

## INTRODUCTION

### 1.1 Background

Hornbills are a group of peculiar and large-bodied birds found only in the Old World tropics (Kemp, 1993). They are among the largest birds in tropical lowland forests (Kinnaird and O'Brien, 2007), and occupy extremes of habitat, from moist evergreen forests with heavy rainfall to arid steppes where every millimeter of rain is precious (Kemp, 1995). Hornbills possess an enormous bill, of bright colors and usually ornamented above with a hollow casque (Delacour and Mayr, 1946). From this prominent and unique structure of decurved bill and casque, hornbills derived their names, and were assigned to the avian order Bucerotiformes and family Bucerotidae (Kemp, 1995; Birdlife International, 2017).

The hornbills are specialized with regard to habitat, food and nesting sites and play a very important role in the forest ecosystem as seed dispersers (Kinnaird, 1998; Krishna *et al.*, 2012). There are a total of 54 recognized species of hornbills in the world belonging to the family Bucerotidae (Kemp, 1993). Among them 32 species are found in Asia (Poonswadet *et al.*, 2013; Shukla, 2016) and the forest of Nepal harbors three species of hornbills with exception, Rufous-necked Hornbill (*Acerosnipalensis*) got locally extinct (Grimmett *et al.*, 2016). The threespecies of hornbills are Great Hornbill, Oriental Pied Hornbill (*Anthracoserosalbirostris*) and Indian Grey Hornbill (*Ocyrosalbirostris*). All three hornbills occur in different protected areas and associated buffer zones of lowland Terai region. Chitwan National Park (CNP) also harbors all these three species of hornbills.

The Great Hornbill (GH) is distributed in lower altitude range of tropical lowland forests, mostly along the western and southern part of the CNP with an elevation ranging from 100m-500m above sea level (BES, 2011). GH is usually seen in small parties, with larger group sometimes aggregating at fruit trees (Ali and Ripley, 1983).

#### 1.1.1 Morphological Characteristics

Great Hornbill is easily identified in the field by its massive body size and diagnostic loud call 'Kok-Kok' sound (Ali and Reply, 1989; Grimmett *et al.*, 2016). It is a large and conspicuously long bright yellow and black casqued on the top of its massive bill which is hallowed and is believed to be the result of sexual selection (Birdlife international, 2017). Male and female are nearly same but male has little bit large, light- colored and dark red eye borrow than the female, which help to separate these two genders. Body measured up to 1.5m, short legs and narrow foot (Chaudhary, 2002;Sapkota, 2005).

Both the sexes have large casqued beak but differs in the color pattern. Great hornbill is larger than the others hornbills and black and white-colored body part, black and yellow beak. Inner face part and body part are black in GH. Two white lines marked in the wings and the inner part of neck and belly is white in color. Clearly observed from a distance where it roosts in large, wide and open tall tree.

### 1.1.2 Distribution of Great Hornbill

The Great Hornbill has a wide distribution in south east Asia, occurring in China (rare resident in west and south-west Yunnan and south-east Tibet), India (locally fairly common, but declining), Nepal (local and uncommon, largely in protected areas), Bhutan (fairly common), Bangladesh (vagrant), Myanmar (scarce but locally common), Thailand (widespread, generally scarce but locally common), Laos (formerly common; currently widespread but scarce and a major decline has occurred), Vietnam (rare and declining resident), Cambodia (rare), Malaysia (uncommon to more or less common) and on Sumatra, Indonesia (now rare) (Figure 1) (Ali and Reply, 1987;Kannan and James, 1998;Mackinnon *et al.*, 2000;Datta, 2004).

The bulk of the population is found in India, where it is restricted to the Himalayan foothills, hill forests in northeast India and disjunctly, the wet evergreen forests of west India. In the north and northeast there continue to record from Uttarkhand, Uttar Pradesh, West Bengal, Assam, Meghalaya, Arunachal state, Nagaland and Mizoram, while in the wet western forests it occurs in Maharashtra, Goa, Karnataka, Kerala and Tamil Nadu (Naniwadekar and Datta, 2016). Datta (2004) list this species among the four most threatened or rare hornbill species in India. Because of shifting cultivation and logging and traditional hunting by tribes, these hornbills is restricted in various parts of the Anamalai Hills of Southern India (Kannan *et al.*, 1998).

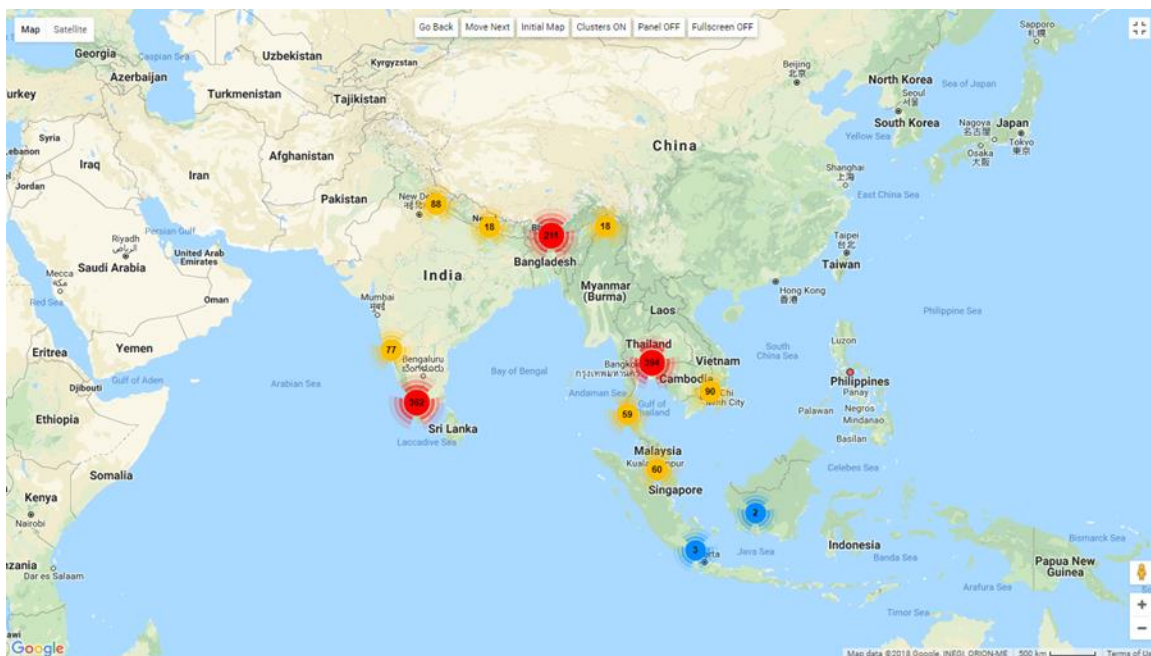


Figure 1: Worldwide distribution of Great Hornbill (Birdlife International, 2017).

GH is a rare and local resident. This species was recorded from Sanischare, Jhapa district west to Chitwan (Fleming, 1968). It was considered a local resident mainly reported from Chitwan National Park where it was seen occasionally and proved breeding (Gurung, 1983; Scharringa, 1987; Cox *et al.*, 1989; Inskipp *et al.*, 1991). There were a few records from elsewhere (Figure 2): Bardia National Park (BNP) (Suwal and Shrestha, 1988; Wangdi, 1988); Nawalparasi district, Chitwan district (Cox, 1978; Lambert, 1979; Fairbank, 1980); Dharan, Sunsari district (Kratter, 1987).

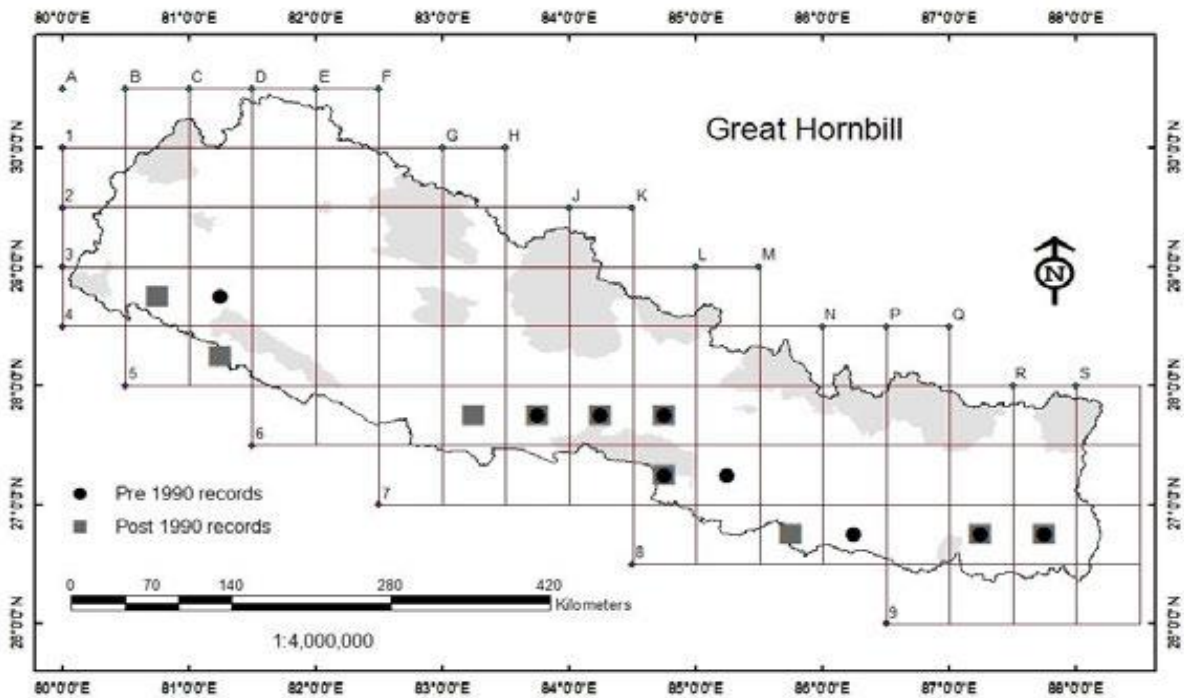


Figure 2: Distribution map of Great Hornbill in Nepal (Birdlife International, 2017).

### 1.1.3 Ecology of Great Hornbill

#### 1.1.3.1 Habitat

This species is found in wet evergreen and mixed deciduous forest, ranging out into open deciduous areas to visit fruit trees and ascending slopes to at least 1,500m (Mudappa and Raman, 2009). The same nesting site is used year after year if possible. They are known to inhabit elevations of 600 to 2000m in Thailand (Poonswad and Tsuji, 2008).

The home range of Great Hornbill varies from less than four square kilometers during the breeding season to fifteen square kilometers in the non-breeding season (Poonswad and Tsuji,

2008). This species is found in large group during the foraging time and a maximum of 35 individuals was recorded during the morning time while foraging in the *Figspp.* in the Chitwan National Park (Chaudhary, 2002; Bidari, 2013 in Inskippet *al.*, 2016). But during the breeding season this species are seen in pairs. Generally they prefer large open trees for feeding and travel the long distance in search of food. However, they are highly vocal, with a peak calling at dusk and dawn that increases during the breeding season.

### **1.1.3.2 Feeding Ecology**

Asian hornbills are dedicated fruit consumers but supplement their diet with animal food (Kinnaird and O'Brien, 2007). They are predominantly frugivorous that feed on both lipid-rich and sugar-rich fruits but feed on small mammals, birds, amphibian, reptiles and insects as well. The feeding can takes place at any time of the day and depends on habit and foraging abilities of species and individual. The feeding method includes from a simple picking up a food item to more complex and energetic feeding like levering over object, digging into the ground, snatching, swooping, plucking and hawking. Food items are manipulated in different ways (Delacour and Mayr, 1946). As a result, GH relies on these fruits as its primary source of energy during the breeding season when the energy needs are significantly higher for both the parents and young (Chaudhary, 2002).

### **1.1.3.3 Breeding Biology**

Great Hornbills breed between the months of February and May. The casqued size of male is important in attracting and fighting for mates (Golding and Williams, 1986). Males compete for females by butting into each other in the presence of female prior to the breeding season. This could possibly be a display of superiority in competition for a mate. Mates or potential mates, also perform duets where the male calls, the female replies, and they continue on in a loud sound. *Bucerosbicornis* remains together throughout their lives (Mobley, 2008; Raman, 1998).

During the breeding period, which lasts between February and May, a monogamous pair chooses a tree to lay eggs and usually one egg and rarely two (Golding and Williams, 1986). The nesting tree is usually a very tall, old growth and the same one is used every year if possible. Great hornbill also invests energy in defending nesting territory. They are only territorial during the breeding season, and may defend 100m area around the nest. The incubation period usually lasts between 38 and 40 days (Choy, 1980). Protected within the tree, the female completes a full molt which renders her flightless for a period of time. After the young emerge, the parents continue to feed them until they reach roughly 15 weeks of age, at which point they are considered independent (Poulsen, 1970; Datta and Kannan, 2003; Jones and Kannan, 2007; Mobly, 2008).

### **1.1.4 Threats**

The great hornbill has declined as a result of extensive habitat loss and destruction. Logging is likely to have impacted on this species throughout their range, particularly as it shows a preference for forest areas with large trees that may be targeted by loggers (Setha, 2000). Forest clearance for agriculture, poaching for its casque and the pet trade are major threats (James, 2008). Great Hornbill is protected avian fauna of Nepal (National Park and Wildlife Conservation Act, 2029) and listed as Near Threatened in IUCN red list 2016.

## **1.2 Objectives**

### **1.2.1 General objective**

The general objective of the study was to assess the distribution, abundance and threats of Great Hornbill in Chitwan National Park.

### **1.2.2 Specific objectives**

The specific objectives of the study were:

- To determine distribution of Great Hornbill in the CNP.
- To estimate the population status in CNP.
- To assess the conservation threats and measures of Great Hornbill in CNP.

## **1.3 Rationale**

The Great Hornbill is a near threatened bird species in the IUCN Red list of Threatened species. A very limited study on Great Hornbill has been carried in Nepal and also in Chitwan. Birdlife International (2016) has been listed GH as near threatened because it suffered a rapid population declines due to the loss of primary forest cover throughout much of its range and the true rate of decline may be greater than currently estimated and evidence of such declines would result in the species being uplifted in the future. This study generated current information on the distribution, population and threats and existing conservation measures of the great hornbill in CNP.

## 2. LITERATURE REVIEW

### Distribution

Very limited research works have been done in Nepal. This species was first recorded in Nepal by Hodgson at Hetauda, Makwanpur district (Hodgson, 1829). Later species was recorded at Hetauda in May 1947, the species was considered rare in central dun (Biswas 1961). Inskipp and Inskipp (1985) first time recorded species from the low lands of Terai. Chaudhary *et al.* (1998) recorded 38 individuals from different parts of the CNP. Chaudhary (2002) recorded 4 GH from three different habitats in Parsa National Park. Inskipp *et al.* (2013) recorded 54 GH from the western part of Chitwan National Park. Bird Life International claimed 44 GH species are permanently resident from CNP and associated buffer zone in 2010.

Mudappa *et al.* (2003) evaluated the conditions of hornbill distribution and abundance in rainforest fragments in the Southern Western Ghats, India by applying the points count methods. Golding *et al.* (1986) monitored the breeding biology of the GH in the southern India and detected no evidence of mud delivery rather exclusively used of fecal materials for nest buildings. Das (2014) monitored the seasonal migration of GH in the high forest areas of Nameri National Park, Assam, India. Shukla *et al.*, (2016) estimated the population of Great Hornbill and habitat sharing with the Rufous-necked hornbill in the Indian Eastern Himalaya. Kitamura (2011) assessed displays the fruiting habitats and seed dispersal by hornbills in tropical forest, Asian continent. Chan *et al.*, (2008) studied the behavior of a female Great Hornbill and Rhinoceros Hornbill in secondary forest in Eng Neo Avenue, Singapore.

### Population Status

There are no any further scientific researches done in this species from Nepal. Many researchers have done researches in different countries on the abundance, distribution and conservation threats in the GH.

Datta (2008) mentioned the abundance of Hornbills from three different habitats in Arunachal Pradesh, India. Barid Brien *et al.* (2010) studied the status and conservation in four species of hornbills (Great Hornbill, Pied Hornbill, Rhinoceros Hornbill and Rufous necked Hornbill) from North and Central Western Ghats, India and found that very low densities of Great Hornbill. Many hornbill species were recorded from India, Thailand, Indonesia, Cambodia and Vietnam. Gale *et al.* (2006) estimates the density of the nine hornbill's species in a lowland forest site in Southern Thailand. Poonswad and Tsuji (2008) estimated the abundance and distribution of three different hornbills and hence found the Wreathed Hornbill has largest home range than others hornbill's species in Khao Yai National Park, Thailand. Seta (2001) also monitored the Great Hornbill abundance and threats in Cambodia and recorded low densities nearly about 15

individuals in forested hills of the South-West Cambodia. Walston *et al.* (2000) recorded a flock of around 50 individuals in forested hills of the South-East Cambodia.

## **Threats**

Very few researchers are done in the conservation threats in Great Hornbills. Chaudhary *et al.* (1998 and 2002) found the possible threats of GH and other two species of Hornbill from different parts of CNP and PWR. He recorded the illegal trade of different body parts of Hornbills in local market especially the border areas with India.

Kannan (2009) identified hunting is the major threats of hornbills by the tribal Nyishi Community in the Pakke Tiger Reserve Arunachal Pradesh, India. Datta *et al.* (1998) reported the hunting of Great Hornbill by tribal group for commercial costumer and even daily traditional headgear in Western Ghats of India. Raman *et al.* (2009) studied the conservation status of hornbills (Bucerotidae) in the Western Ghats, India. Naniwadekar *et al.* (2008) studied the possible threats analysis of Great Hornbill from Arunachal Pradesh, north-east India.

Kattiet *al.* (1992) reported that hunting by tribal people is more severe in the foothill forests of Anamalia, south India. Setha (2000) reported that GH was significantly declines in Cambodia in recent decades chiefly by logging and hunting. Azua *et al.* (2003) mentioned the hunting and illegal trade mainly by the tribal groups is the major threats to the seven species of hornbills in the Southern part of Vietnam. Thongaree *et al.* (2013) assessed the distribution and conservation status of Great Hornbill in Thailand.

### 3. MATERIALS AND METHODS

#### 3.1 Study area

##### 3.1.1 Location and Topography

The Chitwan National Park is situated in South Central Nepal, covering 952.63 km<sup>2</sup> in the subtropical lowlands of the inner Terai (DNPWC, 2017) located between 27°.11' and 27.45'N and 83.47' and 84.52'E ranging from 140-900masl (Fig.3).The CNP possesses a diversity of ecosystems, including Rapti, Reu and Narayani rivers. The Churia hills rise slowly towards the east from 150m to more than 800m. The west portion of the park is comprised of the lower but more rugged Someshower hills. Chitwan-Parsa-Valmiki complex covers a 3,549 km<sup>2</sup> huge block of alluvial grasslands and subtropical moist deciduous forest (Wikramanayake *et al.*, 1999).

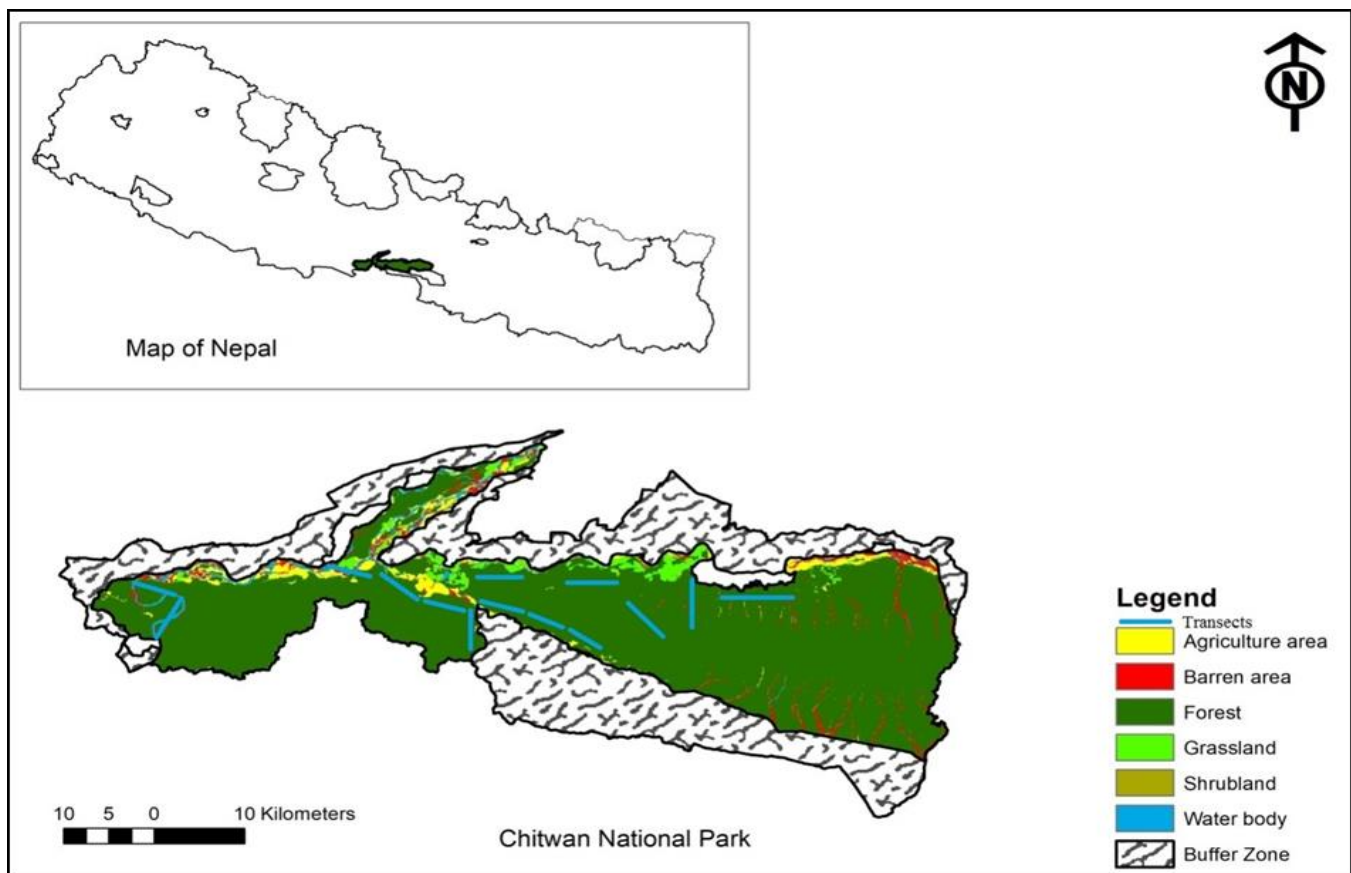


Figure 3: Map showing the study area: Chitwan National Park and Buffer Zone.



### 3.1.2 Climate

Chitwan has tropical monsoon climate with high humidity all through the year (Gurung, 1993). The area is located in the central climate zone of the Himalayas, where monsoon starts in mid-June and eases off in late September. During these 14-15 weeks most of the 2,500 mm yearly precipitation falls, it is pouring with rain. After mid-October the monsoon clouds have retreated, humidity drops off, and the top daily temperature gradually subsides from 43°C to 25°C (DNPWC, 2017).

### 3.1.3 Flora

The typical vegetation of the Inner Terai is Himalayan subtropical broadleaf forests with predominantly Sal trees covering about 70% of the National Park. The forest stands of Sal occur on well drained lowland ground in the center. Along the Southern face of the Churia hills, Sal is interspersed with Chir pine (*Pinus roxburghii*). On Northern slopes, Sal associates with smaller flowering tree and shrub species such as Beleric (*Terminalia bellirica*), Rosewood (*Dalbergiasisso*), Axlewood (*Anogeissus latifolia*), Elephant apple (*Dilleniaindica*), Grey Downy Balsam (*Garugapinnata*) and creepers such as Bauhinia vahlii and *Spatholobusparviflorus*.

Terai-Duar savanna and grasslands cover about 20% of the Park's area. More than 50 species are found here including some of the world's tallest grasses like the elephant grass called *Saccharum ravennae*, Giant cans (*Arundodonax*), Khagra reed (*Phragmites karka*) and several species of true grasses. Kans grass (*Saccharum spontaneum*) is one of the first grasses to colonize new sandbanks and to be washed away by the yearly monsoon floods (Shrestha *et al.*, 2006).

### 3.1.4 Fauna

Chitwan National Park is home to more than 78 species of mammalian fauna (CNP Office, 2015) but it offers important habitat for a variety of wildlife.

Apart from King Cobra and Burmese python, 17 other species of snakes, starred tortoise and monitor lizards occur. Several numbers of butterfly, moth and insects are not yet fully surveyed. Major reptilian species are Marsh Mugger crocodile (*Crocodylis palustris*) and Gharial crocodile (*Gavialis gangeticus*) are recorded from Narayani River. The Chitwan National Park is rich in avifauna and nearly about 80% of total bird species of Nepal are found in this park along with some critically endangered and vulnerable and nearly about two-thirds of Nepal's globally

threatened species. Additionally, Black-chinned Yuhina (*Yuhinanigrimenta*), Gould's Sunbird (*Aethopygagouldiae*), Blossom-Headed Parakeet (*Psittacula roseate*) Slaty-Breasted Rail (*Gallirallus striatus*), an uncommon winter were sighted in Spring (Giri and Chaudhary, 2008).

Critically endangered species such as Bengal Florican (*Euphodos bengalensis*) and lesser florican (*Syphotides indica*) inhabits in alluvial grasslands, the vulnerable Lesser Adjutant Stork (*Leptoptilos javanicus*), Grey-Crowned Prinia (*Prinia cinereocapilla*), Swamp Francolin (*Francolinus galaris*).

The Park was established primarily for the protection of Bengal Tiger (*Panthera tigris*) and One-horned Rhinoceros (*Rhinoceros unicornis*). The park is home to threatened mega wild animals such as Tiger, Elephant (*Elephas maximus*), Rhino, (Jnawali *et al.*, 2011) Chitwan has the largest population of Indian Rhinoceros in Nepal estimated of 605 to 645 individuals in total in the country as of 2015 (DNPWC, 2016). Large herds of Asian wild elephant are found in dwelling in the National Park.

## 3.2 Materials

Following materials were used during the study.

1. Birds of Nepal (Grimmet *et al.*, 2016)
2. GPS (Garmin Etrex20)
3. Nikon Camera (Coolpix p900)
4. Topographic-map (1: 50,000)
5. Binocular (Bushnell 8x40)
6. Datasheet
7. Notebook and pen

## 3.3 Methods

### 3.3.1 Reconnaissance survey

A preliminary survey was made in October 2017 to select the sampling sites. The sites were selected through the interaction with local people, park staffs and bird watchers that helped to identify the survey sites. This survey was also beneficial to understand and acquaint the geographical and climatic condition along with topography of the area.

### 3.3.2 Field Survey

Survey Design: The field design was prepared using topographic map and local bird watchers. The intensive study area was divided into five parts and each part was called as a block namely

A (Madi), B (Amaltari), C (Ghatgain), D (Sauraha) and E (Triveni) respectively. Line transects (Bibby *et al.*, 1992) were drawn according to the home ranges preferred by Great Hornbill. The five blocks include altogether 14 transects i.e. Madi (T1, T2 and T3), Amaltari (T4 and T5), Kasara (T6, T7, T8 and T9), Sauraha (T10, T11 and T12) and Triveni-ghat (T13 and T14).

The Great Hornbills are frugivorous birds and used the upper canopy of the trees, thus the forest types and areas were selected depending upon roosting and feeding trees.

#### 3.3.2.1 Transects Survey

Hornbills were surveyed through walking transects. Direct observations (Bibby *et al.*, 1992) were made through binoculars and visual scanning on walking intransect. Altogether fourteen transects were walked in two different habitats, two times each during the study period between November 2017 to February 2018. Transects were monitored in the morning and evening. A slow jungle walk surveyed the entire areas with one local nature guide and three observers. Nearly 20 km stretch was covered in each day and presence of hornbills was recorded. A total of 20 days was spent in the field for locating this bird. The total distance walked was 140 km. Calls were also recorded only for the confirmation of species presence. Flock sizes were also recorded during the survey time. When the hornbills were observed, the latitude and longitude at the beginning point and the end point of transect were also noted down immediately with the help of GPS.

#### 3.3.2.2 Habitat types

During the survey of Great Hornbill, data on habitat types and composition were also collected along the trails in two different habitats; riverine forest and Sal forest. Fruiting tree species were also counted and recorded mainly the fig species because fig fruits are an important component of Great Hornbill diet (Lambert, 1991; Kannan, 1994).

#### 3.3.2.3 Great Hornbill count

The number of individual and gender of observed Great Hornbills were recorded. In each observation GPS location, foraging activity and roosting and plant species were recorded. The male and female hornbill was distinguished and noted down separately and the flock size was also recorded.

#### 3.3.2.4 Threats

As for the threats of Great Hornbill, a series of questionnaire survey and direct observation data sheet were assembled and distinguished into possible threats as hunting, habitat loss and human

disturbance. During field survey habitat types, conditions of roosting trees, availability of big Sal trees were also recorded.

A set of questionnaire (Annex I) was prepared to get information about different aspects of Great Hornbill and to understand local's opinion towards the bird.

Most of the questions were closed type in the questionnaire, but some open ended questions were also included to get more explorative approach from the respondents. The respondents from the different places were chosen at random, based on the distance of their settlement from the park boundary. The model of questionnaire was delivered to 60 bird guide and 40 local people of nearby villages choosing about forty bird guides and sixty local peoples. The villages lie in the southern part of the park where the abundance of Great Hornbill was maximal.

### 3.4 Data analysis

Distribution of GH was mapped digitizing topographic-map of the study area and prepared the GH distribution map by using GIS software Arc View 10.4 version (Chang, 2015).

As for the population status the individuals of the GH were categorized into sex. Sexes were differenced on the basis of eye color and the size of casque. Male to female ratio, crude density and relative abundance in different habitats were also calculated and the flock sizes also estimated.

$$\text{Crude density} = \frac{\text{Total hornbill found}}{\text{Total area surveyed}}$$

Student's T-test was used to judge the significant associations among the number of hornbill recorded in each season of different transect and among the sex recorded in two seasons using R-studio version 3.4.

Number of GH recorded in each habitat type was used to determine distribution pattern. The distribution pattern of the hornbill was calculated by variance to mean ratio (Odum, 1971) which is based on the fact that in Poisson distribution, the variance (S<sup>2</sup>) is equal to the mean.

$$\text{Distribution pattern (DP)} = (S^2/X)$$

If,

(S<sup>2</sup>/X) =1, distribution is random

(S<sup>2</sup>/X) >1, distribution is uniform

(S<sup>2</sup>/X) <1, distribution is uniform

Where, S<sup>2</sup> = variance, X = mean

## 4. RESULTS

### 4.1 Habitat type

A total of 140 km including 70 km each in the Sal and riverine forests were surveyed. Among the two types of habitat surveyed, relatively higher numbers of hornbills were observed in riverine forest. Fourteen and eleven hornbills were recorded in riverine and Sal forest respectively (Table 1). Along with the habitat types, the major fruiting trees of Great Hornbill were also recorded (Table 1). The major fruiting tree species recorded were Simal (*Bombaxceiba*), Lasune (*Dysoxylumbinectariferum*) and Dumri (*Figusbengalensis*). *Dysoxylumbinectariferum* was widely observed and very important fruit bearing plant.

Table 1: Great Hornbills recorded in different seasons and habitat types.

Transect ID	Seasons		Habitat Types	Fruit tree species
	Summer	Winter		
T1	0	0	Sal	Absence
T2	2	0	Sal	<i>Figusbengalensis</i>
T3	2	0	Sal	<i>Dysoxylumbinectariferum</i>
T4	4	0	Riverine	<i>Bombaxceiba, Dysoxylumbinectariferum</i>
T5	4	5	Riverine	<i>Dysoxylumbinectariferum, Ficusbengalensis</i>
T6	2	0	Riverine	<i>Bombaxceiba, Ficusbengalensis</i>
T7	2	0	Sal	<i>Bombaxceiba</i>
T8	4	5	Riverine	<i>Dysoxylumbinectariferum, Ficusbengalensis</i>
T9	2	0	Sal	<i>Dysoxylumbinectariferum</i>
T10	2	5	Sal	<i>Bombaxceiba, Dysoxylumbinectariferum</i>
T11	2	0	Sal	Absence
T12	2	6	Riverine	<i>Ficusbengalensis, Dysoxylumbinectariferum</i>
T13	0	0	Riverine	Absence
T14	2	0	Riverine	Absence

The dominant trees species were *Shorearobusta* in the Sal forest and *Dalbergiasisoo* and *Acacia catechu* in riverine forest (Table 2). The major vegetation types were *Shorearobusta* which associate with *Pinusroxburghii*, *Syzygiumcumini*, in the Churia hills and *Termenaliachebula*, *Phyllanthusemblica*, in the lowland. Whereas the major vegetation components in Riverine forest were *Bombaxceiba*, *Dalbergiasisoo*, *Murrayakoenigii* associated with *Fig.* species and *Dysoxylumbinectariferum*. But in some areas there were patches of Khair). In other areas there were mixed forest mainly Khair and Sissoo.

Table 2: Major types of habitat with dominant trees species in CNP

Habitat types	Distance walked (km)	Great Hornbill		Dominant Tree Species
		Summer	Winter	
Sal forest	70	18	5	<i>Shorearobusta</i> , <i>Lagestroemiaparviflora</i> , <i>Dilleniapentagyna</i>
Riverine forest	70	12	16	<i>Dalbergiasisoo</i> , <i>Acacia catechu</i> , <i>Trewianudifolia</i> , <i>Albizziaprocera</i>

#### 4.2 Distribution of GH in relation to habitat characteristics.

The GH was found to be uniformly distributed in both habitats during two seasons ( $S^2/X=0.87$ ; Standard deviation=10.658). Great Hornbills were found to be more abundant in the Riverine forest than Sal forest. There were no significant difference between abundance of GH in both the seasons (summer season  $t=2.4019$ ,  $df=2$ ,  $p=0.1383$  likewise winter season  $t=2.875$ ,  $df=2$ ,  $p=0.1027$ ) in both riverine and Sal forests habitat. During both seasons, Riverine forest supported higher proportion of GH than Sal forest (Fig.4).

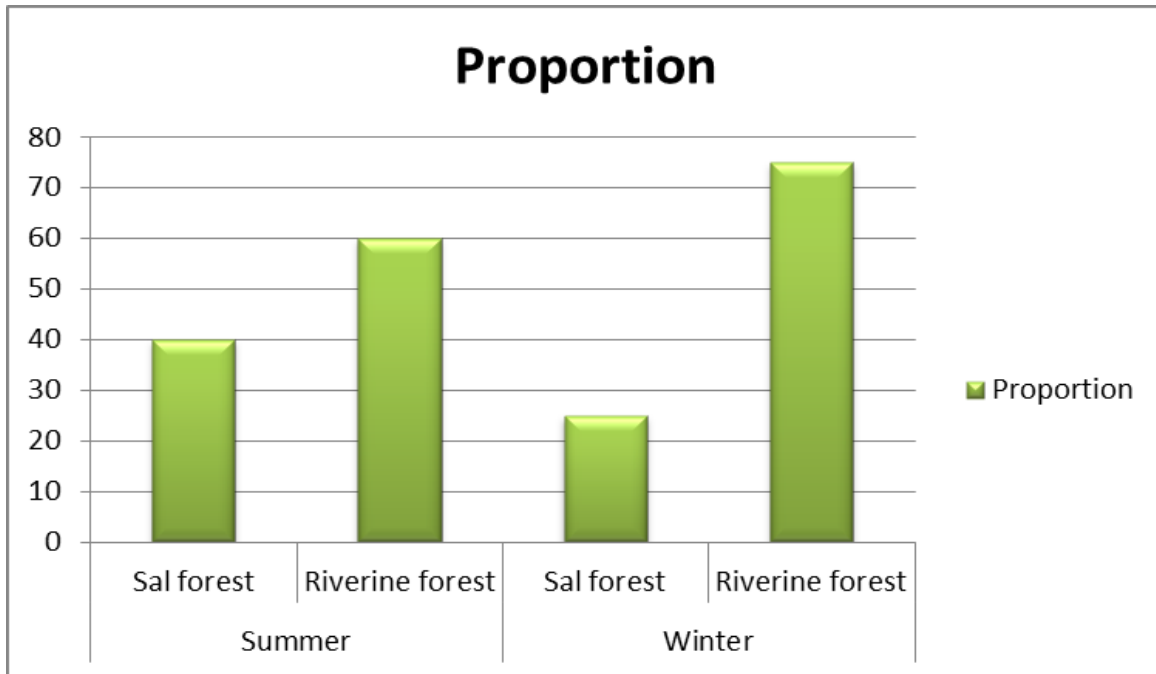


Figure 4: Proportions of Great Hornbill recorded in summer and winter season in two different habitats.

Great Hornbill distribution was found to be uniform (scattered in the riverine forest) in different places (Fig.5)

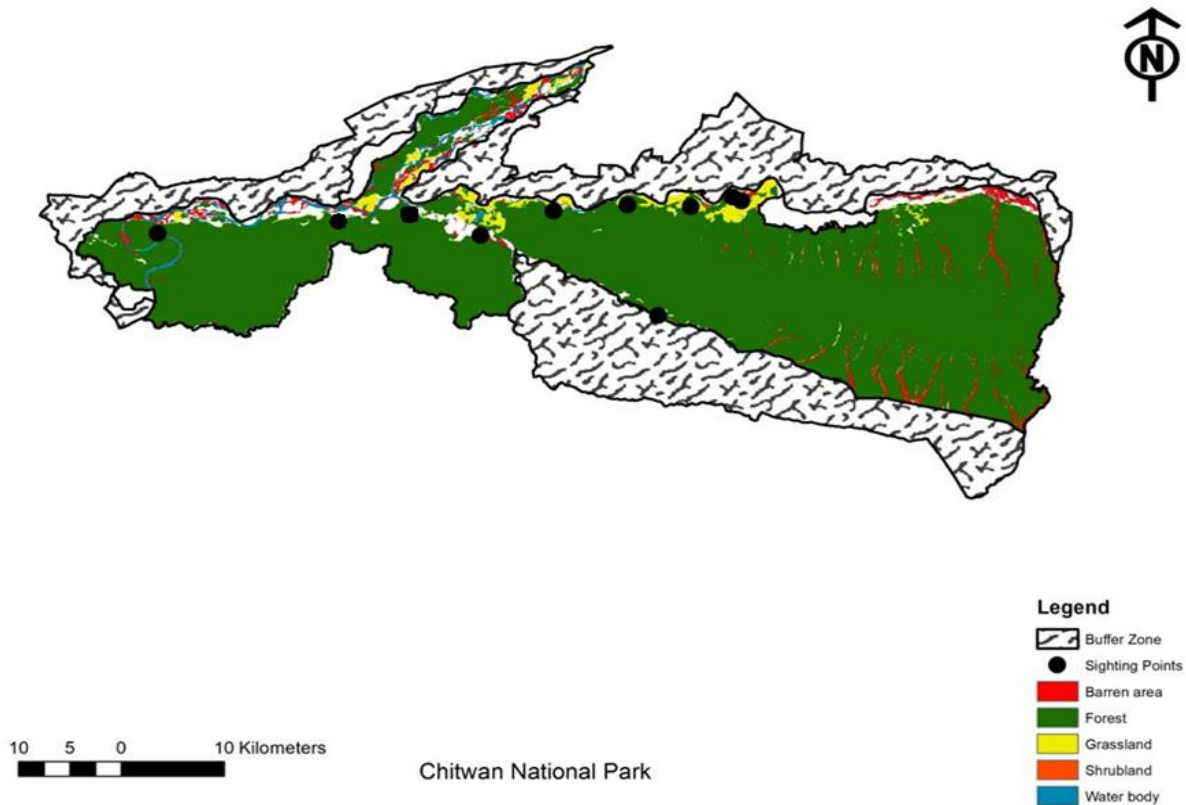


Figure 5: Map showing distribution of Great Hornbill in different parts of the Chitwan National Park.

### 4.3 Population estimation

A total of 21 individuals of Great Hornbill were recorded during winter survey whereas 30 individuals were seen in summer. Among the 14 surveyed transect, hornbills were observed in 11 transect (Table 3). A total of seven flocks including four in winter and three flocks in summer season were recorded (Table 3). The flock size ranged between 3 (T5 and T8) to 6 individuals (T4 and T12). The crude density of GH was 0.03 individuals/km<sup>2</sup> and 0.18 individuals/km<sup>2</sup> respectively in CNP. There was no significant difference among individuals recorded in two different seasons and habitats ( $t = 1.9468$ ,  $df = 14$ ,  $p = 0.07191$ ).

Table 3: Flock size and sex composition of Great Hornbill.



Transect	Winter					Summer				
	Flock	Total	Male	Female	M:F ratio	Flock	Total	Male	Female	M:F ratio
T1	0	0	0	0	0	0	0	0	0	0
T2	0	0	0	0	0	0	2	1	1	1
T3	0	0	0	0	0	0	0	0	0	0
T4	0	0	0	0	0	1	6	4	2	2
T5	1	5	3	2	1.5	1	4	2	2	1
T6	0	0	0	0	0	0	2	1	1	1
T7	0	0	0	0	0	0	2	1	1	1
T8	1	5	3	2	1.5	1	4	2	2	1
T9	0	0	0	0	0	0	2	1	1	1
T10	1	5	3	2	1.5	0	2	1	1	1
T11	0	0	0	0	0	0	2	1	1	1
T12	1	6	3	3	1	0	2	1	1	1
T13	0	0	0	0	0	0	0	0	0	0
T14	0	0	0	0	0	0	2	1	1	1
<b>Total</b>	<b>4</b>	<b>21</b>	<b>12</b>	<b>9</b>	<b>1.33</b>	<b>3</b>	<b>30</b>	<b>16</b>	<b>14</b>	<b>1.14</b>

Seven flocks with 35 individuals of hornbills were seen in seven transects and flock size ranged between 3 and 6 individuals (Table 4).

Table 4: Flock with maximum and minimum flock in different transects.

Transect	Flock	Max. flock size	Min. flock size	No. of Individual
T4 T5 T8	3	6	3	14
T5 T8 T10 T12	4	6	3	21

Hornbills were not equally distributed among the transect in the winter season ( $t = 2.1026$ ,  $df = 14$ ,  $p = 0.05407$ ). Males were abundant both in winter and summer seasons than female (Fig.6). The sex ratio significantly difference in transect, in winter the average sex ratio (male: female) were 1.33:1 whereas in summer the average sex ratio were 1.14:1 respectively.

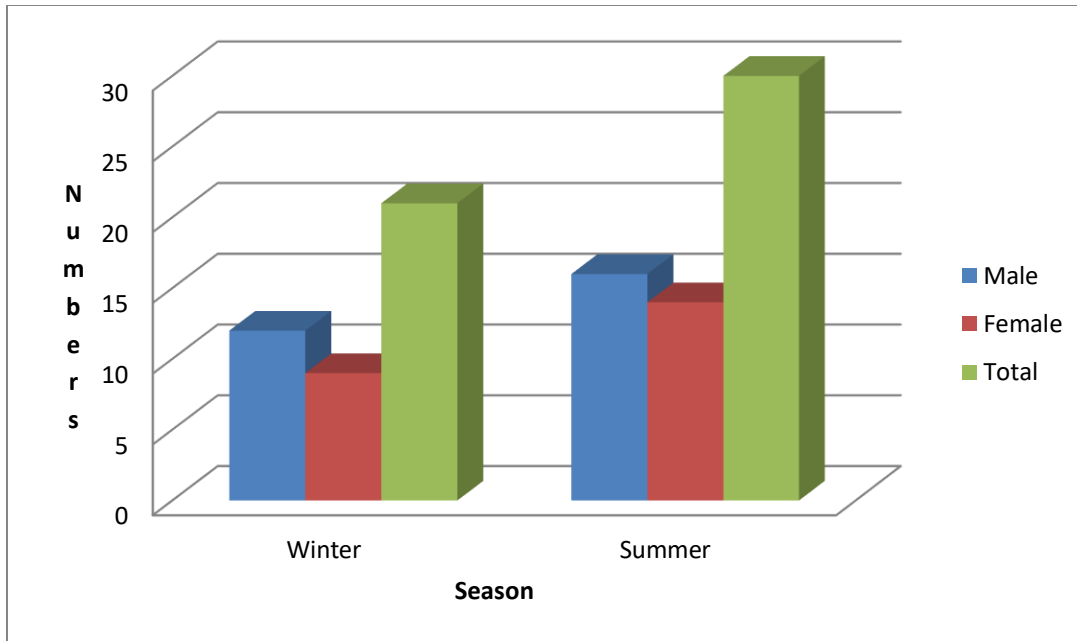


Figure 6: Sex wise population of Great Hornbill in two different seasons.

#### 4.4 Threats of GH

A total of 100 respondents were selected to assess their perceptions on the possible threats to GH of Chitwan. Out of total respondents, 60 were the nature guide and remaining 40 were the local people from different location namely Sauraha, Amaltari and Madi. Majority (60%) of respondents perceived habitat loss was major threats followed by human disturbances and poaching (Fig.7). Both field survey and questionnaire survey identified forest fires, floods and heavy wind were also threats to loss of nesting and foraging trees in different parts of the park. Other threats for GH observed during the field survey were human disturbance.

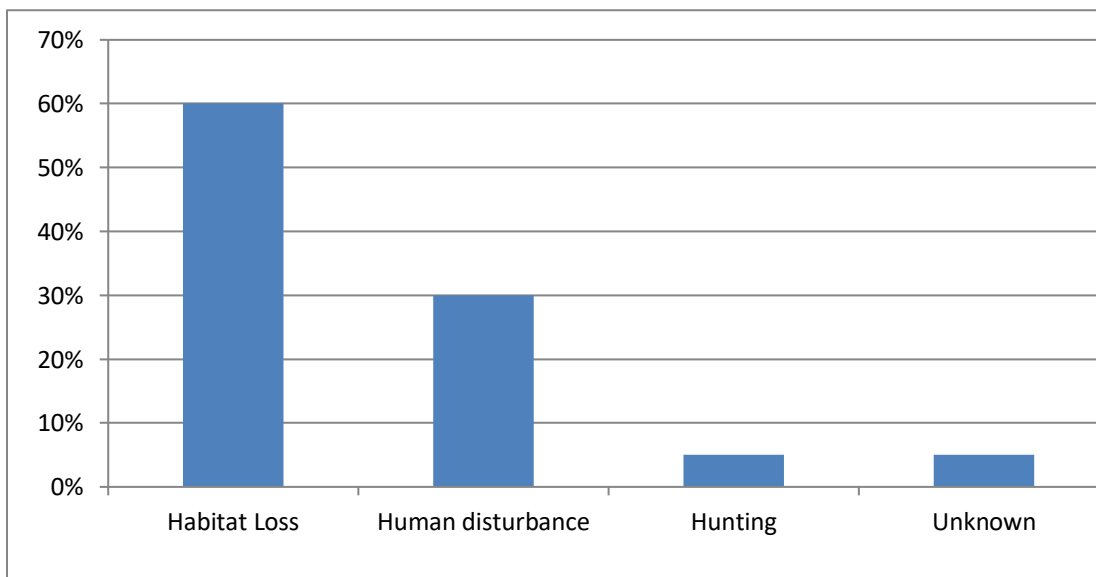


Figure 7: Perceived threats of Great Hornbill in Chitwan National Park.

## 5.DISCUSSION

In the past, there was no report of Great Hornbill abundance from the Chitwan National Park. From the limited data set it is probably not appropriate to generalize patterns in the abundance of this species. However, a clear result is the overall higher abundance of the Great Hornbill, in riverine forest than Sal forest.

### 5.1 Habitat use by GH

Utilization of different habitats was found to be statistically insignificant. The result of this study revealed that the higher numbers of Great Hornbills were recorded in riverine forest than Sal forest. The higher abundance of fruiting trees species (example, *Ficus spp.*, *Dysoxylumbinectariferum* and *Bombaxceiba*) in the riverine forest has significantly contributed higher abundance of the GH in riverine forest. Very few fruiting trees were recorded in Sal forest where lower numbers of hornbills were recorded. Similar trend of higher number of GH in forest with higher frequency of fruiting trees such as Lauraceae, Myrtaceae, Myristicaceae and Fagaceae were recorded in Arunachal Pradesh, India (Datta 2008). Therefore, abundance fruiting trees greatly affects the habitat use of the GH.

Diet selection has a great impact on the daily activity budget, foraging strategy and territorial behavior of GH (Kinnaird and O'Brien, 2007). The lipid-rich fruits include those in the genus *Knema* and *Myristica* commonly known as nutmeg trees, and several in the family Lauraceae such as *Beilschmiedia* (Kitamura, 2011) are important determinant for the distribution and abundance of the GH. The lipid-rich fruits may be available throughout the year; they are particularly abundant during the breeding season.

In Chitwan, the figs frequencies were higher in the riverine forest than in Sal forest may have resulted in the higher abundance of the Great Hornbill in the riverine forest. The GH probably follow food resources such as ephemeral fruiting figs in which there is intra-tree synchrony in ripe fruit abundance and hence their movements are dictated by the local availability of fruiting trees at a given period of time. Suryadiet *al.* (1996) predicted that hornbills ranging is influenced by the availability of figs fruit. Chaudhary (1998) recorded higher number of GH in Sal forest in the eastern part of the CNP. But it is not wise to compare that survey with the present study because studies are not in the same area and methodologies are also different. Previous survey was during breeding season, at that time GH are mostly nest in Sal forest.

### 5.2 Distribution of GH

Great Hornbill was recorded from different parts of the Chitwan National Park; mainly in riverine habitat. Majority of hornbills was recorded from south west part of the national park which categorized by diverse habitats. Eastern part of the park seems to be lower abundance of

great hornbill as well as the northern part too. The higher proportion of GH was seems to be in riverine forest (60%) than in Sal forest (40%) in summer season. Likewise 75% in riverine than 25% in Sal forest in winter season. Figs densities are reportedly an important determinant of Great Hornbills abundance. Figs fruits are an important component of hornbill diet (Lambert, 1991; Kannan, 1994).

The distribution pattern of Great Hornbill was uniform within the study area. Bibby *et al.* (1998) suggested that the uniform distribution of the bird is possibly related to the uniformly distributed resources, but in Chitwan the patches of fruiting trees are aggregated more in riverine forest than in Sal forest. Similar observation was made by Chaudhary *et al.* (2007) working outside the park and observed 63 Great Hornbills in Namuna Buffer Zone Community Forest of CNP, Nawalparasi district. Likewise Bidari *et al.* (2013) also recorded 54 Great Hornbill in the western part of national park. So, the western part of the national park is the suitable habitat for the Great Hornbill. The riverine types of habitat which supports large number of fruiting trees are suitable foraging sites of these birds.

Great Hornbill was seen frequently flying back and forth between two habitat types i.e. riverine forest and Sal forest especially in the early morning hours and at dawn. No significant differences were found in both Riverine and Sal forest habitat. But study done by Datta (1996) in Arunachal Pradesh depict possibly low disturbance and availability of fruiting trees and nesting trees that Great Hornbill was significantly higher in unlogged forest than in other habitat.

### **5.3 Population status of GH**

The population of Great Hornbill in the Chitwan National Park was found an average of 25 individuals (30 in summer season and 21 in winter season respectively). Out of total transect (14) surveyed; only 11 transect supported GH. Higher abundance of Hornbills was observed in riverine than Sal forest, but no significant difference in both the seasons. Four flocks were observed in winter season whereas 3 flocks were observed in summer season. The male and female sex ratio was not significantly different in both the seasons. In summer it was observed that the hornbills are in the pairs as this is their breeding season and in winter they are more likely to aggregate associated with fruiting trees for feeding.

The abundance of this species tends to be correlated with the density of large and old trees for nesting. Indeed, recent work has shown a significant nesting preference for larger trees, usually in old growth forest (James and Kannan, 2009). Great hornbills are arboreal and live mainly in wet, tall, evergreen forests. Old growth trees that extend beyond the height of the canopy are preferred for nesting and the height of the tree and availability of natural cavities large enough to hold a female and her eggs are more important than the type of tree species (James and Kannan, 2009).

Setha (2007) recorded low densities of GH in forested hills of the south east Cambodia, but Datta (1996) found that the GH abundance was significantly higher in unlogged forest than in other forest in Arunachal Pradesh, India. Similarly, Gale and Thongaree (2006) reported that an insignificant difference in abundance of GH in different parts of Southern forest in lowland of Thailand with measuring the crude and ecological density was 0.08 ind/km<sup>2</sup> and 0.21 ind/km<sup>2</sup> respectively. Presumably lower densities in this case are the result of a combination of factors including the absence of particular habitat structure and food resources. The consistent population densities within protected areas in west and northeast India and Thailand between 1.3 and 4 individuals per sq. km respectively indicate that the population within these sites, given the approximate habitat that lies within the suitable elevation range, can be estimated on a precautionary basis at 23,000-71,000 individuals (Gale and Thongaree, 1991).

Poonswad and Tsuji (2008) also found the relatively low densities of GH successively year in Khoa Yai National Park, Thailand because of the threats by different tribal people in different areas of the Park. The abundance of this species tends to be correlated with the density of large trees and therefore, large trees are most common in unlogged forest. Recent work reported, the species is usually seen in small parties with larger groups sometimes aggregating at fruit trees in Anamalia foothills of southern India (James and Kannan 2009). No seasonal differences in the abundance were observed because this species are resident and seasonal migration not occurred. Das (2014) also reported insignificant difference in seasonal abundance of GH in forest areas of Nameri National Park, India as the GH is local resident bird which no alters in seasonal variation.

Present estimation of crude density 0.18 individuals/km<sup>2</sup> of GH was low in comparison with other sites. Kannan and Mudappa (2009) reported low densities (0.5-2.3 birds/km) of GH in all sites in Western Ghats, India. Thus from the overall findings and research, the reasons for lower densities of GH were possibly the result of lower abundance of lipid rich food resources but other factors need further investigation. For instance, comparing data on adult sex ratios just prior to and during the breeding season and availability of nest sites, one can estimate the proportion of breeding females in the population.

#### **5.4 Threats of GH**

Local people perceived habitat destructions and human interference were main threats but habitat loss is not the issue in the Park. Loss of fruiting and nesting trees by flood and wind may be the issue. It was difficult to obtain information, but some people may be involved in hunting or trapping the GH. Villagers around the CNP enter the Park illegally for fodder, fuel wood and other forest products collection.

Datta (2004) reported collection of old logged trees is a cause of habitat loss. Even in Chitwan, the villagers enter the Park for hunting hornbills and local trade on hornbill's beak (Chaudhary, 1998). Similar report is available from India too ( Datta, 1998).

Hunting and poaching is considered as the major threats to the GH throughout the world, but poaching seems to be in lower (Figure 8) in CNP. These types of perception also exists in Cambodia (Tan Setha 2000) where GH was significant declines in recent decades by logging and hunting for the illegal trade in local markets.

Another threat for GH in Chitwan National Park was found that large numbers of tourist visited inside the Park as jeep safari which directly hinders the GH activities. The unwanted noise by jeep and tourists might disturbs the foraging activities of many birds including GH as maximum numbers of the fruiting trees are located in the trails.

## **6. CONCLUSION AND RECOMMENDATIONS**

### **6.1 Conclusion**

Great Hornbill is widely but sparsely distributed in the CNP and the distribution pattern was found to be uniform due to the availability of food resources mostly in Riverine forest and large nesting trees in the Sal forest. From the intensive study area, a total of twenty-five hornbills were recorded in 11 different transects and maximum of six and minimum of two hornbills were observed in the majority of transects. Among transects in CNP, maximum birds were recorded from Amaltari to Kasara transects and found absence in Trivenighat to Baaguwan Post transect. Insignificant difference was found in between male and female ratio. Bird was recorded in both seasons where higher number of bird was found in summer season than in winter season. Higher number of GH was recorded in riverine forest than compared with Sal forest. Great Hornbills are highly abundant in the western part of the park than the eastern and northern part. Habitat loss due to flooding and cutting of old Sal trees were the major threats of GH.

### **6.2 Recommendations**

On the basis of this study, following recommendation suggested.

- The present survey had not covered all the area of CNP and further explorations are required to understand distribution, abundance and habitat relation of this species.
- The relationship between distribution of GH and fruiting phenology of trees species is very interesting and important behavior which should be studied for the habitat preference.
- The GH is under threats; therefore conservation awareness program should be launched among the students and people nearby the Park.



## **Annex I**

### **Questionnaire Set**

Name:..... Age..... Sex: M/F Date:.....

Occupation:..... Address:.....

1. Have you ever seen Great Hornbill? How does it look like?

- a) Yes                                                  b) No

if yes, please describe.....

2. Where did you see it? Place/Habitat.....

.....

3. How frequently have you seen? (Write time and period)

- a) Daily at all time..... b) Sometimes at..... c) Once at.....

4. What is the size of flock you have seen?

- a) Single..... b) Flock.....( i. Adult....ii. Sub-adult.....)

5. Have you ever heard the calling Hornbill?

- a) No                                                  b) Yes

If yes, at what time (, morning, noon, evening)?

6. Do you know the current status of Great Hornbill?

- a) Yes (about)                                                  b) No

7. If there is any value or use of Great Hornbill?

- a) Yes b)

If yes, then what are the uses?..... (General)

- i) Commercial trade ii) Medicinal  
iii) Mythological iv) Others

8. Whether there is any harm by this bird related with your livelihood?

- a) No b) Yes

If yes, then what are they?..... (General)

Specify.....

9. Do you think this bird is important?

- a) No b) Yes

If yes, then what are they?..... (General)

Specify.....

10. Is there any relation with the ethnicity/ community/ religion/ tradition etc?

- a) Yes b) No

If yes, then what are they?..... (General)

Specify the relation.....

11. What you think, whether population of the bird is increased recently? Why?

.....

12. If increased, what may be the cause? .....

a) Commercial trade    b) Hunting for meat    c) Habitat loss    c) Others

13. What should be done for the Protection of this bird?

a) Awareness    b) Strengthening the legislation    c) Others.....

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