

## NEST AND ROOST HABITAT CHARACTERISTICS OF THE GREY-FACED BUZZARD IN NORTHEASTERN CHINA

WEN-HONG DENG<sup>1</sup>

*Ministry of Education Key Laboratory for Biodiversity Science and Ecological Engineering, College of Life Sciences, Beijing Normal University, Beijing, 100875, China*

GAO WEI

*School of Life Sciences, Northeast Normal University, Changchun, 130024, China*

ZHENG GUANG-MEI

*Ministry of Education Key Laboratory for Biodiversity Science and Ecological Engineering, College of Life Sciences, Beijing Normal University, Beijing, 100875, China*

**ABSTRACT.**—The habitat of the Grey-faced Buzzard (*Butastur indicus*) has diminished substantially because of forest management for timber production and farmland reclamation in recent years. An understanding of the characteristics of nest and roost sites of this bird is important for its conservation. We studied Grey-faced Buzzards during their breeding season in Zuoqia Nature Reserve, Jilin Province, China, from March 1996–August 1998. This species selected both nesting and roosting sites in mixed-deciduous forests that contained Korean larch (*Larix olgens*) more frequently than available in the study area. Most nests were located in Korean larches and in Chinese pines (*Pinus tabulaeformis*; 70%), whereas nests in broadleaf trees were relatively infrequent (30%). Eight nests (75%) were located on the upper third of a slope, three nests (19%) were located on the middle third, and one nest (6%) on the lower third. Buzzards used 11 tree species for roosting; however, (58%) of all roosts were located in three tree species (Korean larch, Chinese pine, and River birch [*Betula nigra*]). Higher canopy closure and taller trees best separated roost sites from random plots with a discriminant analysis. Mean roost height was  $9.6 \pm 0.5$  m. Roost trees averaged  $11.2 \pm 0.6$  m in height with mean DBH (diameter at breast height) of  $16.9 \pm 0.3$  cm. Buzzards selected nest and roost sites in forests characterized by tall (>12 m) conifers, hardwood understory, and high canopy closure (>70%).

**KEY WORDS:** *Butastur indicus*; *habitat use*; *Grey-faced Buzzard*; *nest site*; *nest tree*; *roost site*.

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### CARACTERÍSTICAS DEL HABITAT DE LOS DORMIDEROS Y DE ANIDACION DEL BUITRE DE CARA GRIS DEL NORESTE DE CHINA

**RESUMEN.**—El hábitat del buitre de cara gris (*Butastur indicus*) ha disminuido substancialmente en los últimos años, a causa del manejo del bosque para la producción de madera y la recuperación de tierras para agricultura. Una comprensión de las características de los sitios de nido y de los dormideros de esta ave, es importante para su conservación. Estudiamos el buitre de cara gris durante su temporada de cría en la Reserva Natural de Zuoqia, Provincia de Jilin, China, desde marzo del 1996 hasta agosto del 1998. Esta especie escogió sitios de anidación y dormideros en los bosques deciduos mixtos que contenían una mayor frecuencia de *Larix olgens* en el área del estudio. La mayoría de los nidos se localizaron en *Larix olgens* y *Pinus tabulaeformis*; 70%, mientras que los nidos que estaban en árboles de hojas anchas fueron relativamente poco frecuentes (30%). Ocho nidos (75%) fueron localizados en el tercio superior de una pendiente, tres nidos (19%) fueron localizados en el tercio medio, y un nido (6%) en el tercio inferior. Los buitres utilizaron 11 especies de árboles como dormideros; sin embargo el 58% fueron localizados en tres especies de árboles *Larix olgens*, *Pinus tabulaeformis* y *Betula nigra*. La cobertura del dosel y los arboles mas altos fueron separados de los dormideros mediante la utilización del analisis discriminante. La media de la altura de los dormideros fue de  $9.6 \pm 0.5$  m. Los árboles que sirvieron como dormideros tuvieron una altura promedio de  $11.2 \pm 0.6$  m, con media DAP (diámetro a la altura del pecho) de  $16.9 \pm 0.3$  cm. Los buitres escogieron nidos y dormideros en bosques carac-

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<sup>1</sup> E-mail address: dengwh@bnu.edu.cn

terizados por altas coníferas (>12 m), árboles del sub-dosel, de madera dura con copas cerradas y altas (>70% alto de dosel).

[Traducción de César Márquez]

The large number of published reports that describe habitat selection and habitat characteristics among birds attests to the enormous variation observed and to the biological importance of this topic. In addition to its importance, an understanding of the response by birds to environmental habitat change is necessary before conservation strategies can be developed and implemented (Schmutz 1989). A theoretical framework for habitat selection has been provided by Fretwell and Lucas (1970), and functional and theoretical aspects of habitat selection have been summarized by Cody (1985). Within these frameworks, nest and roost characteristics are very important factors related to avian habitat selection.

Among subtropical birds, raptors are one of the least-studied groups and relatively little is known about their nest and roost characteristics. Grey-faced Buzzard (*Butastur indicus*) is a summer migrant in northeast China (Cheng 1987, Anonymous 1988). It seems that most of the Grey-faced Buzzards that breed in northeastern China migrate to Okinawa, Taiwan, the Philippines, Indonesia, Malaysia or nearby regions to winter (Chang 1980, Cheng 1987, Ehimekensibu et al. 1989, Deng et al. 1997). This buzzard has been listed as a threatened species in National Second Class Protected Species in China Data Book of Endangered Animals (Zheng and Wang 1998). The habitats of this species have been substantially reduced because of forest management for timber production and farmland reclamation in recent years (Zheng and Wang 1998). An understanding of the characteristics of nest and roost sites of this bird is particularly important for its conservation. However, very little is known about nesting ecology of Grey-faced Buzzards either in China or in other areas. In this paper we describe the nest and roost characteristics of this raptor in northeastern China. Our null hypotheses were: (1) no difference exists between nesting sites and randomly-placed plots within the study area, (2) no difference exists between the immediate nest site and general habitat within nest stands, and (3) no difference exists between roosting sites and randomly-placed plots within the study area.

#### STUDY AREA

The study area, ca. 84 km<sup>2</sup> in size, was located in Zuojia Natural Protection Area and included the Tumengling Mountains and Zhujia Mountains ranging from the eastern ChangBai Mountains to the western plain (126°1'–127°2'N, 44°6'–45°5'E). Elevation at the site ranged from 200–500 masl. The climate is east monsoon, characterized by hot, dry summers and cold, snowy winters. The vegetation within the study area was quite diverse, although the existing forest is secondary. The most common trees present in the study area were Mongolian oak (*Quercus mongolica*), dahur birch (*Betula davurica*), Manchurian linden (*Tilia manschurica*), Japanese elm (*Ulmus japonica*), Scotch pine (*Pinus sylvestris*), Korean larch (*Pinus koraiensis*) and Masson pine (*Pinus massoniana*) (Deng et al. 1997). In the study area, hawthorn raspberry (*Rubus crataegifolius*), dahurian rose (*Rosa dahurica*), Korean rose (*Rosa doreana*), willowleaf spiraea (*Spiraea salicifolia*), ural falsespiraea (*Sorbaria sorbifolia*), prickly rose (*Rosa acicularis*), amur barberry (*Berberis amurensis*), amur honeysuckle (*Lonicera maackii*), manchur honeysuckle (*Lonicera ruprechtiana*), and sakhalin honeysuckle (*Lonicera maximowiczii*) dominated the shrub layer. The study area consists of ca. 30% open habitat and 70% forest habitat.

#### METHODS

**Survey Methods.** We surveyed the study area at least four times each year, 20 March–20 August, 1996–98, using conventions suggested by Newton and Marquiss (1982) and Steenhof (1987) to describe occupancy and activities at nesting sites. We attempted to locate all buzzard nests within the study area. We used behavioral cues and systematic searches of potential nest substrates to locate nests. We determined the sex of buzzards by body size and plumage characteristics (Deng et al. 1997). We established six transects in the study area ( $\bar{x}$  = 3 km, range = 2–5 km). Each transect was 50 m wide and parallel to the forest edge. Each transect was divided into 100 m segments from one end to the other. Sites were surveyed within a 4-hr period beginning 30 min after sunrise by walking along each side, with 5-min stops at each 100 m interval. We walked along one side and came back along another one. A nesting area was considered occupied if a territorial pair or evidence of a territorial pair (such as observations of an incubating bird, nest construction, or nest maintenance) was observed, otherwise the area was classified as unoccupied. We located roosts (the perch location where a bird spends the night) by observing buzzards at roost sites. Only roost sites where buzzards remained stationary upon initial detection were used in analyses. We recorded eagle nest and roost locations with GPS receivers and plotted these on geologic survey maps to the nearest 10 m using Universal Transverse Mercator (UTM) coordinates.

Most of our habitat-sampling protocol was adopted from Seamans and Gutiérrez (1995). We measured site characteristics in sample plots centered on buzzard nest

trees and roost trees and at random locations in forest habitat. Detailed vegetations were collected in 12 nest stands and 12 random plots. Nesting habitat data were collected at four sample points 25 m from each nest in each cardinal direction. Also, four sample points were located in each cardinal direction and at a random distance between 100 m and 1000 m from the nest tree to represent available habitat. This sampling was designed to address nest-site level habitat selection occurring within a hypothetical Grey-faced Buzzard home range. In each nest stand, four sample points were measured within both nesting and available habitat to increase the number of points available for use in the assessment of model stability (Mueller-Dombois and Ellenberg 1974). We categorized the forest type (conifer, if the proportion of conifers was >70%; mixed conifer/broadleaf, if the proportion of conifer and broadleaf was near equal; broadleaf forest, if the proportion of broadleaf was >70%) and slope position (lower, middle, upper third) at each site, and measured 12 habitat characteristics. At each plot center, we estimated slope aspect with a compass, slope angle (°) with a clinometer, and relative canopy closure (%) with a spherical densiometer. We measured tree DBH (diameter at breast height in cm) with calipers, and tree height with a clinometer. We used a variable radius-plot method (Mueller-Dombois and Ellenberg 1974) to estimate basal area (m<sup>2</sup>/ha) of conifers and broad-leaf trees. In addition, we recorded nest and roost tree species, percent height (roost height/tree height) relative to the height of the tree, and distance from nest trees to roost trees. We used the variance of tree height and variance of tree diameters of all trees in each sample plot as an index of forest structural heterogeneity.

**Data Analysis.** We pooled data among years after finding no difference using a series of Kruskal Wallis tests (Zar 1984), with sequential Bonferroni adjustments (Rice 1990). We compared forest types and slope position of eagle sites and random sites using chi-square analysis. We estimated the mean slope aspect of eagle nests and roosts using circular statistics (Batschelet 1981), and compared aspect of eagle nests and roosts with random sites using a Watson-Williams test (Zar 1984). We assessed univariate normality of the variables using skewness, kurtosis, and probability plots. We assessed the equality of variance of variables between groups using an *F*-max test. We used logarithmic and square-root transformations to normalize variables and equalize variances for variables that deviated from normal distribution. For analyses, we only used those variables which approximated a normal distribution and had comparable variances between groups, either before or after transformation. We tested the null hypotheses of no difference in variable means between eagle nest and roost plots and random plots using multivariate analysis of variance (MANOVA, Stevens 1996). For the MANOVA, we used Wilk's Lambda to compare linear combinations of variables between used and random sites. If the MANOVA was significant, we tested individual variables using a series of *t* tests with sequential Bonferroni adjustments. We used discriminant analysis (DA, Stevens 1996) to model data, to estimate which characteristics contributed the most to differences be-

tween groups. We used cross validation (Capen et al. 1986) to evaluate the stability of the DA model.

We took detailed measurements of all nest trees (age, height, DBH, canopy and nest height) using the same techniques used for measuring trees in sample plots. We estimated nest tree age by extracting a core sample with an increment borer and counting the rings. We used circular statistics to estimate mean orientation of the nest relative to the tree trunk. We used a chi-square analysis to test for differences in tree species between nest and random tree distributions. We used paired-sample *t* tests (Zar 1984) to compare nest tree height and DBH to random trees within nest stands.

## RESULTS

**Roost-site Characteristics.** Of 86 roost sites we measured, we used 58 (one each for 30 males and 28 females) as independent samples for analysis. The distribution of forest types at Grey-faced Buzzard roosts differed from random sites throughout the study area ( $\chi^2 = 9.06$ ,  $df = 2$ ,  $P < 0.05$ ), with most roosts in the mixed conifer/river birch forest type. Position of roosts sites on the slope differed from a random distribution ( $\chi^2 = 9.06$ ,  $df = 2$ ,  $P < 0.05$ ). Forty-seven roosts (81%) were located on the middle third, eight (14%) roosts were on the upper third, and three roosts were (5%) on the lower third of the slopes. Mean aspect at roost sites differed from aspect at random sites ( $F = 8.94$ ,  $df = 1, 112$ ,  $P < 0.05$ ; mean aspect = 6.8°, mean vector length = 0.60, angular deviation = 68.5°). Buzzards used 11 tree species for roosting, however over half (58%) of all roosts were located in three tree species (Korean larch, Chinese pine, and river birch). Mean roost height was  $9.6 \pm 0.5$  m in the roost tree. Roost trees averaged  $11.2 \pm 0.6$  m tall in height with mean DBH of  $16.9 \pm 0.3$  cm.

Roost plots differed from random plots (MANOVA; Wilk's Lambda = 0.51,  $F = 16.8$ ,  $df = 10, 109$ ,  $P < 0.05$ ). The *t*-tests indicated most variables differed between roost and random plots (Table 1). Higher canopy closure and taller trees best separated roosts from random plots in the DA (Table 2). The pooled DA correctly classified 78.6% of the roost and random plots (Table 3).

**Nest-site Characteristics.** We found 12 Grey-faced Buzzard nests and used all nest sites as independent samples for analysis (Fig. 1). The distribution of forest types at nests differed from random sites ( $\chi^2 = 15.62$ ,  $df = 2$ ,  $P < 0.05$ ), with most nests in the mixed-conifer/river birch forest type. Position of nest sites on the slope differed from an independent distribution ( $\chi^2 = 11.26$ ,  $df = 2$ ,  $P < 0.05$ ). Eight nests (75%) were located on

Table 1. Habitat characteristics at Grey-faced Buzzard roost sites ( $N = 58$ ) and random plots ( $N = 58$ ) in the Zuoja and Tumengling mountains, northeastern China, 1996–98.

VARIABLE	MEAN $\pm$ SD		$t^b$	$P$
	ROOST	RANDOM <sup>a</sup>		
Tree height (m)	13.8 $\pm$ 1.5	9.1 $\pm$ 1.2	5.63	<0.01
Tree DBH (cm)	28.7 $\pm$ 11.3	21.2 $\pm$ 8.6	2.84	0.01
Tree basal area (m <sup>2</sup> ha <sup>-1</sup> )	10.6 $\pm$ 4.9	9.3 $\pm$ 5.8	0.98	0.46 <sup>c</sup>
Canopy closure (%)	81.9 $\pm$ 18.5	62.4 $\pm$ 13.1	8.56	<0.01
Tree height variance	1.9 $\pm$ 1.6	0.8 $\pm$ 0.5	4.29	<0.01
Tree DBH variance	3.9 $\pm$ 1.6	2.1 $\pm$ 0.9	2.91	0.01
Distance from water (m)	348.6 $\pm$ 57.9	401.2 $\pm$ 345.5	0.42	0.61
Tree crown volume (m <sup>3</sup> )	12.2 $\pm$ 5.5	7.9 $\pm$ 3.8	3.21	<0.01
Slope angle (%)	22.5 $\pm$ 11.4	13.6 $\pm$ 6.8	8.27	<0.01

<sup>a</sup> Random sites were located throughout the study area by using GIS.

<sup>b</sup> Degrees of freedom = 98.

<sup>c</sup> No significant difference.

the upper third of the slope, three nests (19%) were located on the middle third, and one nest (6%) on the lower third. Mean slope aspect at nest sites was northerly (mean aspect = 295°, mean vector length = 0.37, angular deviation = 56.5°), and differ significantly from random sites ( $F = 15.13$ ,  $df = 1, 22$ ,  $P < 0.05$ ).

Nest plots differed from random plots (MANOVA; Wilk's Lambda = 0.68,  $F = 7.96$ ,  $df = 8, 23$ ,  $P < 0.05$ ). The  $t$ -tests indicated that four of the eight variables differed between nest and random plots (Table 3). Larger DBH, taller trees, greater canopy closure, and greater basal area of mature trees best separated nest sites from random sites in the DA (Table 3).

**Nest-tree Characteristics.** Grey-faced Buzzard nests were located in five tree species. Fifty percent ( $N = 6$ ) of nests were located in Korean larches, 25% ( $N = 3$ ) were in Chinese pines, and 8% each were in river birch, Mongolian oak, Manchurian linden (*Tilia mandshurica*), respectively. Mean aspect deviation of the nests in the trees was northwesterly (mean aspect = 342.5°, mean vector length = 0.51, angular deviation = 56.5°), but did not differ from a random distribution ( $z = 1.2$ ,  $P > 0.05$ ). The distribution of random tree species differed from nest tree species ( $\chi^2 = 8.9$ ,  $df = 2$ ,  $P < 0.05$ ). Nest trees were larger, denser, and taller than trees randomly located within the nest stand (Table 4).

Table 2. Mean habitat characteristics at Grey-faced Buzzard nest ( $N = 12$ ) and random plots ( $N = 12$ ) in the Zuoja and Tumengling mountains, northeastern China, 1996–98.

VARIABLE	MEAN $\pm$ SD		$t^b$	$P$
	NEST	RANDOM <sup>a</sup>		
Tree height (m)	15.1 $\pm$ 2.2	10.6 $\pm$ 1.7	8.24	<0.01
Tree DBH (cm)	31.9 $\pm$ 9.2	25.2 $\pm$ 6.7	3.13	0.01
Tree basal area (m <sup>2</sup> ha <sup>-1</sup> )	17.6 $\pm$ 5.1	9.6 $\pm$ 3.7	4.94	<0.01
Canopy closure (%)	84.5 $\pm$ 15.6	62.7 $\pm$ 22.0	8.76	<0.01
Tree height variance	1.5 $\pm$ 1.1	1.3 $\pm$ 0.6	0.87	0.42 <sup>c</sup>
Tree DBH variance	3.2 $\pm$ 1.8	3.1 $\pm$ 0.8	0.69	0.49 <sup>c</sup>
Distance from water (m)	229.5 $\pm$ 112.6	314.2 $\pm$ 258.6	0.28	0.87 <sup>c</sup>
Tree crown volume (m <sup>3</sup> )	13.8 $\pm$ 6.9	8.1 $\pm$ 3.8	3.47	<0.01
Slope angle (%)	25.5 $\pm$ 8.5	21.3 $\pm$ 7.1	1.22	0.06 <sup>c</sup>

<sup>a</sup> Random sites located in each cardinal direction from nest at a random distance between 100 and 1000 m.

<sup>b</sup> Degrees of freedom = 94.

<sup>c</sup> No significant difference.

Table 3. Discriminant analysis results of habitat characteristics at Grey-faced Buzzard roost and nest plots in the Zuojia and Tumengling mountains, northeastern China, 1996–98.

VARIABLE	ROOST PLOTS ( <i>N</i> = 58)			NEST PLOTS ( <i>N</i> = 12)		
	MEAN RANK	MEAN STRUCTURE COEFFICIENT <sup>a</sup>	POOLED DATA STRUCTURE COEFFICIENT <sup>a</sup>	MEAN RANK	MEAN STRUCTURE COEFFICIENT <sup>a</sup>	POOLED DATA STRUCTURE COEFFICIENT <sup>a</sup>
Tree height (m)	1.9	0.57	0.64	2.5	0.54	0.62
Tree DBH (cm)	6.3	0.21	0.33	6.6	0.29	0.28
Tree BA (m <sup>2</sup> ha <sup>-1</sup> )	8.7	0.16	0.13	9.2	0.11	0.09
Canopy closure (%)	1.2	0.76	0.81	1.0	0.80	0.83
Tree height variance	2.7	0.53	0.58	3.6	0.35	0.59
Tree DBH variance	4.9	0.29	0.45	5.7	0.39	0.36
Distance from water (m)	9.9	0.04	0.03	9.9	0.07	0.01
Tree crown volume (m <sup>3</sup> )	3.1	0.42	0.53	3.9	0.55	0.44
Slope angle (%)	1.3	0.68	0.77	1.8	0.68	0.72

<sup>a</sup> Structure coefficient is correlation between a single variable and discriminant function.

#### DISCUSSION

Most Grey-faced Buzzard nest and roost sites were found on the upper third of north-facing slopes. This corresponded to the distribution of mature mixed conifer/river birch forests on the study area. In addition, most nest and roost sites had an understory of Mongolian oak, which con-

tributed to the forest structure. Raptors have shown some selection for slopes, but slope orientation patterns were not always consistent (Klopfer 1965, Delannoy and Cruz 1988, McIntyre and Adams 1999, Nijman et al. 2000). In selecting nest sites, Grey-faced Buzzards avoid slopes with southern aspects. We suggest that the birds are selecting exposures to insulate the nest against hot weather conditions during incubation and to place their nests close to hunting habitat. Data from accipiter studies (Shuster 1980, Moore and Henny 1983, Speiser and Bosakowski 1987) also show an obvious avoidance of southern slope aspects for nesting.

The majority of nests (75%) were built in conifers rather than in deciduous hardwood trees. Grey-faced Buzzards preferred to build their nests in dense canopy closure of Korean larches and Chinese pines (Table 4). Broad-leaf trees were rarely used as nest trees despite the preference for broad-leaf trees in nest stands. We propose that broad-leaf trees are partly avoided because they seldom have a larger triple and quadruple primary crotches. All nest trees were generally greater in DBH and height when compared to those random trees (Table 4). Large raptors require large tree-forks to place the nest in (Newton 1979, Mader 1982). Grey-faced Buzzard nests were always situated below or in the bottom quarter of the tree canopy, which had an open branch structure. Raptors nest in the lower quarter of the canopy with open branch structure probably to allow the buzzards access to the nest both above and within the canopy; this positioning may also hide the nest

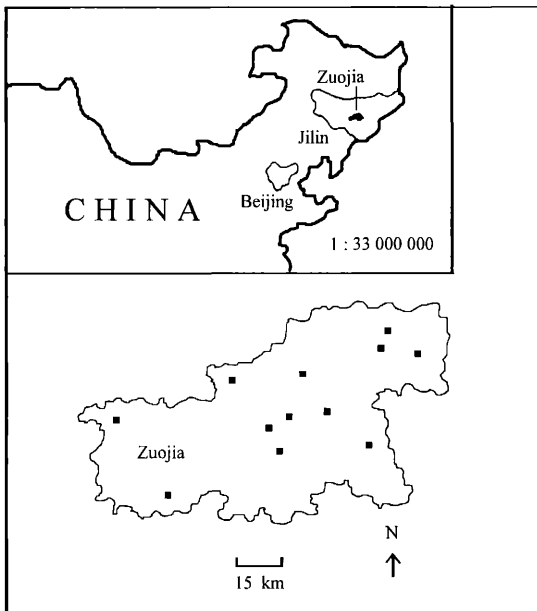


Figure 1. The study area and locations of the nest sites (solid squares indicate nest location) of the Grey-faced Buzzard in Zuojia Nature Reserve, northeastern China.

Table 4. Characteristics of Grey-faced Buzzard nest ( $N = 12$ ) and random trees ( $N = 12$ ) in the Zuoqia and Tumenling mountains, northeastern China, 1996–98.

VARIABLE	MEAN $\pm$ SD		$t^b$	PVALUE
	NEST TREES	RANDOM TREES <sup>a</sup>		
Age (yr) <sup>c</sup>	56.2 $\pm$ 5.1	54.8 $\pm$ 3.4	0.16	0.91
Tree height (m)	18.8 $\pm$ 3.1	14.3 $\pm$ 2.6	4.23	<0.01
Tree DBH (cm)	32.5 $\pm$ 9.7	24.9 $\pm$ 9.2	3.44	<0.01
Tree crown volume (m <sup>3</sup> )	3.6 $\pm$ 1.1	2.4 $\pm$ 0.7	3.16	<0.01
Nest height (m)	12.5 $\pm$ 3.4	—	—	—

<sup>a</sup> Random trees were located a random distance (10–100 m) in a random direction from the nest tree.

<sup>b</sup>  $t$  values from matched pair test, significant at  $\alpha = 0.05$ .

<sup>c</sup> Estimated by extracting at core sample with an increment borer and counting the rings.

from potential predators (Selas 1996, Malan and Robinson 2001). Cerasoli and Penteriani (1996) suggested that tree-nesting raptors might select trees for their size and structural features, such as a tall and open canopy, that allow unobstructed access to nests. In this study, however, Grey-faced Buzzard seem to prefer dense to open canopy for nesting.

In our study, Grey-faced Buzzards selected nest and roost sites primarily in mixed conifer/river birch forests in the largest and tallest trees, with relatively high canopy closure. Forests composed of larger trees with high variation in tree heights may provide an accessible prey base for buzzards and provide protection from potential disturbance from human activities. This kind of vegetation structure allows more small animals to occur and also prevents humans from entering. In addition, Grey-faced Buzzards are heat intolerant and may require mature, multi-storied forests to thermoregulate effectively (Feng 1991, Deng et al. 1997). The middle partition of north-facing slopes, forested with multi-storied mixed conifer habitat, may provide suitable cooler microclimates for buzzards. However, habitats such as hardwood forests seem to lack the complete vertical structure of most typical nest and roost sites.

Trees frequently used for roosting were often those with dense foliage or high canopy closure. In contrast, available trees rarely or never used for roosting appeared to provide little cover. In addition to concealing birds from potential human disturbance, the dense cover of most roost sites probably provided a favorable microclimate. We found that individuals often used the same roost site on successive days, although our presence may have disturbed the buzzards. Although we climbed up

each nest tree to measure the characteristics of nestlings in every five days during nestling period, the buzzards did not change their roost sites. Belthoff and Ritchison (1990) suggested that Eastern Screech-Owls (*Otus asio*) did not use the same roost site on successive days, and suggested reuse of sites could attract potential predators. However, repeated use of roost sites by Grey-faced Buzzards is very common, probably because they have few predators in the study area (Deng et al. 1997). Also, suitable roosts with dense foliage may be extremely limited in the study area.

The forest tracts inhabited by buzzards were large in extent as exemplified by the comparatively long distances (>15 km) to human habitation (Deng et al. 1997). Nest sites were also more often found in dense forests, where little disturbance of any kind occurred and that may have had a greater density and diversity of prey species than edge areas (Kojima 1982, Ricketts and Ritchison 2000). However, we found most nest sites closer to logging roads (or discernable trails) than random sites: six nests (50%) were very close (<30 m) and four (33%) were within 60 m. In our study, forests roads often represented the break in deep contiguous forests. In dense contiguous forests, logging roads may aid the buzzards by providing open flyways. On several different occasions, we observed buzzards flying, perching, and plucking prey along logging roads in the study area. Speiser and Bosakowski (1987) found Northern Goshawks (*Accipiter gentilis*) often nested near logging roads in northern New Jersey and southern New York. Raptors often nest near logging roads or in an exposed position that allows easy access to and from the nest to deliver sticks and prey.

Moore and Henny (1984) pointed out the im-

portance of past experience (success or failure) in nest site selection by raptors, but at least for first-time nesters, the role of early experience and imprinting to the natal habitat may be of primary importance (Newton 1979). For a variety of nonpasserines, studies of marked individuals have shown that nesting sites are more likely to be reoccupied in years following successful nesting attempts and abandoned after nesting failures (e.g., Newton and Marquiss 1982, Marks 1986, Thorsstrom and Quixchán 2000). We did not quantify foraging habitat of the buzzards in our study area. Available information indicated that Grey-faced Buzzards commonly forage in open areas (e.g., pastures, marshes, paddy fields) where they find most of their prey (Kojima 1982, Ehimekensibu et al. 1989). Their foods mainly include frogs, reptiles, rodents, and some birds (Cheng 1987, Ching et al. 1989, Severinghaus 1991). According to our observations, Grey-faced Buzzards often hunt from perches, typically at a top of dead tree; once detected the buzzards then dive down to capture prey. Because our study did not involve marked Grey-faced Buzzards among years, whether the same individual birds reoccupied nests is open to question. Future studies should examine Grey-faced Buzzard Eagles in more detail and should address the nature and extent of individual variation in habitat use. Additional factors such as prey, density, prey accessibility, and competition with other raptors need to be addressed in future studies of the nestling ecology of Grey-faced Buzzards.

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#### LITERATURE CITED

- ANONYMOUS. 1988. A study of the northward migration of Grey-faced Buzzard Eagles passing PaKua Mountain in the spring. *Ann. Taipei Wild. Bird Soc.* 12:12-18.
- BATSCHLETT, E. 1981. Circular statistics in biology. Academic Press, San Francisco, CA U.S.A.
- BELTHOFF, J.R. AND G. RITCHISON. 1990. Roosting behavior of postfledging Eastern Screech-Owls. *Auk* 107: 567-579.
- CAPEN, D.E., J.W. FENWICK, D.B. INKLEY, AND A.C. BOYNTON. 1986. Multivariate models of songbird habitat in New England forests, Pages 171-176 in J. Verner, M.L. Morrison, and C.J. Ralph [Eds.], *Wildlife 2000: modeling habitat relationships of terrestrial vertebrates*. Univ. of Wisconsin Press, Madison, WI U.S.A.
- CERASOLI, M. AND V. PENTERIANI. 1996. Nest-site and aerial point selection by Common Buzzards (*Buteo buteo*) in Central Italy. *J. Raptor Res.* 30:130-135.
- CHANG, W.F. 1980. Travellers who do not need visas, the Grey-faced Buzzard Eagle. *Environment* 1:58-64.
- CHENG, TSO-HIN. 1987. A synopsis of the avifauna of China. Science Press, Beijing, China.
- CHING, H.C., S.T. YU, AND C.H. CHIANG. 1989. A survey of Grey-faced Buzzard Eagle hunting in ManChou Area. KenTing National Park, Taipei, China.
- CODY, M.L. 1985. Habitat selection in birds. Academic Press, New York, NY U.S.A.
- DELANNOY, C.A. AND A. CRUZ. 1988. Breeding biology of the Puerto Rican Sharp-shinned Hawk (*Accipiter striatus venator*). *Auk* 105:649-662.
- DENG, W.H., X. WANG, AND W. GAO. 1997. Breeding habitat selection of the Grey-faced Buzzard Eagle. *J. North-east Normal Univ.* 9:57-61.
- EHIMEKENSIBU, KOCHIKENSIBU, OITAKENSIBU, AND MIYAZAKIKENSIBU. 1989. The migration route of Grey-faced Buzzard Eagle *Butastur indicus* from Shikoku to Kyushu. *Strix* 6:125-131.
- FENG, H.L., G.Q. XIANG, AND K.Q. HANG. 1991. Observation on breeding Grey-faced Buzzard Eagle. Chinese Avian Studies, No. 3., Chinese Science Press, Beijing, China.
- FRETWELL, S.D. AND H.L. LUCAS. 1970. On territorial behavior and other factors influencing habitat distribution in birds. I. Theoretical development. *Acta Biotheor* 9:16-36.
- KOJIMA, Y. 1982. Territory and territorial behavior of the Grey-faced Buzzard Eagle *Butastur indicus*. *Tori* 30: 117-147.
- KLOPFER, P. 1965. Behavioral aspects of habitat selection. a preliminary report on foliage preferences of birds. *Wilson Bull.* 77:376-381.
- MADER, W.J. 1982. Ecology and breeding habitats of the Savanna Hawk in the Llanos of Venezuela. *Condor* 84. 261-271.
- MALAN, G. AND E.R. ROBINSON. 2001. Nest-site selection by Black Sparrowhawks *Accipiter melanoleucus*: implications for managing exotic pulpwood and sawlog forests in South Africa. *Environ. Manage.* 28:195-205.
- MARKS, J.S. 1986. Nest-site characteristics and reproductive success of Long-eared Owls in southwestern Idaho. *Wilson Bull.* 98:547-560.
- MCINTYRE, C.L. AND L.G. ADAMS. 1999. Reproductive characteristic of migratory Golden Eagles in Denali National Park, Alaska. *Condor* 101:115-123.
- MOORE, K.R. AND C.J. HENNY. 1983. Nest site character-

- istics of three coexisting Accipiter hawks in northeast Oregon. *Raptor Res.* 17:65–76.
- AND J. HENNY. 1984. Age specific productivity and nest site characteristics of Cooper's Hawks. *Northwest Sci.* 58:290–299.
- MUELLER-DOMBOIS, D. AND H. ELLENBERG. 1974. Aims and methods of vegetation ecology. John Wiley and Sons, New York, NY U.S.A.
- NEWTON, I. 1979. Population ecology of raptors. Buteo Books, Vermillion, SD U.S.A.
- AND M. MARQUISS. 1982. Fidelity to breeding area and mate in sparrowhawks *Accipiter nisus*. *J. Anim. Ecol.* 5:327–341.
- NIJMAN, V., S. VAN BALEN, AND R. SÖZER. 2000. Breeding biology of Javan Hawk-Eagle *Spizaetus bartelsi* in west Java, Indonesia. *Emu* 100:125–132.
- RICE, W.R. 1990. A consensus combined p-value test and the family-wide significance of component tests. *Biometrics* 46:303–308.
- RICKETTS, M.S. AND G. RITCHISON. 2000. Nesting success of yellow-breasted Chats: effect of nest site and territory vegetation structure. *Wilson Bull.* 112:510–516.
- SCHMUTZ, J.K. 1989. Hawk occupancy of disturbed grasslands in relation to models of habitat selection. *Condor* 91:362–371.
- SEAMANS, M.E. AND R.J. GUTIERREZ. 1995. Breeding habitat of the Mexican Spotted Owl in Tularosa Mountains, New Mexico. *Condor* 97:944–952.
- SELAS, V. 1996. Selection and reuse of nest stands by sparrowhawk (*Accipiter nisus*) in relation to natural and manipulated variation in tree density. *J. Avian Biol.* 27:56–62.
- SEVERINGHAUS, L.L. 1991. The status and conservation of Grey-faced Buzzard-Eagles and Brown Shrikes migrating through Taiwan. Pages 203–223 in T. Salathé, [Ed.]. ICBP Tech. Publ. 12. Taiwan, China.
- SHUSTER, W.C. 1980. Northern Goshawk nesting requirements in the Colorado Rockies. *West. Birds* 11:89–96.
- SPEISER, R. AND T. BOSAKOWSKI. 1987. Nest-site selection by Northern Goshawks in northern New Jersey and southeastern New York. *Condor* 89:387–394.
- STEENHOF, K. 1987. Assessing raptor reproductive success and productivity. Pages 157–170 in B.A. Giron Pendleton, B.A. Millsap, K.W. Cline, and D.M. Bird [Eds.], Raptor management techniques manual. Scientific and Tech. Series No. 10, Natl. Wildl. Fed., Washington, DC U.S.A.
- STEVENS, J. 1996. Applied multivariate statistics for the social sciences, 3rd Ed. Lawrence Erlbaum Publishers, Mahwah, NJ U.S.A.
- THORSTROM, R. AND A. QUIXCHÁN. 2000. Breeding biology and nest site characteristics of the Bicolored Hawk in Guatemala. *Wilson Bull.* 112:195–202.
- ZAR, J.H. 1984. Biostatistical analysis. Prentice-Hall, Englewood Cliffs, NJ U.S.A.
- ZHENG, G.M. AND Q.S. WANG. 1998. China red data book of endangered animals. Chinese Science Press, Beijing, China.

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