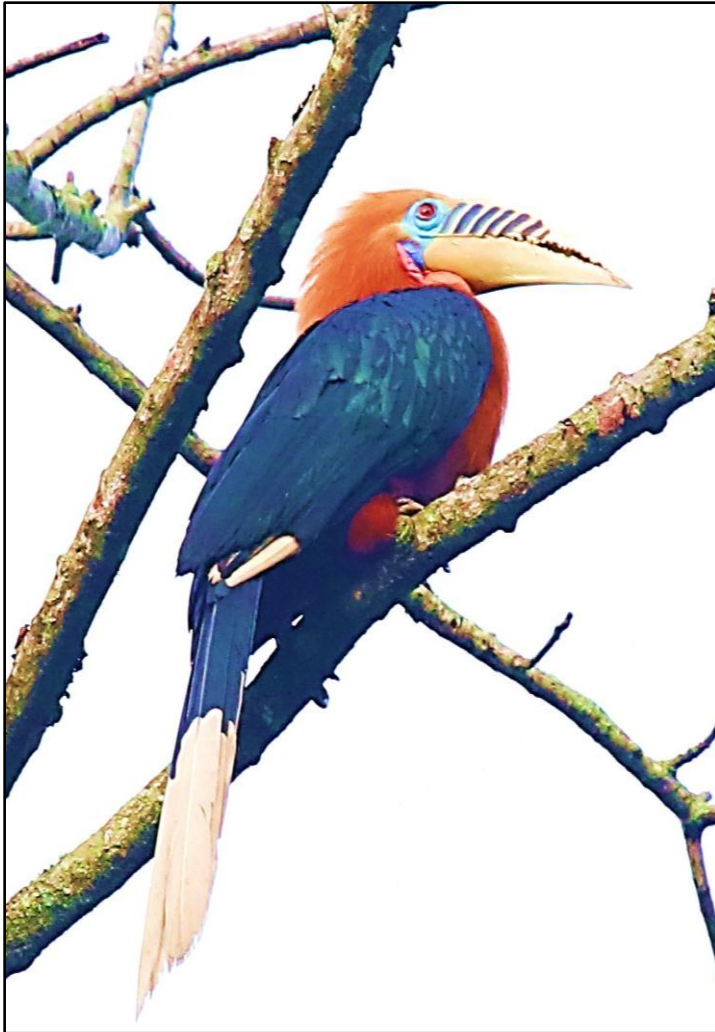


“Foraging behavior, food resources, and habitat use of Rufous-necked hornbill (*Aceros nipalensis*) in Jigme Singye Wangchuck National Park, Bhutan”



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OVERVIEW



MALE



FEMALE

- ❖ Plays important role in seed dispersal
- ❖ Indicator species for the health of forest.

Status

- ❖ IUCN relict category: Vulnerable
- ❖ Estimated global population: 1500-7000 individuals

Distribution: World wide

- Currently known from Bhutan, India, Myanmar, southern Yunnan and south-east Tibet, China, Thailand, Laos and Vietnam
- **Extinct** from Nepal and **close to extinction** in Vietnam.



Habitat selection

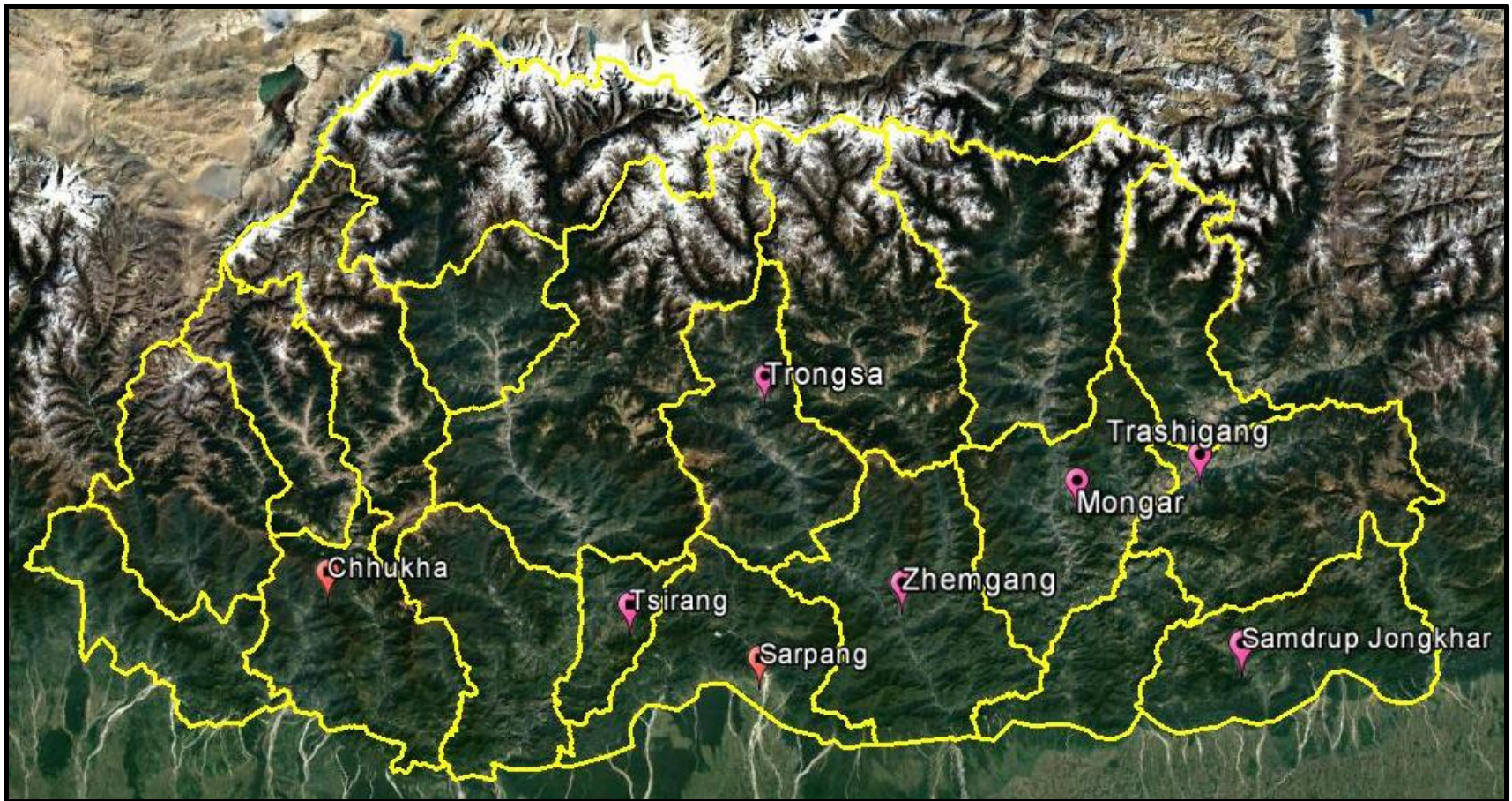
- Mature Broadleaved forest
- Altitude b/n 600-1,800m asl
- max 2,200 m; min 150m asl.

(Source: Birdlife International, 2017)



The nest of Rufous-necked hornbill at Gonphaii locality; A) Photograph taken on 15th July of 2016, during the breeding season, B) Nest after fledging of chicks (28 July, 2016).

District wise distribution within Bhutan



- ❖ Fairly common (Inskipp *et al.*, 1999; Datta, 2009).
- ❖ Broadleaf forest of 8 districts

Objectives of research

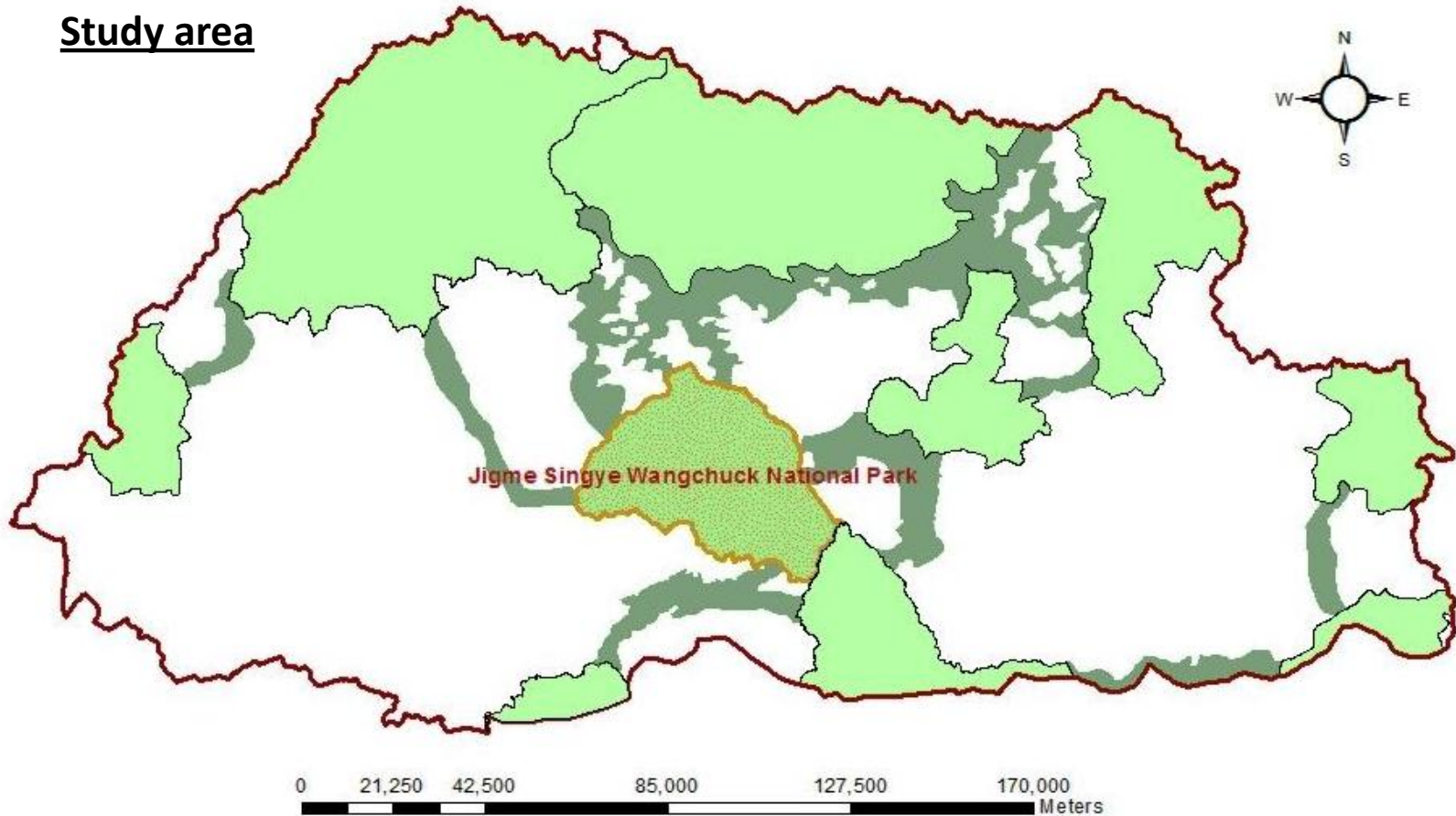
To document :

- habitat characteristics
- diet composition
- nesting cycle
- potential threats




**the present study attempt to address the conservation needs of Rufous-necked Hornbill by integrating local people to value, monitor and conserve wildlife and their habitats.



Study area



Legend

-  Jigme Singye Wangchuck National Park
-  Protected areas
-  Biological corridors

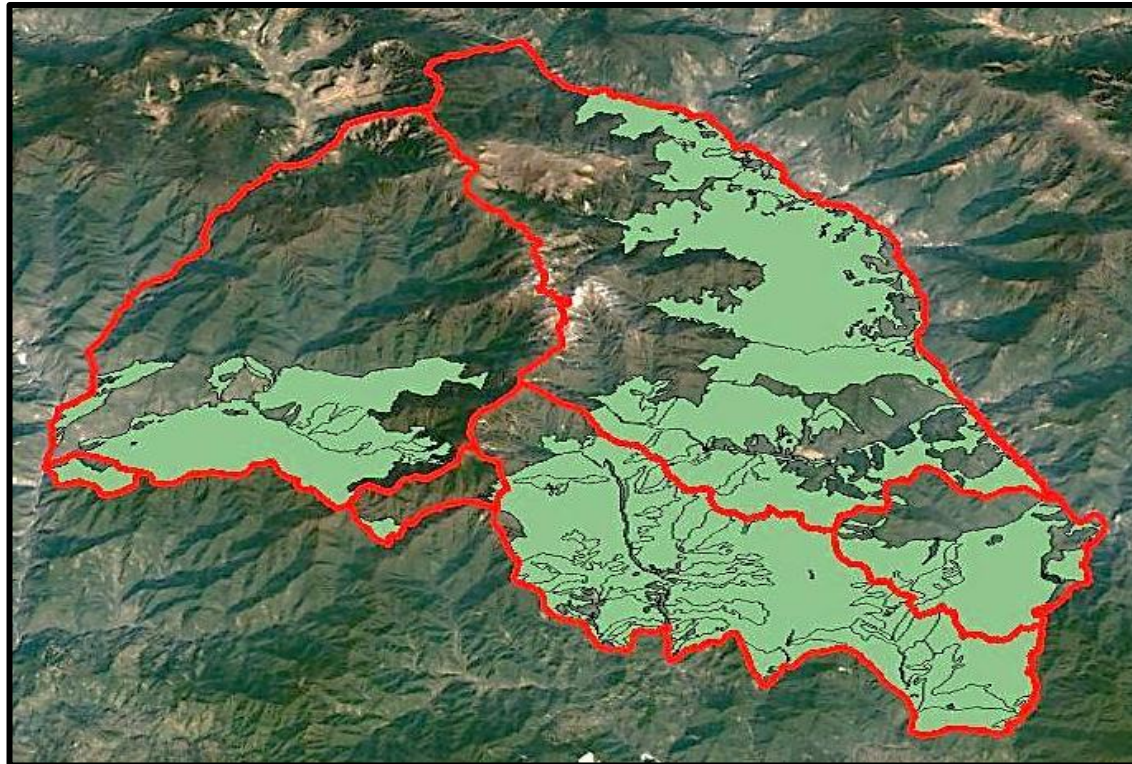
Jigme Singye Wangchuck National Park (JSWNP)

- ❖ 1,730 square kilometres
- ❖ central Bhutan.
- ❖ occupies most of the Trongsa District, as well as parts of Sarpang, Tsirang, Zhemgang and Wangduephodrang districts.

RESEARCH DESIGN

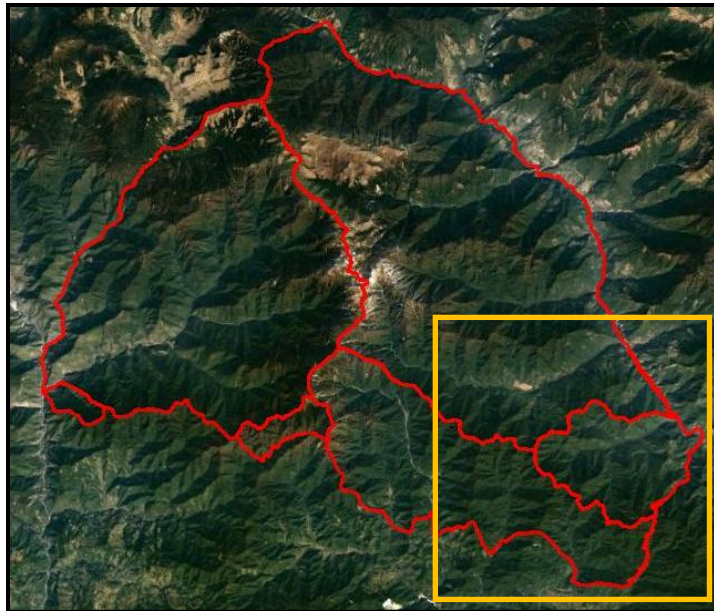
- ❖ terrain of study area: very steep and rugged
- ❖ randomized line transect was adopted using the accessible area and existing trails for the survey in broadleaf forest.

- ❖ **Field data was collected as:**
 - a) land cover plot with habitat parameter,
 - ❖ *vegetation sampling plots were established in five intensive sites only.*
 - b) RNH ecology with its various behavioral characteristics.

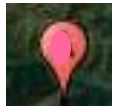


Distribution of broadleaf forest in JSWNP

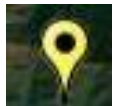
SAMPLING SITES



Legend



Intensive study sites



Other study sites

(Google Earth map showing five intensive study sites and other three study sites)

Methods:

Sampling duration

- ❖ 11 months: June (2016) to April (2017)
- ❖ Days spent: 42 days
- ❖ Total effort walked: 361 km

Vegetation sampling

- Total vegetation sampling plots: 125 (25 plots per intensive site)
- Size of each plot: 0.001ha
- Trees marked: GBH \geq 20 cm.

*** Habitat characteristics was represented by species composition, density (trees/ha), tree basal area (m^2/ha), and Shannon's diversity index (H').

Population density estimation of RNH

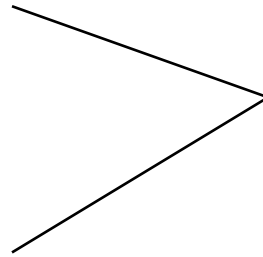
- Line transect density estimation.
- Repeated transect walk
- Time: 6:00hr-11:00hr and afternoon's 12:00hr-17:00 hr.
- Transect width: Within 10m from line transect
- Population density of RNH was calculated using the formula (Rahayuningsih & Nugroho, 2013);

$$D = \frac{n}{2WL}$$

Methods continue.....

Others:

- a. Nesting sites*
- b. Breeding cycle*
- c. Foraging records*
- d. Conservation threats*



Focal observation









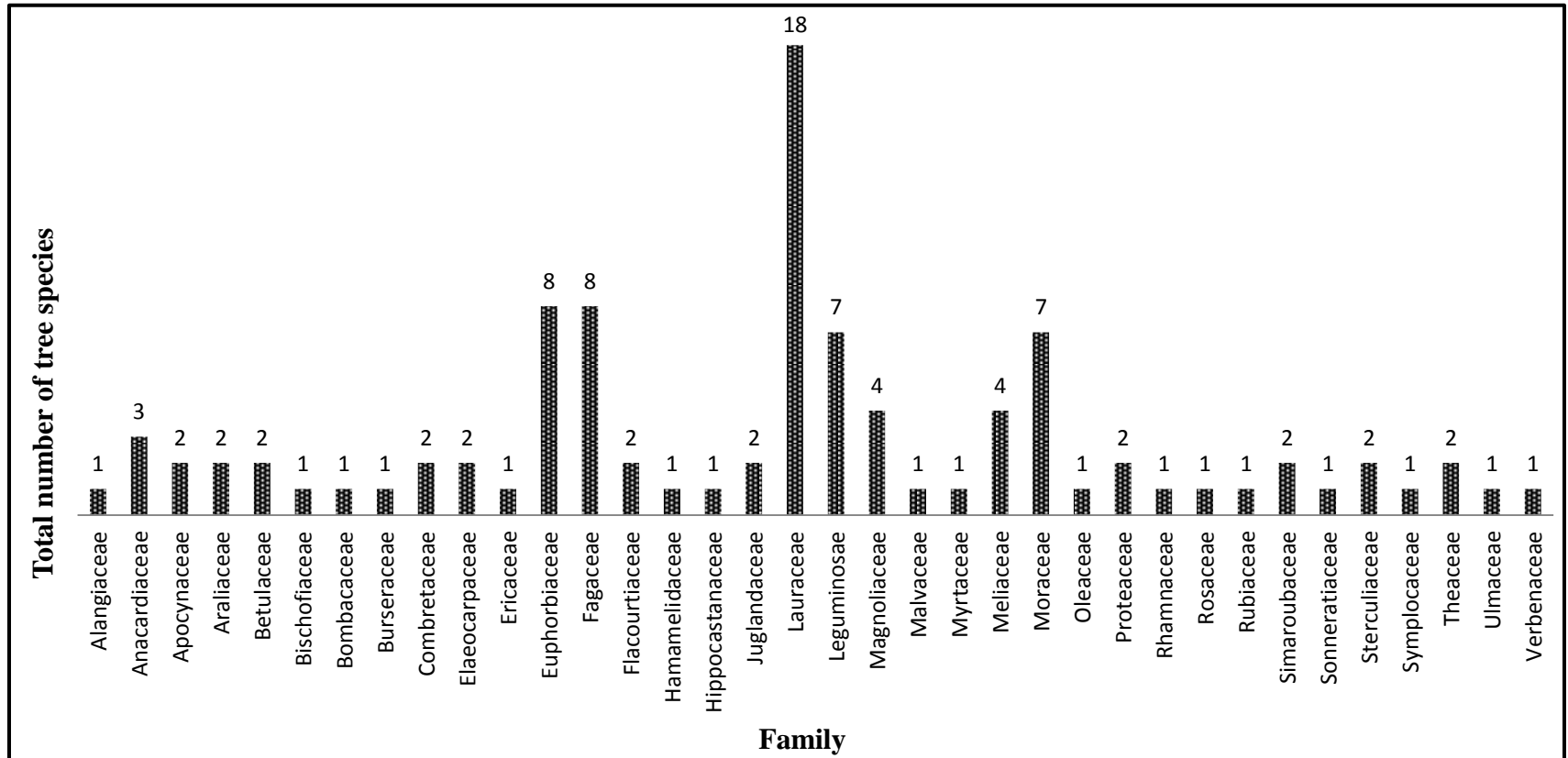






FINDINGS

Vegetation composition in RNH habitat



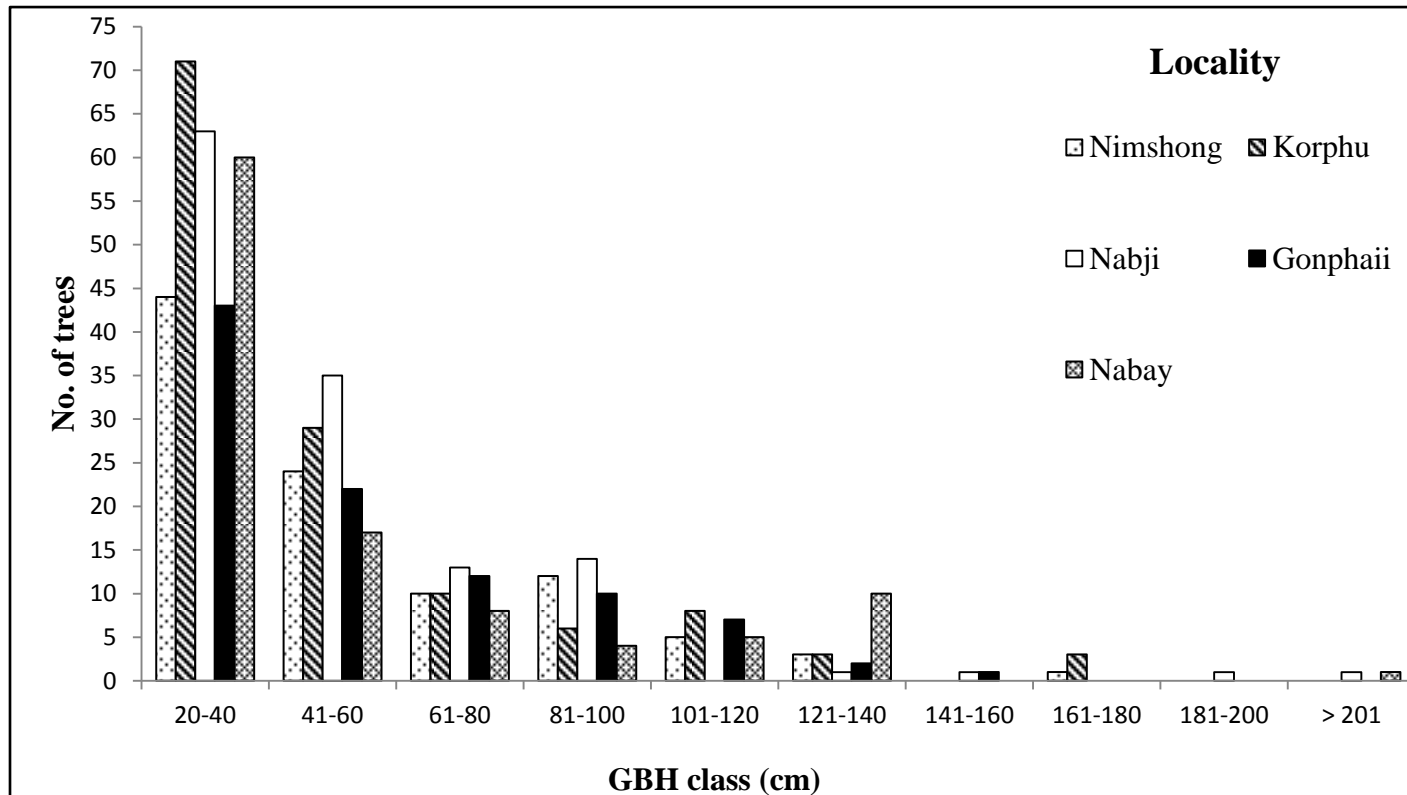
- **Sampled trees:** 560 individuals
- **Species:** 98
- **Genera:** 70 genera
- **Family:** 36
- **Dominant family:** Lauraceae

Most common genera : *Albizia*, *Beilschmiedia*, *Cinnamomum*, *Ficus*, *Helicia*, *Lithocarpus*, *Litsea*, *Macaranga*, *Mallotus*, *Michelia*, *Morus*, *Persea*, *Phoebe*, *Quercus* and *Terminalia*.

Tree densities and forest structure

Si No.	Study sites	BA (m ² /ha)	No. of trees per ha	Shannon's diversity index	No. of cut stumps per ha	No. of dead trees per ha
1	Nimshong	10.70	396 ± 7.55	1.50	12	8
2	Korphu	13.95	520 ± 10.8	1.48	8	44
3	Nabji	12.24	516 ± 13.66	1.40	4	36
4	Gonphaii	10.58	388 ± 8.34	1.47	24	44
5	Nabay	8.58	420 ± 10.86	1.39	24	32

- Overall average tree density was 448 ± 58.13 trees/ha.



- Girth class distribution (GBH ≥ 20 cm) of trees measured across five habitat sites of Rufous-necked hornbill (n=560); The average GBH was 49.9 cm.

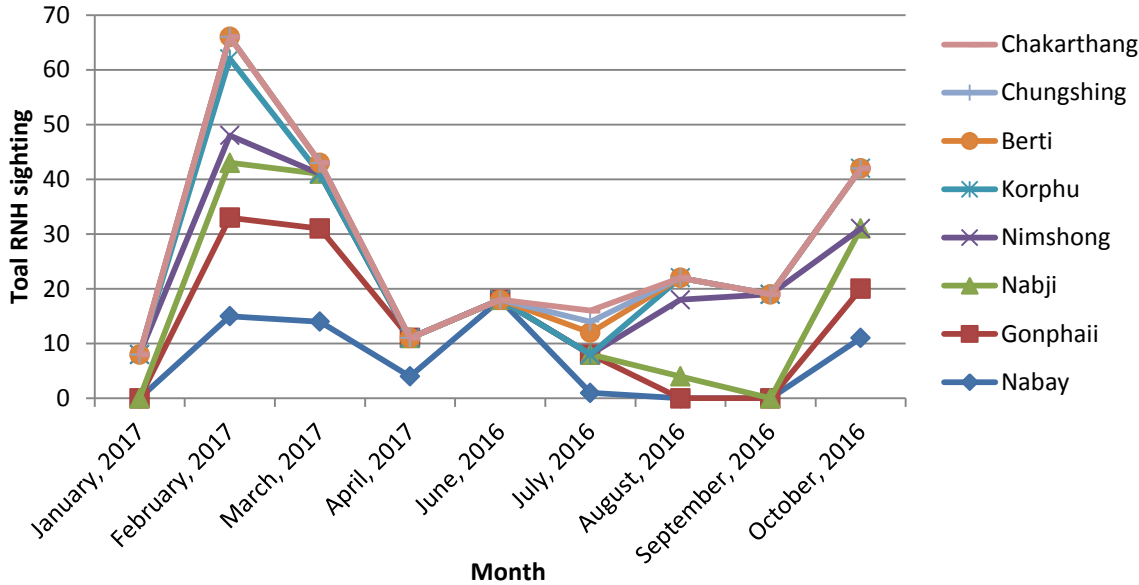
Distribution and sighting records of RNH

Si. No.	Area	Days spent	No. of transect	Transect length (km)	Total sightings	Density rate/km ²
1	Nabay	9	1	15	63	0.14 ± 0.014
2	Gonphaii	8	1	5	58	0.41 ± 0.05
3	Nabji	6	2	12	35	0.20 ± 0.03
4	Nimshong	8	1	8	46	0.16 ± 0.015
5	Korphu	5	3	24	29	0.23 ± 0.02
6	Berti	4	1	9	10	0.04 ± 0.01
7	Chungshing	1	1	7	2	0.01
8	Chakarhang	1	1	3	2	0.03
				TOTAL	245	1.22 ± 0.12

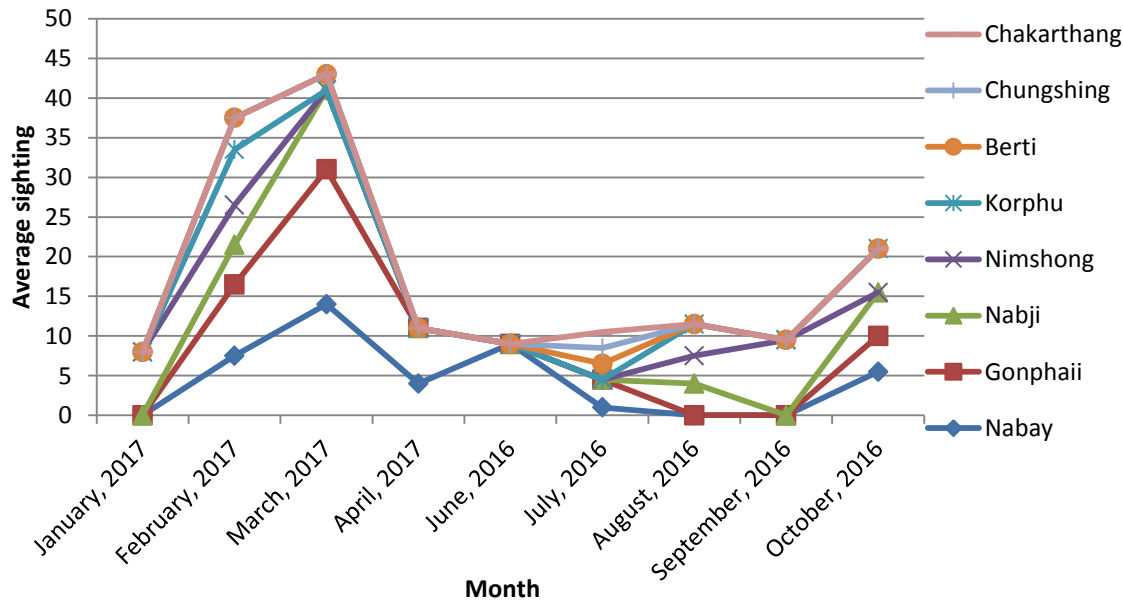
- ❖ Total population density: 1.22 birds/km² (± 0.12).
- ❖ The total minimum RNH estimation: 43
- ❖ Sampling elevation range: 644m-1608m asl.
- ❖ frequently sighted along the edges of forest clearings/river side, open, moist and groves of large fruit trees, similar to those recorded by Inskipp *et al.* (1999).

Gale and Thongaree (2006): The density estimates are the starting point for monitoring populations and judging the success or failure of conservation and management actions.

Monthly variation in RNH sightings

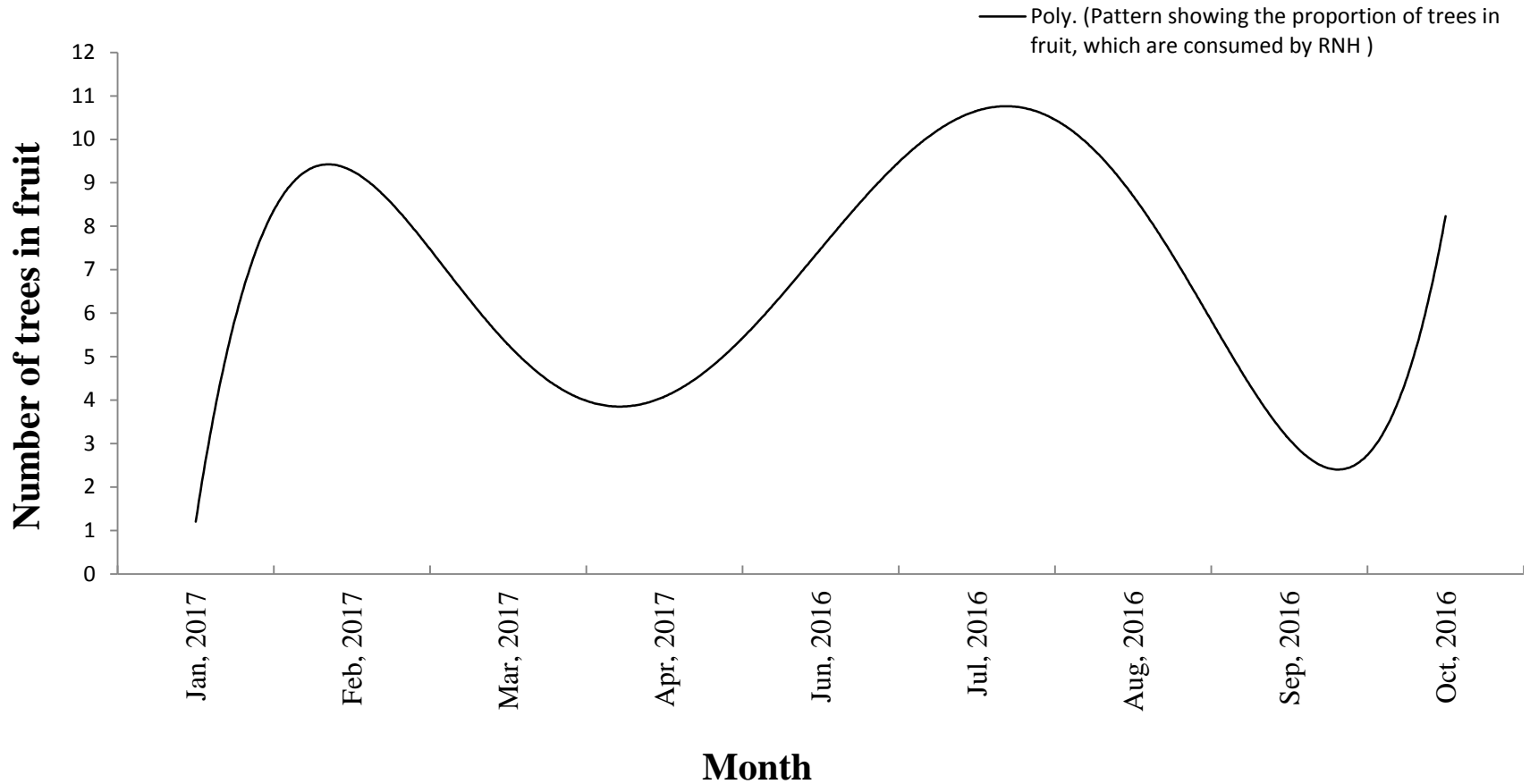


- Monthly sighting records of Rufous-necked Hornbill (n=245).



- Monthly average sightings of Rufous-necked hornbill (n=161).

FRUITING PHENOLOGY



Graph showing the fruiting period and its monthly availability, which were consumed by Rufous-necked hornbill in sampling areas.

A. Relationship between monthly average sightings of RNH and the number of trees in fruit, consumed by RNH at that month, recorded from eight sampling sites.

		Number of trees in fruits (monthly)	Monthly average sightings of RNH
Number of trees in fruits (monthly)	Pearson Correlation	1	0.226
	Sig. (2-tailed)		0.558
	N	9	9
Monthly average sightings of RNH	Pearson Correlation	0.226	1
	Sig. (2-tailed)	0.558	
	N	9	9

** Correlation is significant at 0.05 level (95% confidence interval)

B. Relationship between tree density of five vegetation sampling sites and RNH density recorded in that localities.

		Tree density/ha	RNH density/km ²
Tree density/ha	Pearson Correlation	1	-0.239
	Sig. (2-tailed)		0.699
	N	5	5
RNH density/km ²	Pearson Correlation	-0.239	1
	Sig. (2-tailed)	0.699	
	N	5	5

** Correlation is significant at 0.05 level (95% confidence interval)

Conclusion: *Having p-value greater than the significance level of 0.05 in both the cases indicates that there is inconclusive evidence about the significance of association or no significant linear relationship between the variables under study.*

Flock size composition of RNH recorded from sampling areas inside Jigme Singye Wangchuck National Park of Bhutan.

	Flock size (frequency)						
Month	1	2	3	4	5	6	8
Jan, 2017							1
Feb, 2017	9	25	1	1			
Mar, 2017	5	2	2	4		2	
Apr, 017	1	5					
Jun, 2016	14	2					
Jul, 2016	11	2					
Aug, 2016	4	7		1			
Sep, 2016	4		2	1	1		
Oct, 2016	13	6	3	2			
TOTAL	61	49	8	9	1	2	1

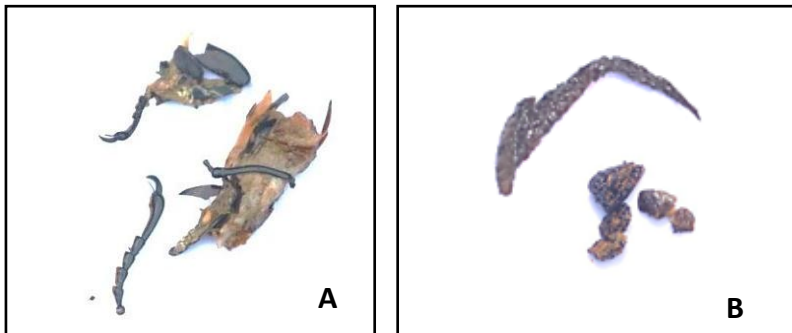
** The large groups of ≥ 5 were usually sighted at the time of feeding on a single fruiting tree during the non-breeding season between September 2016 to March of 2017

DIET AND FOOD TYPES

- ❖ Total food plant recorded: 35 species under 13 families
 - *Important tree families in the diet of RNH were Moraceae and Lauraceae.*
- ❖ Animal foods: Mostly invertebrates

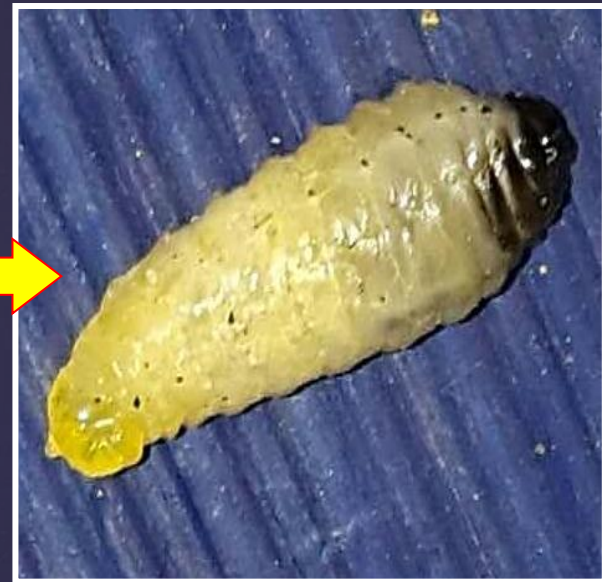
A. Food consumption in breeding cycle period (June-July of 2017 and April 2016)

- ❖ No. of food plant species: 21 species, comprising of 18 genera under 11 families .
- ❖ Anacardiaceae, Burseraceae, Combretaceae, Daphniphyllaceae, Elaeocarpaceae, Flacourtiaceae, Magnoliaceae, Meliaceae, Moraceae, Lauraceae and Rosaceae.
- ❖ Lauraceae and Moraceae represents the highest species, showing food preferences and availability during the breeding season.
- ❖ Invertebrates consumed:
 - a. Remnants adult beetles (coleopteran),
 - b. fresh water crabs (molluscs) and
 - c. larva of hymenoptera (bee).



A) Remnants of adult beetle (coleopteran) and B) fresh water crabs (molluscs)

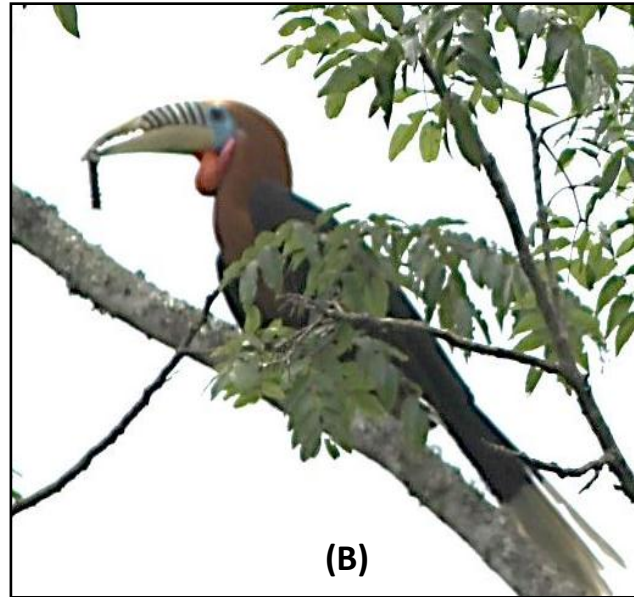




Male RNH with portion of bee hive (left image) in the beak at nest hole. The second image shows the bee larva, which was collected after regurgitation below the nest tree in same day.

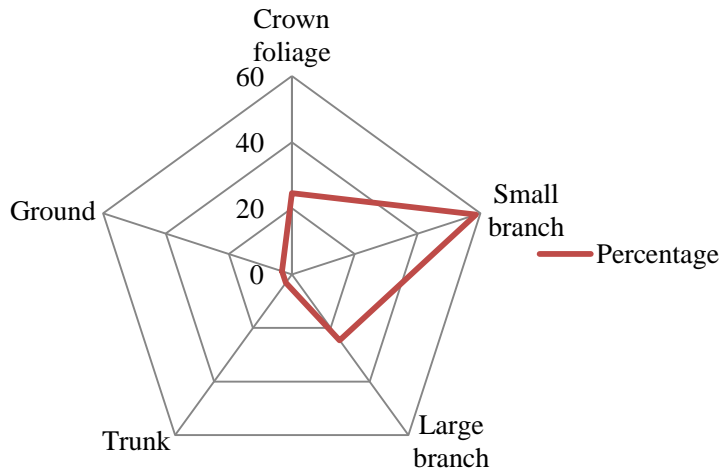
B. Diet composition during non-breeding season (August 2016 to March 2017)

- No. of food plant species consumed: 18 species (under six families) + 2 unidentified.
- Alangiaceae, Anacardiaceae, Combretaceae, Lauraceae, Moraceae and Rhamnaceae
- Moraceae (7 species) and Lauraceae (6 species) represented the highest species
- Invertebrates:
 - a. larva of Lepidoptera (Caterpillar)
 - b. two unknown species of insects



A) unknown species of insect, and B) caterpillar (larva of Lepidoptera).

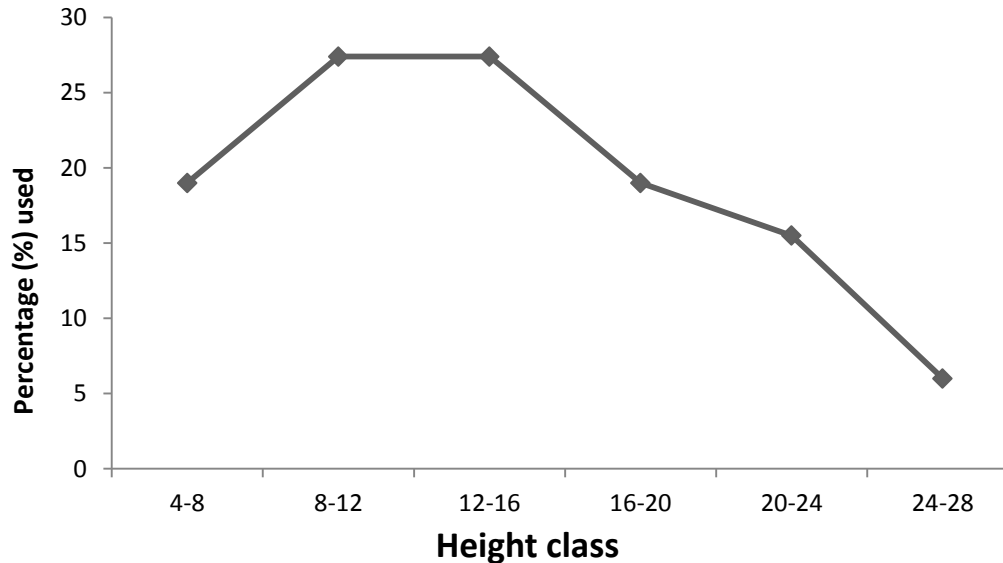
FORAGING BEHAVIOUR



5 perch types:

- crown foliage
- small branch (<75 mm diameter)
- large branch (> 75 mm diameter)
- trunk
- ground.

Five types of feeding perches used by Rufous-necked hornbill, recorded from sampling areas within Jigme Singye Wangchuck National Park (JSWNP).



Height preferred for feeding above the ground by Rufous-necked hornbill.

- ❖ feed on the ripen food while resting on a branch or clinging onto the foliage to reach the ripened fruit.
- ❖ Foraging method: plucking.
- ❖ Active feeding usually occurred between 6:00hr-12:00hr and 15:00hr-17:00hr for non-breeding season.



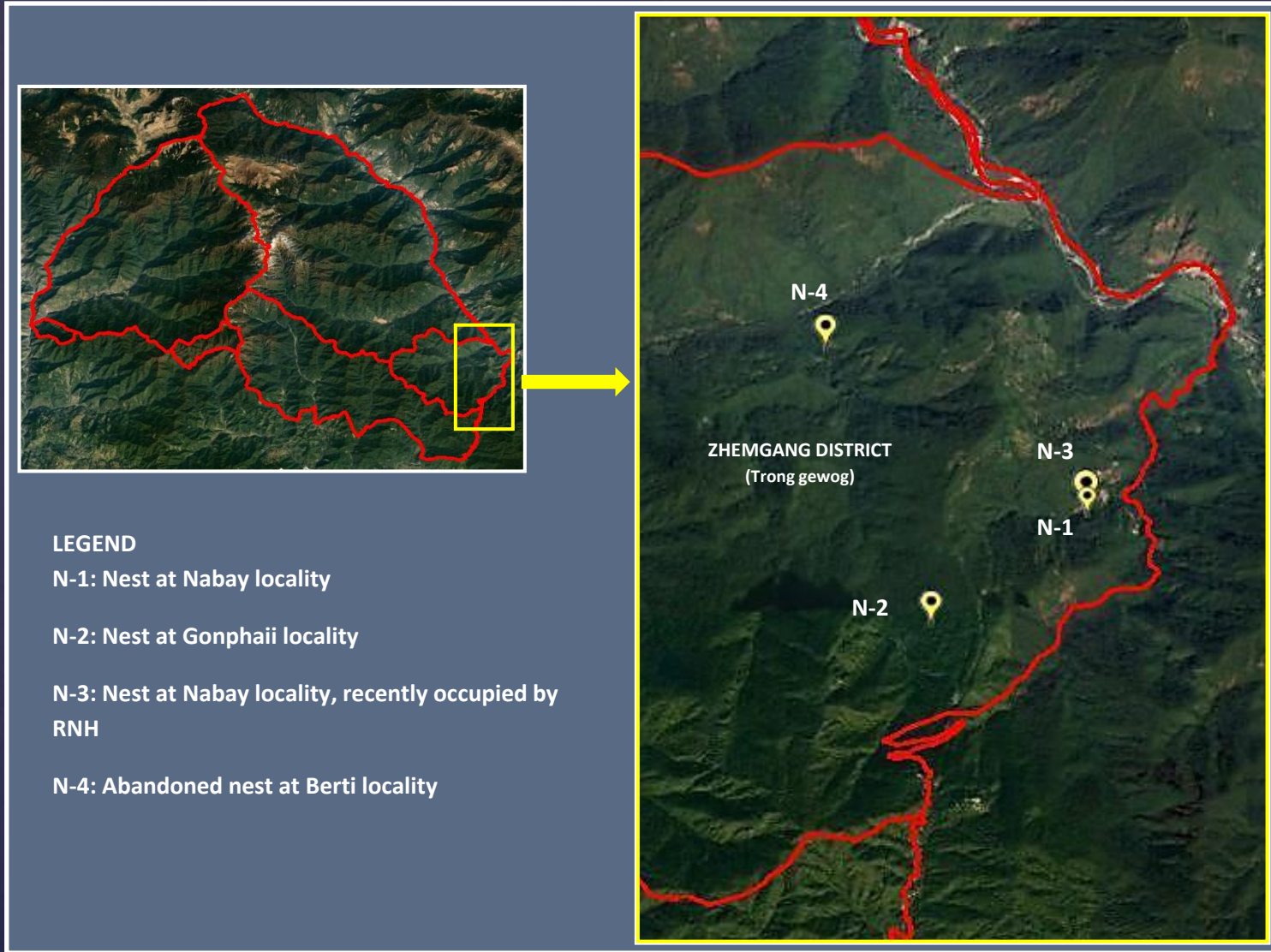
Kinnaird and O'Brien (2007): The hornbills select the fruits that, on average, provide superior energetic rewards and usually more protein per fruit than those eaten by other animals.

- ❖ The foraging method on the ground was not observed directly, however, twice a RNH were seen near a water hole.



Injured Rufous-necked hornbill near the stream (upper beak was broken).

Location of RNH nesting tree.

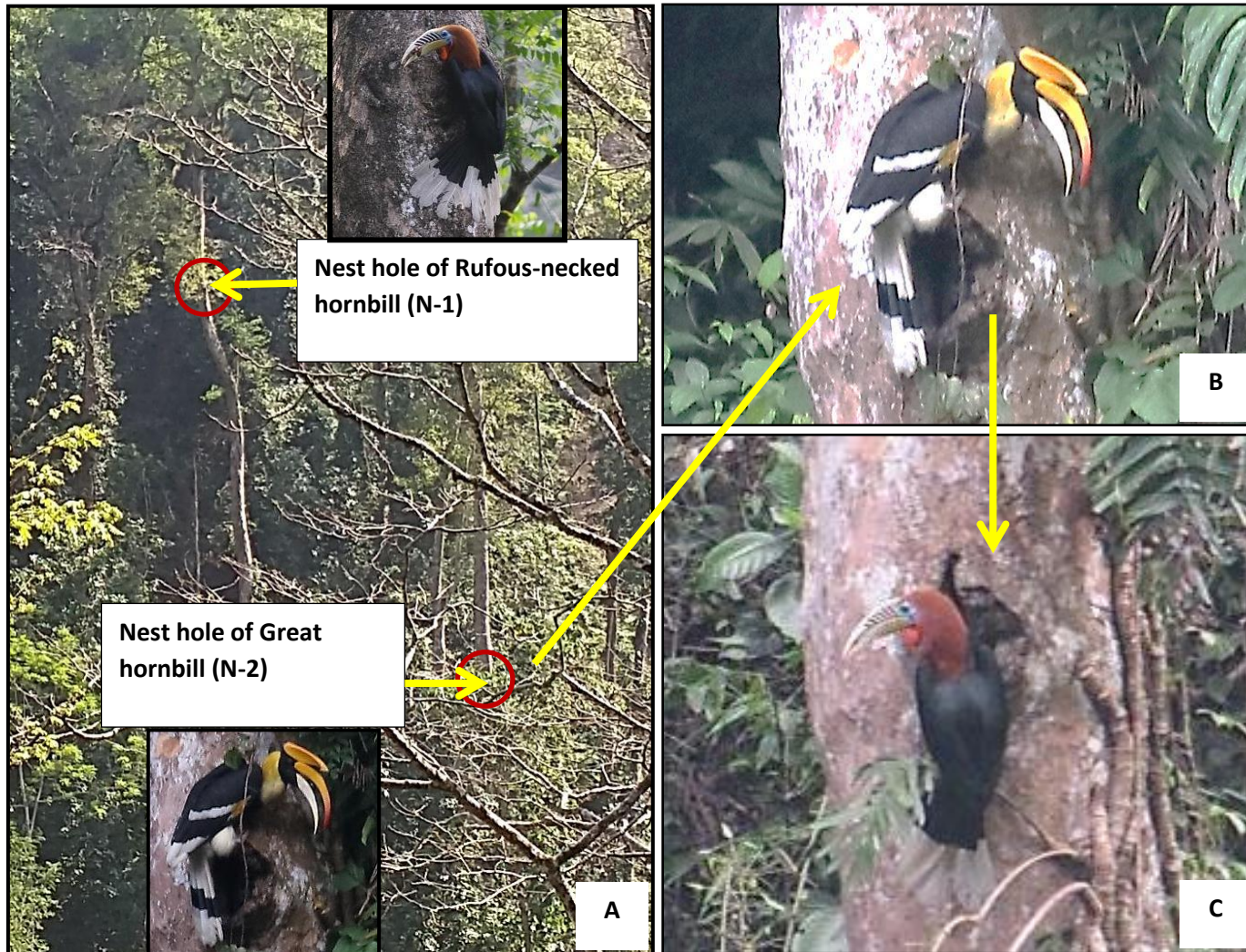


Map showing the location of RNH nesting tree at “Trong gewog” under Zhemgang district.

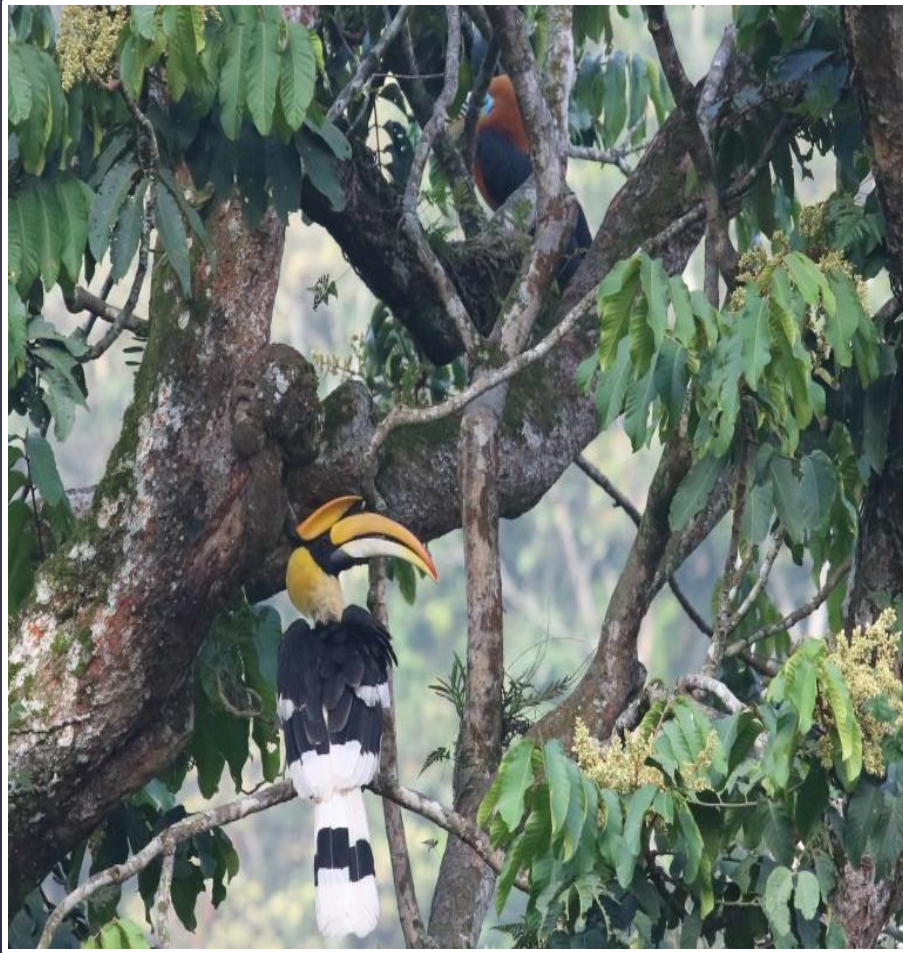
Characteristics summary of RNH nesting site.

Si No.	Parameters	Nabay (N-1)	Gonphaii (N-2)	Nabay (N-3)	Berti (N-4)
1	GPS location	27°07'08.5"N; 90° 40'01.6"E	27°06'15.2"N; 90° 38'44.2"E	27°7'10.62"N; 90°40'1.56"E	27°08'27.4"N; 90° 38'08.4"E
2	Nest status	-2016: Active -2017: Abandoned	-2016: Active -2017: female inside the nest but not sealed (22 nd Apr-17 th may, 2017)	-2016: Occupied by GH -2017: Same nest occupied by RNH	Abandoned
3	Nesting tree species	Altingia excelsa	Engelhardia sp.?	Altingia excelsa	Unidentified
4	Tree density (trees/ha)	36	8	36	-
5	Tree height (m)	33	23	31	21
6	GBH (cm)	109	108	105	98
7	Height of nest cavity from ground level (m)	21	4	17	7
8	Girth at nest hole	≈86	98	97	80
9	Nest opening orientation	NW	NE	SE	NW
10	Cavity depth	-	45	-	-
11	Cavity width (cm)	-	36	-	-
12	Altitude (m)	924	1549	919	736

Sympatric relationship:



- A) Active nests of RNH and Great hornbill located at same habitat range in Nabay locality, 2016;
- B) B & C) Nest previously occupied by Great Hornbill in breeding season of 2016 was recently occupied by Rufous-necked hornbill on 26th April of 2017.



Rufous-necked hornbill and Great hornbill recorded together on same tree in Nabay locality (September, 2016).



The nest of Rufous-necked hornbill located at Gonphaii locality.

Abandoned nest (2 years before)



Why?

- nest tree located just a meter away from walking trail used by the cattle herder and local people.
- temporary camp set by cattle herder to hold the night, logging, firewood collection and patches of abandoned (before 1 year) agricultural field within 20m range from the nesting tree.

BREEDING CYCLE

Summary for the breeding cycle of Rufous-necked hornbill

Nesting site	Imprisonment		Fledging	
	Date	Year	Date	Year
Nest 1: Nabay locality (N-1)	14 April	2016	25 July	2016
Nest 2: Nabay locality (N-3)	26 April	2017	-	-
Nest 3: Gonphaii locality (N-2)	22 April**	2017	28 July	2016

** Gonphai locality (N-2): The female was observed entering the nest on 22nd April of 2017 but the nest was not sealed yet, as of last observation done on 17th May, 2017.

Complete breeding cycle;

From nest N-1: 102 days.

Hornbills show a strong fidelity to their nest sites, returning year after year to the same cavity (Kemp, 1995; Kinnaird & O'Brien, 2007).

The timing of nesting in hornbills is thought to be an adaptation to cope with seasonal pulses in food availability (Leighton, 1982; Kemp, 1995).

Nesting Habit of Rufous-necked Hornbill (RNH)

“An approach to conservation”



2. When a female agrees to use the nest cavity, she begins to seal the nest opening and spends time in the nest. A narrow, vertical opening is left in the sealing, through which the male feeds, and the female and the brood defecate.



1. Female RNH before nesting. During the nesting, the cavities are checked by both members of a pair, especially the female by going around and poking her head into holes.



4. After a total of about 125 days of incarceration, the female breaks the nest's seal and leaves, the chicks following shortly afterwards.



3. Male continue feeding the female and chick with variety of food items.



The juvenile RNH with adult male (left- 29th July, 2016) and female (right-14th August, 2016)

Observations on feeding behaviour of male RNH at nesting site during breeding season.

(Nest location: Nabay locality (N-1): 27°07'08.5"N and 090°40'01.6"E)

4 days observation (continuous)

6:00hr-18:00hr

Time of male visiting the nest:

- Initial: 8:15hr
- Final: 17:17hr.

Time interval for male arrival to the nest:

- minimum 19 minutes to maximum 3 hours 25 minutes.

Visiting frequency of male feeding the female:

- minimum of 4 times and maximum of 5 times in a day

Time spent feeding the female:

- 30 to 75 seconds

- Male becomes vigilant, remaining silent and concealing themselves on disturbances.
- Did not visit the nest directly; first perch on a nearby branch, scan the area and then approach the nest hole silently.
- Always visit the nest from same compass direction.
- On disturbance, they fled over and keep watching from distance.







- A) Male RNH scanning the area before visiting the nest (27th April, 2016);
B) B) Male feeding the female (8th June, 2016- this pair was not breeding).

HABITAT DISTURBANCE AND THREATS TO HORNBILL SPECIES



Cattle migration (left) and temporary camp (right) set in the RNH habitat by the cattle herder.



Clearing of forested area for shifting cultivation



The high power transmission lines constructed in the habitat of RNH



Logging in RNH habitat.

- ❖ Most of the Asian hornbills are hunted for their body parts: (Bennett *et al.*, 1997; Aiyadurai *et al.*, 2010; Naniwadekar & Datta, 2013).
 - a. casque and tail feathers for traditional attire
 - b. For consumption of their meat,
 - c. for their body fat, which is believed to have medicinal properties

In Bhutan;

- ❖ No threats of hunting have been so far reported from JSWNP. This was also confirmed from the local villagers.

Recommendation

- The present study identified five localities as important habitats of RNH within JSWNP.
- Detail studies on the distribution and its food resources are needed for conservation of their habitats.
- There is a need to develop a management and action plan for long term monitoring of Rufous-necked hornbill by the forest department and a field/conservation biologist.
- Conservation education and awareness to the local people residing within or proximity to the RNH habitat need to go hand-in-hand with all protection and conservation effort.
- The habitat of JSWNP should be well managed for the conservation of all other important species for our future generation.

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SAVE THE
“**VULNERABLE**”
RUFOUS-NECKED
HORNBILL



THANK YOU

“SAVE NATURE”