

Status and Habitat Assessment of Bengal Florican *Houbaropsis bengalensis* in the Grasslands of Uttar Pradesh, India



Project Report

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Project Profile

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- 2. Names of the Investigators and Research Fellows** Investigators: Dr. K. Sivakumar, Shri Subharanjan Sen, Dr. G.S. Bhardwaj
Researchers: Rubi Sharma (JRF), Omkar Dhavale (JRF), Sutanu Satpathy (Intern)

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Foreword

The Bengal Florican *Houbaropsis bengalensis* (Gmelin 1789), identified as the mostcritically endangered among the bustards by IUCN, is a habitat specialist species and prefers only short, open and undisturbed grasslands. Considered an indicator of the health of moist *terai* grasslands, it was once common in the flat alluvial grasslands of the Terai Arc Landscape (TAL), in the foothills of the Himalaya. The bird is especially noticeable in the months from February to May due to its characteristic flight display. Ever-increasing human pressure, conversion of grasslands to other land use practices and tree-oriented forestry activities are some of the factors leading this bustard to the brink of extinction. Invasion of grasslands by plantations, pesticide pollution, invasive species and uncontrolled grazing are other factors resulting in degradation of its habitat, consequently leading to its decline.

The present study was undertaken by the Wildlife Institute of India with the aim of updating the status of the Bengal Florican and its habitat in the *terai* grasslands of Uttar Pradesh, especially in the landscape of Dudhwa Tiger Reserve. The findings of the present study suggest that the floricans are being sighted in new areas such as Pilibhit and Kishanpur Wildlife Sanctuary, compared with 1988, but that the population has declined across the distribution range in Dudhwa Tiger Reserve, as reported earlier. However, the method that has traditionally been used to estimate the population of the Bengal Florican seems to have always given underestimates. Hence, a new method using an occupancy model with distance sampling has been validated and recommended by this study for estimating Bengal Florican populations.

The study has provided several recommendations for the recovery of the Bengal Florican populations and their habitats in Uttar Pradesh.

I compliment Dr. K. Sivakumar, Dr. Gobind Sagar Bhardwaj and Shri Subharanjan Sen, scientists, Wildlife Institute of India and Ms Rubi Kumari Sharma and Shri Omkar Davale, researchers for undertaking this eye-opening status survey and bringing to the fore the immediate need for a recovery plan for this grassland bird.

Member Secretary

Uttar Pradesh State Biodiversity Board

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Research Team



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Summary

The present study, a status survey of the Bengal Florican, was carried out in all potential florican habitats of Uttar Pradesh, especially Dudhwa National Park (NP), Katarniaghat. Wildlife Sanctuary (WLS), Kishanpur WLS, Pilibhit Reserve Forest (RF) and Lagga-Bagga from April 2011 to June 2014. The breeding behaviour of the floricans and their habitats were also studied in Dudhwa NP and Kishanpur WLS. The field work was carried out in three different seasons: first in the breeding season (March–May), second in the pre-breeding season (January–February) and third in the post-breeding season (June–July) of the floricans during 2012–2014. The area search method, which has been used in the past, was used to estimate the population of Bengal Floricans in the state. Apart from this, an attempt was made to use the occupancy model using distance sampling to estimate the population. The focal animal sampling technique was used to study the behaviour of floricans in Dudhwa NP. The vegetation structure of florican habitats was studied using the vegetation quadrat sampling method. Using the area search method, the population of the floricans was found to vary between years from eight to 34 individuals in Uttar Pradesh. In 2012, the estimated population of the floricans was eight individuals, but it was estimated to be about 34 individuals in 2013 and 22 individuals in 2014. The presence of floricans in new areas such as Pilibhit RF and Kishanpur WLS was very encouraging although the population of floricans had declined in Dudhwa, compared with 1988.

However, using a spatial model and the point count technique, specifically the Royle repeat count model (Royle, 2004, 2008), we could intensively monitor floricans in area of 11.65 km² extending across three protected areas, namely Dudhwa NP, Kishanpur WLS and Pilibhit Tiger Reserve, during the peak breeding season. Katarniaghat was excluded because floricans have been absent there in the last 2 decades. The total number of male floricans obtained using the Royle repeat count model in the Presence software package was 10.34 in 11.65 km², with a SE of 3.29 and a confidence interval of 5.54–19.28. The total occupancy was estimated at

0.318, with a SE of 0.083 and a confidence interval of 0.1856–0.5103. Therefore, it was estimated that the total area of suitable grasslands available for breeding floricans in Dudhwa NP, Kishanpur WLS and Pilibhit RF was 112.750 km². Assuming that the density of floricans in this 112.750 km² area was the same as the density in the total area surveyed, the total number of male floricans in all the suitable grasslands was estimated at 99.26 individuals. Assuming that there was an equal sex ratio in the landscape, the total population of floricans in Uttar Pradesh was estimated to be about 198 individuals, occurring exclusively in the grasslands of Pilibhit Tiger Reserve, Dudhwa NP and Kishanpur WLS.

It was found that the Bengal Florican prefers grasslands with specific compositions for breeding. First, the most obvious difference between the grassland habitats used by the floricans and other grasslands was the species richness. Floricans preferred grasslands with the smallest number of species. The species present in these grasslands included *Desmostachya bipinnata*, *Imperata cylindrica*, *Saccharum spontaneum*, *Themeda gigantea*, *Saccharum bengalense*, *Vetiveria zizanioides*, *Grewia sclerophylla* and *Grewia asiatica*. In contrast, there were 29 species of grass in grasslands that were avoided by floricans.

Similarly, florican territories had a much lower density of plants (uneq.var.) t-test, $p = 0.033\%$) compared with other grasslands in Uttar Pradesh. The density of grasses was greater in the florican display territories than in other parts of the grasslands (uneq.var. t-test, $p = 0.01$). However, no significant differences were found between the height of the plants in florican territories and those in non-territory areas of the grasslands. Obviously, the grass growth is largely determined by the monsoon and certain soil characteristics, which were more or less uniform in a grassland.

In the pre-breeding season, all the potential grassland patches could be classified on the basis of the three different communities, dominated by *Desmostachya bipinnata*, *Imperata cylindrica* and *Themeda arundinacea* respectively, whereas four communities were found in the breeding season. In this season, a community

dominated by *Saccharum narenga* formed in addition to the other three communities.

It was observed that at the beginning of the breeding season the floricans spent the most time (52.32%) feeding in the grasslands and the ecotone areas of the grasslands. It was observed that later, i.e. after 15 days, the males invested almost equal times for feeding (38.53%) and movement (44.04%). In contrast, the time spent moving or searching increased to 76.76% when all the males started displaying in an arena.

The presence of Bengal Floricans in new areas such as Pilibhet RF and Kishanpur WLS is very encouraging, but the floricans were unable to use the grasslands of Katarniaghat and Lagga-Bagga because they were degraded. Therefore, it is suggested that the grasslands of these two protected areas be restored. Further, the existing grasslands in Dudhwa NP, Pilibhet RF and Kishanpur WLS need to be managed so that they are florican-friendly for conservation of Bengal Floricans in the long term in Uttar Pradesh.

(V.B. Mathur)

Director

Wildlife Institute of India

1. Introduction

The bustards constitute a distinctive, homogeneous Old World family and have been judged to share their ancient origins with the cranes and crane-like birds (Gruiformes) (Peter, 1934; Del Hoyo et al., 1996). Bustards are large, stout, long-necked, long-legged birds inhabiting open areas such as grasslands, agricultural fields, shrubby country and deserts. Bustards exhibit sexual dimorphism, with the females generally being smaller than the males, but in floricans, it is vice versa. There are 11 genera, 25 species and 44 taxa of bustard, with three species having become extinct. The Indian subcontinent has six species of bustard, including three endemic species—the Great Indian Bustard *Ardeotis nigriceps*, Lesser Florican *Sypheotides indica* and Bengal Florican *Houbaropsis bengalensis*. The Bengal Florican is the least studied bustard. The non-resident bustards are the Great bustard *Otis tarda*, Little Bustard *Tetrax tetrax* and Houbara Bustard *Chlamydotis undulata*. The Bengal Florican is now confined to certain protected grasslands of Uttar Pradesh, West Bengal and Assam, in India, and Nepal. Until the mid-1800s, all these three resident Indian bustards were commonly seen in the *terai* of Uttar Pradesh (Sankaran & Rahmani, 1986). And after the early 1900s, the Great Indian Bustard has totally vanished from this region.

After the commencement of the International Symposium on Bustards, in Jaipur, in 1980 (Goriup & Vardhan, 1983), and N.J. Collar's suggestion that the range and population of the Bengal Florican had declined rapidly in 30 years, the first survey was carried out by ICBP in collaboration with national authorities and a local biologist. Long-term conservation proposals were made for all these species. The first extensive work on the status and ecology of the Bengal Florican was started by the Bombay Natural History Society (BNHS) in 1986–1988 across its present distributional range in India. As a result of this study, the Bengal Florican was declared the rarest bustard, with an estimated population of 250–300 individuals

in India and the world population around 400 individuals. It was listed as a critically endangered species in the IUCN Red List.



Once widely distributed in some alluvial plains grasslands in northern India, Nepal and Bangladesh, the Bengal Florican is presently restricted to a few pockets in protected areas in India and Nepal. With its precarious conservation status and special habitat and its being an indicator of a threatened habitat, namely grasslands, the Bengal Florican is an effective flagship species for conservation of the wildlife of grassland ecosystems. The florican is a habitat specialist species and prefers only short, open, undisturbed grasslands. Listed in Schedule I of the Indian Wildlife Protection Act it has also been listed in the National Wildlife Action Plan 2002–2016. According to National Forestry Commission recommendation no. 172, 'Project Bustards' should be initiated to protect the highly endangered Great Indian Bustard, Lesser Florican, Bengal Florican and other grassland animals and plants.



The Bengal Florican was once common in the flat alluvial grasslands of the Terai Arc Landscape (TAL), in the foothills of the Himalaya. The *terai* region is a flat alluvial stretch of land lying between the Himalayan foothills and the Gangetic plain. It extends through Uttar Pradesh, parts of Bihar, north-west Bengal and Assam. It is also found in south-west Nepal. The *terai* grasslands, the only habitat of floricans, remain only in some protected areas, such as Dudhwa NP, Pilibhit RF, Kishanpur WLS and Katarniaghat WLS, due to constant changes in land use policies and forest management techniques, uncontrolled expansion of agriculture and human settlements. And it is 3 decades now after the last florican survey in the *terai* grassland of Uttar Pradesh was conducted. There have been considerable changes in the landscape ecology, vegetation structure, climatic conditions and anthropogenic pressure. So the extent of the grassland habitat remaining for Bengal Floricans is now very little, as a result of which floricans may go extinct. This study was conducted to make clear the present status of the species and the prospects of its survival in the future in Uttar Pradesh.

2. Objectives

- To survey and monitor the potential grasslands in all the potential grasslands of Uttar Pradesh to confirm the presence of the Bengal Florican.
- To assess the current status of the Bengal Florican in Uttar Pradesh, especially Dudhwa Tiger Reserve.
- To identify the major threats to the Bengal Florican and its habitat in these areas and formulate a plan for restoring it.
- To initiate a Bengal Florican conservation network and enhance the capacity among the local people and local NGOs to protect the Bengal Florican and its habitats through exchange programmes, raising awareness and motivation.
- To spreading the message of conservation of the Bengal Florican in the areas close to Bengal Florican habitats through school children using posters and drawings of Bengal Floricans.



3. Review of literature

3.1 Distribution

There are two subspecies of the Bengal Florican distributed in two parts of the world, one in the Indian subcontinent and another (the Indochinese subspecies) in South-east Asia. In the Indian subcontinent, *Houbaropsis bengalensis bengalensis* (Gmelin 1789) is a monogeneric member of the bustard family. In the 19th century, it was common in the *terai* and *duars* grasslands, which extend from the River Jamuna, in the west, to the Brahmaputra Valley, in the east (Hodgson, 1847). It was distributed from Nepal through Uttar Pradesh, Bihar, West Bengal, Assam and Arunachal Pradesh in India, Bhutan and Bangladesh (Ali & Ripley, 1969). In Nepal it is found in some protected grasslands of Chitwan, Suklaphanta and Royal Bardia reserves and the Kosi Barrage area (Inskipp & Inskipp 1983, 1985). In India the major population is found in some of the protected grassland patches of Assam and Uttar Pradesh, and there are some floricans in Arunachal Pradesh and West Bengal. Bihar does not have a population at present. According to Inskipp and Inskipp (1882), there was a misinterpretation about the florican population in Bhutan. There was probably no suitable grassland habitat there. And most probably the Bengal Florican has become extinct in Bangladesh too (Karim, 1985; Khan 1982, 1986).

The Indochinese subspecies, *Houbaropsis bengalensis blandini* (Delacour 1929) was first described by Jean Delacour, who got a female specimen from Svay Rieng Province, Cambodia in June 1928. There were a few new records of *H. b. blandini* in before 1960, all concentrated around the lower Mekong floodplain, in both Cambodia and adjacent Vietnam, with three reports from areas north of the Tonle Sap Lake, in Cambodia (Eames, 1995; Thomas & Poole, 2003; Davidson, 2004). However, in April 1999, Bengal Floricans were observed in the grasslands around a Khmer Rouge-era dam at Ang Trapeang Thmor, Banteay Meanchey Province, Cambodia (Goes & Veasna, 1999). Again, in 2002, during the

documentation of the country's Important Bird Areas, records from an additional four locations were found—these were two sites from a seasonally inundated grassland around Tonle Sap Lake, a location in north-west Cambodia at the margin of the Tonle Sap floodplain and a site in the Mekong Delta (Seng Kim Hout et al., 2003; Davidson, 2004).

3.2 Status

The Bengal Florican is the rarest bustard in the world, having a population not greater than 350–400 (Narayan & Rosalind, 1990; Birdlife International, 2002). It is listed as a critically endangered species in the IUCN Red List and in Appendix-I of CITES (2007). According to Inskipp and Inskipp (1983), there were 56–82 birds in Nepal and only two males were seen in Dudhwa NP. In 1985, a survey carried out by the BNHS found five male floricans. An intensive work was carried out by Sankaran and Rahmani subsequently (1987–1989) and the population in the park was estimated to be at least 40 floricans, including 14 territorial males. Further surveys conducted in 1992 (in which three displaying males were found) and 1993 (one displaying male) in the *terai* added one more site, i.e., Kishanpur WLS, 30 km south of Dudhwa (Javed & Rahmani, 1998). Other than Dudhwa, there was no indication of any viable population in Uttar Pradesh. There are a few potential sites in Uttar Pradesh (Lagga-Bagga, Katarniaghat and Sohagi Barwa), in which there may a few more individuals.

In West Bengal, Jaldapara WLS is the only site having floricans. Ten individuals were recorded in Jaldapara in 1989. In Assam, the estimated population includes 80 in Manas NP, 35 in Orang NP and 30 in Kaziranga NP. There is also a record of about 20 individuals from Arunachal Pradesh.

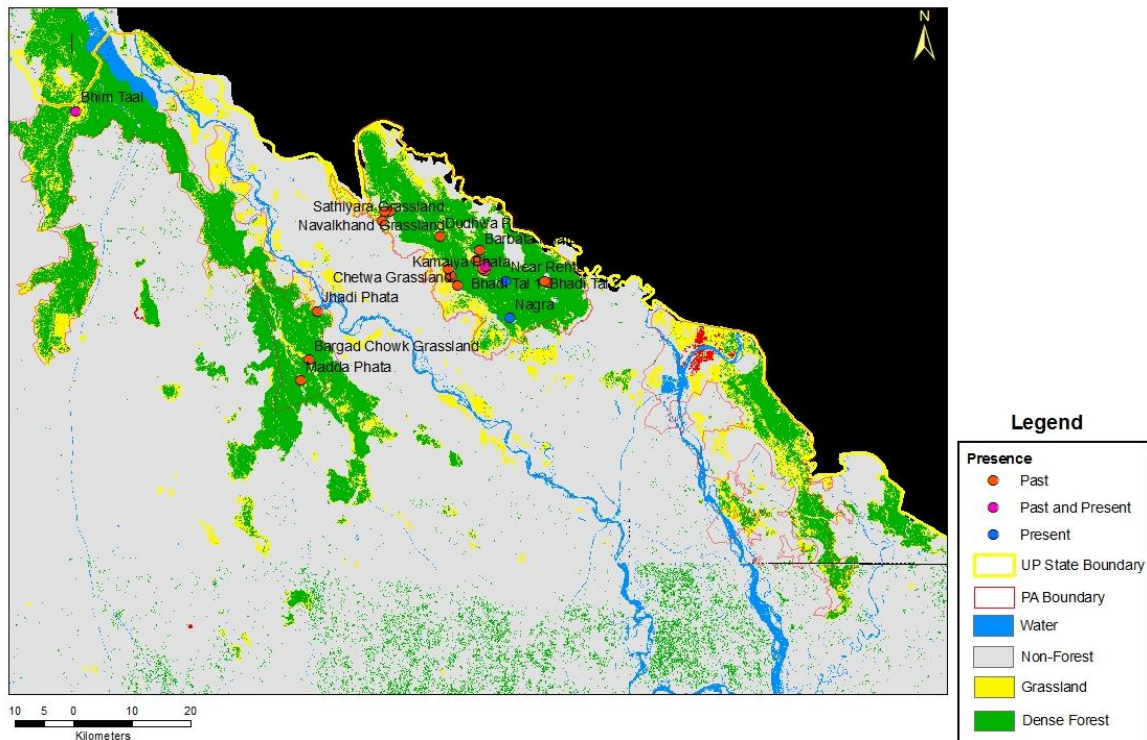


Fig 3.1. Past and present distribution of Bengal florican in Uttar Pradesh.

3.3 Morphology

In morphology and appearance the Bengal Florican is very similar to the Lesser Florican: size, 64 cm; weight, 1.2–1.7 kg; upperparts and tail buffy brown, vermiculated and patterned black, with broad white panel on closed wing; slight crest; head, neck and underparts black, with elongated breast feathers; legs pale yellowish; bill dark horn to plumbeous brown, with yellow lower mandible. In the female the black on the head and underparts is replaced with buff, and there is no white on the wing; the crown is brown, with a buff central stripe. The size of female is 68 cm and its weight is 1.7–2.2 kg.



The immature is similar to the adult female. The first spring male is partially black, often reverting to the female plumage in second autumn, but thereafter it retains the full adult male dress. The complete adult plumage of the male is assumed in a very irregular manner (Baker, 1921). Chicks: above and below warm rufous buff; crown rufous, mixed with rufescent brown and bordered by a stripe of the same colour from each side, meeting behind the nape and continuing partly down the back of the neck; ear-coverts bordered with rufescent brown; back and wings mixed rufous buff and rufescent brown; a patch of rufous bordered by rufescent brown from lower neck to breast and a patch of rufescent brown on each side of the breast; thighs with three broad rufescent brown bands on outer sides (Inglis, 1922).

The subspecies *H. b. blandini* is slightly different from *H. b. bengalensis*. The bill is flatter and broader at the base, the plumage is a rather richer colour, and the male has shorter ornamental feathers on the head and neck (Delacour, 1929).

3.4 Habitat

Being a habitat specialist and providing a classical example of a narrowly adopted niche structure, the species is becoming rare due to destruction of its habitat. Once it was common in the grasslands of the *terai*, *duars* and Brahmaputra Valley, extending from the *kader* of the River Ganges, of north-western Uttar Pradesh, in the west, to the *churs* of the rivers Dihang, Dibang and Brahmaputra and the foothills of the Mishimi Hills, in Arunachal Pradesh, in the east (Narayan & Rosalind, 1990).

The Bengal Florican is essentially a bird of flat, moist, large, open grasslands dominated by densely growing and comparatively short species of grass and shrub. In an early account of its habitat in north India and Nepal, Hodgson (1847) wrote that the Bengal Florican inhabited “wide-spread plains sufficiently elevated to be free from inundation and sufficiently moist to yield a pretty copious crop of grasses but grasses not so thick nor so high so as to impede the movement or the vision” of the bird. Later, Baker (1912) found the bird occupying low-lying and flood-prone grasslands.

According to Ali and Ripley (1969), the Bengal Florican lives in “tall grassland interspersed with scattered scrub and bushes, especially where grass has been grazed down to about half meter height or regenerating after the seasonal fire”. Inskipp and Inskipp (1983) have also found them almost entirely in pure grassland habitats in Nepal. But Narayan (1992) says that the present population of the Bengal Florican survives only in artificially maintained and protected grasslands. The maximum height of grass around the open patch usually varies from 60 to 150 cm (averaging around 70 cm in the beginning and about 125 cm towards the limit of the territory). In Dudhwa, where the grass becomes very dry and burns completely, the males establish territories in freshly burnt areas with scanty vegetation (Rahmani et al., 1996). The composition, height and density of the vegetation may vary in different florican habitats. Generally the territorial male

prefers open areas with good visibility where cover is available a short distance away. The floricans avoid areas with very tall and dense grass and even lightly wooded grasslands in Assam and prefer fairly dense, short grass of uniform height. In Dudhwa, however, some of the territories are in small (about 2 ha) openings in forests, where the grass often grows in clumps and is not as dense as in Assam. The lightly wooded grassy areas around these openings are used as peripheral zones by the territorial males in the same way that males in Assam use the tall grass areas around their territories.

The dominant grasses in most of florican habitats are *Imperata cylindrica*, *Saccharum narenga* and *Saccharum spontaneum*. *Setaria pumilla*, *Desmostachya bipinnata*, *Themeda* spp. and *Cymbopogon* spp. are some other common grass species. The dominant plants in florican areas, especially in Assam, include Simul or Silk Cotton *Bombax ceiba* and Khair *Accacia catechu* among the trees, *Cyperus* spp. among the sedges and *Grewia sapida*, *Sonchus* spp. and *Vernonia* spp. among the shrubs. Areas with extensive growth of very tall and dense 'Elephant' grass of the *Pharagmites–Erianthus–Arundo* group are not used by floricans; however, these species may be found growing to a limited extent around most florican habitats.



During the warmer part of the day, the males rest in grasses taller than themselves, often close to their territories (Narayan, 1992). In Nepal all the females were recorded in tall grasses, especially *Saccharum spontaneum*, while the males favoured short *Imperata*-interspersed patches of tall grasslands (Peet, 1997). The short grasslands appear to be favoured by males when they are foraging and displaying (Inskipp & Inskipp, 1983; Sankaran, 1996; Peet et al., 1999a & b).

3.5 Foraging

Territorial males usually forage in a leisurely manner, rarely rushing to catch insects. This activity occupies a large part of a male florican's active period. It moves slowly, pausing frequently, pecking or picking up materials from the vegetation or ground. The diet of a male florican is mixed, and to a large extent the composition depends upon the season and availability of food. Whereas male floricans are largely vegetarian in some months, they survive almost exclusively on insects in others. They often snap up grasshoppers, locusts, moths, beetles and

various other small insects from the ground. They take the tender and succulent shoots of young *Imperata cylindrica* and other species of grass and sedge. Floricans have also been recorded as catching small vertebrates (Hodgson, 1847). Floricans rarely drink water—their food usually contains enough moisture. They have been observed drinking water sometimes in Manas NP. Dudhwa being comparatively drier, the floricans there go to drink more regularly from streams and *nalas*. Occasionally, at dusk, about 10 to 30 minute after sunset, the male florican indulges in brief and vigorous feeding of insects. The emergence of termites might be one reason for this activity, but sometimes this behaviour has been observed in the absence of termites also (Narayan, 1990).

3.6 Breeding and nesting behaviour

Bengal Florican males are territorial for 4 months during the breeding season. In the breeding season, a male establishes a territory in an ideal habitat having sufficient food and defends it from other males and advertises its presence. These displays serve to attract females as well as warn other males. An earlier account by Hodgson (1847) indicates that the birds prefer particular spots and that if one is shot in a favoured site it is quickly replaced by another. The size of the breeding territory varies from 2 to 4 ha and invariably includes an open patch of area 1–2 ha where the grass is short (≤ 50 cm) and not too dense, at least for the first 3 months of the breeding season. Essentially the birds display in two different manners: stand-displays and flight-displays. In the first one, male floricans move to the open and short grassland patches and stand with erect neck and upturned head. Sometimes they fluff up their head, neck and breast feathers and stand in this manner for a few seconds to over 2 minutes. In 1847, Hodgson gave the first description of the flight-display after a Nepali *shikari*'s observation that the Bengal Florican rises perpendicularly in the air, humming in a deep, peculiar tone and flapping its wings, rising about 15 or 20 yards and again falling in the same manner, and with the same utterance. Ali and Ripley (1969) described that the displaying male “springs up vertically 8 or 10 meters above the grass-tops with a

deep croak and a peculiar deep humming, hovering on extended quivering wings and floats down perpendicularly to the same spot, repeating the maneuver every little while.”

But after Narayan’s study in 1990, it came to light that the flight-display of the male Bengal Florican is quite different from what had been described so far. Bengal Floricans do not spring up vertically as the Lesser Florican does and consequently cannot come down perpendicularly to the same spot. They rise to a maximum height of only about 3–5 m and do not really hover. No croaking or humming sound is produced, and the frequency of the flight-display is quite low (about 2–3 jumps per hour on average). The display-flight of the Bengal Florican was first properly described by Sankaran (1991) and Narayan (1992). The flight-display usually takes place in the open patch of the male’s territory. Once the male is aroused, it fluffs up the head, neck and breast feathers. Just before taking the jump, it inflates the breast pouch even further, draws the head further back and lowers the body by bending the legs partly. The bird springs up diagonally forward at an angle of about 45°. A loud and rapid wing-flapping sound is heard when it is ascending. When it reaches a peak 4–5 m high, the flapping stops and the wings are opened, displaying the glistening white wing feathers vividly against the jet black body. It is then that the male delivers its sharp, whistle-like ‘*chip-chip*’ call. It glides down a metre or two, moving forward on open wings, with the pouch drooping under the breast and the head thrown back. Just 1–2 m above the ground, it begins to flap its wings again and moves forward, gaining the lost height. On reaching the apogee, it stops flapping and floats down more or less vertically, with partly open wings, drooping pouch and dangling and even paddling legs. During the display flight, it covers anything between 20 and 40 m of ground, and from take-off to landing takes 6–8.5 seconds. The bird calls four to seven times when in the air.

The mating of the floricans was described after two incomplete observations at Manas NP. Generally the male and female enter tall grass, and the female sits down. The male starts pecking at the female’s head and neck vigorously but softly.

This probably lasts for several seconds, and finally the male mounts her and copulates. As the male moves away, the female gets up abruptly, shakes her body and quickly moves away. The male stands and preens for a while and moves to the open patch of its territory, where it resumes its stand-display. The Bengal Florican does not make a nest, and the eggs are simply laid on the ground in the grass. According to Baker (1935), the number of eggs laid is invariably two, but sometimes only one egg is laid. In 1921, Baker found two fresh eggs, which hatched on the 25th and 28th days.

3.7 Migration

In 1982, Ripley listed the Bengal Florican as resident in the Indian sub-continent. It is most likely resident in Nepal also, but the possibility of local or even long-distance movements should not be ruled out (Inskipp & Inskipp, 1983). In the Tonle Sap floodplain, Cambodia, floricans breed in a mosaic of grasslands and deep-water rice during the dry season. In the wet-season, birds have been recorded from grassland patches within dry *Dipterocarpus* forest, 30–60 km from their known breeding grasslands (Gray et al., 2009).

An observation of floricans flying at Suklaphanta WLS, Nepal towards the India border was made by Baral *et al.* in 2003. They suspected that some birds occupy territories in the grasslands of Lagga-Bagga, where Rahmani (2001] found one florican.

3.8 Threats to the population

Bengal Florican has very small, rapidly declining populations largely as a result of the widespread loss of its grassland habitat (Birdlife International, 2002). Grasslands are also the least studied and most poorly protected ecosystem (Rahmani, 1988, 1992; Eames, 1997; Baral, 1998; Buckton et al., 1999). There have been huge declines in the area and quality of grasslands across South Asia and South-east Asia (Bell & Oliver, 1992; Peet et al. 1999a; Eames, 1997). Virtually

all the remaining grasslands within the range of the species are subject to intense pressures, which threaten their future (Rahmani, 1988, 1992; Javed & Rahmani, 1991; Bell & Oliver, 1992; Eames, 1997; Peet et al., 1999a). In many areas, grasslands of conservation value are restricted to protected areas but continue to suffer degradation (Bell & Oliver, 1992; Peet, 1997). Grasslands are generally poorly represented in protected-area systems (Rahmani, 1988, 1992; Eames, 1997; Baral, 1998, Buckton et al., 1999). Furthermore, most grassland patches are now small and isolated, and the populations of this species are thus susceptible to local extinction; moreover, many regions within its range are prone to political instability, and so long-term protection of several sites cannot be guaranteed (Narayan, 1992, 1995). As so little is known of the whereabouts of the species during the non-breeding season, the protected-area coverage may be insufficient during this period (Narayan, 1995).

Expansion of agriculture, uncontrolled multiplication of free ranging livestock, inappropriate grass cutting and ill-managed burning practices have always being the biggest threat to the existence of grasslands. Alteration of open grasslands into tree plantations without any scientific perception is also a major threat to the survival of the Bengal Florican. Opening up of grasslands before the commencement of the breeding season is one of the major requirements of florican habitats. Moreover, conservation measures are difficult to implement in Indian protected areas, given the “meagre strength of Forest Department staff”, poor infrastructural facilities, lack of funding and lack of training (Choudhury, 1995b). In addition, the staff are over-aged due to non-recruitment of fresh staff members, and this is a great hurdle in implementing conservation and protection efforts. Management practices often fail to consider the ecological requirements of the species, and such oversight may lead to local extinctions in several cases (Javed, 1999). Indiscriminate burning of grass in the dry season every year by the frontline staff is the most prominent example of unscientific management. Massive areas of all grasslands are burnt once or twice a year in the name of ‘tradition, clearing dry

grass, promoting fresh growth of grass, or improving visibility', eventually causing degradation of the grasslands over a long period.

4. Study area

The present work was carried out in the *terai* grasslands of northern Uttar Pradesh, mainly in Dudhwa, in Lakhimpur District, and adjoining areas such as Kishanpur WLS. A few other potential sites, namely Pilibhit, Lagga-Bagga and Katarniaghat, were also covered under this project. Dudhwa NP, in Uttar Pradesh, India contains one of the best protected areas of subtropical tall grassland, locally called *terai* grassland.

4.1. Dudhwa National Park

The survey was carried out in Dudhwa Tiger Reserve, comprising Dudhwa National Park and Kishanpur WLS, with an area of 883.73 km². The park is located on the Indo-Nepal border, in Lakhimpur-Kheri District (Fig 3.2), between latitudes 28° 18' N and 28° 42' N and longitudes 80° 28' E and 80° 57' E. The area of the national park is 490.29 km². The park has a buffer area of reserved forests on the northern (124.01 km²) and southern (66 km²) sides. Both the park and the buffer zone were once part of North Kheri Forest Division. They were carved out and declared a national park in 1977 (De, 2001). From mosaic grasslands and dense Sal *Shorea robusta* forests to swampy marshes, the terrain of the area is as diverse as the wildlife it harbours. While the northern boundary of the park lies along the Indo-Nepal border, the Suheli River lies along the southern boundary. Apart from the Tiger, the flagship species of the park, Dudhwa NP is home to the Swamp Deer, Hog Deer *Axis porcinus*, Spotted Deer *Axis axis*, Barking Deer *Muntiacus muntjac* and Sambar *Cervus unicolor*. It is also the home of two critically endangered species, the Hispid Hare and the Bengal Florican. The Great Indian One-horned Rhinoceros was successfully reintroduced in 1984.

4.2. Katarniaghat Wildlife Sanctuary

The Katarniaghat WLS covers an area of 400.6 km² in the *terai* of Bahraich District. In 1987, it was brought under the purview of Project Tiger, and together with Kishanpur WLS and Dudhwa NP, it forms the Dudhwa Tiger Reserve. The Katarniaghat forest provides strategic connectivity between the tiger habitats of Dudhwa and Kishanpur, in India, and Bardia National Park, in Nepal. Its fragile *terai* ecosystem comprises a mosaic of Sal and Teak forests, lush grasslands, numerous swamps and wetlands. It is home to a number of endangered species including the Bengal Florican.

4.3 Kishanpur Wildlife Sanctuary

Kishanpur WLS straddles Lakhimpur and Shahjehanpur districts. It lies between latitudes 28° 14' N and 28° 30' N and longitudes 80° 18' E and 80° 30' E and covers an area of 203.41 km². These two protected areas constitute the Tiger reserve though continuous forest tracts. These two protected areas are two independent large blocks, lying about 15 km apart on either side of the Sharda River. The intervening land is largely rural, with vast stretches where agriculture is practiced.

4.4. Pilibhit Reserve Forest

Pilibhit RF, one of India's 41 Tiger reserves under Project Tiger, is situated along the India-Nepal border, in the foothills of the Himalaya and the plains of the *terai*, in the north-western part of Uttar Pradesh. It falls between latitudes 28° 41' 31.2" N and 79° 51' 10.8" E, in Pilibhit District. The north-eastern boundary of the reserve is the Sharda River (Nepali: Mahakali River), which defines the Indo-Nepal border, while the south-west boundary is marked by the Sharada River and the Khakra River. The area of the core zone of the Tiger reserve is 1089 km², and area of the buffer zone is 627 km². The elevation ranges from 168 to 175 m above MSL. The forests and grasslands of the reserve constitute habitat for over 127 animals, 556 bird species and 2100 flowering plants. A large number of rare and threatened species, including the Tiger, Leopard, Swamp Deer, Hog Deer, Barking Deer, Hispid Hare and Bengal Florican, are present.

All these study sites fall within the TAL, which extends from the Yamuna River, in the west, to Valmiki Tiger Reserve, in the east. The entire landscape consists of the Shivalik Hills, the adjoining *bhabar* areas and the *terai* plains. The *terai* (“moist land”) is a narrow belt of marshy grasslands, savannahs and forests at the base of the Himalayan range in India, Nepal and Bhutan, from the Yamuna River, in the west, to the Brahmaputra River, in the east. According to the biogeographical classification of Rodgers and Panwar (1988), the area of the reserve falls within the Terai-Bhabar Biogeographic Subdivision of the Upper Gangetic Plains (7a) Biogeographic Province. A high water table, annual flooding and the synergistic influence of deliberate annual grassland fires characterize the *terai* tract (Mathur, 2000). Once the *terai* represented a vast expanse of wilderness or a lush belt of green vegetation comprising mainly moist deciduous forests dominated by the valuable Sal (*Shorea robusta*), interspersed with tall grasslands and numerous swamps.

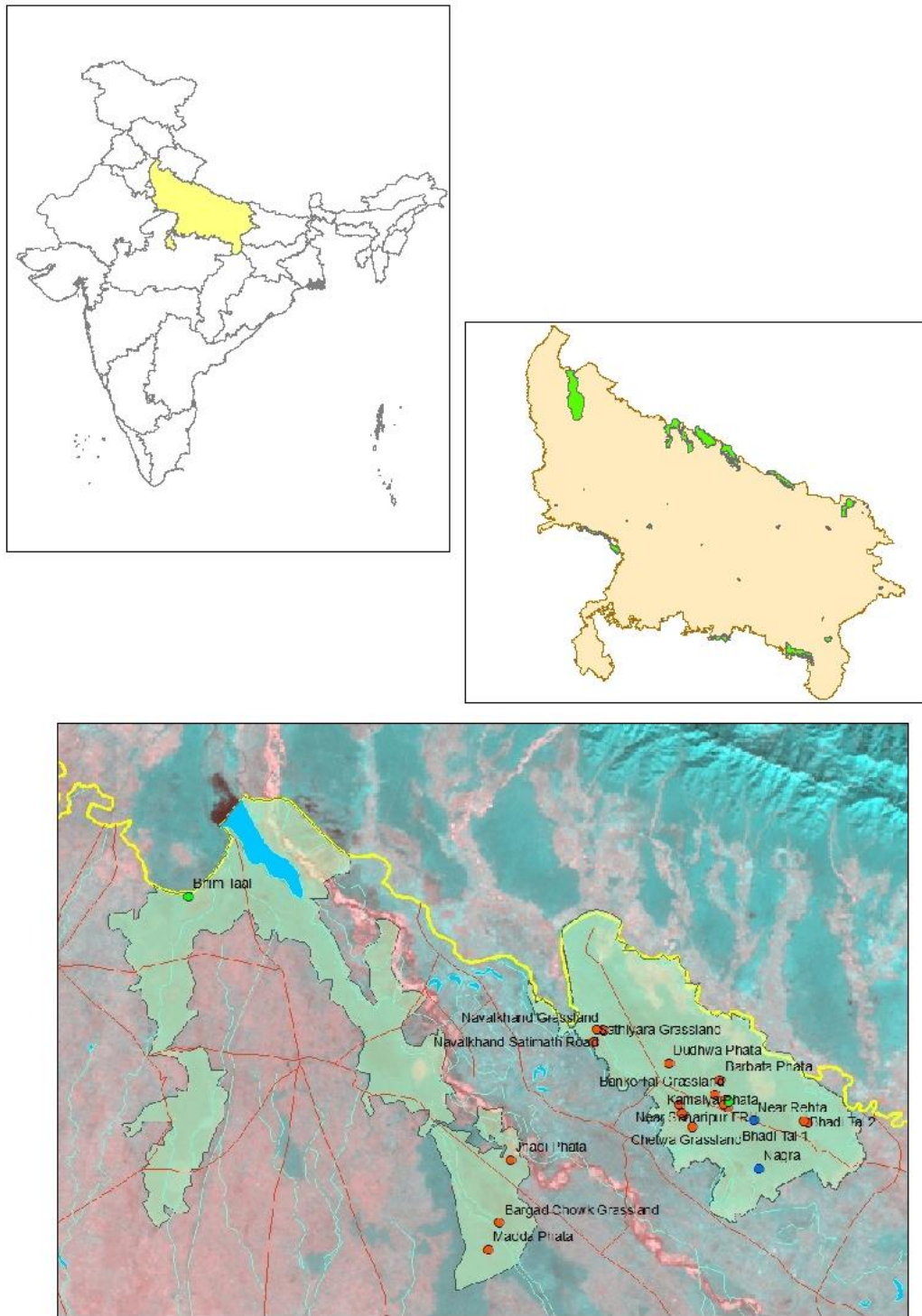


Fig. 3.2: Dudhwa NP (top) and Kishanpur WLS (below).

4.5. Intensive study site: Dudhwa National Park

The park is a vast alluvial plain, the *doab* of the Mohana and Soheli rivers. The general slope of the area is from north-west to south-east. The altitude ranges from 182 m, in the extreme north, to 150 m, in the farthest south-eastern part, above MSL. There are three distinct seasons in Dudhwa: winter (October to early March), summer (mid-March to mid-June) and the monsoon (mid-June to October). The rainy season generally begins in the middle of June and lasts up to September. The total annual rainfall is 1500 mm, and the humidity is 90%. The temperature ranges between a minimum of 9.1°C, in winter, and a maximum of up to 40–45°C, in summer.

According to Champion and Seth's (1968) revised classification, the forest types of Dudhwa Tiger Reserve can be classified as Northern Tropical Semi Evergreen Forests, Northern Indian Moist Deciduous Forests, Tropical Seasonal Swamp Forests and Northern Tropical Dry Deciduous Forests. The vegetation is chiefly of the moist deciduous type and is dominated by Sal (*Shorea robusta*). Typical of *terai*, these forests are interspersed with tracts of low-lying grasslands that tend to get flooded during the monsoons. The park and the buffer areas have plantations of varied species such as Teak (*Tectona grandis*), Mulberry (*Morus alba*), Paper Mulberry (*Braussonetia papyrifera*), Sisham (*Dalbergia sissoo*), Khair (*Acacia catechu*), Simul (*Bombax ceiba*) and Eucalyptus. These plantations have mostly been unsuccessful, leaving behind scattered clusters of trees in varying densities.

The grasslands occupy about 120 km² of the park. These are dominated by the following grass species: *Arundo donax*, *Phragmites karka*, *Narenga porphyrocoma*, *Desmostachya bipinnata*, *Bothriochloa pertusa*, *Saccharum spontaneum*, *S. munja*, *Imperata cylindrica*, *Heteropogon contortus*, *Themeda arundinacea*, *Cymbopogon martini*, *Vetiveria zizanoides*, *Typha elephantina* and *Cynodon dactylon*.

The reserve has a vast and varied heritage in its fauna. The innumerable large and small *taals*, rivers and *nalas*, vast grasslands, densely forested areas, open woodlands and mixed forests provide a unique admixture of shelter, food and habitat conditions for wildlife. There are 47 species of mammal found here, of which 12 are listed in Schedule I of the Wildlife (Protection) Act, namely the Tiger, Asiatic Elephant, Leopard, Leopard Cat, Sloth Bear, Swamp Deer, Hispid Hare, Fishing Cat, Pangolin, Ratel, Giant Flying Squirrel and the reintroduced One Horned Rhinoceros. There are 450 species of bird, of which nine species are endangered and are listed in Schedule I of the Wildlife (Protection) Act. Ten species of amphibian and 79 species of fish have been recorded.

5. Methods

5.1 Status of Bengal Florican

5.1.1 Area search method

The traditional area search method was used to locate florican leks in Uttar Pradesh (Sankaran & Rahmani, 1986; Manakadan & Rahmani, 1986). Areas with potential breeding habitats were visited during the breeding season, when displaying territorial males are most visible. Floricans are very territorial during the breeding season (Ali & Rahmani, 1982–1984, Sankaran & Rahmani, 1986; Manakadan & Rahmani, 1986), and so different display sites were assumed to be territories of different males. As females are more difficult to locate, the population estimates were based on the assumption of an equal sex ratio. The survey was conducted mostly in the morning and evening, when florican display the most. Observations were made through a pair of 8 × 42 binoculars from the top of a vehicle or from watch towers. The number of floricans seen, their sexes, activity, time, weather, condition of the habitat, time spent in each area and distance from the road were recorded.

In Nepal floricans have been observed in agricultural fields (Inskipp & Collar, 1984), and a few floricans use an agricultural field, i.e., Koklabari Seed Farm, as their breeding ground (Sharma, 2009) near Manas NP. Therefore, attempts were made to survey agriculture fields around potential habitats of the florican in the state. Moreover, a questionnaire survey was carried out with the help of the forest department and the villagers in the fringe areas of the grasslands. Bengal Florican posters were used during the survey. Revenue grassland areas or seed farm areas were also searched and visited.

5.1.2 Occupancy model using distance sampling

Grasslands were surveyed for bengal floricans (from March to the end of May i.e. during the peak Bengal Florican breeding season) by halting the survey vehicle at all available sites along the road that were on the periphery of the grassland being surveyed (point count method) and the researchers involved have surveyed the grassland from the roof of the vehicle using binoculars (Hawk Brand). The principle assumption of this survey was that any male florican present in the grassland being surveyed would undertake flight displays for the purpose of attracting females and in doing so they would become visible to the researchers for the purpose of collecting data on the number of males present in the surveyed areas. Since the average sighting distance of displaying floricans was 300m, therefore, the distance between two sampling points were kept at 600 m interval. Further, assuming an equal sex ratio, the total population would be considered to be twice the number of males obtained as the final result of the data analysis. Since the female does not display and the chances of finding a female were very low, the survey was undertaken for the purpose of undertaking a count of the males . The following data were collected during the survey, the GPS locations of the site the researchers surveyed from, time taken by the survey, time of initiation and end of the survey, dominant vegetation and it's average height as well as the bearing of the florican (when sighted) and the distance to the florican taken from a rangefinder (so as to be able to project the GPS coordinates of the florican's territory). This survey was

carried out for an average of 6 hours (divided into 3 replicates) for 44 separately named and compartmentalized grasslands in 4 protected areas namely, Dudhwa NP, Pilibhit Tiger Reserve, Kishanpur WLS and Katarniaghat Wildlife Sanctuary. Suhelwa Wildlife Sanctuary was not surveyed as forest department records showed that the area did not have any grasslands large enough to hold Bengal floricans. Sohagi Barwa Wildlife Sanctuary was also survey but dropped later due to high degradation of grasslands there that was unfit for Bengal floricans. Further, there was no floricans found in Katarniaghat Wildlife Sanctuary in last two decades, Katarniaghat has been left out of the data analysis as there is no evidence that there are floricans in the area.

5.1.3 Data analysis for population estimation

The major grasslands in the three protected areas (Dudhwa NP, Pilibhit Tiger Reserve and Kishanpur WLS) were classified visually using Google Earth and delineated using polygons. The grasslands were classified visually as the researchers had visited all the major grasslands and had access to maps from the forest department in which the grasslands were delineated. Moreover, the grasslands had different species assemblages, and computer-based classifications of the grasslands were not very accurate. Grasslands that were named and compartmentalized differently (for administrative purposes) but that bordered each other or were partially united were considered as single unified grassland polygons for the purposes of analysis. Grasslands located on the periphery of protected areas and thus subject to grazing pressure and encroachment-related disturbances from the surrounding human populace were excluded. These polygons were converted to a shape file format for use in ArcGIS 9.3. The GPS locations of the stationary viewpoints used for the survey were imported into ArcGIS 9.3, and buffers of a radius of 300 m were created for each of these viewpoints (as through our experience in the field we were able to visually estimate this distance to be the average distance up to which a male florican can be clearly recognized and

identified as a florican with certainty during the short period of its display in the prevailing field conditions).

The area of overlap between the grassland polygons and the buffers was the area surveyed by the researchers (assuming an equal preference and uniform distribution of Bengal Floricans across undisturbed grasslands).

The data collected through the survey were analysed using the Presence 5.9 software package. A Royle repeat count model was run with three temporal replicates, with the time taken for the survey being taken as a sampling covariate and the area of the grassland covered by the researchers being taken as a detection covariate (this was done to account for differences in the area covered and the time durations of the survey in different grassland sites) (Royle, 2004, 2008).

The total number of individuals obtained using the statistical model (taking into account the detection probability and site occupancy of the individuals) for the extent of suitable habitat covered by the survey was then extrapolated to the total suitable grassland area (as obtained through the classification and delineation of suitable grassland habitats) to derive the total population of male individuals present in the three protected areas. Under the assumption of an equal sex ratio, the number of males multiplied by 2 will yield the total population estimate. The number of floricans obtained as secondary information was not used in the analysis.

5.2 Habitat parameters

During the survey, the status of the breeding habitats was also assessed. The assessment followed the methods of Sankaran and Rahmani (1986) and Manakadan and Rahmani (1986). Vegetation surveys were carried out in circular plots of radius 50 m laid randomly in each potential grassland patch in the pre-breeding season and in the peak breeding season and the results were compared later. The vegetation inside the territories will also be compared with the vegetation of non-

territorial areas. The number of vegetation plots laid in each grassland patch was based on the size (area) of the grassland patch. The number of grass species, number of other associated plant species, grass height and grass cover were recorded in each plot. A herbarium was prepared for plant identification and for maintaining records.

Insects and other invertebrates were caught by sweeping with nets and kept in plastic containers containing alcohol and identified later at the laboratory of the Wildlife Institute of India. The other birds and animals sighted in and around the study area were also listed.

Factors affecting grassland habitats were also studied in relation to distance from human settlements, livestock population present in the territories and the presence of invasive plant species. The annual grass burning time was recorded in each grassland patch.

6.3 Breeding biology of the species

After a territorial male was located, its behaviour was observed, mainly using the focal animal sampling method (Altman, 1974), from the top of a vehicle. The territory was observed early in the morning (0630 to 1000 hours) and late in the evening (1630 to 1900 hours), when floricans are most active. The activities of the floricans were classified as resting or roosting, preening, locomotion, flying, foraging and walking, standing-display or flight-display. Some earlier studies have reported that female floricans are sighted less frequently compared with male floricans (Inskipp & Inskipp, 1983; Ali et al., 1985; Rahmani et al., 1991).

6. Results

6.1 Status survey

6.1.1 Dudhwa National Park

During the study period, five forest ranges of Dudhwa NP were surveyed. These are the Sathiyana, Dudhwa, South Sonaripur, North Sonaripur and Belraien ranges. The past florican records were from three major places, as mentioned in Sankaran and Rahmani (1987–1989) but a fourth florican site was identified in Belraien. An intensive survey were carried out on the basis of past records around Sathiyana. The areas surveyed were (1) the area around Sathiyana FRH, (2) the Salukapur Rhino enclosure area, in South Sonaripur, (3) the area around Sonaripur FRH and some patches in North Sonaripur Range, and (4) Bhadi *taal* and a few small patches near Kila Forest Rest House. We refer to these four areas as Sathiyana, Salukapur, Sonaripur and Belraien. A total of 23 potential grassland sites were identified in Dudhwa before the starting breeding season of florican.

Table 6.1. List of potential grasslands of Bengal Florican in Uttar Pradesh that were monitored.

Sl. No.	Name of Grassland	Area
1	Bhadi Tal	Dudhwa cluster
2	Billy Arjun Singh	Dudhwa cluster
3	Chanpara	Dudhwa cluster
4	Grassland 7	Dudhwa cluster
5	Barua Gul	Dudhwa cluster
6	Kakraha	Dudhwa cluster
7	Madraiya	Dudhwa cluster
8	Sonaripur Main	Dudhwa cluster
9	Sonaripur Lesser	Dudhwa cluster
10	Chandan Chowki	Dudhwa cluster
11	Bar Fanta Road 64	Dudhwa cluster
12	Grassland 4	Dudhwa cluster
13	Banke Tal	Dudhwa cluster
14	Sarotha	Dudhwa cluster

Sl. No.	Name of Grassland	Area
15	Iron Machan	Dudhwa cluster
16	Chapra	Dudhwa cluster
17	Sonaripur b	Dudhwa cluster
18	Kila	Dudhwa cluster
19	Nagra	Dudhwa cluster
20	Dud 7	Dudhwa cluster
21	Sonaripur Belraien Road	Dudhwa cluster
22	Nan Tal	Dudhwa cluster
23	Saheli Baba Majr	Dudhwa cluster
24	Babaniah	Dudhwa cluster
25	Bhainsalot	Dudhwa cluster
26	Gahi	Dudhwa cluster
27	Ghantalwa	Dudhwa cluster
28	GI 5	Dudhwa cluster
29	Katarniaghat FRH	Katarniaghat cluster
30	Khajwa	Katarniaghat cluster
31	Nainiha	Katarniaghat cluster
32	Ruia	Katarniaghat cluster
33	Bargad Chowki	Kishanpur cluster
34	Chaltua	Kishanpur cluster
35	Gulrahi	Kishanpur cluster
36	Jhadi Tal adjoining patch	Kishanpur cluster
37	Marha	Pilibhit cluster
38	Simal	Pilibhit cluster
39	Bhimal	Pilibhit cluster
40	Compt 96	Pilibhit cluster
41	Compt 98 + 58	Pilibhit cluster
42	Compt 105	Pilibhit cluster
43	Compt 106	Pilibhit cluster
44	Mainakot	Pilibhit cluster

6.1.1.1 Sonaripur

In Uttar Pradesh, the breeding season of the Bengal Florican starts in February and ends at the end of July. Every potential grassland patch was visited in the morning and the next day in the evening to count the total number of displaying male floricans in the park. On 26 March 2012, the first male florican was sighted in the grassland situated between Sonaripur FRH and Sonaripur Railway Station at 1730 hours. And the first flight-display was recorded on 6 April 2012. All the other nearby grass patches were scanned thoroughly for 2 months, but there was no other record of floricans from the place. Subsequently three birds were sighted here in 2013 and four floricans were sighted here in 2014. Although in general the Bengal Floricans showed very strong site fidelity with regard to the displaying territories in these grasslands, two territories that were used by the birds in 2013 were abandoned by them in 2014.

6.1.1.2 Salukapur

The grassland patches inside Salukapur Rhino enclosure were better protected than any other grasslands in Dudhwa. Grass burning in the enclosure was a little delayed compared with the other patches because most of the grasslands are located in lowland area and will not burn properly if the grasses have not dried well. The Rhino enclosure has habitats that are suitable for floricans, i.e., short and open grassland patches mostly dominated by *Imperata cylindrical*. In 2012, many visits were made on foot/elephant back/vehicle, but not even one individual was recorded. But in 2014, three floricans were sighted, and there might have been more floricans in this grassland that might have been missed because the grass was very tall.

6.1.1.3 Sathiyana

Navalkhand and Madraiya were the two major grasslands in Sathiyana, along with two other grasslands near Cheetal Chowraha and Chapra Phanta, near Sathiyana

FRH. There were no sightings of floricans in 2012, but four birds were sighted in 2013 in this grassland. In 2014, two birds were located by the frontline staff of the forest department, but the project team could not locate these floricans even after 12 days of continuous surveying.

6.1.1.4 Belraien

There are records of floricans from Bhadi Taal Phanta and Nagra Taal, near Kila FRH. So both these places, and Naan Taal and Churrela Phanta, were searched occasionally. Churrela Phanta had a highly degraded grassland habitat and was not suitable for floricans any more. Bhadi Taal Phanta and Nagra Taal still have good habitats, but floricans were not present. The only florican found in Belraien was found 800 m from Kila FRH, i.e., in Naan Taal Phanta. This grassland was too disturbed by the local livestock and the people who had settled in the villages at the boundary of the park.

Table 6.1. List of grasslands surveyed in Dudhwa NP, with GPS locations and past and present records of floricans

Sl. No.	Name of Grassland	Latitude (°N)	Longitude (°E)	Past Record	Present Survey
1	Kakraha	28.4506	80.67375	Yes	No
2	Kamaiyan	28.4378	80.66912	Yes	No
3	Base Camp	28.4603	80.67052	Yes	No
4	Mini Fence	28.4383	80.67416	Yes	No
5	Chetwa Road	28.43502	80.68683	Yes	No
6	Naan Taal	28.3667	80.80166	No	Yes
7	Nagra	28.38264	80.78280	No	No
8	Churrela	28.40961	80.83224	No	No
9	Bhadi Taal	28.44158	80.844	Yes	No

Sl. No.	Name of Grassland	Latitude (°N)	Longitude (°E)	Past Record	Present Survey
10	Near Rehta	28.4416	80.77491	No	Yes
11	Sonaripur Belraien road	28.4549	80.7437	Yes	No
12	Sonaripur FRH	28.4582	80.73644	Yes	No
13	S D Singh road	28.44769	80.73575	Yes	No
14	Sonaripur railway station	28.46364	80.73972	Yes	Yes
15	Banke Tal (Ring Road)	28.47826	80.72245	Yes	No
16	Road no. 64	28.49059	80.72659	Yes	No
17	Sarota Phanta	28.50933	80.65535	No	No
18	Madraiya Phanta	28.49173	80.58865	No	No
19	Tediya Phanta	28.52357	80.56207	Yes	No
20	Cheetal Chowraha	28.53438	80.56729	Yes	No
21	Chapra Phanta	28.53374	80.55463	Yes	No
22	Satimath Phanta	28.546	80.54549	No	No
23	Naval Khand Phanta	20.54718	80.56026	Yes	No

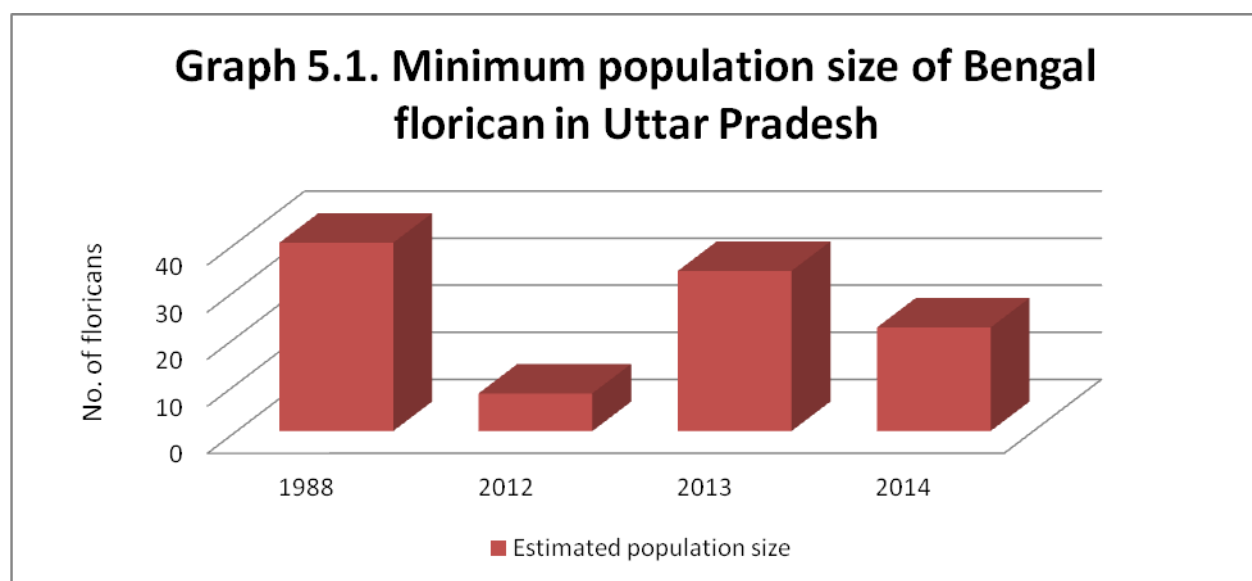


Table 6.2. Number of Bengal Floricans in Uttar Pradesh (2012–2014) based on area search method

Sl. No.	Place	No. of Male Floricans Sighted in 1988 (Javed & Rahmani, 1998)	No. of Male Floricans Sighted in 2000–2001 (Kumar, 2013)	No. of Male Floricans Sighted in 2012	No. of Male Floricans Sighted in 2013	No. of Male Floricans Sighted in 2014	Estimated Population of Bengal Floricans in 2014
1	Dudhwa NP	19 (40)*	33 (66)	2 (4)	12 (24)	7 (14)	14
2	Katarniaghat WLS	0	-	0	0	0	0
3	Kishanpur WLS	0	3 (6)	0	1 (2)	0	0
4	Pilibhit RF	0	-	1 (2)	4 (8)	4 (8)	8
5	Lagga-Bagga	0	-	0	0	0	0
	Total	40	72	8	34	22	22

* Estimated minimum population size (with 1:1 male:female ratio).

6.1.2 Kishanpur Wildlife Sanctuary

In Kishanpur, seven grasslands were surveyed at 7 day intervals during March–April. After the grass burning, Jhadi Taal had a good habitat for the Bengal Florican and Barasingha. Floricans have been recorded in the past at Marha Phanta, Jhadi and Badgad Chowki (near the bridge on the Ull River), but no florican was sighted at these places in 2012 and 2014. A single male was located in 2013 in this sanctuary.

Table 6.3. List of grasslands surveyed in Kishnapur WLS, with GPS locations and past and present records of Floricans

Sl. No.	Name of the Grassland		Latitude (°N)	Longitude (°E)	Past Records	Present Survey
1	Chaltua Phanta		28.31839	80.39211	No	No
2	Marha Phanta		28.28221	80.41353	Yes	No
3	Jhadi Taal		28.39423	80.43198	Yes	No
4	Kishanpur Phanta	FRH	28.38832	80.41808	No	No
5	Simal Phanta		28.3789	80.4106	No	No
6	Taar Kothi		28.370167	80.380194	No	No
7	Ull River Chowki)	(Bargad	28.313853	80.424469	Yes	No

6.1.3 Pilibhit Reserve Forest and Lagga-Bagga

In 2012, Pilibhit was surveyed for a month, along with Lagga- Bagga, which is connected to Royal Suklaphanta Wildlife Reserve, in Nepal. Suklaphanta had a good number of floricans and huge grassland patches that are connected to the grasslands of Lagga-Bagga. So it was thought that Lagga-Bagga should also have some floricans. But at the end of the survey only one florican had been recorded, from Bhim Taal Phanta, in Mahof Range, of Pilibhit. The florican was an adult and was observed only in flight, once, and its territory was not found. But in 2013 and 2014, four floricans were sighted around the Bhim Taal Phanta grasslands.

Table 6.4. List of grasslands surveyed in Pilibhit RF and Lagga-Bagga, with GPS locations and past and present records of floricans

Sl. No.	Name of Grassland	Latitude (°N)	Longitude (°E)	Past Records	Present Survey
1	Bhim Taal	28.71674	79.99113	Yes	Yes
2	Compartment 96	28.74776	80.06448	No	No
3	Compartment 98	28.72699	80.06972	No	No
4	Compartment 58	28.72083	80.07260	No	No
5	Mainakot	28.70962	80.10136	No	No
6	Compartment 106	28.69817	80.02084	No	No
7	Compartment 107	28.69697	80.00168	No	No
8	Lagga-Bagga Pillar No. 27	28.78744	80.16262	No	No
9	Lagga-Bagga Pillar No. 25	28.80586	80.14653	No	No
10	Lagga-Bagga Pillar No. 26	28.80027	80.13554	No	No

6.1.4 Andeshnagar Cattle Farm

Andeshnagar Cattle Farm is located at 28° 02' 56.11" N, 80° 43' 27.16" E. It has an area of 1300 acres. It is situated 12 km from Lakhimpur District. It is the second largest central cattle breeding centre in India. There was one florican sighting at the farm in 1987. But there were no floricans here as the habitat does not seem to be suitable, possibly due to disturbance.

6.1.5 Abundance of Bengal Floricans using Royle repeat counts

It was found that the present method of estimating the Bengal Florican. the area search method, always underestimated the population size if the survey was not carried out properly. During this study, five displaying territories were identified and the territories visited daily with stop over of 3 hours' of search. It was found that if we visited the territories of any males over a period of only 1–3 days, there was a 80% chance of missing birds. A minimum of 10–12 days of continuous visits to the grasslands was required to sight all five birds. The jumping display of the Bengal Florican is very brief, and the number of jumps is also small compared with the Lesser Florican. Therefore, a minimum of 10–12 days' continuous monitoring of an arena (a grassland in which a group of males display) is required to sight all the displaying males.

In this context, the Bengal florican population was also estimated using a new spatial model with a point count technique, the Royle repeat count model. Using this technique, we could intensively monitor the floricans' area of 11.65 km² in three protected areas (Dudhwa NP, Kishanpur WLS and Pilibhit Tiger Reserve) during the peak breeding season. These areas have been chosen randomly based on grids. Katarniaghat was excluded due to the absence of floricans here in the last 2 decades. The total number of male floricans in the 11.65 km² area as determined using the Royle repeat count model in Presence was 10.34, with a SE of 3.29 and a confidence interval of 5.54–19.28. The total occupancy was estimated at 0.318, with a SE of 0.083 and a confidence interval of 0.1856–0.5103. Therefore, it was estimated that the total area of suitable grassland available in Dudhwa NP, Kishanpur WLS and Pilibhit RF for breeding floricans was 112.750 km². On the basis of the assumption that the density of floricans in the entirety of this 112.750 km² area was the same as the density in the total area surveyed, the total number of male floricans in the entire suitable grassland area was estimated at 99.26 individuals. Assuming that there was an equal sex ratio in the landscape, the total population of floricans in Uttar Pradesh was about 198 individuals, these being

found exclusively in the grasslands of Pilibhit Tiger Reserve, Dudhwa NP and Kishanpur WLS.

6.2 Ecology of Bengal Florican habitat

6.2.1 Grassland vegetation community classification

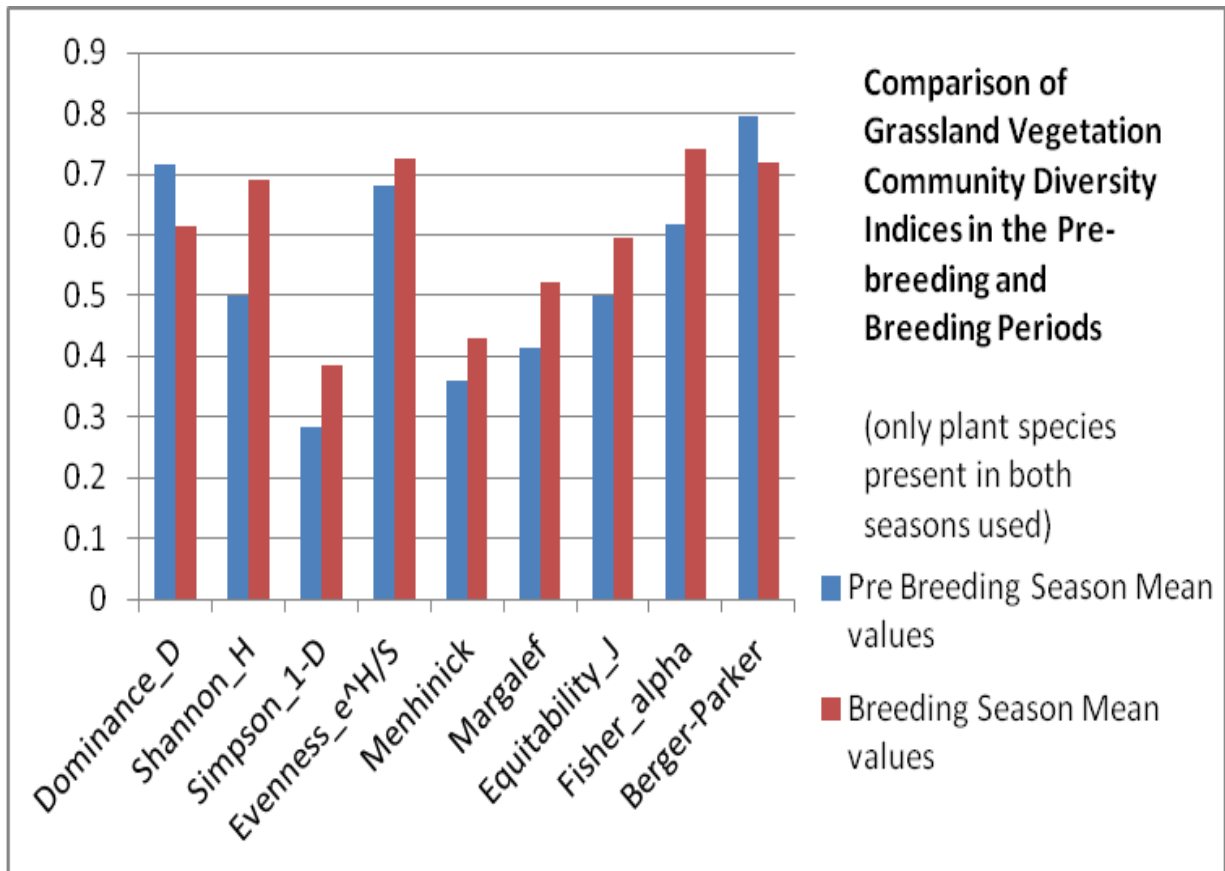
The vegetation survey was done in two seasons, the pre-breeding season (October–November) and the breeding season (March–April). A total of 25 potential grassland patches were intensively studied, of which 18 patches were from Dudhwa NP and the rest were from Kishanpur WLS. In the pre-breeding season, a total of 99 vegetation plots were laid, whereas in the breeding season 97 plots were sampled. The sampling plots in the pre-breeding and breeding seasons were in the same patches but not at the same locations. For both seasons' data, community classification was performed using the PC-ord 4.34 software package through cluster analysis and indicator species analysis.

6.2.2 Vegetation community during the pre-breeding and breeding seasons of the Bengal Florican

The grassland plant community showed significant differences in terms of its community structure and composition between the pre-breeding and breeding seasons. Twenty-six plant species were found during the vegetation sampling process (see Annexure 1), of which only 16 species were found in the grasslands during the pre-breeding season, whereas all 26 were found during the breeding season.

The number of taxa present per plot showed a very slight yet significant increase ($p = 0.005$), from 2.69 in the pre-breeding season to 3.1 in the breeding season. Interestingly, even though the number of taxa per plot increased in the breeding season, the population density of the plant community showed an overall significant ($p = 0.0007$) decrease per plot from an average of 117.41 individuals per plot to an average of 75.47 per plot. Thus although the species diversity increased

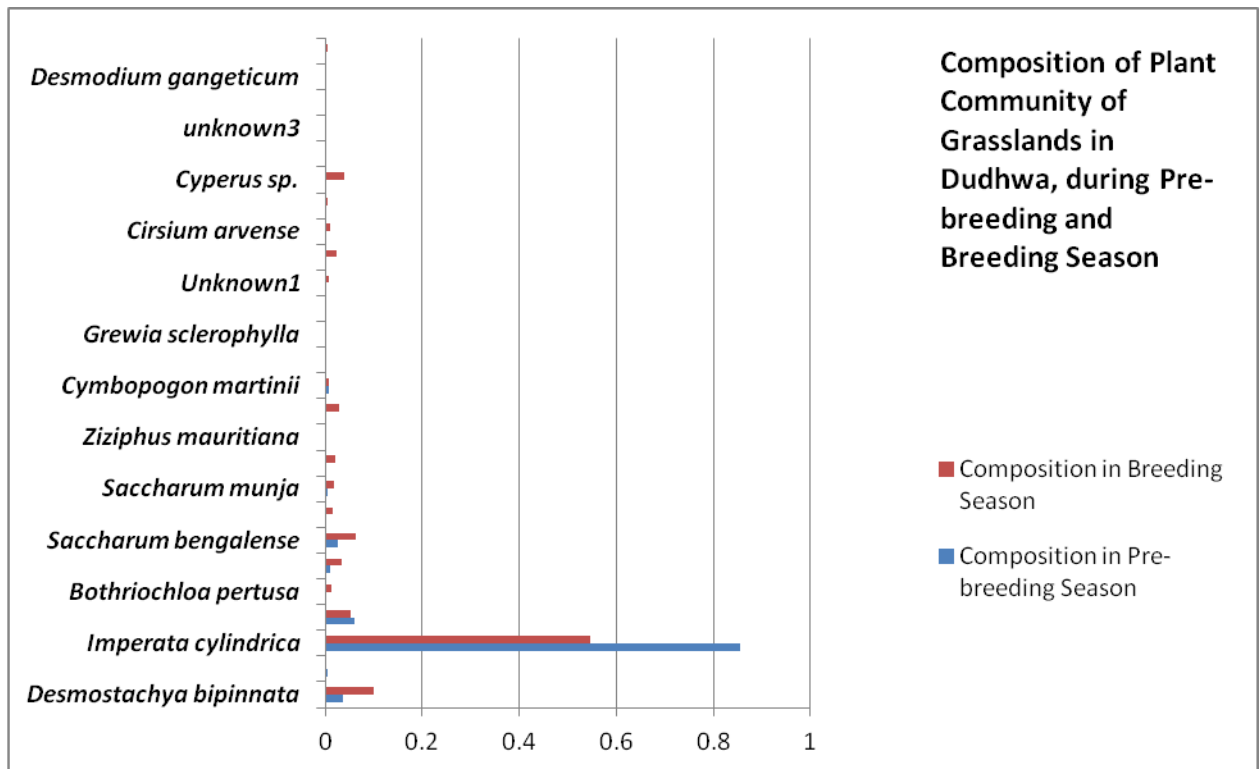
slightly during the breeding season from the pre-breeding season levels, the population density decreased.



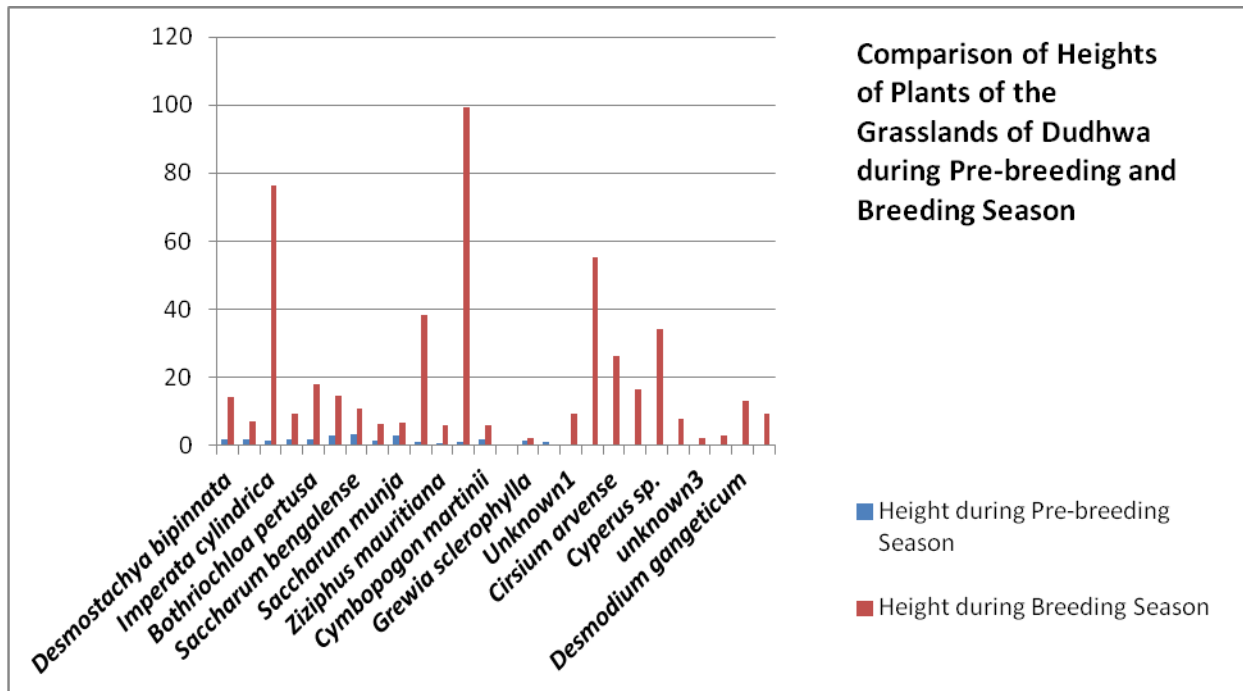
6.2.3 Differences in the composition of the plant community between pre-breeding and breeding seasons

During the pre-breeding season, a total of 16 plant species were found during the sampling, with the dominant species being *Imperata cylindrica*, *Saccharum spontaneum*, *Desmostachya bipinnata*, *Saccharum bengalense* and *Themeda gigantean*, which together made up 97.1% of the plant community (*I. cylindrica* alone made up 84.08% of the plant community). In the breeding season of the Bengal Florican, the share of these dominant species in the plant communities reduced greatly, with the addition of another 10 species not found during the sampling undertaken in the pre-breeding season. Thus even though the

aforementioned species remained reasonably dominant in the samples, their share in the structure and composition of the community fell (to 79.39%) with the increase of the share of species such as *Vetiveria zizanioides*, *Saccharum munja*, *Phragmites karka*, *Ziziphus mauritiana* *Cynodon dactylon* (to a combined 8.33%) (these species were present during the pre-breeding season but had a low share of the composition). Of the 10 additional species found during the breeding season, two species, *Capillipedium assimile* and *Cyperus* sp. had a significant share (6.2%).



6.2.4 Differences in the heights of the plants in the grassland community



During the breeding season, there was a tremendous increase in the heights of all the grassland plants that had been present in the pre-breeding season. The increase in height was particularly phenomenal for two dominant species, *I. cylindrica* (which registered an average increase in height of 61.5 times compared with the average height of the pre-breeding season) and *Phragmites karka* (which registered an average increase in height of 34.4 times the height of the pre-breeding season). The other species showed moderate increases in height, from 1.6 to 8.7 times the height of the pre-breeding season.

Table 6.6. Checklist of important plant species found in the grasslands of Dudhwa with indication of presence/absence during the pre-breeding and breeding seasons

Sl. No.	Scientific Name	Common Name	Pre-breeding Season	Breeding Season
1	<i>Desmostachya bipinnata</i>	Kush	+	+
2	<i>Apluda mutica</i>	Nerkati	+	+
3	<i>Imperata cylindrica</i>	Phunsh/Meyari	+	+
4	<i>Saccharum spontaneum</i>	Kansh	+	+
5	<i>Bothriochloa pertusa</i>	Sendha	+	+
6	<i>Themeda gigantea</i>	Ulla	+	+
7	<i>Saccharum bengalense</i>	Tawar	+	+
8	<i>Vetiveria zizanioides</i>	Garder/Khash	+	+
9	<i>Saccharum munja</i>	Munj	+	+
10	<i>Phragmites karka</i>	Narkul	+	+
11	<i>Ziziphus mauritiana</i>	Ber	+	+
12	<i>Cynodon dactylon</i>	Doob	+	+
13	<i>Cymbopogon martinii</i>	Jarakush	+	+
14	<i>Fimbristylis dichotoma</i>	Pinefruit grass	+	+
15	<i>Grewia sclerophylla</i>	Bendu	+	+
16	<i>Dichanthium annulatum</i>	Baib	+	+
17	Unknown 1	Bhur	-	+
18	<i>Capillipedium assimile</i>	Bashi	-	+
19	<i>Cirsium arvense</i>	Kanta	-	+
20	<i>Ichnocarpus frutescens</i> Br.	Dudhi	-	+

Sl. No.	Scientific Name	Common Name	Pre-breeding Season	Breeding Season
21	<i>Cyperus</i> sp.	Bhadai	-	+
22	Unknown 2	Jungly dhanian	-	+
23	Unknown 3	Fern	-	+
24	Unknown 4	Ratashi	-	+
25	<i>Desmodium gangeticum</i>	Jungly urad	-	+
26	<i>Grewia asiatica</i>	Phalsa	-	+

6.2.5 Pre-breeding season

During the pre-breeding season, a total of 16 plant species were recorded (14 grass species and two herbaceous plant species) from 99 vegetation plots inside the potential grasslands of floricans. The vegetation plots laid in different areas were as follows:

Name of the Place	No. of Plots
Sathiyana	20
Sonaripur	18
Salukapur	29
Kishanpur WLS	32

Community 1: *Desmostachya bipinnata*–*Cymbopogon martinii*–*Saccharum bengalense*

This community was found in 44 plots having 15 species. Although the maximum numbers of individuals were contributed by *Imperata cylindrica* (4492 individuals),

Desmostachya bipinnata, with a density of 7.04/m² was the dominant species in the community and was highly associated with *Cymbopogon martini* and *Saccharum bengalense*. The important value index (IVI) for the community was 300. The species diversity value, 0.35, indicated that the species were not evenly distributed. *Saccharum spontaneum* had the maximum height, 1.5 m. The distribution of all the species in this community was contiguous, as calculated from the A/F ratio (Shameem, 2011).

Table 6.7. Densities, frequencies, IVI values and A/F ratios of different grasses in Community 1

Species	Density	Frequency	IVI	A/F Ratio
<i>Desmostachya bipinnata</i>	7.04	43.18	33.93	0.30
<i>Apluda mutica</i>	1.47	15.91	8.14	0.46
<i>Imperata cylindrica</i>	129.66	88.64	144.89	1.30
<i>Saccharum spontaneum</i>	7.88	45.45	32.70	0.30
<i>Bothriochloa pertusa</i>	0.49	6.82	4.12	0.83
<i>Themeda arundinacea</i>	0.46	4.55	3.48	1.76
<i>Saccharum narenga</i>	4.59	40.91	36.15	0.22
<i>Vetiveria zizanioides</i>	1.01	4.55	3.91	3.85
<i>Saccharum bengalense</i>	1.67	22.73	16.75	0.26
<i>Phragmites karka</i>	0.12	6.82	3.11	0.20
<i>Ziziphus mauritiana</i>	0.03	2.27	1.03	0.44
<i>Cynodon dactylon</i>	0.29	4.55	2.00	1.10
<i>Cymbopogon martinii</i>	1.96	9.09	5.81	1.87
<i>Fimbristylis dichotoma</i>	0.03	2.27	0.90	0.44
<i>Dicanthium annulatum</i>	0.43	4.55	3.08	1.65

Community 2: *Imperata cylindrica*–*Saccharum spontaneum*

Imperata cylindrica–*Saccharum spontaneum* was the second most dominant community in the grasslands of Dudhwa, with 40 vegetation plots. In this community, the population is constituted by 12 species, among which *Imperata cylindrica* has the highest density (149.80/m²) and frequency (77.50), followed by *Saccharum spontaneum*, with a density of 12/m² and a frequency of 50. The IVI value of *Imperata cylindrica* was 153.52, and the height was 0.96 m. The species diversity value of the community was 0.27. The A/F ration shows that all the species in the community were contiguously distributed.

Table 6.85. Densities, frequencies, IVI values and A/F ratios of different grasses in Community 2

Species	Density	Frequency	IVI	A/F Ratio
<i>Desmostachya bipinnata</i>	3.33	40.00	33.78	0.16
<i>Imperata cylindrica</i>	149.80	77.50	153.52	1.96
<i>Saccharum spontaneum</i>	12.00	50.00	46.75	0.38
<i>Bothriochloa pertusa</i>	0.03	2.50	1.31	0.40
<i>Themeda arundinacea</i>	2.25	15.00	16.29	0.79
<i>Saccharum narenga</i>	4.86	27.50	27.65	0.51
<i>Vetiveria zizanioides</i>	0.13	5.00	2.93	0.40
<i>Saccharum bengalense</i>	0.19	7.50	4.11	0.27
<i>Phragmites karka</i>	0.44	5.00	2.83	1.40
<i>Cynodon dactylon</i>	0.35	2.50	1.49	4.40
<i>Cymbopogon martinii</i>	0.76	7.50	5.30	1.07
<i>Dicanthium annulatum</i>	0.48	2.50	1.28	6.00

Community 3: *Themeda giganteae*.

This community had eight grass species in 12 vegetation plots. *Themeda arundinacea* had the highest density (4.55/m²) and frequency (83.33). *Apluda mutica* was the associated grass species in this community, with frequency 50. The IVI value of *Themeda arundinacea* was 80.15, and the height was 2.24 m. The distributions of *Apluda mutica*, *Themeda arundinacea*, *Phragmites karka* and *Grewia sclerophylla* were random, whereas the other species in the community were contiguously distributed.

Table 6.9. Densities, frequencies, IVI values and A/F ratios of different grasses in Community 3

Species	Density	Frequency	IVI	A/F Ratio
<i>Desmostachya bipinnata</i>	0.85	33.33	20.26	0.06
<i>Apluda mutica</i>	1.38	50.00	26.57	0.04
<i>Imperata cylindrica</i>	49.53	50.00	126.33	1.56
<i>Themeda arundinacea</i>	4.55	83.33	80.15	0.05
<i>Saccharum narenga</i>	1.59	41.67	26.23	0.07
<i>Phragmites karka</i>	0.11	16.67	5.59	0.03
<i>Cymbopogon martinii</i>	0.32	16.67	7.95	0.09
<i>Grewia sclerophylla</i>	0.11	16.67	6.25	0.03

6.1.1.2. Breeding season

In the breeding season, a total of 97 vegetation plots were laid, in which we found a total of 26 plant species. Seven herbaceous plant species were recorded in this season, along with three grass species that were not present in the pre-breeding season. Four different grass communities were found, in the vegetation plots, which were laid in 25 grassland patches. These communities were as follows:



Community

1: *Imperata cylindrica*–*Saccharum spontaneum*

The community was represented by 43 plots and having 17 plant species. The *Imperata cylindrica* dominates the community with the maximum density 115.30/m² and 100% frequency followed by *Saccharum spontaneum* 7.94/m² and

60.47%. *Imperata cylindrica* also had the maximum IVI value of 168.10. *Saccharum spontaneum* had the maximum height of 0.59m. The A/F ratio shows the contiguous distribution of all these species in the community.

Table 6.10. Densities, frequencies, IVI values and A/F ratios of different grasses in Community 1

Species	Density	Frequency	IVI	A/F Ratio
<i>Desmostachya bipinnata</i>	12.79	69.77	51.88	0.21
<i>Imperata cylindrica</i>	115.30	100.00	168.10	0.91
<i>Saccharum spontaneum</i>	7.94	60.47	37.40	0.17
<i>Themeda arundinacea</i>	0.35	6.98	4.57	0.57
<i>Saccharum narenga</i>	2.48	32.56	21.07	0.18
<i>Vetiveria zizanioides</i>	0.89	20.93	10.08	0.16
<i>Saccharum bengalense</i>	1.21	20.93	12.62	0.22
<i>Phragmites karka</i>	0.83	6.98	4.03	1.34
<i>Ziziphus mauritiana</i>	0.09	2.33	1.16	1.29
<i>Cynodon dactylon</i>	0.21	2.33	0.97	3.01
<i>Cymbopogon martinii</i>	0.30	11.63	4.20	0.17
<i>Grewia sclerophylla</i>	0.03	2.33	0.82	0.43
Unknown 1	1.18	11.63	5.29	0.69
<i>Ichnocarpus frutescens</i>	0.68	2.33	1.24	9.89
<i>Cyperus</i> sp.	0.53	2.33	1.26	7.74
<i>Desmodium gangeticum</i>	0.41	2.33	1.16	6.02
<i>Grewia asiatica</i>	0.09	2.33	1.16	1.29

Community 2: *Saccharum narenga*–*Capillipedium assimile*–*Cirsium arvense*

There were 14 species in 18 vegetation plots in the community, with the most dominant one being *Saccharum narenga*, with a density of 22.30/m² and frequency

of 100%, followed by *Capillipedium assimile* and *Cirsium arvense* having densities of 11.71/m² and 5.57/m², respectively, and both having a frequency of 16.67. *Saccharum narenga* had the highest IVI value, 152.80, and *Desmostachya bipinnata* had the maximum height, 1.66 m. The species distribution in this community was contiguous.

Table 6.11. Densities, frequencies, IVI values and A/F ratios of different grasses in Community 2

Species	Density	Frequency	IVI	A/F Ratio
<i>Desmostachya bipinnata</i>	2.47	27.78	20.67	0.25
<i>Apluda mutica</i>	0.49	5.56	4.01	1.26
<i>Imperata cylindrica</i>	2.61	16.67	15.49	0.74
<i>Saccharum spontaneum</i>	1.62	27.78	21.23	0.17
<i>Bothriochloa pertusa</i>	4.23	11.11	21.68	2.70
<i>Themeda arundinacea</i>	0.56	22.22	14.29	0.09
<i>Saccharum narenga</i>	22.30	100.00	152.80	0.18
<i>Vetiveria zizanioides</i>	0.07	5.56	2.61	0.18
<i>Saccharum bengalense</i>	0.14	5.56	3.81	0.36
Unknown 1	0.64	5.56	3.70	1.62
<i>Capillipedium assimile</i>	11.71	16.67	36.59	3.32
<i>Cirsium arvense</i>	5.57	16.67	21.29	1.58
<i>Ichnocarpus frutescens</i>	0.71	5.56	4.91	1.80
<i>Cyperus</i> sp.	0.64	5.56	3.94	1.62

Community 3: *Desmostachya bipinnata*–*Cyperus sp.*–*Saccharum bengalense*–*Cymbopogon martini*

This community was represented in 25 vegetation plots through 18 species, of which *Desmostachya bipinnata* was the most dominant species, with a density of 13.82/m², a frequency of 68% and an IVI value of 70.28, followed by *Cyperus sp.* (density 12.55/m²), *Saccharum bengalense* (density 4.37/m²) and *Cymbopogon martinii* (density 2.39/m²). *Desmostachya bipinnata* had the maximum height, 0.50 m. The distribution was contiguous for all the species.

Table 6.12. Densities, frequencies, IVI values and A/F ratios of different grasses in Community 3

Species	Density	Frequency	IVI	A/F Ratio
<i>Desmostachya bipinnata</i>	13.82	68.00	70.28	0.24
<i>Imperata cylindrica</i>	7.06	40.00	28.47	0.35
<i>Saccharum spontaneum</i>	3.76	44.00	27.05	0.15
<i>Bothriochloa pertusa</i>	1.47	20.00	11.23	0.29
<i>Saccharum narenga</i>	1.02	24.00	10.43	0.14
<i>Vetiveria zizanioides</i>	3.45	28.00	21.61	0.35
<i>Saccharum bengalense</i>	4.37	44.00	29.27	0.18
<i>Phragmites karka</i>	6.40	12.00	15.84	3.50
<i>Ziziphus mauritiana</i>	0.46	12.00	3.71	0.25
<i>Cynodon dactylon</i>	9.75	12.00	21.32	5.33
<i>Cymbopogon martinii</i>	2.39	28.00	13.04	0.24
<i>Grewia sclerophylla</i>	0.36	20.00	6.68	0.07
<i>Cyperus sp.</i>	12.55	32.00	37.46	0.96
Unknown 2	0.81	16.00	6.07	0.25
Unknown 3	0.10	12.00	3.07	0.06
Unknown 4	0.15	12.00	3.45	0.08
<i>Desmodium gangeticum</i>	0.61	12.00	3.99	0.33
<i>Grewia asiatica</i>	1.93	24.00	14.05	0.26

Community 4: *Themeda arundinacea*

The community had five grass species and one unknown plant species in 11 vegetation plots. *Themeda arundinacea* had the highest density (26.44/m²) and frequency (100%). *Themeda arundinacea* also had the highest IVI value and maximum height of 216.68 and 1.20 m, respectively. All the species were contiguously distributed, except *Saccharum narenga*, which was randomly distributed in the community.

Table 6.13. Densities, frequencies, IVI values and A/F ratios of different grasses in Community 4

Species	Density	Frequency	IVI	A/F Ratio
<i>Desmostachya bipinnata</i>	2.66	36.36	31.46	0.16
<i>Saccharum spontaneum</i>	0.46	18.18	11.15	0.11
<i>Themeda arundinacea</i>	26.44	100	216.68	0.17
<i>Saccharum narenga</i>	1.96	54.55	42.14	0.05
<i>Vetiveria zizanioides</i>	0.46	18.18	11.15	0.11
Unknown 1	0.81	18.18	10.83	0.19

One-way ANOVA was used on different parameters for the pre-breeding season to identify the factor causing the variations between the three[**four?**] grass communities. We found that the number of plant species and the total number of individuals of all those species across the three communities had a significant difference of $F(2, 96) = 5.42, P = 0.006$ and $F(2, 96) = 4.03, P = 0.02$, respectively. The heights of individuals of the grasses and the cover had no significant differences across the three communities.

Similarly, in the breeding season the numbers of species of grass in the four different communities were significantly different, $F(3, 93) = 8.57, P = 0.000044$. Also, the numbers of individuals of all the grass species, $F(3, 93) = 8.47, P = 0.000049$, and the cover of the grasses, $F(3, 93) = 6.08, P = 0.00079$, across the communities were significantly different. There was no significant difference in the heights of plant individuals in these communities.

Although the floricans found were few in number and constitute a small sample, certain differences between the habitat used by the floricans and the general available grassland were evident after statistical analysis. First, the most obvious difference between the grassland habitat used by the floricans and the general grassland area available was the number of species of plant in the two: nine species of plants were found in areas used by the floricans, out of the 29 species found in the total grassland area sampled. The plants found in the areas used by the floricans were *Desmostachya bipinnata*, *Imperata cylindrica*, *Saccharum spontaneum*, *Themeda arundinacea*, *Saccharum narenga*, *Vetiveria zizanioides*, *Grewia sclerophylla*, *Grewia asiatica* and an unidentified species.

Florican territories had much lower densities of plants (uneq.var. t-test $p = 0.033\%$) compared with the average grassland sample plot. Also a distinction could be observed in the field between areas used by the floricans for display and areas used for other purposes such as feeding and resting. A statistically significant difference was found in the density with regard to these two types of areas (uneq.var. t-test $p = 0.01$), with areas used for displays having a higher density of plants compared with areas used for other behaviours but not for displaying. No significant differences were found between the average height of the plants and the total area covered by the plants between the florican territories and the average grassland area sampled.

6.3 Behaviour

The floricans sighted at the Sonaripur grasslands were selected for focal sampling to study their various behavioural activity patterns. The florican territories were

mostly close to the road, where the grasses were short and open during the initial period of the breeding season, and so it was easy to locate these individuals even if they were not displaying. Only three sets of data (0630 to 1000 hours and 1630 to 1900 hours) in a day were collected at intervals of 7 days. Though the sample size was very small, some important activity changes were recorded.

The first activity data were collected 2 days after the arrival of the birds at the grassland. The males initially spent 52.32% of the time feeding, 35.10% in exploring the area within the territory and 12.58% standing. Later (after a week), the time spent in feeding (38.53%) and walking (44.04%) was approximately the same. The time spent in vigilance/looking out by standing in a place had increased up to 17.43%. After 15 days of establishing the display territories, the floricans spent 76.76% of the time walking, 15.49% feeding, 4.23% standing and 3.52% (the minimum) preening. Preening was not observed earlier. The special display behaviour was repeated 12 times during the day. Every day, in the morning, the males displayed at least twice by jumping, but this was observed more often in the evening (up to 10 displays). Therefore, the evening is better for counting floricans in the Dudhwa grasslands.

Some other behavioural patterns were also observed during this study. On 1 April 2012, in the morning, when observations were being made on a floricane, a Jackal was found just 50 m away from the bird. As soon as the Jackal went off the grassland, the floricane also left the patch and flew towards North Sonaripur Range. The same evening, the entire grassland patch was again scanned along with a few other nearby patches, but floricane was not found. The same evening, in North Sonaripur range, 3 km from this floricane territory, where the road goes to Rehta railway station, a new floricane was recorded in a small patch very close to the railway line. The next morning, the first floricane was found back in its territory, but the second individual found near the Rehta railway line the previous day was not present at its patch. After repeated visits to both the sites on the same day, it became clear that the same floricane was using both grasslands patches. The second

site was never used as a breeding ground because all the displays were made only at the first site. The activities observed at the second ground were only related to foraging.

6.4 Insect diversity and feeding ecology

As the floricans are omnivorous in nature, they feed on both plants and insects present inside their breeding areas. So, it was also important to record the insect species present in these habitats. The same sweeping technique was used to sample the insects and to prepare a list of the insects present in the grasslands of Dudhwa NP. Nine orders of the class Insecta were listed, and insects belonging to eight of these orders were identified up to family level. The insects belonging to the order Odonata were not identifiable due to the changes in the body colours of the specimens after treatment for preservation. The order Diptera had the highest number of families (4), followed by the Coleoptera (3), Araneae (3) and Hemiptera (3).



Table 6.14. List of insects collected from Dudhwa NP and Kishanpur WLS

Order	Family
Coleoptera	Curculionidae
	Coccinellidae
	Chrysomelidae
Araneae	Thomisidae
	Tetragnathidae
	Araneidae
Hemiptera	Reduviidae
	Jassidae
	Coreidae
Diptera	Asilidae
	Muscidae
	Drosophilidae
	Simuliidae
Hymenoptera	Formicidae
Lepidoptera	Nymphalidae
Mantodea	Mantidae
Orthoptera	Tettigonidae
	Acrididae

6.5 Questionnaire survey

A questionnaire survey was administered to the forest department staff at Dudhwa. The questionnaire was related to their sightings of Bengal Floricans inside the protected area and the frequency of sightings. We found that 76.66% of the staff had never seen a Bengal Florican in their life. The other 26.66% staffs gave details of their sightings in the past. None of the staff members had seen a florican recently. Two of the tourist guides in the park confirmed that they had had florican sightings at two places near Sonaripur the previous year.

Data were also collected through a questionnaire survey from 10 villages in and around Dudhwa NP and Kishanpur WLS about the florican presence outside the protected areas. Only one florican sighting from the croplands outside the park was recorded. This sighting was made during the rainy season.



6.6. Capacity building and conservation network

A one-day workshop titled “The Status Survey and Conservation of Bengal Florican” was conducted on 16 March 2012 to initiate a Bengal Florican conservation network and enhance capacity building among the local forest staff and local NGOs to protect the Bengal Florican and its habitats through exchange programmes, awareness and motivation. The workshop was held at the meeting hall of the Dudhwa Forest Complex. Around 30 forest staff members, including the Deputy Field Director, ACFs and Range Officers participated in the workshop. A poster was published and distributed to the field staff. A brief slide presentation on the identification of the Bengal Florican and its habitat and displaying behaviour was also made.

7. Discussion

According to Rahmani et al. (1990), floricans are sighted regularly at Dudhwa from early March. They report that in 1988, the first male florican sighting was made some time after the annual grass burning on 19 February and the first display of florican was recorded on 11 March. In 1989, a female florican was sighted on 27 February, and the first display flight was recorded on 1 March. During the present study, the first male florican was sighted on 26 March and the first display was recorded on 6 April. This temporal delay in the sighting of floricans can be attributed to human-induced disturbances or management practices. For last couple of years the grass burning period in the park is between February and March. Prior to burning, owing to the excessive height of the grass, the area is not suitable for floricans. And after burning it takes a few days for new grass to emerge and provide the required shelter for the floricans. So it is very important to burn the grass in time. It is recommended that the burning period not coincide with the peak activity period of the floricans.



The population of floricans in Uttar Pradesh, as determined using the area search method, varied between years from eight to 34 individuals. In 2012, the estimated population of floricans was eight individuals, but in 2013 it was about 34 individuals. In 2014 the estimated population was 22 individuals. The presence of floricans in Pilibhit RF and Kishanpur WLS during this study period is very

encouraging although the population of floricans in Dudhwa had declined compared with 1988.

However, using occupancy models and the distance sampling technique, specifically the Royle repeat count model, our estimate of the total population of floricans in the grasslands of Pilibhit Tiger Reserve, Dudhwa NP and Kishanpur WLS was about 198 individuals.

It was found that Bengal Floricans prefer a grassland with a specific grass composition for breeding. The most obvious difference between the grassland habitat used by the floricans and other grasslands was the species richness. Floricans preferred grasslands with the smallest number of species, but these needed to include *Desmostachya bipinnata*, *Imperata cylindrica*, *Saccharum spontaneum*, *Themeda gigantea*, *Saccharum bengalense*, *Vetiveria zizanioides*, *Grewia sclerophylla* and *Grewia asiatica*. In the grasslands that were avoided by floricans, there were 29 species of grass.

Similarly, florican territories had a much lower density of plants (uneq.var. t-test $p = 0.033\%$) compared with other grasslands in Uttar Pradesh. The density of grasses was greater in the florican display territories than in other grasslands (uneq.var. t-test $p = 0.01$). However, there were no significant differences in the height of plants between florican territories and non-territory areas of grasslands. Obviously the grass growth is largely determined by the monsoon and certain soil characteristics, which were more or less uniform in a grassland.

In the pre-breeding season of Bengal Floricans, all the potential grassland patches could be classified into three different communities dominated by *Desmostachya bipinnata*, *Imperata cylindrica* and *Themeda arundinacea*, respectively, whereas in the breeding season, four different communities were found. A separate community was formed that was dominated by *Saccharum narenga*.

It was observed that at the beginning of the breeding season, that the floricans spent the most time (52.32%) feeding in the grasslands as well as in the ecotone areas of the grasslands. Later, i.e. after 15 days, the males were observed investing almost equal times in feeding (38.53%) and movement (44.04%). The time spent in movement or searching increased to 76.76% when all the males started displaying in an arena.

The presence of Bengal Floricans in new areas such as Pilibhit RF and Kishanpur WLS is very encouraging although the floricans were unable to use the grasslands of Katarniaghat and Lagga-Bagga because they are degraded. Therefore, it is recommended that the grasslands of these two areas be restored and that the existing grasslands of Dudhwa NP, Pilibhet RF and Kishanpur WLS be protected, monitored and managed so that they are floricane-friendly.

This is the first time that Bengal Florican populations have been estimated using the Royle repeat count model or occupancy models with the distance sampling technique. We estimated that about 198 individuals occur in the grasslands of Pilibhit Tiger Reserve, NP and Kishanpur WLS.

This study also found that the traditional method of estimating Bengal Florican populations might be good for monitoring but always underestimates the population due to the elusive behaviour of this bird. Therefore, the new technique will be a better method. However, the traditional area search method will still be used for monitoring purposes as it is easy for the frontline staff of the forest department to follow it.

It has been proved that the behaviour of floricane also tends to change. When a male first arrives at its breeding ground, he spends most of his time in search of food. In the next stage, he explores his territory and the surrounding areas and settles down. In the last stage, which is the major one, it spends of the most time moving within the territory and attracting the female through the display.

8. Threats

8.1 Lack of national policy on grassland management in India

Due to an inadequate grassland conservation policy and management practices or a mind-set that assumes that grasslands are wastelands, many of the state-owned grasslands and village pasture lands of Uttar Pradesh have either been planted extensively or converted to other types of land use, including agriculture and urbanization. Several grasslands in the region have been converted into either woodlands or croplands. In addition, due to excess grazing, most of the remaining grasslands have also been degraded to the extent that even the top soil had been removed. Complete removal of grasses from these grasslands outside protected areas is not conducive for use by floricans.

8.2 Habitat loss

There are five clusters of potential florican grasslands in Uttar Pradesh. All these grasslands are believed to be still conducive for floricans. These include grasslands surveyed in 1988 (BNHS, 1988) Bengal Floricans were found only in three regions, Dudhwa NP, Kishanpur WLS and Pilibhit RF.



Floricans were not seen in two other potential habitats, Katarniaghat WLS and Lagga-Bagga, during 2012–2014. The other grasslands outside protected areas in Uttar Pradesh were highly degraded and were not conducive for Bengal Floricans. Floricans prefer a mosaic of pure but undisturbed grass patches with the previous year's grass to settle down in at the beginning of the breeding season. Changes in land-use pattern over the decades have resulted in a drastic decline of the grassland habitats in Uttar Pradesh. Many of these grasslands have been reclaimed for agriculture to meet the demands of the growing population. The ever-growing cattle population in the region has also caused overgrazing of the grassland habitats. The grasslands in Katarniaghat WLS, which was known to be one of important regions for floricans, have been degraded dramatically by overgrazing by domestic cattle. Because of the degradation in parts of Uttar Pradesh in the *terai* landscape, the grasslands either completely failed to attract floricans or attracted only a few individuals.

8.3 Plantations

It was observed that grasslands have wrongly been considered as wastelands and hence large-scale plantation has been carried out in many grasslands outside protected areas. Encroachment of woodlands into grasslands was also noticed in some parts of Dudhwa and Pilibhit Tiger reserves. Grasslands with plantations were avoided by the floricans as these birds prefer pure grasslands with a few trees here and there. Because of the plantations, several potential grasslands of floricans fail to attract these birds nowadays.

8.4 Pesticide pollution

The Bengal Florican is an omnivorous species. The food items of this florican include various plant parts and many types of invertebrate: grasshoppers, beetles, flying ants, hairy caterpillars, centipedes, worms, frogs, small lizards, crop shoots, leaves, herbs and berries. Insects form the large part of the diet of the Bengal Florican. The crop fields in the *terai* are known to be excellent breeding grounds for

insects. The use of pesticides in crop fields in Uttar Pradesh close to certain Bengal Florican habitats, especially in Katarniaghat WLS, may also threaten the floricans' health.

8.5 Poaching

Poaching does not seem to be a major threat as most of the present florican habitats are inside protected areas and are well protected. However, according to villagers, displaying male floricans are easy victims of hunting. Therefore, it is believed that the Bengal Floricans outside protected areas are highly exposed to poaching.



8.6 Loss of habitats inside protected areas

At present, Bengal Floricans occur only inside protected areas in Uttar Pradesh. Four protected areas (Dudhwa NP, Pilibhit Tiger Reserve, Kishanpur WLS and Katarniaghat WLS) have considerable numbers of grasslands that are potential habitats of floricans. There were sightings of floricans in only three of these four

protected areas during the period of this 3-year study. There were no sightings of floricans in Katarniaghat WLS, which is a cause of concern now. Over-grazing of grasslands in Katarniaghat WLS has degraded the habitats of floricans severely. It is important to restore some of grasslands in this protected area to attract floricans in the future. Dudhwa NP has the only grasslands in Uttar Pradesh that has had a considerable population of floricans in the last 3 decades, largely due to better protection. However, some of the protected grasslands in Dudhwa are also becoming unfit for floricans, largely because these grasslands are managed only for the Tiger and its prey species.

8.7 Existing conservation and management practices

The Bengal Florican is listed 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 four areas in Uttar Pradesh by declaring them as national parks or wildlife sanctuaries, but the focus is on the Tiger and the other major mammalian species here. At present, there are no exclusive conservation and management practices for Bengal Floricans.

9. Recommendations

9.1 Restoration of Bengal Florican habitats in Uttar Pradesh

Fewer than five protected areas (grasslands) exist exclusively conserving floricans in Uttar Pradesh. These include Dudhwa and Pilibhit Tiger reserves, where floricans have actually been seen in the last 3 years. There are two areas (Katarniaghat WLS and Lagga-Bagga RF) with potential grasslands that are conducive for floricans. Grasslands such as Marha Phanta, Jhadi and Badgad Chowki, in Kishanpur WLS, and the grasslands around the forest rest house at Katarniaghat WLS need to be restored to preventing grazing by domestic cattle. Although, having exclosures inside these protected areas is not advisable, better protection can be given to these four grasslands so that they recover and become conducive for floricans (see

Results section for preferred grass species). If necessary, plantation of grasses that are preferred by the floricans can be carried out in these grasslands, with better protection and monitoring mechanisms.

9.2 Management of invasive and woodland species

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

9.3 Florican-friendly land use pattern

Floricans prefer a mosaic of pure but undisturbed grass patches with the previous year's grass to settle down in at the beginning of the breeding season. In fact, the recent satellite study conducted by the BNHS has found that Bengal Floricans are resident in Pilibhit and are not migrating as was expected (Dr. A. Rahmani, pers. comm.). Therefore, it is recommended that a mosaic of old grasses be left during burning for floricans as well as other grassland wildlife. The use of pesticides in adjoining agricultural fields has been found to be detrimental for the survival of floricans. Therefore, local communities need to be advised about 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.



9.4 Florican-friendly grassland management in Uttar Pradesh

The Bengal Florican is the rarest bird of Uttar Pradesh. As the population in Dudhwa NP and Pilibhit RF may well be the last viable population remaining in the *terai* region of Uttar Pradesh, careful management of the grasslands of this region is of utmost importance. As the floricans start preparing for breeding by the middle of February, the grasslands that have been traditionally used by the Bengal Floricans must be burnt before the birds arrive. Ideally the important florican areas should be burnt over a period of a month, starting from the middle of January. It is also recommended that a mosaic of old grasses be left during burning for floricans as well as other grassland wildlife.

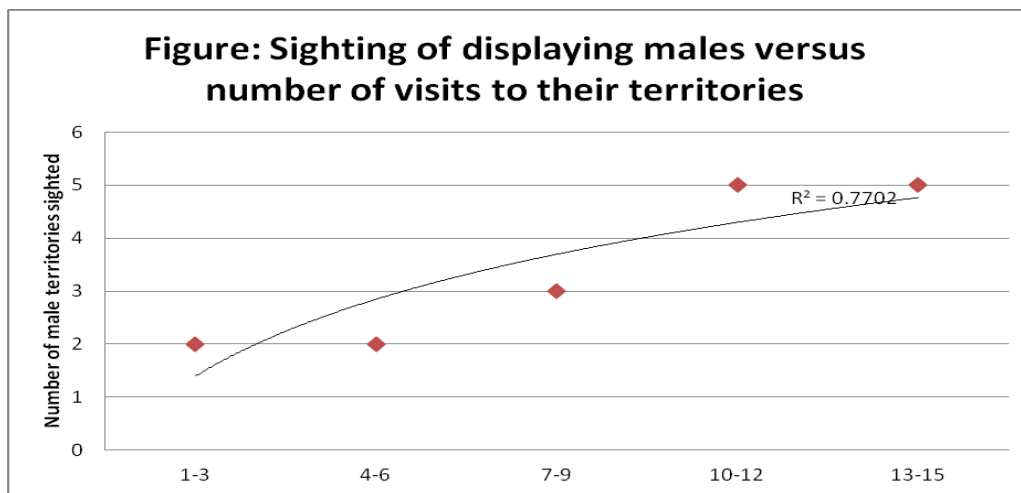
The forests and grasslands of Dudhwa NP were chiefly protected for conserving the Tiger, Rhino and Swamp Deer. Harrowing and sowing of seeds of succulent grasses to provide better grazing grounds for the herbivores, especially the Swamp Deer, was the practice in the park. If harrowing is to be done, it must be carried out within a week of burning of grass before most of the birds have started nesting, i.e. before the end of the first week of February.

Maintaining shorter grasslands (usually dominated by *I. cylindrica*), which are currently being replaced by tall grasslands or forests, needs to be considered,

particularly where these are used by the Bengal Florican. The management of grasslands has tended to concentrate on large threatened mammals such as the Tiger *Panthera tigris* and the Greater One Horned Rhinoceros *Rhinoceros unicornis* but needs to take into account other threatened taxa, including birds. The grassland management, including grass burning, should be planned in such a way that it does not coincide with the breeding activities of the birds.

9.5. Research and monitoring

The Bengal Florican, a species that very rare in Uttar Pradesh, is largely seen from February to April, when it breeds and the males display. Its population and range are decreasing at an alarming rate due to loss of breeding habitats. The breeding populations in Uttar Pradesh have declined sharply, but the occurrence of this species in new areas such as Pilibhit and Kishanpur WLS is welcome news for the state. However, the absence of floricans from another protected area, Katarniaghat, and the declining population in Dudhwa NP are not very encouraging. Therefore, it is important to understand the details of the ecological requirements of this species and to monitor the birds continuously, wherever they be.



1 Number of days visited continuously

It was found that the present method of estimating populations of Bengal Floricans using the area search method gives under-estimates if the survey is not carried out

properly. During this study, five displaying territories were identified and the territories visited daily for 3-hour searches. It was found that if we visited the territories of the males for only 1–3 days, there was a 80% of chance of missing birds. A minimum visit of 10–12 continuous days was required to sight all the five birds that used a grassland. The jumping display of Bengal Floricans is very brief, and the number of jumps is small compared with Lesser Floricans. Therefore, a minimum of 10–12 days' continuous monitoring of an arena (grassland in which a group of males display) is recommended to sight all the displaying males.

It is also suggested that certain grasslands in Dudhwa be monitored using CCTV cameras fixed at vantage points to study the displaying behaviour of males more accurately. This will also help perfect monitoring techniques. and the park authorities can also monitor the population.

9.6 Other recommendations

- There is an urgent need for trans-boundary collaboration between India and Nepal as Lagga-Bagga, of Pilibhit Forest division, is contiguous with Suklaphanta WLS, in Nepal. Both areas have good grasslands, and Suklaphanta WLS is known to have Bengal Floricans. There is a probability of there being Bengal Floricans in Lagga-Bagga. Therefore, it is proposed that these grasslands of Lagga-Bagga be managed to be florican-friendly.
- Ecotourism activities should be encouraged, and an awareness campaign should be conducted in the fringe villages. This will help minimize the use of pesticides in these regions.
- Mass awareness and sensitization towards grasslands and Bengal Floricans are required for not only the local people but also the frontline staff of the forest department. The target group should be especially those who have settled in or near protected areas and reserve forests. They should be informed of the importance and legal status of the Bengal Florican.

10. Abstract of significant findings

- Using the area search method, the population of floricans in Uttar Pradesh was determined as varying from eight to 34 individuals. In 2012, the estimated population of floricans was eight individuals, but in 2013 it was about 34 individuals and in 2014, the corresponding number was 22. The presence of floricans in Pilibhit RF and Kishanpur WLS during the period of this study is very encouraging although the population of floricans declined in Dudhwa NP compared with 1988.
- Using occupancy models and distance sampling technique, specifically the Royle repeat count model, we estimated the total population of floricans in the grasslands of Pilibhit Tiger Reserve, Dudhwa NP and Kishanpur WLS to be about 198 individuals.
- It was found that Bengal Florican prefer grasslands with a specific grass composition for breeding. The most obvious difference between the grassland habitat used by floricans and other grasslands is the species richness. Floricans prefer grasslands with the least number of species, but these should include *Desmostachya bipinnata*, *Imperata cylindrica*, *Saccharum spontaneum*, *Themeda gigantea*, *Saccharum bengalense*, *Vetiveria zizanioides*, *Grewia sclerophylla* and *Grewia asiatica*. In comparison, there were 29 different species of grass in other grasslands that were avoided by floricans.
- Similarly, the florican territories had a much lower density of plants (uneq.var. t-test $p = 0.033\%$) compared with other grasslands in Uttar Pradesh. The density of grasses was greater in the florican display territories than in the other parts of the grasslands (uneq.var. t-test $p = 0.01$). However, no significant differences were found between the heights of the plants in florican territories and non-territory areas of the grasslands. Obviously the

grass growth is largely determined by the monsoon and certain soil characteristics that were more or less uniform in the grasslands.

- In the pre-breeding season of the Bengal Floricans, all the potential grassland patches could be classified into three different communities dominated by *Desmostachya bipinnata*, *Imperata cylindrica* and *Themeda arundinacea*, respectively, whereas in the breeding season four different communities were found. A separate community was formed that was dominated by *Saccharum narenga*.
- It was observed that at the beginning of the breeding season the floricans spent the greatest time (52.32%) feeding in the grasslands and in the ecotone areas of the grasslands. Later, i.e. after 15 days, the males were observed investing almost equal times feeding (38.53%) and moving (44.04%). But the time spent in moving or searching increased to 76.76% when all the males started displaying in an arena.
- The presence of Bengal Floricans in new areas such as Pilibhit RF and Kishanpur WLS is very encouraging although floricans were unable to use the grasslands of Katarniaghat and Lagga-Bagga because these areas were degraded. Therefore, it is recommended that the grasslands of these two areas be restored and that the existing grasslands in Dudhwa NP, Pilibhit RF and Kishanpur WLS be protected, monitored and managed for the long-term conservation of Bengal Floricans in Uttar Pradesh.

11. Research output

- For the first time, Bengal Florican populations have been estimated using occupancy models and the distance sampling technique, specifically the Royle repeat count model. Using this model, we could estimate the total population of floricans in the grasslands of Pilibhit Tiger Reserve, Dudhwa NP and Kishanpur WLS to be about 198 individuals.

- The presence of Bengal Floricans in new areas such as Pilibhit RF and Kishanpur WLS is very encouraging although floricans were unable to use the grasslands of Katarniaghat and Lagga-Bagga because these areas are degraded. Therefore, it is recommended that the grasslands of these two areas be monitored and the existing grasslands of Dudhwa NP, Pilibhit RF and Kishanpur WLS be protected, monitored and managed for the long-term conservation of Bengal Floricans in Uttar Pradesh.
- By participating in this project, one student from the Forest Research Institute could complete his M.Sc. dissertation.
- The research output of this study will help restore the grasslands habitats of the Bengal Florican in Katarniaghat WLS and Lagga-Bagga RF.
- Sutanu Satpathy has carried out his M.Sc Dissertation on Bengal florican as part of this project and awarded M.Sc Environmental Science from the Forest Research Institute University in 2013.

13. Utility of the research findings

- The traditional method of estimating Bengal Florican populations might be good for monitoring but it always underestimates the population size due to the elusive behaviour of this bird. Therefore, the new technique using occupancy models and distance sampling, specifically the Royle repeat count model will be a better method for estimating the numbers of Bengal Floricans. Using this model, we estimated the total population of floricans in the grasslands of Pilibhit Tiger Reserve, Dudhwa NP and Kishanpur WLS to be about 198 individuals. It is recommended that this method be used to estimate populations of Bengal Floricans. However, the traditional area search method can still be used for monitoring purposes by the frontline staff of the forest department as it is easy to use.

- Studies on the vegetation composition will help restore the grassland habitats of the Bengal Florican in Katarniaghat WLS and Lagga-Bagga RF.
- This study trained the frontline staff of the forest department to monitor Bengal Floricans in Uttar Pradesh.

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