sighted in other areas between Shahpura and Kekri. Villages Kadera, Deopura and Sheshpura, there at least 10 to 15 individuals had been found during the year 2015 monsoon (pers. Comm. Mr. Rajendersingh).

Prathapgarh district also has potential breeding sites villages Bajranghad, Kadiawath, Sidpura and Mohwdikheda where during 1999 survey 28 birds (25males and 3

females), in 2010 survey 8 males were sighted. In 2014 we had enquired local bird watcher and forest department officials, but they have confirmed that no Floricans have been seen during year 2014. In the same way no Florican sighted during 2015 as well.

**4.4.2. Gujarat:** In **Naliya** breeding site only two males were sighted in search of 8 days effort. In the same sites in 1994 survey 36 individuals, 1999 survey 67 (64 males and 3 females) (Sankaran 2000), during 2010 survey 22 individuals were sighted. This site was considered as second largest breeding congregation site in 2010 (Bhardwaj et al. 2011). In our survey only two males could be found in different places (one was sighted another was reported). In interview with local and forest department officials confirmed that Floricans were not frequently seen since 2012 year due to insufficient rains, in fact during our survey the male was displaying in dried grass at Lala Bustard Sanctuary, Jahkavu.

In **Velavadar National Park** during 1994 survey 33 individuals, in 1999 survey 19 males, (20 males and 6-7 females in forest department count) 2010 survey 26 individuals were sighted, however in the same year Forest department could count 50 individuals. In year 2014 same thing was happening we could count only 6 displaying males but Forest Department could count 26 individuals this difference must be due to late visit that is 11<sup>th</sup>, 12<sup>th</sup> of September 2014. In **Dahod** district at Rampura site during 1994 survey 5 males, in 1999 survey 11 Floricans (9 males and 2 females) and in 2010 survey 5 males have been sighted. During our survey no single individual was sighted in this site. Interview with local bird watcher group who are interested in Florican conservation reveals that over growing of shrub and tree cover is the main reason for why the Floricans are not breeding (pers. comm. with Mr. Dharmendrasingh and Mr. Zuzar).

#### **4.4.5. Madhya Pradesh (Malwa Plateau)**

Totally in Madhya Pradesh during 1994 survey 34 Floricans, 1999 survey 31 and 2010 survey 12, (Sankaran 2000 and Bhardwaj 2011), and during present survey 10 Floricans were sighted. Trend in breeding population of the species in Malwa plateau is significantly decreasing over the years when comparing to past survey.

In **Sailana Kharmor Wildlife Sanctuary** during year of 1994 survey 18 Floricans, in 1999 survey 28 (25 males and 3 females) and in 2010 survey 8 Floricans were sighted (Sankaran 2000 and Bhardwaj 2011). During 2014 survey 7 males were sighted and during 2015 monsoon 12 individuals were reported (Gadikar 2015). In **Sardharpura**

**Kharmor Wildlife Sanctuary** in 1994 survey 3 males, in 1999 survey 1 male, and 2010 survey 2 males were sighted (Sankaran 2000 and Bhardwaj 2011). During 2014 survey Floricans have not seen, Interview with local forest officials reveals that since 2012 onwards they haven't seen any individual's visiting this sanctuary, the reason is remains unknown, but during our visit to survey grazing was observed in enclosures. In **Petlawad** breeding site during 1994 survey 3 males, in 1999 survey 1 males, in 2010 survey 2 males (Sankaran 2000 and Bhardwaj 2011) and 2014 our survey 3 males were sighted. A better improving in number of males sighted has been observed in this breeding site in present years.

#### **4.4.6. Density**

1982: 1.14/km<sup>2</sup>, 1989: 0.43/km<sup>2</sup>, 1994: 0.57/km<sup>2</sup>, 1999: 0.92/km<sup>2</sup>, **2010**: density is not mentioned any particular density. Instead, only no. of individuals had been sighted in survey was mentioned. We don't consider the number of grasslands in compaction. Because in present days the grasslands mentioned in previous studies, some of them merged into one and some of them fragmented into several. Density state vice in Shokaliya during 2014 2.2/ km<sup>2</sup>, and during 2015 1/ km<sup>2</sup>. In 2014 Shahpura 0/ km<sup>2</sup>, Sailana 1.9/ km<sup>2</sup>, Petlawad 0.8/ km<sup>2</sup>, Naliya 0.3/ km<sup>2</sup>, Dahod 0/ km<sup>2</sup> and Velavadhar 1.4/ km<sup>2</sup>. (Table 5.1 &5.2).

## Threats and Recommendation

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### 5. Introduction

As already known that the major cause of the population decline of species is habitat loss which led by varieties of developmental activities all across the distribution range of species. Though the hunting also one of the main cause of decline, however, the hunting significantly reduced. Conservation measurements and recommendations of the species and its habitat's recovery already emphasised in precise manner in previous reports like "*Status, and distribution and conservative perspectives of Lesser Florican in the North-Western India*" a survey report by Bhardwaj et al. 2011, "*Saving Asia's threatened birds: A Guide for Government and Civil Society*" by Maccann 2011 and "*Guidelines for state action plan for Resident Bustards' Recovery Programme*" Dutta et al. 2013. Along with their suggestions, our recommendation primarily based on the field observation during study period. Prevailing threats varies across breeding habitats in western India.

### 5.0. Threats

#### 5.1. Lack of National Policy on Grassland Management in India

Due to inadequate grassland conservation policy and management practices or a mindset that assumes grasslands are wastelands, many of the state owned grasslands and village pasture lands have been planted extensively with tree species including *Prosopis juliflora*. Several grasslands in the regions have been converted into either woodlands or crop lands. In addition, due to excess of grazing most of remaining grasslands were also degraded to that extent that even the top soil had been removed. Many of the grasslands belonging to state forests departments commonly known as grass *birs* were auctioned every year. Instead of harvesting the grass manually after the monsoon season, the contractors many times lease out these areas to the local graziers due to non-availability of man power to cut grasses. Herds of cattle throng these grasslands and render a great disturbance to the breeding floricans, even trampling their nests and eggs. Complete removal of grasses from grassland also not conducive for florican to breed in the next year but most of private and government owned grasslands were observed with harvesting of entire grasses leaving no habitat for wildlife.



## 5.2. Habitat Lose

Of the 169 potential grasslands of florican available in the north-western India, 91 grasslands still believed to be conducive for florican were surveyed, which include grasslands surveyed during 1999 (Sankaran 1999). Of the surveyed grasslands, Lesser floricans were found only in 24 grasslands as against 37 grasslands in 1999. This was largely due to degradation of grasslands, which have failed to attract floricans. Floricans like pure but undisturbed grass patches with mosaic of last year grasses to settle down at the beginning of breeding season. Changes in land-use pattern over the decades have resulted in a drastic decline of grassland habitat in the north-western India. Many of these grasslands were reclaimed for agriculture to meet the demands of the growing population. Ever growing cattle population in the region have also caused overgrazing of the grassland habitats (Sankaran 2000). In many areas, most

of protected grasslands were lost to agriculture, leased to graziers or ploughed up, a situation that was particularly alarming in privately owned grassland (Sankaran 1995). Grasslands in the Nalliya area of Kutch, which was known to be an important region for florican conservation had been encroached dramatically by immigrants from Haryana, who are ploughing up florican habitats for cotton cultivation, causing a huge loss of habitat for both bustards and local herdsman. Moreover, degradation of grasslands in Gondal, Rajkot, Jamnagar, Ratlam, and Dhar districts in the north western India either completely failed to attract florican or attract few individuals.



### **5.3. Plantation**

It was observed that grasslands have wrongly been considered as waste land and hence large scale plantation was carried out in many grasslands in the north western India. Grasslands with plantation were avoided by the florican as these birds prefer pure grasslands with few trees here and there. Because of plantation, several potential grasslands of florican failed to attract these birds nowadays.



#### 5.4. Invasive Species

Invasion of alien *Prosopis juliflora* was reported in several grasslands in the north western India. Apart from *Prosopis*, several other tree species were also observed invading in the grasslands largely due to grazing. Grazing cattle were also known to spread these invasive species in the grasslands at a faster rate



#### 5.5. Pesticide pollution

Lesser Florican is an omnivorous species. Foods of florican include many types of invertebrate, plus various plant parts: grasshoppers, beetles, flying ants, hairy caterpillars, centipedes, worms, frogs, small lizards, crop shoots, leaves, herbs and berries. Insect form the large part of diet of the Lesser florican. Crop fields in semi-arid and arid zones are known to

be excellent breeding ground for insects. Most of florican sightings during this survey were at the fringes of grasslands which were adjoined with crop fields. It shows that the florican prefer this area largely due to more availability of insects in the region. Use of pesticide in the adjoining agriculture fields around the florican grasslands is being drastically reducing the foods availability. Moreover, insect with pesticide may also threaten the floricans health.



### **5.6. Indiscriminate developmental activities**

Windmills in or around the florican habitat are also seems to be threatening bustard in general and floricans in particular. Once the Great Indian Bustard Sanctuary (Lala village) use to attract several floricans had failed to have single florican this year might be due to mushrooming of windmills around this sanctuary. Apart from windmills, urban expansion, expansion of agricultural activities, road etc in the grasslands are also posing threat to this species.

### **5.7. Hunting**

Displaying male floricans are easy victims of hunting. Severe hunting pressure in the last century could eradicate most of male population (Hume and Marshall 1879–1881, Baker 1921–1930, Birdlife International, 2001), appears to have affected the species drastically (Sankaran 1993). Because of its delicate flesh and excellent taste florican became a best sport-birds of both native people and colonial sportsmen (Jerdon 1839–1840). Sporadic incidences of hunting of this species reported during our survey. However, hunting is not seems to a major threat as most of villagers sympathetic to floricans.

## 5.8. Inadequate Protected Area Coverage

Less than five protected areas (grasslands) are existing exclusively for the conservation of florican/bustards in the north western India. These include Sailana Kahrnor Sanctuary and Sadarpur Florican Sanctuary both in Madhya Pradesh and the third is Velavadar WLS. Former two are exclusively notified for Lesser Florican while the third one is for Black Buck in Gujarat. There is also one sanctuary called Great Indian Bustard WLS which is chiefly for GIB but it is also a habitat of Lesser Florican. In Madhya Pradesh, the Sailana Kharmor Sanctuary (Sankaran 1990) and in Gujarat, the Velavadar Blackbuck National Park were the only two wildlife protected areas reported with floricans during this survey. Velavadar NP is the only grassland in the north western India observed with increase in population of Lesser florican in the last three decades was largely due to better grassland management and protection. Some of the protected grasslands in the region were also unfit for florican largely because of these grasslands managed only for fodder. Currently, less than 5% of Lesser florican habitat is protected by Wildlife (Protection) Act, 1972 is grossly inadequate to save this species.

## 6.0 Existing Conservation and Management Practices

The Lesser Florican *Sypheotides indica* is placed in Schedule I of the Wildlife (Protection) Act, 1972, and hence its hunting, trapping or shooting is prohibited. In addition, the habitat of this species is accorded protection in five areas by declaring them as wildlife sanctuaries. These include Sailana Kahrnor Sanctuary and Sadarpur Florican Sanctuary both in Madhya Pradesh and the third is Velavadar WLS. Former two are exclusively notified for Lesser Florica while the third one is for Black Buck in Gujarat. There is also one sanctuary called Nalia WLS which is chiefly for GIB but it is also a habitat of Lesser Florican. Keeping them as flagship species, for the conservation of Lesser Floricans and its habitat, past and current management practices vary from state to state and are site specific.

### 6.1. Rajasthan State

Saunkhlya closed area is the only area which is set aside for Great Indian Bustards and Lesser Florican. The revenue areas of more than 43 villages constitutes an area of more than 54 square kilometres which is a combination of village pasture lands, revenue land, agricultural land and also some grass *birs* belonging to state forest department. Most of the grasslands and *birs* have been converted into scrublands with *Prosopis juliflora* and other thorny plants like *Acacia nilotica*. The remaining pasturelands, because of overgrazing have resulted into

degraded areas. Only two staffers, Rajender Singh Forester and one chowkidar, Goga Kumhar is well aware of the Lesser Florican. All the Floricans which were observed here, were in the agricultural fields.

The Shahpura area of Bhilwara also represent the same scenario. Even the concerned staff was unaware about the bird. It was only due to Satrughan Singh of Shahpura Bagh, I was able to see some of the sites which are the habitats of the bird. Even the local forest officers had not seen the bird in their lifetime. I could feel the excitement and joy among the staff when they were watching the jumping florican through the spotting scope of Satsingh.

There are no special managerial inputs for its conservation in Pratapgarh. Till 2006 it was only late Thakur Digvijay Singh of Dhamotar who as a keen bird watcher was spreading awareness among the local people in Kriabad area when local DFO got interested in the bird and started monitoring it and came out with its status report (Bhardwaj, 2010). At present there are no managerial inputs for the conservation florican and its habitat as most of the potential habitats are belonging to private individuals. The sighting of two floricans in savannah grasslands belonging to state forest department in Chiklad area may help in developing local conservation program for the Pratapgarh district.

## **6.2. Madhya Pradesh**

Managerial inputs in three important areas in Madhya Pradesh including Sailana grasslands, Sardarpur grasslands in Dhar district and Petlabad grasslands in Jhabua reflect the commitment of state government towards the conservation of this species. *Kharmor Batao Inam Pao* remains the most impressive program where a villager will get the reward for showing a Lesser Florican in his agricultural field. Besides this he will be further rewarded for providing protection till the end of the season.

Many of the grasslands are well protected with chain linked fencing. Some of the places in Saradarpur WLS have too much grazing pressure resulting in the breach of fences. Thus such areas are exposed to over grazing which ultimately reduces sighting of Lesser Floricans. In another observation in the same sanctuary, one of the *chowkidar* had come up with an innovative idea of cultivating small patches of the area with soyabean with an objective to prevent Lesser Floricans going out in agricultural field which are full of insecticides.

### **6.3. Gujarat**

Despite too much grazing pressure the excellent protection measures taken by the local forest officials have resulted in some patches of undisturbed grasslands showing the presence of Lesser Florican in the Rampura grasslands of Dahod district. Owing to grazing pressure and due to invasion of *Prosopis juliflora* many of the grasslands of Kharoda, Tatagolla and Sharda are on the way of becoming scrubland.

Most of the grasslands of Gondal in Rajkot are under immense pressure of grazing. The Kirasana grassland is still intact and is a possible habitat for the florican. But it is slowly being surrounded by concrete jungle of Rajkot.

The only place of pure and undisturbed grasslands is Velavadar wildlife sanctuary where maximum number of floricans were sighted in a small area. In Naliya, a rapid change in land use pattern has been observed. Many of the grasslands belonging to private owners or revenue department which were earlier the habitats of florican had been converted into agriculture lands. Intensive agricultural practices including cultivation of cash crops like cotton using enormous insecticides all around in last couple of years may be viewed as serious threat not only to Lesser Florican but also to other members of the bustard family.

## **7.0. Recommendations**

### **7.1. National Policy on Grasslands Management**

It is important to have a National Policy on Grasslands Management in India appreciating the ecological services provided by this ecosystem. Currently, grasslands are by and large considered as waste lands due to lack of understanding about their ecological services. The practice of tree plantation by the forest department in grasslands or grass *birs* should be avoided. Under the umbrella of Joint Forest Management/ Eco-development or social forestry schemes tree plantations were carried out in a major scale which is harmful to floricans and their habitats as well as associated species in the grasslands. Moreover, current practise of looking grasslands as source of only fodder for cattle needs to be reconsidered. Sustainable use of grassland resources without harming their ecological services needs to be emphasised in the National Policy. The Policy is also required to be suggesting the wildlife especially bustards friendly grassland management in India.

## **7.2. Inclusion of more florican habitats in the existing Wildlife Protected Area Network**

Less than five protected areas (grasslands) are existing exclusively for the conservation of florican/bustards in the north western India. These include Sailana Kahrmor Sanctuary and Sadarpur Florican Sanctuary both in Madhya Pradesh and the third is Velavadar WLS. Former two are exclusively notified for Lesser Florica while the third one is for Black Buck in Gujarat. There is also one sanctuary the Great Indian Bustard WLS, which is chiefly for GIB but it is also a habitat of Lesser Florican. Less than 5% of globally endangered Lesser florican habitat is protected by Wildlife (Protection) Act, 1972. Since the protected florican habitats are comparatively better than non-protected grasslands, it would be better to bring more grasslands under the Wildlife Protected Areas of India by declaring more grasslands as ‘Conservation or Community Reserves’. It is urgently required to bring some of the grasslands in Nalliya region in the protected area network. Similarly, some grasslands in Gonda and Rajkot districts as well as in Ratlam and Dhar districts. Grasslands around Sailana are also need to be declared as ‘Community/Conservation Reserve’ with consensus of local communities. And then the grasslands in the protected areas are need to be managed to fulfil the habitat requirement of bustard in general and lesser florican in particular.



### **7.3. Management of Invasive Species**

Eradication of *Prosopis juliflora* and other invaded tree species from the selected grasslands in the north-western India should be taken up immediately. Eradication and monitoring of invasive species in the grasslands should be a continuous programme following the guidelines of IUCN-Invasive Species Specialist Group.

### **7.4. Florican friendly landuse pattern**

Floricans prefer pure but undisturbed grass patches with mosaic of last year grasses to settle down at the beginning of breeding season. Therefore, it is recommended to leave mosaic of old grasses during harvesting for floricans as well as other grassland wildlife. Instead of leasing out grasslands for grazing it would be better if the grasses are manually cut after the monsoon season that will prevent trampling of cattles on florican nests as well as spreading of invasive tree species in the grasslands. Pesticides use in adjoining agricultural fields found to be detrimental for the survival of floricans, therefore, local communities need to be advised the ill effects of pesticide use and they should be compensated if they incur any loss due to non-use of pesticides around florican habitats.

### **7.5. Florican watch and community involvement in florican conservation**

The financial incentive scheme of Madhya Pradesh Forest Department for rewarding the villagers for giving the information of the presence of bird in their agricultural land needs to be thoroughly reviewed and it may be started in others states of Rajasthan and Gujarat, if it is found be worth. An awareness and sensitisation programme for the conservation of Lesser Florican and its habitat should be initiated by all the state forest departments in the states of Rajasthan, Madhya Pradesh and Gujarat. This should be further supplemented with eco-tourism and sensitive florican watch activities. Local communities need to involved in the management of grasslands and they need to be told the reason behind the decline of florican as well as deterioration of their grasslands. There was an initiative in Nalliya, where grasslands grazing/harvesting was regulated with the help of local communities. Because of this some grasslands in Nalliya region were not disturbed during the breeding season of florican. This initiative was implemented in collaboration with Forest Department, Revenue Department and Local community. If this model works successfully then the same may be tried elsewhere in the country.

## **7.6. Florican friendly grasslands management**

Apart from declaring some of important grasslands as conservation/community reserves, it would also be require to modify the current use of grasslands in the north-western India. Instead of allowing livestock grazing all over grasslands, certain portion of grasslands need to be protected at least for a year period. Next year, these protected grass patches may be used as fodder but protecting other parts of grasslands for another year use. This kind of practice would help the floricans to settle down and to breed.

## **7.7. Research and Monitoring**

The Lesser Florican *Sypheotides indica*, a species endemic to the Indian subcontinent, is largely seen during the monsoon season in north-western India, where it breeds. Its population and range is decreasing at an alarming rate due to breeding habitat loss and threats in the non-breeding habitats, believed to be in south and south-east India. Their breeding habitats have sharply declined in north-western India, which is believed to be a major cause for the decline of this endangered species, and there is hardly any information its non-breeding habitat which is supposed to be in Central and South India. A number of studies have been carried on its population status, habitat-use and behavior in the breeding grounds, but there is practically no information about their habitats, ecology and behavior in non-breeding habitats, the knowledge of which is crucial for their comprehensive conservation plan preparation. It is important to know the status of non-breeding habitat of florican using satellite tracking techniques, understand the migration pattern/movements, and investigate its current status and distribution in north-western India, which could lead to data on the species in other areas. There is also need of continous monitoring of Lesser Florican and its habitat in the states of Rajasthan, Madhya Pradesh, Gujarat and Maharashtra. Studies on impact assessment of mega and even so called eco-friendly projects like wind mills on the Lesser Florican should be initiated. A study on the effects of pesticides and insecticides on Lesser Florican is still lacking. There should be a study on this issue.

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