

Research article

Overview of status and conservation of Bengal florican *Houbaropsis bengalensis* in Nepal

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Suggested citation: Inskipp C., Poudyal L.P., Chaudhary D.B., Shahi R. and Baral H.S. 2024. Overview of status and conservation of Bengal florican *Houbaropsis bengalensis* in Nepal. Nepalese Journal of Zoology, 8(2):30–39. <https://doi.org/10.3126/njzv8i2.74929>

Article History:

Received: 17 October 2024

Revised: 11 November 2024

Accepted: 12 November 2024

Publisher's note: The statements, opinions and data contained in the publication are solely those of the individual author(s) and do not necessarily reflect those of the editorial board and the publisher of the NJZ.



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Abstract

Bengal florican *Houbaropsis bengalensis* is a globally Critically Endangered bustard species found in South and Southeast Asia. In Nepal it is rare, local and declining, and only breeds in three disjunct protected areas in the lowlands: Shuklaphanta and Chitwan National Parks (NPs), and Koshi Tappu Wildlife Reserve and adjoining areas. Declines of Bengal florican in all these protected areas are well documented. Populations decreased by 93% in Shuklaphanta NP between 1982 and 2024; by 75% in Chitwan NP between 1982 and 2023, and by 55% in Koshi Tappu Wildlife Reserve and adjoining areas between 2012 and 2022. The Nepal population is now considered to be less than 100 birds. The species formerly bred in Bardia NP but has not been recorded there since 2010. Koshi Tappu Wildlife Reserve and surrounding areas now support by far the largest population in Nepal. The best habitats for the species in the breeding season comprise areas of short grassland dominated by *Imperata cylindrica* where the birds can forage in the early mornings and evenings, interspersed with patches of taller grassland for concealment and nesting. Reasons for the species' decline in the breeding season are thought to be inappropriate grassland management, especially burning when the birds have started nesting, disturbance, and encroachment of some grasslands by woody vegetation. Outside the breeding season, when the Bengal florican moves from protected areas into nearby unprotected farmlands, the species is further at risk from hunting, trapping, pesticide poisoning and disturbance. We recommend improving grassland management, working with local communities, encouraging multi-season crops in nearby farmlands which are less intensive and less disturbing for Bengal florican, raising conservation awareness with stakeholders, and regular monitoring.

Keywords: Critically endangered bustard; community-managed grasslands; disturbance; grassland loss and modification; predation

1 | Introduction

Bengal florican *Houbaropsis bengalensis* is distributed in India (from the Kumaon terai of Uttarakhand through Bihar and West Bengal to the foothills and plains of Arunachal Pradesh, Assam and Meghalaya), the Nepal terai, Cambodia, Vietnam and historically in Bangladesh (BirdLife International 2018). The species has also been reported from Bhutan, Myanmar and Thailand, but there are no confirmed records from these countries (BirdLife International 2018). Globally, Bengal florican has a very small, declining population; a trend that has recently become extremely rapid and is predicted to continue in the near future (BirdLife International 2024). Its global decline has been largely attributed to the widespread and on-going modification of its grassland habitat, as well as the grasslands' conversion to agriculture (BirdLife International 2024). As a consequence, it is one of the rarest and most threatened of all bustard species worldwide, qualifying as globally Critically Endangered (BirdLife International 2024).

In Nepal, Bengal florican is rare, local and declining. In the latest assessment of all of Nepal's bird species (Inskipp et al. 2016), it was assessed as Critically Endangered. The first record was in the 19th century from the terai, where it was found breeding (Hodgson 1829, 1844). Single specimens were taken from Morang district in 1936 and 1938 (Bailey 1938). Almost all other records are from four highly disjunct protected areas and their buffer zones: Shuklaphanta, Bardia and Chitwan NPs and Koshi Tappu Wildlife Reserve and adjoining areas (Inskipp et al. 2016). Here, Bengal florican inhabits alluvial grasslands dominated by *Imperata cylindrica* (Inskipp et al. 2016). Historically severe hunting pressure probably contributed to its decline (Inskipp & Collar 1984). The most serious current threats are thought to be loss and degradation of its grassland habitat (Inskipp et al. 2016).

Bengal florican (Fig. 1) is one of Nepal's nine protected bird species according to the National Parks and Wildlife Conservation Act 2029 (1973) (DNPWC 1973) and is listed in CITES Appendix I (CITES 2024).



Figure 1. Bengal florican adult male, Koshi Tappu Wildlife Reserve. Photograph taken by Sanjay Tha Shrestha.

Surveys of population numbers and habitat of Bengal florican have been carried out regularly in the breeding season at all four areas where it is known to occur between 1982 and 2024. In Shuklaphanta, surveys were conducted in 1982 (Inskipp & Inskipp 1983), 1990 (Weaver 1991), 2000 (Baral et al. 2003), 2007 (Poudyal et al. 2008a, b), 2014-15, 2021 and 2023 (BCN 2014, 2015, 2021, 2023). In 2024 the survey was carried out by the park administration and Bird Conservation Nepal (Bhatta 2024). In Bardia NP surveys were made in 1982 (Inskipp & Inskipp 1983), 1990 (Weaver 1991), 1998 (Pokharel & Dhakal 1998), 2007 (Poudyal et al. 2008a, b), and in 2013, 2014, 2015, 2021 and 2024 (Shahi 2013, 2014, 2015, 2021, 2024). Bengal florican has not been recorded in Bardia NP since 2010 (Ram Shahi Pers. Obs.). Surveys were carried out in Chitwan NP in 1982 (Inskipp & Inskipp 1983), 2001 (Baral et al. 2003), 2007 (Poudyal et al. 2008a, b), 2012 (Khadka et al. 2013), 2014-15, 2021 and 2023 (BCN 2014, 2015, 2021, 2023). The first survey in Koshi Tappu Wildlife Reserve was conducted in 1982. Later surveys were made in the reserve and also surrounding areas in 2012 (Baral et al. 2013), 2014-15 (BCN 2014, 2015), 2017 (Baral et al. 2020), 2021 (BCN 2021), 2022 (Himalayan Nature 2022), and 2023 (BCN 2023). In 2024 the survey was carried out by BCN and Koshi Bird Society (Sanjib Acharya Pers. Comm., June 16, 2024).

Six birds in Nepal were satellite-tagged by Bird Conservation Nepal (BCN) as part of the 2012-15 Darwin-funded Bird Conservation Nepal Bengal florican Project. Satellite-tagging took place at three sites: Koshi Tappu Wildlife Reserve on 02 April 2013 and 19 April 2014; Shuklaphanta NP on 03 June 2014 and 22 May 2015, and Chitwan NP on 15 May 2016 (Jha et al. 2018). These studies found that Bengal floricans leave their breeding grounds after nesting and move into unprotected farmlands, often only a few kilometres and sometimes up to 30 km. Some birds moved across the international boundary into India (Jha et al. 2018).

The Bengal florican Conservation Action Plan 2024–2033 (DNPWC 2024) is a well-researched and comprehensive ten-year plan. Its goal is to recover Nepal's Bengal Florican population with restoration and maintenance of its habitat (DNPWC 2024). There remain important gaps in our knowledge of the species in Nepal. We do not understand why Bengal florican no longer occurs in Bardia NP, once a good breeding area for the species and why its decline has been so severe in Shuklaphanta and Chitwan NPs, and in Koshi Tappu Wildlife Reserve. Threats to Bengal florican in the non-breeding season when on farmlands outside the protected areas' system have not been investigated. While natural predators such as Asiatic

golden jackal *Canis aureus* and mongooses may have increased at some sites, notably Koshi Tappu Wildlife Reserve (Baral et al. 2013) and Bardia NP (Poudyal et al. 2008a), studies have not been made to determine if they are significant threats to Bengal florican's survival.

The objectives of this paper include documenting Bengal florican's population changes between 1982 and 2024 and investigating possible reasons for these, including why the species disappeared from Bardia NP and why its decline has been so drastic in Shuklaphanta and Chitwan NPs and in Koshi Tappu Wildlife Reserve. Considering the Critically Endangered status of the species, the most important objective is to highlight recommendations for its future conservation in Nepal.

2 | Materials and methods

2.1 | Study areas

Shuklaphanta NP lies in the far west of Nepal and has an altitudinal range of 175–1300 m (BCN et al. 2023). The main vegetation types are dry lowland grasslands (which the Bengal florican inhabits), wet grasslands, forests of sal *Shorea robusta*, mixed deciduous trees, khair-sissoo dominated by *Acacia catechu* and *Dalbergia sissoo*, and marsh in which tall dense grasses are dominant (Schaaf 1978).

Bardia NP is situated in southwestern Nepal, with an altitudinal range of 152–1441 m. About 70% of the park is covered by sal forest; there are also riverine forests of *Acacia catechu* and *Dalbergia sissoo* in the lowlands and deciduous and pine forests in the hills. Lowland dry grasslands and savannah are the other main habitats of the park (BCN et al. 2023).

Chitwan NP lies in central Nepal and has an altitudinal range of 100–815 m. There are numerous small dry grasslands lying alongside the park's rivers. Sal covers around 70% of the park; other lowland forest is riverine *Acacia catechu/Dalbergia sissoo* and a very small area is tropical evergreen forest. In the hills there are pine and deciduous forests (BCN et al. 2023).

Koshi Tappu Wildlife Reserve is situated in lowland eastern Nepal, from 75–81 m (BCN et al. 2023). Approximately 70% of the reserve's land area is covered in grasslands (Heinen 1993), although during high flood years a large area of grassland is destroyed and replaced by new alluvial deposits. Medium-sized grasslands interspersed with young *Acacia* trees are found on sandy islands. Riverine vegetation with *Acacia catechu/Dalbergia sissoo* forest dominates on the islands and edges of the reserve (Peet et al. 1999a).

2.2 | Methods

Population numbers and habitat details were gathered from surveys that have been carried out in the species' breeding season between 1982 and 2024, mainly in April and May, as well as opportunistic observations during the same period. The species was surveyed in the early mornings and late afternoons when it was most conspicuous.

In 1982, numerous aerial photographs (scale 1:50,000) taken in 1977 and 1978 of altitudes up to 305 m were examined. Open grassland areas were clearly visible on the photographs, and these were noted and measured. Almost all were in existing protected areas (Inskipp & Inskipp 1983). The first Bengal florican survey in Nepal was carried out between 13 April and 01 June 1982 when all the major lowland grasslands were

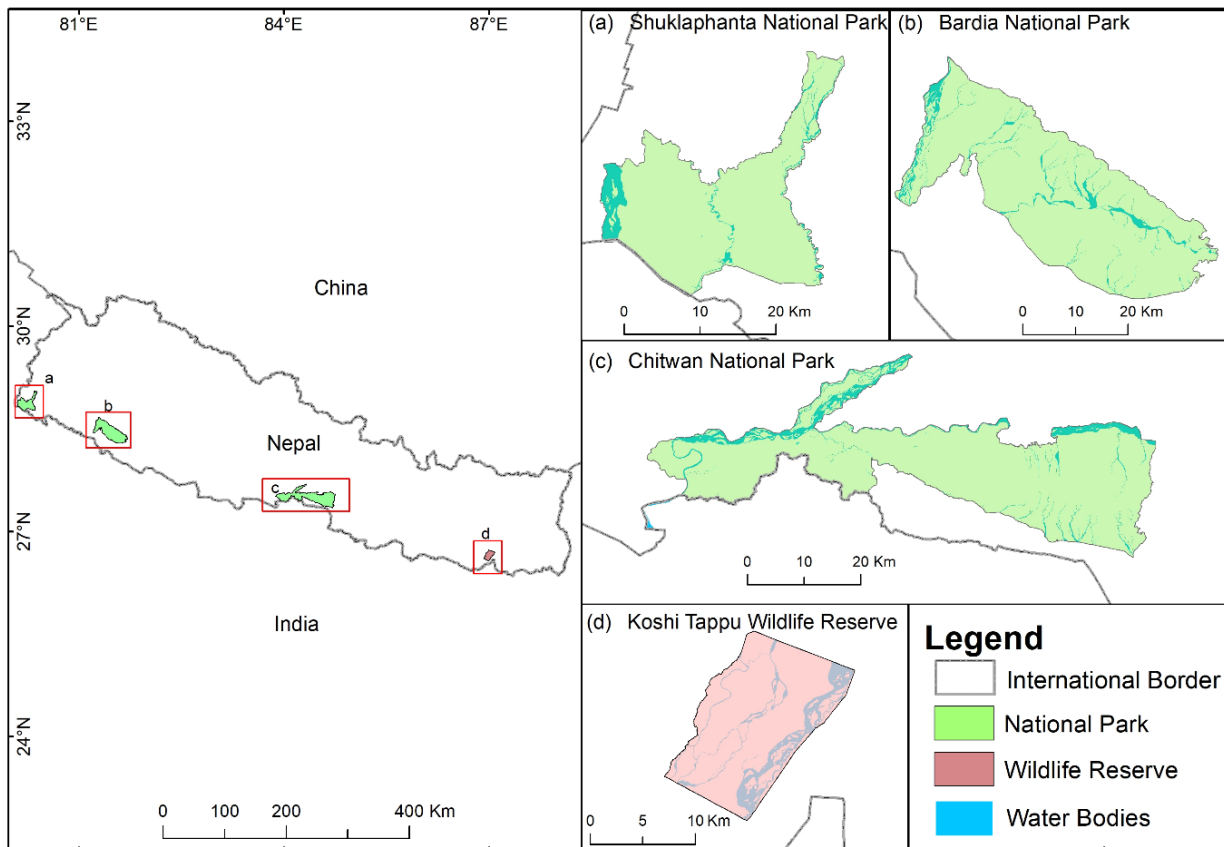


Figure 2. Distribution sites of Bengal florican in Nepal

surveyed (Inskipp & Inskipp 1983), except for Koshi Tappu Wildlife Reserve where logistical difficulties meant that only a third of the reserve could be covered.

In 1982 in Shuklaphanta NP, observations were made using binoculars and a telescope over several days, covering the ground from viewing towers, jeeps and on foot. Detailed notes were made on florican numbers and activity, and on the habitat characteristics of the sites including recording a number of vegetation transects (Inskipp & Inskipp 1983). In 1990, visits were made to known or suspected breeding sites in the park during late March and early April (Weaver 1991). Coverage was made by bicycle and occasionally vehicle using the system of tracks and the observer was escorted at all times by reserve staff. Viewing towers and trees also provided vantage points for viewing the grasslands by binoculars and telescope, generally with minimum disturbance to floricans. Location, numbers and activity of all floricans were mapped, together with habitat observations (Weaver 1991). The same methodology was used in Shuklaphanta NP in 2000 (Baral et al. 2003), in 2007 (Poudyal et al. 2008a; b) and in March and April 2024 (Ram Shahi Pers. Obs., March and April 2024). In 2000, group discussions were held with park officials, game scouts and local people to glean information on the presence of Bengal florican and its conservation (Baral et al. 2003). In contrast to earlier surveys, the sweep survey method was used by BCN in 2014-15, 2021, 2023 and 2024 (BCN 2014, 2015, 2021, 2023). The sweep method was first used in Koshi Tappu Wildlife Reserve in 2012 (Baral et al. 2013). This method involves spacing counters by 50 to 100 m from each other depending on visibility and walking through the grasslands and is described in detail in Baral et al. (2013). In 2024 the sweep method was again used, and much larger area was surveyed for the first time (Bhatta 2024).

Surveys in Bardia NP in 1982, 1990, 1998, 2000 and 2007 used the same methodologies as carried out in Shuklaphanta NP in 1982 (Inskipp & Inskipp 1983; Weaver 1991; Pokharel & Dhakal 1998; Baral et al. 2003; Poudyal 2008a, b). In 2013, 2014, 2021 and 2024, the park was surveyed from viewing towers overlooking the grasslands, by vehicle, and also by walking transects in order to cover parts of the grasslands that were not otherwise visible (Shahi 2013, 2014, 2015, 2021, 2024).

In Chitwan NP the surveys conducted in 1982, 2001, 2007 and 2012 also used the same methodologies as in Shuklaphanta NP in 1982 (Inskipp & Inskipp 1983; Baral et al. 2003; Poudyal 2008a, b; Khadka et al. (2013). However, BCN used the sweep method for later surveys in the park in 2014-15, 2021 and 2023 (BCN 2014, 2015, 2021, 2023).

In Koshi Tappu Wildlife Reserve, coverage of only a third of the area was possible during the first survey from 25 May to 1 June 1982 (Inskipp & Inskipp 1983). At that time the Koshi River course was further west than in more recent years and there was a large grassland in the reserve between the embankment near Kusaha and the river. Access was only allowed on elephant back because of the perceived risk of wild buffalo *Bubalus arnee* attacks and the grass was very tall (Carol Inskipp Pers. Obs.). The first comprehensive survey of the reserve did not take place until 2012 when a different methodology was used compared to that used in earlier years in the national parks (Baral et al. 2013). This survey also covered some areas adjoining the reserve. Reconnaissance trips were made both in the eastern and the western side of the Koshi River between 24 March to 16 April 2012 by Koshi Tappu Wildlife Reserve and Koshi Bird Observatory staff when four survey blocks were established. On 21 and 22 April 11 surveyors, on 23 April, nine surveyors, and



Figure 3. Bengal florican habitats; A- in Shuklaphanta National Park (Photograph by Devraj Joshi); B- in Bardia National Park (Photograph by Ashok Kumar Ram); C- in Chitwan National Park (Photograph by D.B. Chaudhary); and D- in Koshi Tappu Wildlife Reserve (Photograph by Hem Sagar Baral).

from 24 till 26 April, 12 surveyors took part. Surveys of the four blocks were conducted on foot by walking transects once within each block. Major grass species, vegetation type and sward height were noted. Each of the participants used a pair of binoculars. In addition, two digital cameras, two telescopes and one GPS were used throughout the survey. Participants carried watches to note the timing of Bengal florican sightings and mobile phones to communicate about sightings of flying floricans to minimize double counting (Baral et al. 2013). The same survey design was used in 2017 (Baral et al. 2020), 2022 (Himalayan Nature, 2022) and 2024 (Sanjib Acharya Pers. Comm., May 21, 2024). However, the last survey covered greater areas than previous surveys including the Gobargadda area (southwest of Koshi Barrage) and from the Pink Tower to Dakshin Duban (northwest of Koshi Barrage (Sanjib Acharya Pers. Comm., 21 May 2024). Surveys carried out by BCN in 2014-15, 2021 and 2023 used the sweep method (BCN 2014, 2015, 2021, 2023). Available information on Bengal florican's habitat requirements and its location in the nonbreeding season was collated for all the protected areas that have been surveyed. Current and historic grassland management methods were investigated.

3 | Results

Bengal florican records in Shuklaphanta, Bardia and Chitwan NPs and Koshi Tappu Wildlife Reserve and adjoining areas between 1982 and 2024 are summarised in the following Table 1.

In Shuklaphanta NP (Table 1), Bengal florican numbers were similar in 1982 (15 birds) (Inskipp & Inskipp 1982;1983) and

1990 (17 birds) (Weaver 1991). In later years florican numbers continuously declined: 12 birds in 2000 (Baral et al. 2003), 10 in 2007 (Poudyal et al. 2008), eight in 2014-15 (BCN 2014, 2015), seven in 2021 (BCN 2021), five in 2023 (BCN 2023), and also 3 males and 2 Females by BCN team (Table 1). In Bardia NP (Table 1), nine birds were recorded in 1982 (Inskipp & Inskipp 1982, 1983), six in 1990 (Weaver 1991), four in 2000 (Baral et al. 2003), and one in 2007 (Poudyal et al. 2008) and in 2010 (Ram Shahi Pers. Obs., March 2010) (Table 1).

Bird numbers recorded in Chitwan NP (Table 1) between 1982 and 2014-15 ranged from a maximum of 11 birds in 2012 (Khadka et al. 2013) and a minimum of four birds in 2001 (Baral et al. 2003). However, the 2021 and 2023 surveys only produced one and two birds respectively. In March 2024, one bird was seen opportunistically in Hassara, near Sukebhar (D.B. Chaudhary Pers. Obs., March 2024) (Table 1). In 1982 only four Bengal floricans were located in Koshi Tappu Wildlife Reserve (Inskipp & Inskipp 1982) (Table 1). Between 2012 and 2024 florican numbers recorded varied between 47 birds in 2012 (Baral et al. 2013) and 21 birds in 2022 (Himalayan Nature 2022) and 2023 (BCN 2023) (Table 1).

4 | Discussion

4.1 | Habitats and ecology

In the breeding season Bengal floricans were generally recorded in grasslands from 10-110 cm in height. The structure and height of grass swards were found to be very important to the species. In the early mornings and late afternoons male floricans are

Table 1. Bengal florican records in Nepal, 1984–2024

Date	No. of birds	No. of males & females	Reference
Shuklaphanta National Park			
30/4-6/5/1982	15	12 adult males, 1 sub-adult male, 2 females	Inskipp & Inskipp (1983)
24/3-2/4/1990	17	14 males, 3 females	Weaver (1991)
5-14/5/2000	12	10 adult males, 2 subadult males	Baral et al. (2003)
16-28/4/2007	10	8 males, 2 females	Poudyal et al. (2008a, b)
2014/15	8		BCN (2014; 2015)
2021	7		BCN (2021)
2023	5		BCN (2023)
March and April 2024	1	1 male	Ram Shahi <i>Pers. Obs.</i>
27/5/24-1/6/24	5	3 males, 2 females	Bhatta (2024)
Bardia National Park			
17-21/5/1982	9	8- males, 1 female at Lamkauli and Baghaura	Inskipp & Inskipp (1983)
5/4/1990	6	4 males at Lamkauli & 1 male, 1 female at Baghaura	Weaver (1991)
1998	9	At Lamkauli and Baghaura	Pokharel and Dhakal (1998)
28/4-4/5/2000	5	2 males, 2 females at Lamkauli & 1 male at Baghaura	Baral et al. (2003)
2005	3	3 males at Lamkauli & Baghaura	J.B. Khadka in Poudyal et al. (2008a, b)
2006	2	2 males at Baghaura	J.B. Khadka in Poudyal et al. (2008a, b)
2006	1	1 male at Lamkauli	R. Shahi <i>Pers. Obs.</i>
10-15/4/2007	1	1 male at Lamkauli	Poudyal et al. (2008a, b)
2008, 2009	0	No known records	Inskipp et al. (2016)
March 2010	1	1 male at Lamkauli	Ram Shahi <i>Pers. Obs.</i>
2011-2024	0	No known records	Shahi (2013; 2014; 2015, 2021, 2024)
Chitwan National Park			
13-25/4/1982	8	7 adult males, 1 female	Inskipp & Inskipp (1983)
31/3-8/4/2001	4	3 adult males, 1 female	Baral et al. (2003)
13-24/5/2007	5	5 adult males	Poudyal et al. (2008a, b)
April 2012	11	7 males, four females	Khadka et al. (2013)
2014-15	6		BCN (2014; 2015)
2021	1		BCN (2021)
2023	2		BCN (2023)
March 2024	1	1 female	D.B. Chaudhary <i>Pers. Obs.</i>
Koshi Tappu Wildlife Reserve and adjacent areas			
1982	4	3 adult males and 1 female	Inskipp & Inskipp (1983)
21-26/4/2012	47	29 adult males and 18 adult females	Baral et al. (2013)
2014-15	35		BCN (2014; 2015)
23/4-29/4/2017	41	29 adult males and 12 females	Baral et al. (2020)
2021	21		BCN (2021)
21/4-27/4/2022	21		Himalayan Nature (2022)
2023	24		BCN (2023)
March 2024	32	20 males and 12 females	S. Acharya in litt. to C. Inskipp, 21 May 2024

usually found in open short *Imperata cylindrica* grassland for foraging. The species is very shy and wary, and males require tall grass (100 cm or more) for concealment for the rest of the day. Tall grass is needed by Bengal floricans for nesting. Females have chiefly been recorded in tall grass, especially *Saccharum spontaneum* (Inskipp & Inskipp 1983; Weaver 1991; Baral 2001; Baral et al. 2003). The species is omnivorous and feeds on shoots and flowers, and also insects such as grasshoppers and beetles (Ali & Ripley 1987).

4.2 | Grassland management

Traditional thatch grass harvesting was formerly carried out by local people between late December and early January in Bardia, Chitwan and Shuklaphanta NPs, but no longer takes place due to lifestyle changes of local people replacing thatch roof by other materials e.g. CGI sheet and concrete. The cutting was then followed by burning (Laxman Prasad Poudyal).

In Shuklaphanta NP, two main methods are currently used. One utilizes tractors to cut around specific areas and then implements controlled burns within those boundaries. Before that, staff clear the fire-lines. In some areas, particularly tall grasslands, controlled fires are conducted first, followed by tractor cutting. Additionally, some regions solely rely on controlled burning for fire management. Grassland management

continues into April, sometimes until the end of April (Laxman Prasad Poudyal).

In Chitwan NP, grass is now cut by tractors, followed by burning. In 2024, grassland management has been observed taking place as late as April in Shuklaphanta NP (Devraj Joshi in litt. to Laxman Poudyal, May 2024) and also in Chitwan NP (D.B. Chaudhary *Pers. Obs.*, April 2024; T. Giri *Pers. Comm.*, 22 May 2024).

In Bardia NP, the grasslands are also burned, although they no longer cut. However, firing of the two large grasslands (where Bengal floricans used to inhabit) is carried out by the first week of March (A.K. Ram *Pers. Comm.*, 15 April 2024), so considerably earlier than in Shuklaphanta and Chitwan NPs.

Currently these grassland management measures are carried out specifically for large mammals. Cutting and/or controlled burning are planned to remove dry, coarse and unpalatable grasses and produce a new flush which will be highly palatable and nutritious for grazing deer and some other large herbivores (BCN et al. 2023). In Bardia NP, the grasslands are managed partly for the globally Vulnerable, barasingha *Rucervus duvaucellii*. This helps to maintain a healthy deer population which provides the globally Endangered tiger *Panthera tigris* with a good prey base. Another aim of the burning is to maintain the open grassland areas required by the globally Vulnerable

Indian rhinoceros *Rhinoceros unicornis* (D.B. Chaudhary) one of the main focal mammal species for grassland management in Nepal. Preventing succession from *Imperata* grassland to tall grassland of *Saccharum* spp. and *Narenga* spp. is a challenging task (Poudyal et al., 2008a, b).

4.3 | Population changes

Survey results between 1982 and 2024 show that the Bengal florican population has declined sharply at all four sites (Table 1). In Shuklaphanta NP (Table 1), the 2024 survey results obtained by BCN (Bhatta 2024) cannot be compared with earlier surveys because a much larger area was covered. Even so, only five birds were recorded, 67% lower than the 1982 figure. The March and April 2024 survey covered the same area as previous surveys and only located one Bengal florican (Ram Shahi Pers. Obs., March and April 2024), a decline of 93% when compared with the 1982 survey results.

In Bardia NP (Table 1), survey results show an ongoing decline after the first survey: by 33% in 1990 (Weaver 1991), 56% in 2000 (Baral et al. 2003) and 89% in 2007 (Poudyal 2008a, b), compared to 1982 figures. Despite four comprehensive surveys of the park between 2013 and 2024 (Shahi 2013, 2014, 2015, 2021, 2024), there has been no sighting of Bengal florican in Bardia NP since 2010.

In Chitwan NP (Table 1), recorded florican numbers fluctuated between 1982 and 2014-15, but in 2021 and 2023 there were large declines of 87% and 75% respectively when compared with 1982 figures.

Records indicate the species was present in Koshi Tappu Wildlife Reserve until 1986 when it apparently disappeared from the area (Inskipp et al. 2016). The 2012 survey found the Bengal florican made a come-back to the reserve (Baral et al. 2013). However, a survey in 2017 found fewer Bengal floricans (41 birds) over a larger area (168.9km²) compared to 47 birds in 108.1km² in 2012 (Table 1). This indicates a decline of over 13% over five years (Baral et al. 2020). The 2022 survey, which covered the same area as in 2012, found 21 birds (Himalayan Nature 2022), an even greater decline of 55% compared to 2012 data (Table 1).

The 2024 survey result (20 males, 12 females) (Table 1) is not directly comparable to earlier surveys. It was carried out in March when females are more visible in the shorter grass and the survey covered two additional areas compared to earlier surveys (S. Acharya Pers., Comm., May 21, 2024).

4.4 | Possible reasons for decline

Inappropriate grassland management

Current grassland management practices are reducing the ideal grassland habitat for Bengal florican (BCN 2023). These measures often aim to produce an open area of short grassland, without any patches of tall grass that birds could use as a refuge. For example, in March 2024, grassland on Lamkauli phanta, Bardia NP was observed to be very short, with much *Imperata cylindrica* required by male Bengal floricans. However, no tall grass required by floricans to nest and to shelter during much of the day was found there (Carol Inskipp Pers Obs., March 2024).

One major problem for Bengal florican is that grassland management is being carried out after the breeding season has started in all three national parks, although this is happening to a much lesser extent in Bardia where grassland management finishes much earlier than in other protected areas. Forest or

grassland fires can also frequently take place in the dry season due to natural causes and sometimes may be started illegally. Great efforts are made by park staff, sometimes with the help of the army to stop these fires in Bardia NP, but it is a difficult task and not always possible (A.K. Ram Pers. Comm, 15 April 2024).

Fires during the breeding season are highly detrimental to all wildlife in the grasslands: birds, amphibians, reptiles, some mammals, as well as invertebrates which are food for birds and other wildlife. Forest fires are known to alter vegetation types favouring species more resistant to fires and eliminating species that cannot withstand fire (Cronin 1973). Late burning can destroy eggs and young birds or deter the males from displaying (Inskipp & Inskipp 1983).

The long-term ecological effects of burning grasslands annually in Nepal were described as poorly understood by Inskipp & Inskipp (1983) and this is still true as these effects have not yet been studied. The longer dry spells that lowland Nepal is experiencing due to the effects of global climate change must be exacerbating the damaging effects of fire. The latest guidelines on grassland management practices issued by the Department of National Parks and Wildlife Conservation (DNPWC 2023) permit cutting grass and subsequent burning of the cut material. They do not advocate controlled burns (or any type of burning) within the grassland itself.

In Manas National Park, Assam, a Bengal florican breeding survey in 2021 found the species had increased to 50 males and 17 females from 24 males in 2009 (Thakur et al. 2024). Burning is carried out in the park in February before the Bengal florican breeding season. Fires are mostly initiated by park managers to control woody vegetation, although local people may also start fires to encourage the growth of fresh grass (Thakur et al. 2024). The Survival Blueprint for Bengal Florican in India (Chakdar et al. 2021) states that elsewhere in India indiscriminate and untimely dry season burning of grass every year by frontline staff is affecting the Bengal florican. In some protected areas, late prescribed burning of grasses for grassland management overlaps with the breeding season of the bird (Chakdar et al. 2021).

Predation

Numbers of some predators have increased on some grasslands, for example Asiatic golden jackal and mongooses in Bardia NP (Poudyal et al. 2008b). During the study period, a couple of Asiatic golden jackals were observed three times out of a total of nine visits (Poudyal et al., 2008b). Large numbers of Asiatic golden jackals were confirmed to be regularly seen on Lamkauli Phanta in Bardia NP in 2024 (R. Shahi Pers. Obs., March 2024).

Feral dogs, Asiatic golden jackal and Indian grey mongoose *Herpestes edwardsii* may be threats in Koshi Tappu Wildlife Reserve (Baral et al. 2013). The latter two species are possibly increasing in Koshi as they are more adaptable to the widespread disturbance that Koshi faces and are known to flourish in such conditions (Baral et al. 2020). However, studies have not yet been carried out to determine the significance of predator increases on Bengal florican's survival.

Disturbance

As Bengal florican is a very shy bird, disturbance could be a factor in its decline. The previous annual influx of villagers to cut grass for thatching caused a major short-term disturbance in the past. Tourism numbers have increased in all three national parks. In Chitwan NP, numbers grew from 836 in 1974-75 to 146,662 in 2010-11 (DNPWC 2012); in Bardia NP from zero in

1982 (Inskipp & Inskipp 1982), to 5,760 in 2012 and 24,558 in 2019-20 (BCN et al. 2023). Tourist numbers also rapidly increased in Shuklaphanta NP from zero in 1982 to 12, 138 recorded in 2018-19 (BCN et al. 2023).

Disturbance is caused by safari jeep tracks which bisect the largest and more important grasslands in Bardia and Chitwan NPs (D.B. Chaudhary and R. Shahi Pers. Obs, March 2024.) and in Chitwan tourist walking trails often run along grassland sides (D.B. Chaudhary Pers. Obs., March 2024). In Bardia NP some researchers on grasslands have been causing disturbance during the breeding season (R. Shahi Pers. Obs., April 2023). Disturbance from people and cattle grazing during the breeding season is a serious threat in Koshi Tappu Wildlife Reserve and adjacent areas (Baral et al. 2013).

Encroachment of grasslands

In Chitwan NP, a number of grasslands are undergoing plant succession changing consecutively to tall grasses, bushes and trees (Khadka et al. 2013). This is a natural process and is beneficial to some species but makes the grasslands much less suitable for Bengal florican. One of these grasslands is Sukebhar, found to be the best site in Chitwan for Bengal florican in April 1982, when seven males and a female were seen (Inskipp & Inskipp 1983). In 2007, in Baghaura phanta, Bardia NP, more than 100 trees were counted scattered in the grassland (Poudyal et al. 2008a, b). However, visits to Baghaura in 2015, 2020 and 2024 indicated that some trees must have been removed as some grassland remains (Inskipp & Inskipp 2015; Inskipp et al. 2020; Inskipp et al. 2024). In March 2020 and March 2024, Lamkauli was noted to still be a large and extensive grassland, as had been observed in 1982 (Inskipp et al. 2020; Inskipp et al. 2024).

Threats outside protected areas

The satellite tracking studies of Bengal florican showed that the species inhabits degraded grassland and farmland areas near human settlements outside protected areas during the nonbreeding season (Jha et al. 2018). In these unprotected farmlands the floricans are at risk from hunting or trapping (Barber 2014), as well as high disturbance and pesticide poisoning (Jha et al. 2018). There is a lack of knowledge amongst local communities about the importance of conservation of Bengal florican and other grassland wildlife.

5 | Conclusions

Bengal florican populations have sharply decreased in all Nepal's protected areas between 1982 and 2024. The current Nepal population is less than 100 birds, with by far the largest numbers occurring in Koshi Tappu Wildlife Reserve and adjoining areas. The best habitats for the species in the breeding season contain areas of shorter grassland dominated by *Imperata cylindrica*, interspersed with patches of taller grassland. Inappropriate grassland management, especially burning after the start of the breeding season, disturbance, encroachment of grasslands by woody vegetation are significant threats to Bengal florican in Chitwan, Shuklaphanta and Bardia NPs. At Koshi, Bengal floricans are also possibly at risk from predation. In the nonbreeding season when the birds move out of protected areas and into unprotected farmlands, they may be at risk from hunting, trapping, pesticide poisoning and disturbance, but the significance of these factors remains to be studied. Based on these conclusions, authors' experience and extensive consultations; both literature and experts, we would like to

provide following pragmatic recommendations for managing Nepal's lowland grasslands that is sympathetic to Bengal florican.

6 | Recommendations

6.1 | Changes to grassland management

The development of appropriate grassland management guidelines within protected areas and outside protected areas is very important (DNPWC 2024). The updating of protected areas management plans and forest management plans to include grassland management guidelines are recommended (DNPWC 2024). Maintaining interspersed patches of tall grassland with shorter grassland dominated by *Imperata cylindrica* is crucial to Bengal florican conservation when carrying out grassland management. This could be achieved by retaining areas of intact grassland that are not cut or burnt, on a rotational basis. As well as providing grassland birds and other wildlife a refuge, it should also lead to a mosaic of tall and short grass patches required by Bengal floricans (Peet 1997; Peet et al. 1999b; Baral 2001).

It is highly recommended that grassland burning, and other grassland management be carried out before the start of the breeding season. If possible, this should be by mid-February in normal dry years. However, winters with rains make it more difficult for the grasses to burn completely before mid-February, except for places like Shuklaphanta NP and Koshi Tappu Wildlife Reserve where shorter, and drier grasses are more prevalent. In Chitwan and Bardia NPs and parts of Shuklaphanta NP, where hardy species of taller grasses exist, it is hoped that finishing burning by the end of February is more realistic.

We highly recommend that the grassland habitat management procedures (DNPWC 2023) are followed while carrying out grassland management to avoid the nesting season of Bengal florican as recommended above. It is also recommended that the ashes produced by burning the grasses and debris should not be removed from the grassland as they nourish the soil, so creating favourable conditions for new grass shoots to grow. As the DNPWC procedure outlines, management of grasslands should have strict monitoring protocols, before and after the interventions to maintain changes in vegetation as well as monitoring wildlife that come to use the habitat. This is also important because invasive alien weeds, particularly *Parthenium hysterophorus* and *Mikania micrantha* have been spreading in some managed grasslands of Nepal parks. It is recommended that a knowledgeable person be present on the spot to monitor the work while habitat management work is being done. Removal of trees, sapling and bushes that encroach on grasslands is essential for the conservation of Bengal florican. It is recommended that sites where Bengal florican has been recorded in the nonbreeding season are identified and mapped.

6.2 | Working with communities

Farmlands close to the national parks, which may be utilised by Bengal florican outside the species' breeding season need conservation efforts to safeguard the species' population in Nepal. Cultivation of multi-year agricultural crops sugarcane, lemongrass, mentha etc. are recommended as alternatives to short-term crops (Jha et al. 2018). Multi-year crops require less tilling and ploughing compared to seasonal crops, leading to less frequent ground disturbance. These crops also provide more consistent year-round cover compared to short-term crops that leave fields bare for extended periods (Jha et al. 2018). Starting community managed grasslands to meet the demands of grazing

livestock and as soon as possible would be beneficial. If conservationists work closely with farmers, it will be easier to ensure that such managed grasslands benefit both people and Bengal floricans.

Encouraging the local community to protect nonbreeding habitat in the northern part of Koshi Tappu Wildlife Reserve and eastern part of Shuklaphanta NP should aid Bengal florican conservation. Collaboration with the Division Forest Office (DFO) should help to establish community managed grassland at these sites (DNPWC 2024). In areas where land is still relatively cheap, conservation organisations may buy land to manage as mini-grassland reserves. Community members could benefit from grassland supplies outside the birds' breeding season, if they are directly involved in the grassland management.

6.3 | Conservation awareness

The Department of National Parks and Wildlife Conservation and conservation NGOs have an important role to play in raising conservation awareness amongst stakeholders of the globally threatened status of Bengal florican and some other grassland wildlife. These stakeholders include nature guides, Buffer Zone User Committees, Buffer Zone Community Forest User Groups, Community-based Anti-Poaching Units, park staff, tourists and local communities including children. Learning about the behaviour and very shy nature of Bengal florican and encouraging people to be quiet when visiting the grasslands should help to avoid frightening the birds and other wildlife. Posters depicting the Bengal florican should help people to look out for the bird both within the park and in surrounding farmlands. Posters of other grassland wildlife should be useful too. Conservation awareness could be raised by audio-visual programmes on Bengal florican and other wildlife targeting the buffer zones of the lowland protected areas. Producing a children's book about the Bengal florican, its ecology, threats and conservation status is also recommended.

6.4 | Reducing disturbance

Re-routing the current tracks bisecting grasslands to new tracks at the forest edge is recommended. Another possibility is to keep the grasses long adjacent to these tracks to act as a screen. Restricting tourism in grasslands during the Bengal florican breeding time is recommended. Tourists could be confined to watching birds from the existing elevated watch towers, for example. Researchers could be encouraged to carry out their work outside the breeding season.

6.5 | Monitoring

Conducting regular monitoring of the species is important (DNPWC 2024). Establishing and supporting a community-based Bengal florican monitoring programme would be

especially useful in farmlands where the species is known to occur outside the breeding season (DNPWC 2024). Long-term monitoring of permanent grassland plots with different management regimes e.g. fire, cutting, flooding, other disturbances is recommended if this has not taken place already. Monitoring of threats to Bengal florican in the non-breeding season on farmlands would be useful.

DNPWC (2024) recommends that the captive breeding project of Bengal florican in Cambodia (Ali 2022) could be observed and the feasibility of replication in Nepal could be studied. As pointed out in DNPWC (2024), captive breeding is risky and expensive. Searching for nests and obtaining the eggs in the field would be extremely difficult to carry out successfully without causing great disturbance to this highly sensitive and wary species. In our view, captive breeding of the species should be undertaken only if all other options of in-situ conservation measures fail in Nepal. Further satellite-tracking is also recommended in DNPWC (2024) but trapping more birds would again be highly disturbing and so a risky operation in our view. Surely, we already know enough about the species' movements and habitat requirements to successfully carry out *in-situ* conservation?

Acknowledgements

We are grateful to Sanjib Acharya and Himalayan Nature for 2022 survey data and to Sanjib for also providing information on the 2024 survey. Many thanks to Dr Ashok Kumar Ram for his useful comments on earlier drafts of this paper and to Tikaram Giri and Devraj Joshi for providing useful information. Special thanks go to Pawan Rai for map preparation, to Sanjay Tha Shrestha for his Bengal florican photograph, and to Dr Ashok Kumar Ram and Devraj Joshi for habitat photographs.

Authors' contributions

CI researched and drafted the original text. LPP, HSB, DBC and RS made invaluable contributions based on their wide experience of Bengal florican surveys and grassland management in Nepal.

Funding information

No funding was received by the authors.

Conflicts of interest

The authors declare no conflict of interest.

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