Present distribution, status, and ecology of White-winged Wood Duck and Hornbills in Nameri National Park, considering the tropical forest disturbances of Assam

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Abstract

Present distribution, status, and ecology of White-winged Wood Duck and Hornbills were studied in Nameri National Park from 1997 to 2000. The estimated ecological density of White-winged Wood Duck was 1.55 indivi-duals/km^2 and crude density was 0.2 individuals/km^2. Major causes of mortality of the White-winged Wood Duck were hunting and collection of eggs and chicks. A major threat to the population was the cutting down of dense vegetation including trees in the vicinity of wooded streams. Four species of hornbills were recorded in Nameri National Park viz., Great Hornbill, Wreathed Hornbill, Oriental Pied Hornbill and Rufous-necked Hornbills. The study showed that the food plant species and nesting trees of Hornbills have drastically declined in Nameri National Park, especially near Potasali Forest Camp, along the stretches of Bordikorai River, Nameri and Khari-Bogijuli Forest Camp owing to anthropogenic causes. The recorded nesting tree of Hornbills was *Tetrameles nodiflora* and the major food plant species of Great Pied and Wreathed Hornbills were *Amoora wallichii* and *Dysoxylum procerum* etc., whereas, it was fig trees for Oriental Pied Hornbill. The hunting of hornbills in their nest den and foraging sites for their lucrative meat is the major concern for species conservation.

Introduction

The state of Assam has several endangered species of mammals, birds, reptiles and amphibians. Five National Parks and 19 Wildlife Sanctuaries have been declared in various areas of Assam to protect wildlife of conservation concern. These protected areas also sustain large numbers of migratory and residential avifauna. Avian fauna can be good indicators of biodiversity (ICBP, 1992), useful for monitoring environmental changes (Furness *et al*., 1993), and suitable indicators that respond to disturbance (Askins *et al*., 1990). However, the effect of disturbance on tropical birds have not been studied thoroughly (Bierregaard and Lovejoy, 1989; Kattan *et al*., 1994), some of the tropical birds species, for example White-winged Wood Duck - *Cairina scutulata*, many other endemic species like *Arborophila mandelii*, *Heterophasia gracilis, Yuhina bakeri, Spelaeornis longicaudata, Brachypteryx hyperythra* and Hornbill species such as Rufous-necked Hornbill *Aceros nipalensis* and Brown Hornbill-*Anorrhinus tickelli* etc. are even more threatened due to forest degradation than any other forest birds.

The historic distribution of White-winged Wood Duck (WWWD) extended from North-east India, through Bangladesh, Myanmar, Thailand, Laos, Vietnam, Cambodia and Malaysia to the Indonesian Islands of Sumatra and Java. It now survives in relatively few pockets having disappeared from much of its previous range (Birdlife International, 2001). Hence, this species is endangered because it has very small, rapidly declining, severely fragmented population owing to deforestation, wetland drainage and exploitation (Birdlife International, 2001). Various studies has been carried out on the aspects of distribution and ecology of White-winged Wood Duck across the South and South Asian countries by several workers (Chaudhury, 1993a, b, 1995; Das, 1995; Drilling, 2000, 2001; Evans and Timmins, 1994; Green, 1992a, b, c, 1993 a, b, Lambert, 1988; Parr *et al.,* 1993; Talukdar, 1994, 2003; Talukdar and Bhattacharjee, 1995a, b) in recent years. Similarly, the Rufous-necked Hornbill is primarily threatened by the pervasive combination of habitat loss and

Plate 1: Important habitat of White winged Wood Duck (a) Kurua Beel (b & c) Balipung Tower area

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Plate 1: (d) Balipung Tower area (e) White Winged Wood Duck in Nameri NP.

hunting pressure and susceptibility to this factor is manifested in its disappearance from many suitable areas in which it once widely occurred (Poonswad and Kemp, 1993).

It is well known fact that, the conservation of Biological diversity in tropical forest ecosystem is under threat throughout Southeast Asia owing to various anthropogenic problems (Byron and Gillman, 1998; Willot *et. al.,* 2000; Hill *et al.,* 2001). The most widespread human related problems of tropical forests such as encroachments of forest land, selective logging and shifting agriculture caused the forest disturbance that leads to open up the canopy (Hill *et al.,* 2001). As forest landscapes become increasingly disturbed, ecosystem inputs and outputs are altered, and previously existed core habitats become exposed to external conditions, all of which results in a progressive erosion of biological diversity including avian diversity (Castelletta *et al*., 2000; Terborgh and Winter, 1980; Tilman *et al.,* 1994). The creation of rapid forest edges exposed to open habitats can severely modified the local microclimatic conditions, increasing tree mortality and promote the establishment of non-forest species (Lovejoy *et al.,* 1986; Kapos, 1989; Laurance *et al*., 1998; Tabarelli *et al.,* 1999). Again, it is asserted that the avian faunas are the convenient indicators of biodiversity (ICBP, 1992) and also useful for monitoring environmental changes (Furness *et al*. 1993). Again, the avian communities are suitable subject for the study of community response to disturbance. For birds, studies in North America have generally indicated that forest birds, especially forest interior species are vulnerable to destruction of breeding habitat (Askins *et al.*, 1990). Some of the tropical birds species, for example *Cairina scutulata*, many other endemic species such as *Arborophilla mendalai*, *Heterophasia gracilis, Yuhina bakeri, Spelaeornis longicaudata, Brachypteryx hyperythra* etc*. are* critically forest dependent species and Rufous-necked Hornbill *Aceros nipalensis,* Great Hornbill-*Buceros bicornis,* Oriental Pied Hornbill-*Anthracoceros albirostris*, Wreathed Hornbill-*Aceros undulatus* and Rufous-necked Hornbill (*Aceros nipalensis)* etc. are even more vulnerable to forest destruction than any other forest birds. Responses of birds to such habitat modification vary among species with some forest bird species suffering from increased level of nest predation and brood parasitism (Brittingham and Temple, 1983; Donovan *et al.,* 1995; Robinson *et al.,* 1995). These forest dependent species are threatened and sensitive to global extinction as the closed tropical forests are disappeared 4.7 million hectares every year since 1990 and that could be predicted extinction of 1-10 % biodiversity in the next coming 25 years (Thiollay, 2002). Thus it needs to be local monitoring of key forest dependent species to highlight their conservation threats, scope for conservation and assessment of population status. Many tropical forests in recent decades, the formation of artificial forest gap owing to extensive tree felling are much higher in rate than it could be predicted. This is particularly true for the smaller pockets of tropical rain forests of North Eastern India, especially in Assam, where local tree poachers throughout the state formed most gaps due to selective logging since 1990. In Assam alone, almost 60% primary Reserve forest has been logged till 1994 and 80% has been completely razed till date by the regional tree poachers owing to earning easy money, heavy population explosion and unplanned developmental project. Available reports indicated that, till 2006, almost 18,640 hectares area lie encroachment in 10 National Parks and Wildlife Sanctuaries of Assam (e.g. Burhachapori WLS, Laokhowa WLS, Sonai Rupai WLS, Nameri NP, addition to Kaziranga NP, Manas NP, Barnadi WLS, Dibru-Saikhowa BR, Orang NP and Pobitora WLS) of which highest settlers are found in Burhachapori and Sonai Rupai Wildlife Sanctuaries (report from Assam Tribune, 16 September, 2006). Therefore, it is a fact that, the survey of potential habitat sites and species abundance of regional threatened species are need to be highlighted to initiate species oriented conservation initiation for our future generation.

The main objectives of the study were as follows:-

1. To find out the local abundance, distribution status and ecology of the White-winged Wood Duck and various Hornbills species in Nameri National Park.
2. To identifying the potential threats for the species and its possible conservation measures.

Study Area
The Nameri National Park is (27º35´- 26º50´ N and 92º39´- 93º0´E) situated about 40km. distance from the Tezpur cosmopolitan centers of Sonitpur district on the north bank of river Brahmaputra, Assam. It is a fraction of Naduar Reserve Forest, the oldest reserve forest of Assam, constituted in 1878 (Das, 1998). The forest area is unique for its topographical position, with undulating terrain and streams and river networks. It is a narrow strip lying between Kameng district of Arunachal Pradesh and the river Brahmaputra. It is bounded on the north by the Kameng division and east by Lakhimpur district and south by Naduar Reserve Forest of Sonitpur district. The gradient of the plain is slightly high along the foot of the Himalayas, which fall in a narrow strip of 1-5km all along the northern boundary in east-west direction. The belt is covered with very dense tropical forests. The terai belt is extremely flat and contains intermittent swamps. The terrain plain is chiefly composed of tall grassland. To the south of the terrain belt lays relatively highland with east-west alignment. The area is criss-crossed by the river Jia Bhoroli and its tributaries including many small and medium sized streams (locally known as nallas). The soil type of Nameri National Park is mostly of sub-montane. The detailed habitat characteristic of Nameri National Park has been studied by Saikia and Saikia (1999) and the forest is mainly moist mixed semi-evergreen forest. The climate of study area can be characterized by high humidity and copious rain. The season can be classified into pre-monsoon (March–May), monsoon (June-Sep.), retreating monsoon (Oct. & Nov.) and winter (Dec.-Feb.). Average annual rainfall in the study area from 1971-1998 is 2,141mm (data were collected from the environmental department, Gauhati University, Assam, India). More than 70% annual rainfall is received in the study area from May to September. The overall temperature variation between summer and winter is 36ºC (sunny days of July-August) to 11ºC (December and January).

Methods
The study has been carried out from 1 October 1997 to 30 April 2000, in Nameri National Park, Sonitpur, Assam. The following methodologies has been adopted for collecting the necessary data for the works

a. Study design
For convenience, three major camping stations were pre-selected in Potasali, Bogijuli and Sijusa (Figure 1 for locations) within the park area. From Potasali camping station, the study sites of Potasali through Doigrung, and Bhalukpung area were covered. Again, the study area from Potasali to Bogijuli, which includes the area of Balipung, Khari, Tomaljuli and Bagijuli were covered from the Potasali station. The Sijusa camping site helped to conduct the survey in the area between Pakhui, Bogijuli, and Khari. Centrally, the Bogijuli camping station helped conduct detail investigation of the area.

b. Survey
Most of the field trips were made on foot, but few elephant rides and rafting trips were also undertaken, especially during survey in dense forest and river tract. Altogether eight field trips with average eight days per trip were made covering different seasons of the year during whole study period. Bird surveys were undertaken during three time periods: (1) morning (before sunrise to 11:00 hours), (2) afternoon (14:30 to 18:00 hours) and (3) evening (18:30 to 21:00 hours). Occasionally, these time samplings were not followed when covering long transect by foot by day (e.g. 10-12 km/day etc.). Line transect and point count methods were used to collect the distributional status and habitat characteristics data of birds species following Bibby *et al*. (1992) and Gaston (1975). Altogether 15 line transects with a length of 1-8 km and 30m breadth and 20 point transects with 30m radius were designed in terrestrial habitat to assess abundance of Hornbills and 25 line transact with a length of 1-12 km and 25 point transact were designed to covers streams, swamps and water-bodies for White-winged Wood Duck data collection. Apart from these all forest streams flowing through Nameri National Parks were also surveyed especially for White-winged Wood Duck. At dawn (before sun rise to 08:00 hours), the birds often move towards the open-nallas and streams close to forest and during midday they go into the dense forest nallas for hiding under cover, hence the survey was designed accordingly.

Data Collections
White-winged Wood Duck
To gather the White-winged Wood Duck distribution status and population abundance data in Nameri National Park, all swampy areas, nallas and 1st and 2nd order streams in the dense semi evergreen and evergreen forest were carefully surveyed and obtained data were collected and gathered. The number of White-winged Wood Duck encountered was noted down along with their GPS locations and their habitats characteristics. The habitat data were collected using the methods of Pope (1960) and Hays *et al.* (1981). GPS and Compass bearing was used to locate and relocate the site and measurements of the species distribution area. The locations were also plotted on a base map carried during survey periods and the habitat characteristics data were also noted down on the base map which was later finalized during the preparation of distribution map. Apart from that, the forest guards were also employed to record the number of White-winged Wood Duck sightings with date and time along with their locations during their regular field outings, later coordinates were taken if the bird was re-sighted by observers in specific locations during regular field trips.

Techniques for population and habitat data collections
All the nallas that entered into the dense forest or primary forest areas were carefully surveyed during dawn and dusk (as mentioned earlier) for successful White-winged Wood Duck records. It was significance to note that, the spotting and visualization of White-winged Wood Duck is very difficult task in their habitat if special care would not be taken. Thus, we walked very noiselessly in each steps and careful forward with strong vigil by three persons in an around the existing White-winged Wood Duck habitat locations. If suspect for bird existence, then stopped immediately and used pair of binoculars from a considerable distance to look around and confirmed it and then forward again. To cover maximum areas within a day, two groups with three persons (maximum) in each group were divided into separate directions of the selected survey areas and all observed birds were noted down separately by each observer. Special care was taken during the estimation of population data by the teams to reduce sample error of double counts. The numbers of White-winged Wood Duck sighted at time and its flushing direction away from the sighting locations were recorded by the team and later, the data were pooled together and finalized the total number. Percussions were taken to maintain the use of single day observation data for total population estimation. A maximum of three persons group in each field trip was found to be the best methods so we did, and most observation of the White-winged wood Duck was made through this, whereas, if more than three members were used, the birds were either flushed away before it could be sighted or overlooked. It was happened probably owing to broke down of calm and quite situation needed during White-winged Wood Duck survey.

Habitat Ecology and distribution map

For habitat data collections and distribution localities, a base map of the study area was prepared and used in each field survey period. For the preparation of base map 1:50,000 top-sheets of the survey area were used. A separate map was used every survey time by each group. Each bird sighted in the course of the observation was plotted on the map using a code and later a detailed distribution map was prepared. The total areas were measured using digital plane-meter to estimate the density of birds. The vegetation data of species location sites in Nameri National Park was recorded using a quadrate of 10m² in size and specific habitat characters were also noted down (also in descriptive way) and as well as plotted on the 1:50,000 top-sheets by using compass bearing and GPS.

Hornbill's data collection

Distribution of Hornbill species, their nesting sites and food plants were observed and recorded. The nesting trees of Hornbills species were located by following lone males from food sources to the spot in a specific hole bearing trees where they settled and then the possible nests were confirmed by regular monitoring the trees till it selected by bird for nest construction. Again, active nests were confirmed by fresh droppings, accumulation of nest debris and food regurgitates (as per Poonswad, 1995). Once the nesting trees were located, the nesting Hornbill species and trees were identified and monitored regularly. The birds were identified using the book of Ali and Ripley (1983) and plants species were identified following Kanjilal *et al.* (1934) and Kanjilal and Bor (1940). To identify the food plant species, the feeding flocks and individual birds were followed and later the fruit plants were identified using Kanjilal *et al.,* (1936, 1939). The Hornbill distribution localities, their nesting sites and distribution of food plant species were plotted in the base map.

Identification of different threat factors

Different threat factors were observed in the study area based on direct observation and interviewing with the forest officials and local people. The existing anti-poaching camps were visited and observed and review after discussion with the forest guards and officials. The probable measures were suggested for future conservation of the threatened wildlife species and its habitat in the park.

Data analysis

Habitat data of the birds were analyzed with the help of collected data and GIS software available in Assam Remote Sensing Application Centre (ARSAC). The overall vegetation was inventoried and analyzed using Land sat thematic and Indian Remote Sensing Satellite data sheet one for dry and one for wet period. Field study data of habitat classification were incorporated on the map using Geographical Information System algorithms to obtain habitat data and prepared habitat database maps. Habitat classification was done on visual basis with the help of GIS and later the habitat data map was prepared. Total distribution areas of White-winged Wood Duck and Hornbills species were calculated as square kilometer using digital plane-meter. Species-wise density and suitable habitat were calculated based on field observation and following Bibby *et al.* (1992). The formulae used for the calculation of ecological density and crude density of studied species was such as Ecological density = Actual species wise distribution area/total number of individual sighted and species wise Crude density = Total area of species specific habitat/total numbers of birds sighted [formulae used : $\mathbf{CD = A^{TH} / N^{T}}$, where, **CD** = Crude density, $\mathbf{A^{TH}}$ =Total study area, $\mathbf{N^{T}}$= Total numbers of individual sighted; $\mathbf{ED = A^{H} / N^{T}}$, where, **ED** = Ecological Density, $\mathbf{A^{H}}$ = actual total habitat area where species was sighted, $\mathbf{N^{T}}$= Total numbers of individual sighted]. The ecological density referred here is the number of animals in actual habitat area where the species was confirmed by sighting records during present observation and as well as historical reports, whereas, the crude density referred here is the total physical habitat of the study site irrespective of the species sighted (See Kahl, 1964, for Crude & Ecological density). To prepare the species distribution sites, the species specific distribution map was prepared based on GPS locations of the species within 50 meters accuracy. Paired sample t-test, Chi-square test and Kendall's (a) test were performed to analyse the data using SPSS Statistical software Version 11.0.1.

Results

White-winged Wood Duck -*Cairina scutulata*

Distribution

The study revealed that, of the total area surveyed in the park, the species was distributed in the park between the altitudes 93 - 110m MSL. Of the total 200km^2 area of national park surveyed, the only 25.66km^2 area was found to be the suitable for the White-winged Wood Duck, where water bodies and swamps were exists, that represented 12.8% of the total park area (Figure 1). The estimated ecological density of White-winged Wood Duck in the park is about 1.55 individuals/km^2 and the crude density was about 0.2 individuals / km^2. During present survey total of 45 individuals were sighted in 13 different locations namely Balipung tower nalla, Balipung, Kepkepi nalla, Kharimukh, Khari river, Upper Dikorai, Kaliajuli, Raidangjuli, Bogijuli, near Khari camp, Arasuti and Duimukh, of which, the species was highly concentrated in the locations within '26°58' N to 26°52'5"N and 92°50' E to 92°55' E' in Nameri National Park (Figure 1 & Table 1). Although it is quite authenticate to determine the accurate population data of wild White-winged Wood Duck in forest areas using radio-tracking and colour-tagging methods, but the population size could be estimated fairly accurately on the basis of

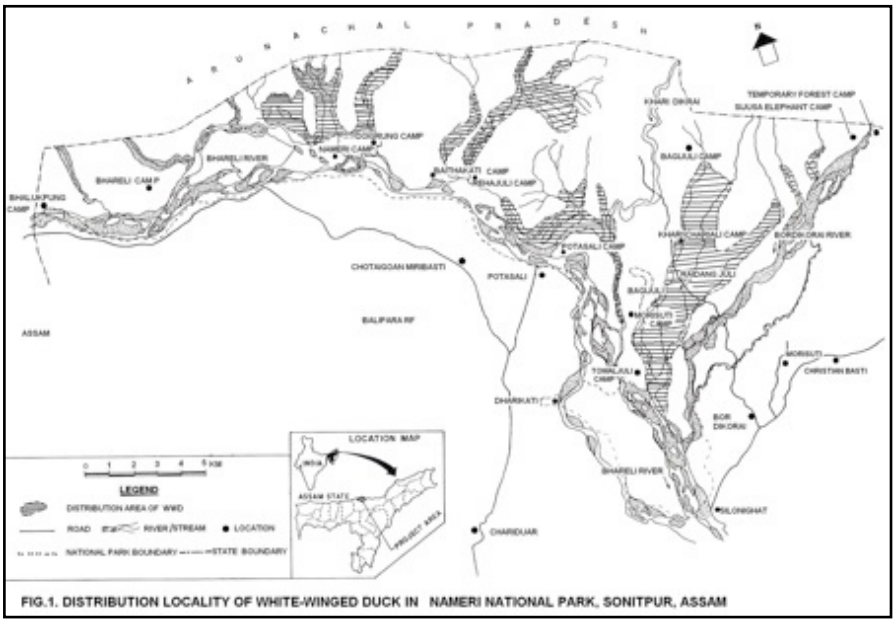

FIG.1. DISTRIBUTION LOCALITY OF WHITE-WINGED DUCK IN NAMERI NATIONAL PARK, SONITPUR, ASSAM

sighting and survey data. The estimated recent population of White-winged Wood Duck in Nameri National Park was 40 ±10 individuals, based on single day sighting data (Table 1). Most of the individuals were local migrants to the close by Arunachal Pradesh (Pakhui Sanctuary) and adjacent reserve forest of Sonitpur district of Assam. The White-winged Wood Duck was frequently observed to fly above the biotope of Nameri National Park towards the Arunachal Pakhui site or Chariduar area, almost every night or early hours of the day, while camping at Bagijuli, Khari and Sijusa forest camp.

Habitat preferences

The habitat preference of White-winged Wood Duck was mostly undisturbed streams, nallas, and swamps, in or nearby dense-mixed moist semi-evergreen forest patches (Figure 1; Plate1). Analysis of X^2 Goodness of fit between the habitats of Dense nallas, Nallas near dense forest, undisturbed open nallas near dense forests, open water wetland and open nallas near scrubland showed that there was a significance differences of habitat used patterns of the WWWD in open water wetland and nallas near disturbed scrubland habitat with others. (χ^2 Goodness of fit: OWW: χ^2 =7.801, df=2, P= 0.02, n=11, Mean = 0.36±0.67SD; ONNSHR: χ^2 =7.364, df=1, P= 0.007, n=11, Mean = 0.0909±0.30 SD; Table 2). Occasionally, the birds were observed to feed and roost in open nallas adjacent to the Khuti areas (domestic cattle camp within the park) and forest camp at very early morning and spend long duration there, if they were not disturbed. Both stagnant and as well as flowing water streams, canals and swamps were used by the bird as roosting and feeding habitats. But streams, flowing through the dense semi-evergreen forest areas with adequate vegetation cover near the forest edges, were the most preferred habitat sites for the White-winged Wood Duck. The analysis of habitat used pattern of WWWD showed that, the dense Nallas and Dense swamps habitat use was highly significant (Paired Sample t-test between habitat: DN-OWW= mean: 3.63±1.43SD, t=8.4, df=10, p = .0001; DN-ONWSHR = mean: 3.90±1.45, t =4.88, df=10, p=0.0001; OWW-DSW= mean: -2.36±3.32, t=-2.35, df=10, p=0.040; DSW-ONNSHR = mean: 2.64±3.26, t=2.68, df=10, p=0.02; Kendall's W(a) test = Kendall's W(a) =.680, Chi Square =37.393, df=5, Asymp Sig: P =.0001) Nesting activity or nesting were not observed but female bird with 11 nestlings during July was sighted in Kurua beel, where Swamp forest patch (dominated by *Salix tetrasperma*) was found. A deserted nest was also observed on a dead tree at Raidangjuli.

Hornbills

The study revealed the presence of four Hornbill species in Nameri National Park, such as Great Hornbill (*Buceros bicornis)*, Oriental Pied Hornbill (*Anthracoceros albirostris)*, Wreathed Hornbill *(Aceros undulatus),* and Rufousnecked Hornbill (*Aceros nipalensis)*. Wreathed Hornbill was commonly distributed throughout the park and adjoining reserve forest areas, but more frequently been sighted above the altitude of 93 m MSL. The Rufous-necked Hornbill was very rare in sightings and only two pairs were sighted in two separate occasions near Bogijuli (at 190m msl) and above Khari River at 200 to 226 m MSL. The Oriental Pied Hornbill was fairly common throughout the study area and

Table 1. Numbers of White-winged Wood Duck sighted in Nameri national park boundary during past (from 1992-1997) and currently studied transacts and also showing the population decline and habitat shrinkage trends (e.g. transacts were laid, based on formerly recorded sites and as well as in new sites).

Sl. No.	Site Name	Latitude	Longitude	Past sightings (1992-1997)	Current sightings (1998-2000)
1	Kharimukh	26º56´40"-26º57´55"	92º52´00"-92º52´30"	4	3
2	Duimukh	26º58´50"-26º59´00"	92º48´45"-92º50´00"	6	1
3	Khari river, near Marisuti	26º53´52"-26º55´00"	92º51´20"-92º51´50"	6	1
4	Arasuti	26º56´40"-26º58´10"	92º50´00"-92º52´30"	8	3
5	Balipung Nalla	26º56´50"-26º57´45"	92º51´00"-92º51´30"	5	5
6	Upper Dikorai	26º59´30"-27º00´00"	92º48´45"-92º52´33"	5	5
7	Kaliajuli	26º52´00"-26º56´10"	92º55´00"-92º56´21"	-	2*
8	Kurua beel	26º55´00"-26º55´50"	92º51´16"-92º52´29"	1	12
9	Balipung Tower nallah	26º56´40"-26º57´00"	92º51´30"-92º51´55"	2	2
10	Kepkepi nalla near Balipung	26º56´40"-26º57´20"	92º50´00"-92º52´15"	2	5
11	Near nameri camp	27º00´00"-26º59´30"	92º46´15"-92º47´30"	2	1
12	Raidang Juli	26º54´00"-26º55´00"	92º52´30"-92º55´10"	-	2*
13	Bagijuli	26º56´40"-26º57´10"	92º53´50"-92º54´00"	-	3*
14	Khuti near Kharimukh	26º56´50"-26º57´10"	92º52´00"-92º52´20"	2	0
15	Magurmari beel	--	--	4	0
16	Hatiduba beel	--	--	1	0
17	Thirteen Miles	27º00´00"-27º55´00"	92º45º00"-92º46º02"	2	0
18	Khari suti	----------	----------	3	0
19	Kachadhara beel	26º55´00"-26º55´30"	92º52´3"-92º52´45"	1	0
20	Behind Potasali camp	26º55´50"-26º56´00"	92º50´00"-92º52´30"	3	0
21	Near Buffalo khuti	26º56´40"-26º58´10"	92º51´16"-92º52´30"	1	0
22	Near Khari Chariali	26º55´00"-26º56´40"	92º53´45"-92º55´40"	2	0
23	Near Sukan nala	26´56´40"-26º56´45"	92º50´54"-92º50´59"	2	0
24	Doigrung nalla	27º00´00"-27º01´50"	92º45´00"-92º48´45"	3	0
25	Dopholagarh boundary	26º52´40"-26º53´00"	92º51´25"-92º52´45"	2	0
Total				67	45

'*' marks in parenthesis indicated the recently sighted area at Nameri NP.

Table 2: Analysis of Habitat preferences of WWWD using χ^2 Test Statistics among six different habitat studied ((DN: Dense Nallas; NNDF: Nallas near Dense forest; OWW: Open Water Wetland; Dense Swamps; ONNSHR: Open nalla near disturbed Scrubland habitat; ONNDF: Undisturbed Open nallas near Dense Forest).

	DN	NNDF	OWW	DSW	ONNSHR	ONNDF
Chi-Square(a,b,c,d,e)	5.818	3.727	7.818	4.909	7.364	3.182
df	4	5	2	4	1	3
Asymp. Sig.	.213	.589	.020	.297	.007	.364

a 5 cells (100.0%) have expected frequencies less than 5. The minimum expected cell frequency is 2.2.
b 6 cells (100.0%) have expected frequencies less than 5. The minimum expected cell frequency is 1.8.
c 3 cells (100.0%) have expected frequencies less than 5. The minimum expected cell frequency is 3.7.
d 0 cells (.0%) have expected frequencies less than 5. The minimum expected cell frequency is 5.5.
e 4 cells (100.0%) have expected frequencies less than 5. The minimum expected cell frequency is 2.8.

large numbers of individuals were encountered in moist semi-evergreen forest within the range of Bogijuli, Morisuti, Khari, and Tomaljuli forest camp and as well as the length of forest patches of Khari and Bordikorai River bank.

Great Hornbill-*Buceros bicornis*
Distribution
The Great Hornbill (*Buceros bicornis*) was commonly distributed all through the park and adjoining reserve forest areas, but more often been sighted at or above the altitudes of 93 m MSL. During dusk, six to seven pairs were regularly seen flying towards the Potasali Range area (Figure 2) and roost on *Ficus benghalensis*, *F. religeosa* and *Bombax ceiba* trees, whereas, majority of them were seen to fly above the park biotope towards the heart of forest and towards the Pakhui Wildlife Sanctuary, Arunachal Pradesh. Great Hornbills were quite shy and generally found to forage in small flocks of 2-7 birds in a specific location. While large flocks were not sighted, the status of this species was common in study area. Almost 18.6 km^2 area of the park was found to be more suitable for the species, where the flocks were frequently observed in those areas (see Figure 2 for Hornbill available area). The habitat was a mixed moist semi-evergreen forest with a vegetation density of 60%. The dominant food plant species of high species sighted area were different, such as *Ficus* ssp., *Dysoxylum hamiltonii* Hiern and *Amoora wallichii* King etc.

Ecology
The Great Hornbill preferred the mixed moist semi-evergreen forest patches for foraging and nesting, wherever vegetation density was 40-60 (Figure 2). In general, Great Hornbills were distributed in the forest patches with plenty of edible wild fruiting trees. Occasionally, they even travel longer distance for food searching, but returned to their definite roosting sites at late afternoon. It was confirmed when we have regularly seen to returned from their destination beyond 5km aerial distances. It was also observed that, at early in the morning, foraging flocks starts feeding on close by roosting sites and then slowly dispersed to the dense forest.

The bird using the same nest hole in preferred nesting sites for successive years. The most preferred nesting trees of Great Hornbill was *Tetramelos nodiflora* R.Br., the tallest and huge trees within forest structure (Figure 2). Of the total nine Great Hornbill nests located so far, seven of them were observed within Nameri National Park in Sijusa and Bogijuli forest camp, whereas, others were located outside the study area. The nests outside the study area were located on the tree holes of *Ficus religiosa* L. in Naduar Reserve Forest. The major nesting site was positioned in the northeastern boundary of the study area adjacent to Pakhui Sanctuary (Figure 2). Apart from this nesting site, the Great Hornbill was also reported to nest all along the Assam-Arunachal border, from the Arunachal Khari camp to Nameri River. The Great Hornbill construct nests in the tree hole at the top most portion of the tree trunk. It was found that, the spotting of Hornbill nest was very effortless in forest areas, because, the food droppings were common in the underneath zone of the nesting trees**.** The Valew trees-*Tetramelos nodiflora* R.Br. associated with food plant species were found to be very common in Nameri National Park, particularly near Sijusa, neighboring the Pakhui Sanctuary. We also found that, the mature Velew trees supported holes on the top most parts of tree trunk in all occasions, but, the Hornbills were never used each and every hole as their nest. They have maintained an average distance of 66 ± 17.46 meter (n = 14, range 50-100m) between two nests.

The major food plant species of Great Hornbills (almost all hornbills) were Ameri -*Amoora wallichii* King (Ameri), *Amoora rahituka* (Roxb.)W.&A. *(*white Ameri) Bandardima-*Dysoxylum hamiltonii* Hiern*., Stixis scandens* Lour., Kari-*Engelhardtia spicata* Lechan ex. Bl.A and fig trees viz., *Ficus*

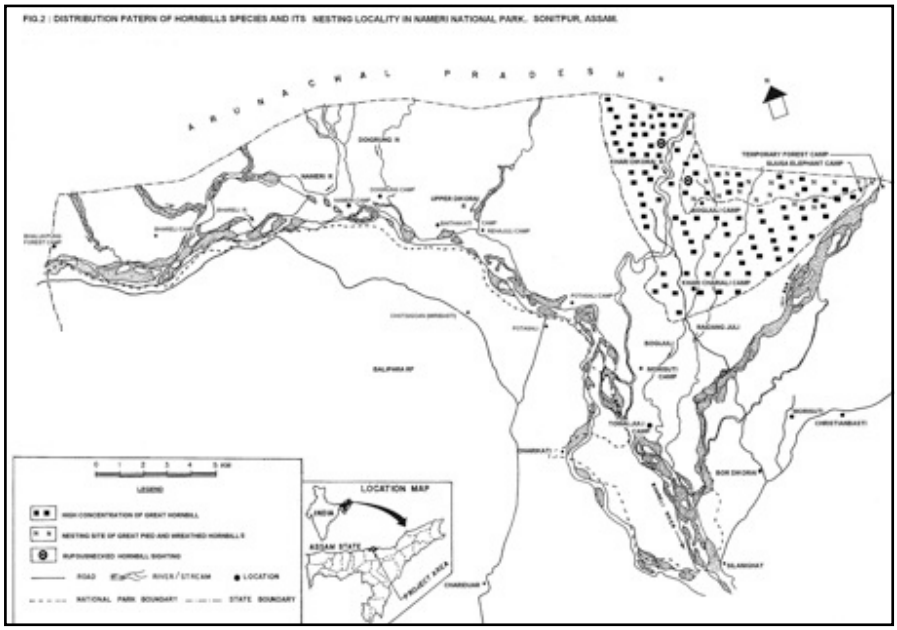

Plate 2: (a) Nesting tree and (b) Roosting tree of Wreathed Hornbill at Nameri NP.

benghalensis L.*, F. benjamina* L.*, F. hispidus* Vahl*, F. religiosa* L*, F. glomerata* Roxb.*, F. rumphii* Bl. etc. These plant species were distributed throughout the study area, but greatly concentrated close to nesting sites (Figure 2), hence it could be concluded that the nesting sites were concentrated near food plant species. The plant species *Amoora wallichii* King, *Ficus benghalensis* L., *F. benjamina* L.*, F. hispidus* Vahl*, F. religiosa* L*, F. glomerata* Roxb.*, F. rumphii* Bl. *Amoora rahituka* (Roxb.) W. &A. and *Dysoxylum hamiltonii* Hiern. were the very common plant species of the study area from Sijusa to Khari camp, in which, most population of Great Hornbills has occurred. The estimated population size of Great Hornbill was 200 individuals within the Park area based on regular census data completed within same day by different observers. The individuals were widely dispersed throughout the park and neighboring reserve forests and in Arunachal Pradesh.

Wreathed Hornbill - *Aceros undulatus*

Distribution

We found that, the Wreathed Hornbill-*Aceros undulatus* was commonly distributed throughout the Park, but more often been sighted at or above the altitudes of 93 m MSL. In the evenings, averaging 8-10 pairs were also seen to return to the Potasali range office area to roost on nearby Ficus trees and most of others were seen to fly above the park biotope towards interior forest patches of Nameri and Pakhui Sanctuary. During early morning, a flock of around 7-10 individuals forage within the campus of Eco-camp near Potasali Range office and later they disperse to the dense forest. The species was found to be very common during early morning and dusk in surrounding forest of Bogijuli camp. High concentration of *Ficus* species near Bogijuli might have attracted the birds almost every day. It was a very commonly sighted location of Hornbills during morning hours at Potasali that, the pairs of Wreathed Hornbills flying above Jia Bharali river towards dense forests of Nameri National Park and come back during evening time to the same site (Plate 2).

Ecology

Wreathed Hornbills are quite shy and generally found to forage in flocks of around, 2-11 individuals. Almost 18.6km^2 area of the park is found to be more suitable, because the species was very common in those areas (Figure 2). The habitat was a Mixed Moist Semi-evergreen forest with vegetation density about 60%. The dominant food plant species were *Amoora wallichii* King, *Ficus benghalensis* L., *F. benjamina* L.*, F. hispidus* Vahl*, F. religiosa* L*, F. glomerata* Roxb.*, F. rumphii* Bl. *Amoora rahituka* (Roxb.) W. & A. *Engelhardtia spicata* Lechan ex.Bl.A, and *Dysoxylum hamiltonii* Hiern. The Wreathed Hornbill has forage majorly on the fig trees and if fruits were plentiful in a particular area, they generally never search for other food items. Total of eight Wreathed Hornbill nests were found in the Nameri National Park, of which 7

nests on the Valew tree-*Tetramelos nodiflora* R.Br. and one nest in *Ficus religiosa* L. tree. We found that, the nesting habitat of Wreathed Hornbill was same with Great Hornbill. Since, the entire nests counted were within the nesting habitat of Great Hornbill (Figure 2). The calculated area of nesting habitat was 7.08km^2 (Figure 2). The major food items of Wreathed Hornbills were also same as Great Hornbills, viz., Ameri- *Amoora wallichii* King, *Amoora rahituka* (Roxb.) W.& A., *Dysoxylum hamiltonii* Hiern., *Engelhardtia spicata* Lechan ex.Bl.A, and Fig trees viz., *Ficus benghalensis* L., *F. benjamina* L., *F. hispidus* Vahl, *F. altissima* Bl., *F. glomerata* Roxb., *F. rumphii* Bl.. The Wreathed Hornbill preferred mostly of undisturbed forest patches of adequately dense and tall trees. On one occasion, it was observed that, six pairs came down to a considerable lower height (approximately 2-4 meter above ground) near Sijusa that was totally undisturbed and potential habitat for foraging.
The species was found to be common in study area and individuals has dispersed throughout the forest area and adjoining Arunachal Pradesh. The estimated population of the species was 250 individuals within the park, based on single day census data. The population size of this species was found to be slightly higher than the Great Hornbill population in Nameri National Park.

Oriental Pied Hornbill - *Anthracoceros albirostris*
Distribution and Ecology
The Oriental Pied Hornbill was relatively common throughout the study area especially in moist semi-evergreen forest patches in an around Bogijuli, Morisuti, Khari and Tomaljuli campsites and as well as along the forest patches of Khari and Bordikorai riverbank. The species was often seen on the isolated fig trees (*Ficus religiosa, Ficus benghalensis*) nearby degraded forest. Even though, the Oriental Pied Hornbill was common throughout the Nameri National Park, the concentration was highest in the eastern most parts from Potasali forest camp to Bogijuli. The species was observed in large flocks of about 12-24 individuals, while foraging. The existence of nesting sites of Oriental Pied Hornbill was not been sighted in Nameri National Park. The estimated population size of Oriental Pied Hornbill was about 350 individuals in Nameri National Park, based on regular census data during survey period of 1997-1998. Among all the Hornbill species, the Oriental Pied Hornbill was found to be more in number, but surprisingly no nest was recorded during whole survey period at study sites.

Rufous-necked Hornbill - ***Aceros nipalensis***
Rufous-necked Hornbill-*Aceros nipalensis* was found to be very rare and was observed sporadically in the study area. Two pairs were recorded during survey time since 1997 in Nameri National Park. The one pair was sighted at Bogijuli area on February 11, 1998 and the second pair was sighted on the biotope above Khari River, adjacent to the Arunachal Khari camp on April 10, 1998. Total of four individuals were recorded. The height of the two locations was about 190 to 220m MSL.

Habitat destruction
Study observed that, most of the ecologically and economically important large tree species have been cut down near Sijusa area, prior to declaration of Nameri as a National Park and leads to reduction of food plant and nesting tree species of Hornbills and other frugivorous bird species thereby affecting their population abundance. This factor was still at large in some localities, particularly adjacent to the Pakhui Sanctuary of Arunachal Pradesh and along the side of Bordikorai River. The information was also gathered that, the Velew tree-*Tetramelos nodiflora,* has been cut down on a large-scale basis in past, in the south and north-eastern boundary of the park. The tree remains such as, the base of the razed trees and the left out part of tree trunks were still lying on the ground.

The forest patches were completely denuded except few individual standing trees like *Ficus religiosa, F. bengalensis* and *Dilenia indica* etc. on the bank of Bordikori rivers under Khari and Tomaljuli forest camp jurisdiction. However, the intensity of forest destruction has been reduced after declaration of Nameri as a National Park, but the illegal operation was not able to stopped completely by the department owing to lack of adequate protection force and infrastructure. Historically, in Bogijuli and Khari area, the existing cane and bamboo forests were dense enough in past, but presently they are largely denuded. The half cut parts of the bamboos and canes were seen during field survey period near Bagijuli Forest Camp sites. Very significantly, the most densely associated closed canopy forest patches were completely cleared out during 1998 for the reason of road construction near Bogijuli forest camp after declaration of Nameri as a National Park. Those forest patches were found to be very potential for hornbills, other forest birds and WWWD species during our first year survey period of 1997.

Discussions
The incidence of high avifaunal diversity (total 365 species of avian fauna has been recorded, see Saikia and Saikia, 1999), occurrence of four Hornbills and White-winged Wood Duck species indicates the diverse habitat types of Nameri National Park.

The species *Cairina scutulata* (White-winged Wood Duck) prefers the streams of thick closed canopy forest in a very less fragmented habitat so as they could manage to keep unexposed themselves from any intruders or escaped from any kinds of sudden confrontation with disturbance factors. The recent fragmentation of dense closed canopy forest habitat in the reserve forest of Tinsukia district, Dibrugarh district and Golaghat district of Assam is also another most important factor for the drastic population declines and local extinction of WWWD in those areas (Chaudhury, 1993a, b). In the present survey Nameri NP, most of the White-winged Wood Duck sightings are made in a place of naturally camouflaged forest streams, shaped by dense undergrowth vegetation and climbers. According to Chaudhury (1993a), the White-winged Wood Duck needs dense undisturbed forests with dead hole bearing trees for nest construction. These characteristics features are usually exist inside the undisturbed habitat alone in the study area. Nameri is one of the most important primary forest habitats adjacent to the Arunachal Pakhui Wildlife Sanctuary. The species of WWWD was formerly widely distributed in different ecological pockets of Eastern Assam, but, the species has been reported from Hahkhati RF, Pobha RF, Dangari RF, Dumduma RF, Philobari area, Tinkhopani RF, Namdang RF, Ranga RF, Bokajan RF, Diyungmukh RF, Lumding RF and Haflong RF etc (Birdlife International, 2001), but, the species has been extinct from those reserve forests in recent times. These Forest areas have recently been critically fragmented and the undisturbed closed forest associated water puddles are become very rare. Presently, the WWWD population has become very fragmented in Assam and few ecological pockets are left for the species survival viz,. Dibru-Saikhowa Biosphere Reserve, Dihing Patkai WLS, Jeypore RF and Nameri NP etc. Literally, Nameri NP is the only one of the most potential stronghold for WWWD conservation where highest population survives in a single forest patch. Although, the Dibru-Saikhowa Biosphere reserve is another most important forest patch for the species owing to existence of swamp forest, but the recent status of the reserve is become very unstable due to alluvial

deposition (siltation) from river Brahmaputra, frequent changes of river courses and as well as various anthropogenic causes.

The Hornbill species are most potential frugivorous forest species that continuously help to restructuring the primary forest habitat by dispersing the native plant seeds along the stretch of their foraging and nesting sites. The examples of seed dispersal could easily be understood when observed the ground zones of live and earlier nesting trees. While the ground zones of nesting trees are flourished with the saplings of hornbill's food plants species, the live nests ground zones are deposited with fresh food droppings. In Assam, the Hornbill species were formerly distributed almost throughout forested zones, but in recent times, the species are become very rare owing to large scale felling of tall trees and fruit bearing trees in protected and unprotected reserve forest areas and thus ultimately restricted to protected area networks alone. The Rufous-necked Hornbill is primarily threatened by the pervasive combination of habitat loss and hunting. Human population growth and encroachment of forested land have proceeded apace in recent years, characterized by habitat degradation and increased hunting pressure even protected areas (Cox *et al.*, 1992; Round 1984, 1985; IUCN, 1997). Its susceptibility to these factors in manifest in its disappearance from many suitable areas in which it once widely occurred, chiefly regions of Nepal, Thailand and Vietnam (Poonswad and Kemp, 1993). The nests in Khasi hills, Meghalaya, were regularly robbed by Naga people (Baker 1922-1930). Locals in Arunachal Pradesh also hunt hornbills enthusiastically (Chaudhury, 2000), a factor that has undoubtedly reduced its populations in all but the most remote areas. The quality of suitable habitats available to Hornbill species being severely reduced by shifting cultivations and logging activities. Smaller Hornbill such as Brown hornbill and Indian Pied Hornbills species etc. tend to survive well in logged forest, while larger species like Great Pied and Wreathed Hornbills are much less tolerant of selective logging (Johns, 1986). Large hornbills usually require very broad trees in which to nest (Poonswad *et al.*, 1987), and as these are invariably the first trees to be felled commercially, they tend to suffer the effects of logging more severely, or at least more rapidly, than most species. During the visit to Potasali area in 1985, the author has sighted abundantly exists huge sized *Tetramelos nudiflora* trees which was no more survived during recent field survey period

It is a well-known fact that, the diversity of bird species is influenced by the diversity of plant species present, independent of structural consideration (Holmes and Robinson, 1981; MacArthur and MacArthur, 1961; Robinson and Holmes, 1984; Karr and Roth, 1971; Roth, 1976). The forest dwelling avifauna including song birds, Woodpeckers, frugivorous, insect eaters and Owl species reflects the importance of these ecological pockets, because, solitary nesting species like these (Saikia and Saikia, 1999) have strong affinities to particular structural features in their habitat (MacArthur & MacArthur, 1961). Apart from that, the endangered species like White-winged Wood Duck, Great Pied Hornbill, Oriental Pied Hornbill, Wreathed and Rufous-necked Hornbill, Masked Fin-foot and Bengal Florican etc (Saikia and Saikia, 1999) could not be sited within the same locality elsewhere in Assam. It implies that, the Nameri National Park is not only important for forest dwelling avian species, but also for the grassland and wetland avifauna of particular importance. Most of the canopy feeding frugivorous birds, primarily the Bucerotidae and Columbidae are declining from the disturbed forest habitat of Assam viz., Chandubi Reserve forest, Rani-Garbhanga Reserve forest (Kamrup district) and Subansiri Reserve forest (Lakhimpur) Bansbari Reserve forest (Gauripur, Dhubri district) and Naduar reserve forest (Sonitpur District) resulted from canopy loss comparing to present study area. The large frugivorous birds are also confronting severe threats of large hole bearing nesting tree due to selective logging of mature trees by illegal tree fellers. There is an evidence of large frugivorous birds extinction from various tropical forests intended for loss of canopy (Terborgh, 1974; Castellatta *et al.,* 2000). It is also important to note that the climax vegetation structure has been inferred to be important in influencing the species composition and abundance of forest birds (Karr and Roth, 1971; Roth, 1976). Again the representation of all forms of forest dwelling avian fauna including song birds, woodpeckers and frugivorous, omnivorous, insectivorous and birds of prey feeding-guild species in primary forest of Nameri National park and absence in various disturbed forest of Assam has reflected the importance of conservation of existing natural ecological pockets in tropical country, since the solitary nesting species (not colonial) like hornbills, owls, woodpeckers etc. have strong affinities to particular structural features (MacAurthur and MacAurthur, 1961). Thus, the species of White Winged Duck and Hornbills are the excellent examples of important biota of better forest types, as these could not survive in disturbed and fragmented forest. Altogether 17 species of Owls, 15 species of Woodpeckers and four Hornbills species occurring in the same habitat (Saikia and Saikia, 1999) is a rare occurrence in any protected areas, and also suggested the good potentiality to support high avian diversity and particular structural features (MacArthur and MacArthur, 1961). The Hornbill species choose nesting sites wherever tall and big trees such as *Tetramelos nodiflora, Amoora wallichii, Ficus religiosa, Ficus glomerata* and *F. bengalensis* etc. are accessible. Those trees have supported nest holes of suitable size and as well as supplied food for them. Because, hornbills are unable to excavate their own nest holes for breeding as done by other birds viz., Woodpeckers and Barbets, hence they indeed use available cavities of trees (Poonswad, 1995) for nest. In various sites of Nameri these nesting sites are disturbed by human being through cutting down of the huge *Tetramelos nodiflora* trees and might be the important limiting factor for the Hornbills. In southern India Great Hornbill usually nests on *Calophyllum* and *Cullenia* species (Ali and Ripley, 1983) where Velew tree is not available. The Oriental Hornbill in Burma nested on *Bombax ceiba* (Baker, 1927), whereas *Bombax ceiba, Lagerstoromia* sp*., Dipterocarpus* sp*., Eugenia* sp. and *Cinnamomum* sp. was the common nesting trees in Thailand (Poonswad, 1995). But the tree species like *Lagerstoromia* sp*., Dipterocarpus* sp*., Eugenia* sp. and *Cinnamomum* sp. etc. has not been reported as a Hornbill nesting trees in Assam. The tree species like *Bombax ceiba, Lagerstoromia* sp. and *Eugenia* sp. are the commonly occurred trees in the Hornbill distribution sites of Nameri National Park, whereas, *Dipterocarpus* is found only in Hornbill areas of Eastern Assam alone. Again, all the reported Hornbill nests are located on the holes of live trees but not in the dead trees as documented by Baker (1927) in his studies, who refers that the Oriental Hornbill sometimes breeds on dead tree holes.

The food (or seed) droppings of Hornbills are very common at the underneath of nest bearing trees. Again, the regeneration of wild fruiting trees are remarkably high in Nameri National Park, predominantly near nesting sites. Hornbills are the excellent seed disperser that collects fruits from various localities and dropped the seeds into the ground zones of their nests and as well as neighbouring foraging sites and ultimately facilitate to increase the plant species diversity throughout its home range. Thus, the hornbill species can be categorized as an essential keystone

species of evergreen and semi-evergreen forest ecosystem, absence of which the plant species diversity and habitat heterogeneity has considerably declined.

Of the total 200km^2 areas of study sites, only 25.66km^2 areas is suitable for White-winged Wood Duck (Figure 1), but, most of other areas are become unsuitable owing to alteration of forested land into an agricultural and barren lands (Das, 1999). The destruction of forest habitats and absence of cover near forested streams are the two major causes of drastic decline of the White-winged Wood Duck population in the tropical forests of Assam. In certain areas of Nameri National Park, the selective logging has eliminated much bigger and mature trees used by White-winged Wood Duck as their nesting trees that leading to declination of nesting pairs in recent times (Das, 1999). During survey period only two nesting spots are sighted. Again, the Ttable-1 also clearly indicated that, out of 22 formerly WWWD distribution sites of Nameri NP, only 13 sites are become active for the species, of which three are newly located sites. Thus, long-term protection of Nameri NP and its adjoining reserve forest areas will help ensure the survival of these Hornbills and WWWD species. Status surveys are urgently be needed throughout the specie's range of distribution to clarify its current distribution status and abundance being charismatic and harmless to human interests, and suffering a variety of threats, hornbills (Duckworth *et al.*, 1999) and WWWD are ideal for use in public education programmes.

In Nameri National Park, the existing anti-poaching camps are located far from each other, which influence the protection efforts of the forest personnel. Three more camps are suggested on the south-eastern boundary of the park to increase protection efforts at the park. Again, on the northern boundary start off from Sijusa anti-poaching Camp to Bhalukpung area that have no anti-poaching camp, a new camp should be incorporated in this area otherwise poachers and illegal tree fellers might be rampant. The number of forest guards should be increased and the appropriate arms should be provided to forest guard to protect the park from the illegal people. The habitat of Nameri National Park should be well managed for the conservation of endangered species like White-winged Wood Duck, Hornbills, Royal Bengal Tiger- *Panthera tigris tigris*, Asiatic Wild Elephant- *Elephas maximus* and Indian Bison- *Bos gaurus* etc. for our future generation.

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