

**ESTIMATING DENSITY OF RUFOUS-NECKED HORNBILL
(*Aceros nipalensis*) USING DISTANCE SAMPLING
IN THUNG YAI NARESUAN (EAST) WILDLIFE SANCTUARY**

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ABSTRACT

The rufous-necked hornbill (RNH; *Aceros nipalensis* [Hodgson, 1829]) is one of thirteen hornbill species found in Thailand and is listed as vulnerable under IUCN Red List. The rufous-necked hornbill has been locally extinct from most of its original habitat in northern Thailand mainly due to habitat loss and fragmentation. The objective of this research was to estimate the density of rufous-necked hornbills in an evergreen forest patch at Thung Yai Naresuan (East) Wildlife Sanctuary located in the core area of the Western Forest Complex, Thailand. Density point counts along five trails were conducted to estimate population density in 2007 and 2008. A total of 75 observations of rufous-necked hornbills were recorded during field surveys. The average density was 5.55 individuals/km², which was ranked as medium density compared to Huai Kha Khaeng and Thung Yai Naresuan (West) Wildlife Sanctuary.

Keyword: Rufous-neck hornbill (*Aceros nipalensis*), Distance sampling, density, Thung Yai Naresuan (East) Wildlife Sanctuary.

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INTRODUCTION

Fifty-four hornbill species have been identified, belonging to the families Bucorvidae and Bucerotidae within the order Bucerotiformes. Of these species, 31 are found in Asia, mainly in monsoon evergreen forests (Poonswad and Kemp, 1993) and thirteen species are recorded in Thailand. The rufous-necked hornbill (RNH; *Aceros nipalensis*) is one of thirteen hornbill species listed as vulnerable on the IUCN Red List 2009 and Appendix I and II of the CITES. The population of rufous-necked hornbill is small and rapidly declining as a result of destruction of evergreen forests. It has been locally extinct from most of its original habitat in northern Thailand (Poonswad and Kemp, 1993; Round, 1998) due to habitat loss and fragmentation (Pattanavibool and Dearden, 2002). Recent studies indicated that the Western Forest Complex (WEFCOM) is the last stronghold for rufous-necked hornbills and one of five hornbill hotspots in Thailand (Trisurat *et al.*, 2013).

In the past, a few studies were conducted to estimate population densities of hornbills in Thailand which contribute to technical development by providing guidance for surveys of hornbill populations (Poonswad *et al.*, 2009; Gale and Thong-Aree, 2006; Jornburom, 2010). New and appropriate techniques (e.g., Distance Sampling [Buckland *et al.*, 2001], Distance Program [Thomas *et al.*, 2005]) have been developed to assess bird populations. This study aimed at estimating density of rufous-necked hornbills in the evergreen forests of Thung Yai Naresuan (East) Wildlife Sanctuary. The results will contribute to effective management and conservation plans of rufous-necked hornbills in the future.

MATERIALS AND METHODS

Study area

This research was conducted in Thung Yai Naresuan (East) Wildlife Sanctuary located in the core area of the Western Forest Complex (WEFCOM). It covers an area of 1,570 km². Geographically, the study area lies at latitudes 15° 10' to 15° 45' North and longitudes 98° 38' to 99° 5' East, at 300 to over 1,400 m above sea level. Four forest types are distinguished in the study area, namely mixed deciduous, montane, dry evergreen and hill evergreen forest (WEFCOM, 2004). In addition, Thung Yai Naresuan (East) Wildlife Sanctuary is recognized as one of the most important habitats for hornbill conservation in Thailand (Poonswad and Kemp, 1993).

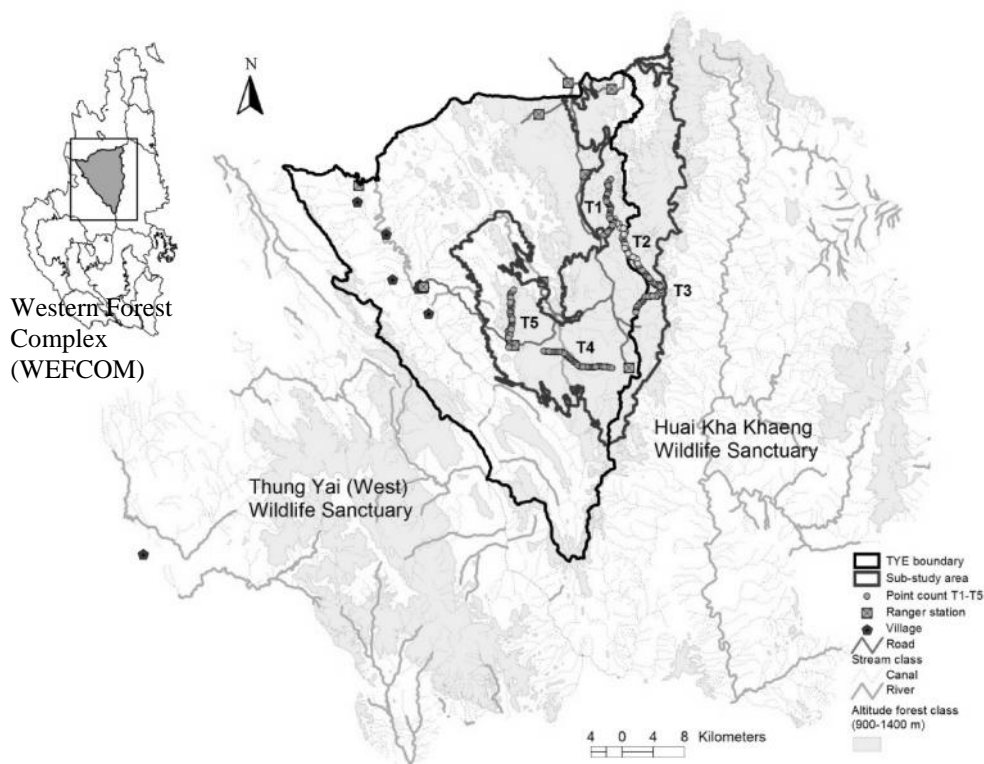


Figure 1 Location of the study area.

Selection of the habitat patch

A preliminary survey in Thung Yai Naresuan (East) Wildlife Sanctuary was conducted and ArcView v3.3 software was used to delineated the boundary of habitat for rufous-necked hornbills. This area encompasses fragmented dry and hill evergreen forests, covering approximately 635.5 km² (Figure 1).

Establishment of point sampling trails and data collection

Point sampling technique was used for sightings of rufous-necked hornbills because the method is likely less biased than line transect sampling (Marsden, 1999). Thus, five trails were established in evergreen forest patches previously identified as rufous-necked hornbill habitat (Poonswad *et al.*, 2009; Jornburom, 2010). Each trail was 9 km long and systematic sampling points were determined at 200 m intervals (Figure 2), which was appropriate to avoid double counting birds between two points (Buckland, 1993; Sutherland, 1996; Gregory *et al.*, 2004). Thus, there were 45 points for each trail. The location of each point was marked using Global Positioning System (GPS).

The point distance sampling was conducted from January 2007 until December 2008 covering both the breeding (January to May) and non-breeding (June to December) season (Chimchome *et al.*, 1998; Poonswad and Kemp, 1993; Kemp, 1995) and visits took place in the breeding season (once; from April to May 2008) and non-breeding season (twice from September to December 2007). At each point, the number *n* of rufous-necked hornbills was counted and the radial distance to each was recorded. If the animals of interest occurred in groups, the perpendicular distance to the center of the group was recorded.

In this study, the radial distance was measured using a range finder. However, in dense vegetation, range finders may not be practical beyond distances of 20 m (Gale and Thong-Aree, 2006). Thus, distances were recorded in increments: 10, 20, 40, 60, 80, 100, 500, and 800 m. Following others, the recorded data at each point included both direct sightings (S) and acoustic (H) detections in a 10-min period (Bibby *et al.*, 1998; Jornburom, 2010; Marsden, 1999; Barraclough, 2000; Gregory *et al.*, 2004; Poonswad *et al.*, 2009). The bird survey was commenced between 06.00 - 11.00 am in the morning and 02.00 - 05.00 pm in the afternoon (Sripanomyom *et al.*, 2010) and no surveying were carried out during rain, heavy mist, or strong winds.

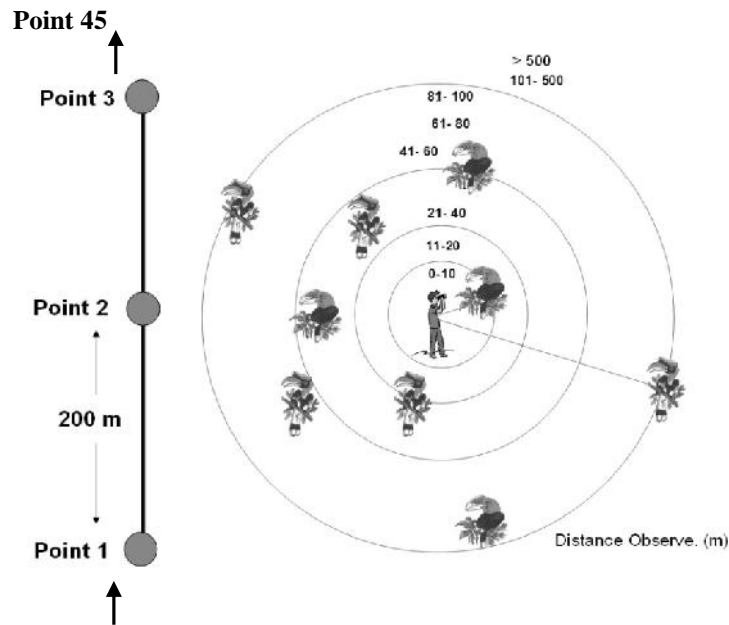


Figure 2 Point count survey used to estimate rufous-necked hornbill density.

Distance sampling model

Distance sampling (Buckland *et al.*, 2001) and DISTANCE 5.0 software (Thomas *et al.*, 2005) were used to estimate encounter rate, detectability and group size of rufous-necked hornbills. The density of rufous-necked hornbills in the study area surveyed (D_g) and (\hat{D}_{RNH}) were estimated as (Buckland *et al.*, 2001);

$$\hat{D}_g = \frac{n\hat{h}(0)}{2K} \quad (1)$$

$$\hat{D}_{RNH} = \frac{n\hat{h}(0)\hat{E}(s)}{2fK} \quad (2)$$

Where $h(0)$ denoted the slope of the probability density function of detection distances evaluated at zero distance. Thus density estimates were obtained from estimates of

$h(0)$ and encounter rate (n/K), is referred to as the effective radius and corresponds to the radial distance from the point transect within which the number of undetected groups was equal to the number of groups detected beyond the circle with that radius. The circular area of detection out to the effective radial distance gives the effective area of detection .

Due to the different detection processes associated with visual (S) and acoustic (H) clues of birds, separate detection functions were fit to the data for each condition. However, given that acoustic detections are unreliable in terms of distance and group size estimation, and can be problematic when it comes to correct species identification, the analysis in the current research was restricted to direct observations (visual detection, S) only.

The density of a particular species \hat{D}_{RNH} was obtained by multiplying the estimated group density \hat{D}_g by the estimated expected group size $\hat{E}(s)$.

RESULT AND DISCUSSION

Species occurrence sampling points

A total of 75 samples were obtained from the field surveys, 46 during the breeding season and 29 for the non-breeding seasons (Table 2). With about 4-5 birds group size was relatively small. Rufous-necked hornbills were often found in Thung Yai Naresuan (East) Wildlife Sanctuary. The result was consistent with previous studies conducted by BirdLife International (2001) and Tifong *et al.* (2007) which indicated similar group sizes and most individuals were not mature (Poonswad and Kemp, 1993; Chimchome *et al.*, 1998).

The average sex ratio for adults was 1:1, and the group size was 3-5 individuals (number of observations $n = 4$). Around trail points, preferred fruits of hornbills were more abundant in the breeding compared to non-breeding seasons which is probably why 46 rufous-necked hornbills were recorded one breeding season and 29 individuals were recorded two non-breeding seasons. So there could have been not enough food for rufous-necked hornbills in the non-breeding season. Of all detections twenty-one records were direct observations (Table 2).

In addition, other hornbill species were present in the study areas including; great hornbill ($n = 144$; $S = 29$ and $H = 115$), brown hornbill ($n = 42$; $S = 28$ and $H = 14$) and oriental pied hornbill ($n = 27$; $S = 7$ and $H = 20$). For, wreathed Hornbill is encountered very little ($n = 5$; $S = 3$ and $H = 2$) respectively.

Table 2 Rufous-necked hornbill occurrence during one breeding and two non-breeding seasons (NB1 and NB2) in Thung Yai Naresuan (East) Wildlife Sanctuary.

	Trail no.	Number of occurrences	
		Breeding season	Non-breeding seasons
Thung Yai Naresuan	1	21	15 (9 NB1 and 6 NB2)
(East) Wildlife	2	7	5 (3 NB1 and 2 NB2)
Sanctuary	3	18	9 (2 NB1 and 7 NB2)
	4	ND	ND
	5	ND	ND
Total		46 (S=17, H=29)	29 (S=4, H=25)

Notes: S = sightings; H = heard; ND = not detected

Along trails 1-3, the rufous-necked hornbill was observed in both seasons. In contrast, they were not detected in both seasons along trails 4 and 5. Although, all trails were positioned in evergreen forest but the topography of trail no. 4 and 5 is much less steep and easily accessible to humans living nearby (WEFCOM, 2004).

The selection model for determination density

Following Buckland *et al.* (2001) only the 21 direct observations were used to define the detection function for estimating density of rufous-necked hornbills in Thung Yai Naresuan (East) Wildlife Sanctuary.

Field data indicated that few rufous-necked hornbills were recorded at a strip 0-20 m due to disturbance by of the observers and at distances beyond 160 m, due to poor visibility. In this study, bird observations beyond the distance of 160 m were not included. The effective strip detection radius (EDR) was determined as 64.06 m and the highest abundance of rufous-necked hornbill was found at the strip radius 40-80 m.

Density and comparison

The result of our analysis using DISTANCE 5.0 program revealed that the density of rufous-necked hornbill in cluster (\hat{D}_g) was 3.06 individual/group; expected value ($\hat{E}(s)$) of cluster size was 1.81/ km²; and the density of individual rufous-necked hornbill (\hat{D}_{RNH}) was 5.55 birds/ km² (Table 3) which was considered a medium density compared with the rufous-necked hornbill found at Thung Yai Naresuan West (8.06 birds/km² [Poonswad *et al.*, 2009]) and Huai Kha Khaeng Wildlife Sanctuary (3.36 and 3.69 birds/km² [Poonswad *et al.*, 2009; Jornburom, 2010]). This is due to the fact that the Thung Yai Naresuan West has greater size and contiguous habitat than the other two areas. Generally, large habitat patches provide larger abundance of high quality food and may thus accommodate higher densities of hornbills as has been pointed out by Sitompul *et al.* (2004) and Pattanavibool and Dearden (2002).

Table 3 Density of rufous-necked hornbills at Thung Yai Naresuan (East) Wildlife Sanctuary.

Point parameter	Standard estimate	Percent coefficient error of Variation	95% confidence interval	
\hat{D}_g	3.0642	0.96608	31.53	1.5902 5.9048
$\hat{E}(s)$	1.8125	0.22765	12.56	1.3883 2.3664
\hat{D}_{RNH}	5.5539*	1.8848	33.94	2.7874 11.066

Note: * \hat{D}_{RNH} = density of rufous-necked hornbill summary direct observations only data (S = 16 and cluster size = 4) of breeding and non-breeding seasons; $\hat{E}(s)$ = the estimated expected group size; \hat{D}_g = the estimated group density

CONCLUSION AND RECOMMENDATION

In total 75 observations of rufous-necked hornbill were made along five trails in Naresuan (East) Wildlife Sanctuary during January 2007 – December 2008. In addition, the estimated density of rufous-necked hornbills was 5.55 birds/km², which was considered as medium compared to Huai Kha Khaeng and Thung Yai Naresuan (West) Wildlife Sanctuaries.

In this research, the survey was conducted one time. In order to support accuracy and serve as a guide for conservation and determination of population viability analysis (PVA; Akçakaya, 2005) of rufous-necked hornbills, field surveys should be repeated several times ($n > 2$). In addition, density should be estimated separately for the breeding and non-breeding season because the distribution of rufous-necked hornbills is different in each season which will affect the density analysis. However, the intensity and frequency of surveys must consider for example; time period, travel, budget, accessibility of the area, and number of observers as well. In addition, the radial distances should be measured exactly rather than in intervals.

ACKNOWLEDGEMENTS

We thank the Department of National Park, Wildlife and Plant Conservation of Thailand for granting permission to conduct this research in Thung Yai (East) Wildlife Sanctuary. We thank the Wildlife Conservation Society (WCS) Thailand for support with field survey and materials. We are also grateful to the Thailand Hornbill Project for scholarship support through their project on the genetics of hornbills in fragmented-forest landscape and their population and habitat status in Thailand, funded by the National Center for Genetic Engineering and Biotechnology (BIOTEC), Thailand. This research was made possible with great success.

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APPENDIX

Figure A The detection function (a) and associated probability density (b) function with data pooled by all season for direct sightings for rufous-necked hornbills – half-normal with no adjustment terms with right truncation at 160 meters and data grouped into four intervals for analysis.

