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RESEARCH ARTICLE

Status of the Red-naped Ibis *Pseudibis papillosa* in agricultural landscapes of Nepal

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Abstract The Red-naped Ibis *Pseudibis papillosa* is one of the least-studied large South Asian wading birds. The species is categorized as a fairly common species in Nepal but there has not been a careful assessment to estimate its population, understand population trends, the species' habitat requirements and conservation status in Nepal. In this study, we provide novel empirical information on Red-naped Ibis use of lowland Nepal's agricultural landscapes with an intent to develop a preliminary assessment of its status. In 2018, we established 100 transects of 500-m length each in agricultural landscapes of four districts and these were monitored seasonally until 2022 for a total of 875 transects. Red-naped Ibis were sighted in 137 transects with more sightings in Kapilvastu (34% of transects) and during the monsoon (36%), while the least sightings were in the Sarlahi district (12%) and during the summer (30%). Flock sizes ranged from 1 to 17. In 2022, 14 nests were discovered in eight districts, the majority of which were outside protected areas (57%) with Red-naped Ibises mostly nesting in forests (36%). Most nests were located on *Bombax ceiba* (50%) and *Shorea robusta* (29%), and the mean height of nesting trees was 20.28 meters. Our research suggests that Red-naped Ibis are widespread and resident, but not abundant on Nepal's agricultural lands.

Keywords *Bombax ceiba*, habitat loss, nesting site, seasonal variation, *Shorea robusta*, waterbird.

Introduction

Agricultural landscapes provide feeding, roosting, and nesting habitat for diverse bird communities throughout the year (Sundar and Subramanya 2010; Muñoz-Sáez *et al*. 2017; Li *et al*. 2020). However, contemporary intensified agricultural practices, rapid land-use changes, agrochemicals, hunting, and lack of nesting trees could be placing farmland birds in jeopardy (Mitra *et al*. 2011; Stanton *et al*. 2018; Katuwal *et al*. 2021). South Asian agricultural landscapes have retained considerable bird diversity (Sundar and Kittur 2012; Katuwal *et al*. 2022a), with conducive conditions for foraging and breeding (Sundar *et al*. 2016; Ghimire *et al*. 2021). These agricultural landscapes, especially those that support traditional agroforestry, have the largest known breeding populations of several large waterbirds including storks and cranes (Koju *et al*. 2019; Kittur and Sundar 2021; Katuwal *et al*. 2022b). Despite growing work on how large waterbirds use South Asian agricultural areas, the ability of several species to survive on these landscapes is still poorly known, especially resident ibis species.

Red-naped Ibis *Pseudibis papillosa* (Figure 1) is endemic to South Asia, breeding primarily in India, Nepal, and Pakistan, and perhaps in Bangladesh and Myanmar, with a non-breeding population probably present in China (Matheu *et al*. 2020;

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Figure 1. A flock of Red-naped Ibis in paddy field in Sarlahi district, Nepal.

BirdLife International 2022). It is found both within and outside of protected areas, primarily in drier environments such as open fields and dry cultivated land, as well as near urban and village garbage sites (Soni *et al*. 2010a; Inskipp *et al*. 2016). In addition to inhabiting riverbanks, grasslands, and sometimes poultry farms, this species mostly consumes frogs, snakes, small fish, earthworms, many insects and scavenges on cattle carcasses (Soni *et al*. 2010a; Rajesh and Kumar 2017; BirdLife International 2022). The flock size ranges largely from 1 to 10 with larger flocks of about 30 being uncommon (Inskipp *et al*. 2016; Rajesh and Kumar 2017; Matheu *et al*. 2020). The breeding period starts mostly from March to October (Matheu *et al*. 2020). The colony size is often solitary or forms sporadic tiny colonies mostly in large trees such as *Bombax ceiba*, *Ficus religiosa* and sometimes on man-made structures like electricity pylons, and communication towers (Sangha 2013; Inskipp *et al*. 2016; Matheu *et al*. 2020). The vast majority of this information is anecdotal, and this species of ibis is among the least studied large waterbirds in the world.

The Red-naped Ibis is the most abundant and widespread of the three ibis species present in lowland Nepal (elevation mostly below 300 m; Inskipp *et al*. 2016). It has been documented from the Suklaphanta National Park in the west to the Mai valley in the east (Inskipp *et al*. 2016). It is classified as Least Concern and considered to be "fairly common" in Nepal (Inskipp *et al*. 2016). However, despite these vague descriptions, and an absence of field data that could be used to assess its population, the species is believed to be diminishing, and the factors that are listed for these declines are habitat loss and degradation, illegal hunting, and agrochemicals (Inskipp *et al*. 2016; BirdLife International 2022). No systematic field assessment has been conducted to examine the habitat needs and conservation status of the Red-naped Ibis and it is likely that available information, including suggestions of population declines, are not accurate. Therefore, we set out to understand the seasonal use of agricultural landscapes by Red-naped Ibis in lowland Nepal, which is the northern-most portion of its distribution range. We provide novel field information based on a systematic multi-year, multi-site survey, thereby developing the first evidence-based information that can be used to assess the status and habitat requirements of the species in Nepal.

Study area

We conducted this research in the lowlands of Nepal, where the terrain is flat and largely suited to agriculture (< 300 m elevation; Figure 2). Rice *Oryza sativa* was grown throughout this region during the monsoon (June to September), but crops vary seasonally with farmers growing Maize *Zea mays* during the summer (March to

May) and growing multiple crops (Wheat *Triticum aestivum*, various vegetables) during winter (November to February) months (Katuwal *et al*. 2022a). Sugarcane *Saccharum officinarum* is planted in some locations, whereas some people leave their land fallow after rice or winter crop harvest until the monsoon. Seven protected areas exist in lowland Nepal, however, our study covered only three of them (Bardia National Park, Chitwan National Park, Koshi Tappu Wildlife Reserve, and their buffer zones; Figure 2). For management purposes, these protected areas are divided into the core region and the buffer zone, the latter zone consisting of forests, human settlements, and agricultural fields.

Methods

We selected Sunsari, Sarlahi, Chitwan, and Kapilvastu districts of Nepal for the Farmland Bird Survey Program (FBSPN; Figure 2). FBSPN was initiated in 2018 with 116 transects (farmland = 100, forest = 8 and river = 8). To survey farmland birds, we selected 28 - 30 non-overlapping squares in each district from a 2x2 km grid that was overlaid over the entire study area (see Katuwal *et al*. 2022a). For bird surveys, we used a 500-meter transect inside each grid. Each transect was surveyed during the summer, the monsoon, and the winter. Due to national rules that prevented travel to combat the spread of COVID-19, we did not conduct surveys in 2020, and resumed monitoring from December 2021 for a total of 875 transects. However, beginning in 2021, we surveyed only farm transects because forest and river transects were few and our objectives of establishing differences in bird community composition between farmland, forest, and river habitats had been met (see Katuwal *et al*. 2022a). In this study, we exclusively utilized data from 100 farmland transects. Between April 2018 and August 2022, each transect was visited approximately 12 times. However, we merged two trips done during the same season in 2018 (see Katuwal *et al*. 2022a), resulting in a total of three visits each season (summer, monsoon, and winter).

In addition, we opportunistically documented nests of this species from March to September 2022 (Figure 2). The first nest was observed in March, but we are unable to definitively state whether the nesting season commenced then since the species is known to start nesting much earlier (Matheu *et al*. 2020). We recorded the GPS coordinates of the nesting tree as well as the tree's species name and height. We could not monitor nests with repeated visits and therefore do not provide any information related to breeding success and related aspects.

Results

We recorded Red-naped Ibis in 62 (Kapilvastu = 19, Sunsari = 17, Chitwan = 16, and Sarlahi = 10) of 100 farmland transects (Figure 2). However, we observed Red-naped Ibis only 137 times out of 875 total transects conducted between 2018 and 2022. The highest number of sightings was recorded in Kapilvastu (N = 47, 34 % of transects with Red-

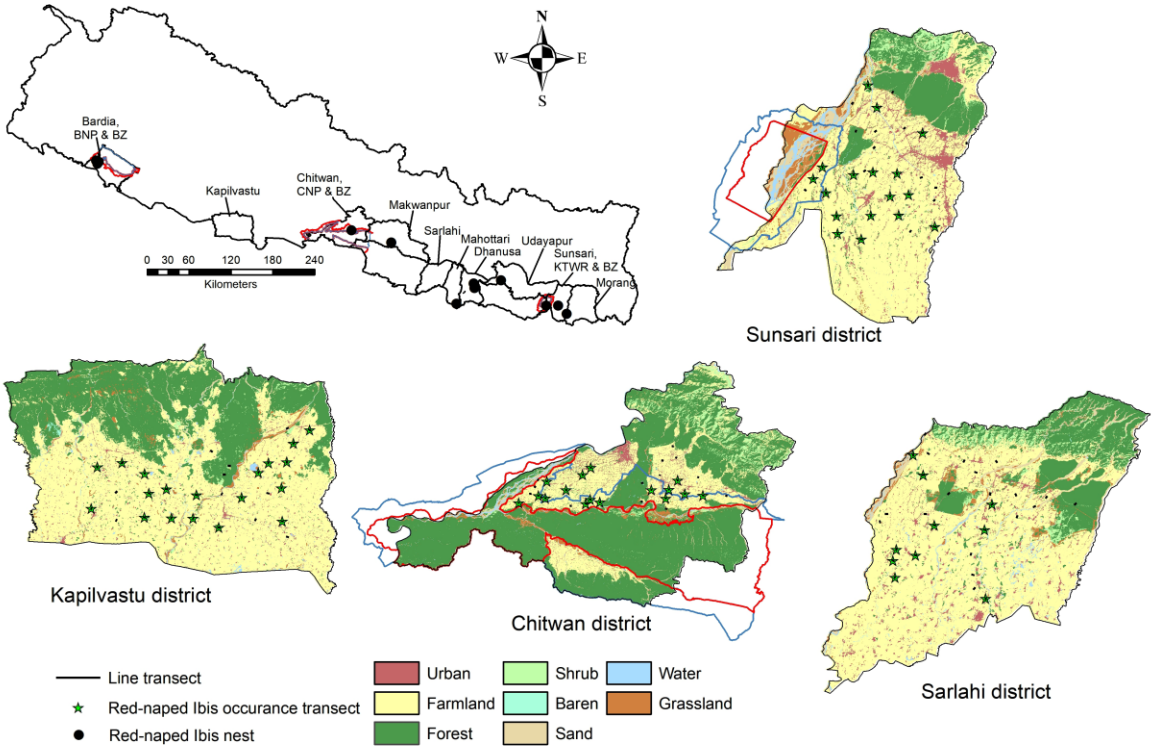

Figure 2. Red-naped Ibis nesting and transect occurrences in Nepal. In 2018, we established 116 transects (Farmland = 100, River = 8, and Forest = 8) in four districts (Kapilvastu, Chitwan, Sarlahi, and Sunsari) for the Farmland Bird Survey Program from 2018 to 2022. We only used farmland transects for this study. Eight land use classes generated from satellite images are also displayed. (BNP: Bardia National Park, CNP: Chitwan National Park, KTWR: Koshi Tappu Wildlife Reserve, and BZ: Buffer Zones.)

naped Ibis), followed by Chitwan (*N* = 41, 30 %), Sunsari (*N* = 33, 24 %), and Sarlahi (*N* = 16, 12 %). Seasonally, Red-naped Ibis were seen in slightly more transects during the monsoon (*N* = 49, 36 %) compared to winter (*N* = 47, 34 %), and summer (*N* = 41, 30 %). Red-naped Ibis flock size within transect ranged from 1 to 17 ibises; 6 % (*N* = 8) of flock size was ≥ 10, 14 % (*N* = 19) of flock size was from 5 to 9, while the majority of flocks (*N* = 110, 80 %) were with 1 to 4 ibises.

In 2022, we discovered 14 nests across eight districts (Bardia = 4, Chitwan = 1, Makwanpur = 2, Mahottari = 1, Dhanusa =2, Udayapur = 1, Sunsari =2, and Morang =1; Figure 2). We discovered more nests outside protected areas (*N* = 8, 57 %) with the rest of the nests located in both core and buffer areas of protected areas (Figure 2). The majority of nests were constructed on trees in forests (*N* = 5, 36%), followed by farmlands (*N* = 4, 29 %), human habitations (*N* = 4, 29 %), and one in shrublands/ grasslands. Most nests were on *Bombax ceiba* (*N* = 7, 50 %) and *Shorea robusta* (*N* = 4, 29 %), while *Terminalia* spp., *Breonia chinensis*, and *Haldina cordifolia* were less frequently used (each with one nest). The mean (± SD) height of nesting trees was 20.28 (± 7.17) m.

Discussion

We discovered Red-naped Ibis to be uncommon on lowland Nepal's agricultural landscapes in contrast to existing literature that suggests that the species is "fairly common" (Inskipp *et al*. 2016). Our surveys were conducted on relatively wet agricultural fields, and it is likely that more Red-naped Ibis occur in areas that have other open fields, as observed in semi-arid parts of western India (Ameta *et al*. 2022; Asawra *et al*. 2022). It is also possible that Red-naped Ibis use drier habitats such as riverbanks and urbanized settings such as dumping grounds, that are frequently cited as a habitat of this species, and in western Nepal, which we did not survey.

In Kapilvastu, Chitwan, and Sunsari districts, we observed Red-naped Ibis in relatively more transects. This could be because these regions have extensive agricultural lands that are used to grow paddy during the monsoon season and farmers typically leave their land fallow after harvesting rice, creating habitats that may be favorable for these birds. In Sarlahi, in contrast, dominant annual crops were sugarcane and maize, and these crops might offer the species less food and foraging grounds. According to Inskipp *et al*. (2016), the species' entire population in Nepal is still unknown, and our study is insufficient to estimate the species' total population in the country. To ascertain ibis' status across Nepal, future investigations require to collect standard metrics such as density to enable estimation of population sizes, and additional related information such as habitat preference.

The seasonal differences in number of transects with Red-naped Ibis were insignificant suggesting that the species is a resident of lowland Nepal. The very similar numbers in all three seasons are also suggestive that breeding pairs may be territorial, though this aspect will require specific study to confirm. A slightly higher number of transects with Red-naped Ibis during the monsoon than winter could be suggestive of its preference for wet farm soils relative to drier agricultural lands. During the summer, they may be at the nest leading to the small decline we observed during this season. In Rajasthan, Red-naped Ibis displayed distinct seasonal fluctuations in abundance with the lowest numbers during the summer, but the seasons with the highest numbers varied with location (summer in Churu city, Soni *et al*. 2009; monsoon in Dungarpur district, Asawra *et al*. 2022; winter in Udaipur district, Ameta *et al*. 2022). These studies suggest that local conditions such as levels of urbanization, agricultural crops grown, irrigation systems, distribution and size of wetlands on the landscape and prevalence of uncultivated fields contribute to seasonal variations in Red-naped Ibis abundance. Therefore, we urge a comprehensive investigation of the factors determining the presence of the species in Nepal.

There has been only one detailed study of the breeding ecology of the Red-naped Ibis which was conducted in a small Indian city (see Soni *et al*. 2010b). We observed its breeding season from March to September, which matches existing information. However, our study should be considered preliminary and detailed information is needed before we can be sure of the nesting season. Most Red-naped Ibis nests were located on trees that were in forests, farmland, and human settlements. Like Red-naped Ibis, other large waterbird species also construct nests on trees in environments dominated by humans such as cities and farmlands (Soni *et al*. 2010b; Karki and Thapa

2013; Koju *et al*. 2019; Ghimire *et al*. 2021; Kittur and Sundar 2021; Katuwal *et al*. 2022b). As a result, their protection and conservation are contingent on the views of the farmers who own these lands (Katuwal *et al*. 2021). In our study sites, most Red-naped Ibis nests were built on *B. ceiba* and *S. robusta*, though we are unable to make any assessment of preferred tree species. Previous studies on other large waterbirds have demonstrated the preference of several South Asian waterbird species to use these two tree species for nesting (Sundar *et al*. 2016; Koju *et al*. 2019; Bhattarai *et al*. 2021; Katuwal *et al*. 2022b). Tall trees are preferred for breeding by waterbirds, but such trees are not common on the agricultural lands of lowland Nepal (Koju *et al*. 2019; Katuwal *et al*. 2022b). Potentially due to paucity of nest trees, Red-naped Ibis were observed constructing nests on electricity pylons in some locations of Rajasthan, India (Ali *et al*. 2013; Sangha 2013). In other locations, they used only trees for nesting with nests located on *Ficus religiosa*, and *Azadirachta indica* (Soni *et al*. 2010b). More recent observations in two small cities of Rajasthan showed Red-naped Ibis entirely nesting on artificial structures despite abundant availability of tall trees (Charan *et al*. 2022). These studies and anecdotal observations are suggesting that Red-naped Ibis may have varied nesting habits depending on location and may not be limited by trees in contrast with other resident large waterbirds in south Asia that nest entirely or largely on trees (Kittur and Sundar 2021; Katuwal *et al*. 2022b). In this paper, we are unable to report on breeding success, but our descriptive data provides previously unknown nuances to the breeding ecology of the Red-naped Ibis.

The Red-naped Ibis appears suitable as a focal species to understand how human modified landscapes are utilized by large waterbirds and appear to use forests similarly for nesting relative to trees on agricultural areas. Such species that show versatility in using varied conditions could be flagships to understand impacts of different human activities. Our paper, and the other papers in this issue of *SIS Conservation*, has systematically collected multi-season, multi-location information on the habits of this endemic ibis from several areas across South Asia enhancing known information on the species' habits substantially. We suggest that the Red-naped Ibis be considered as a species for long-term study given its apparently plastic behaviour, and its occurrence in countries that appear to have landscape and cultural conditions that are similar. Such work may help provide detailed understanding of how to retain large waterbirds on human-modified landscapes in densely populated areas where creation of protected areas may be very challenging.

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