BREEDING HABITAT SELECTION BY SYMPATRIC GREY-FACED BUZZARDS AND NORTHERN GOSHAWKS IN NORTHEAST CHINA

Author: Deng, Wen-Hong

Source: Journal of Raptor Research, 40(4) : 264-269

Published By: Raptor Research Foundation

URL: https://doi.org/10.3356/0892-1016(2006)40[264:BHSBSG]2.0.CO;2

J. Raptor Res. 40(4):264–269

BREEDING HABITAT SELECTION BY SYMPATRIC GREY-FACED BUZZARDS AND NORTHERN GOSHAWKS IN NORTHEAST CHINA

WEN-HONG DENG[1]
Ministry of Education Key Laboratory for Biodiversity Science and Ecological Engineering, College of Life Sciences, Beijing Normal University, Beijing, 100875, China

ABSTRACT.—I studied breeding habitat selection by sympatric Grey-faced Buzzards (*Butastur indicus*) and Northern Goshawks (*Accipiter gentilis*) at local (0.1 ha circles) and landscape (1017 ha circles) scales in Zuojia Nature Reserve, Jinlin province, China from 1995–1999. Compared to paired random plots, Grey-faced Buzzards selected nest sites with dense shrubs and steep slopes with a northerly slope aspect. They nested in sites with fewer open areas that were relatively far from the nearest forest edge and nearest disturbance, compared to random plots. Northern Goshawks selected nest sites with taller trees and denser shrubs than those in the random plots. Goshawk nest sites also were relatively far from the nearest forest edge and the nearest disturbance, compared to random plots. Comparing nests of Grey-faced Buzzards to those of Northern Goshawks, I found that most nest sites of the Grey-faced Buzzards were located on the upper third of the slope while most Northern Goshawk nest sites were on the lower portion of the slope. Grey-faced Buzzards were associated with smaller nest trees on steeper slopes than were Northern Goshawks. Buzzard nest landscape-scale plots had larger forest patch size, smaller amounts of open areas, greater distance to the nearest forest edges, and less human disturbance, compared to Northern Goshawk plots.

KEY WORDS: *Grey-faced Buzzard*; Butastur indicus; *Northern Goshawk*; Accipiter gentilis; *habitat preferences*; *spatial scales*; *sympatric raptors*.

SELECCIÓN DE HÁBITAT REPRODUCTIVO POR *BUTASTUR INDICUS* Y *ACCIPITER GENTILIS* EN ÁREAS DE SIMPATRíA EN EL NORESTE DE CHINA

RESUMEN.—Estudié la selección de hábitat reproductivo por parte de *Butastur indicus* y *Accipiter gentilis* a nivel local (parcelas circulares de 0.1 ha) y a nivel de paisaje (parcelas circulares de 1017 ha) en zonas de simpatría entre 1995 y 1999 en la Reserva Natural de Zuojia, provincia de Jinlin, China. Comparado con las parcelas al azar, los individuos de *B. indicus* seleccionaron nidos en sitios con arbustos densos y una pendiente pronunciada, con una mayor proporción de laderas de exposición norte. A diferencia de las parcelas al azar, *B. indicus* anidó en sitios con menos áreas abiertas que estuvieron relativamente lejos del borde del bosque más cercano y de zonas impactadas. *Accipiter gentilis* seleccionó sitios de anidación con árboles más altos y vegetación arbustiva más densa en comparación con las parcelas de muestreo al azar. Los nidos de *A. gentilis* también estuvieron relativamente lejos del borde del bosque y de las zonas impactadas. Al comparar los nidos de *B. indicus* con los de *A. gentilis* encontré que la mayoría de los nidos de *B. indicus* se localizaron en el tercio superior de las laderas, mientras que los nidos de *A. gentilis* se localizaron en la parte inferior de las laderas. *B. indicus* se asoció a árboles de nidificación más pequeños y los nidos se localizaron en pendientes más inclinadas en comparación a los nidos de *A. gentilis*. En las parcelas a nivel de paisaje, los nidos de *B. indicus* tuvieron un tamaño de parche de bosque mayor, menos áreas abiertas, mayores distancias hasta el borde del bosque más cercano y menos impacto humano en comparación a los nidos de *A. gentilis*.

[Traducción del equipo editorial]

Animal behavior can be understood as a system of trade-offs evolved to maximize the fitness of an organism (Krebs and Davies 1993). An important determinant of fitness for an individual is the ability to find a suitable place to live and reproduce (Cody 1985). This is especially true for birds, whose breeding habitat selection is influenced by vegetation structure, topography, predation risk, or food supply (Robbins et al. 1989, Krüger 2002). In sympatric species of the same ecological guild, interaction pat-

[1] Email address: dengwh@bnu.edu.cn

terns vary from predator-prey relationships to interspecific competition to coexistence and mutualism (Schoener 1983, Bertness and Callaway 1994, Sergio et al. 2003). Raptors are ideal focal species for studies of the habitat characteristics and associations among sympatric species because they are usually long-lived birds with high territory fidelity.

In northeast China, the Grey-faced Buzzard is a migratory species (Cheng 1987) occurring in conifer, broad-leaf, and mixed forest (Deng et al. 2003). Since 1995, a number of studies have focused on the distribution and population status of Grey-faced Buzzards in Zuojia Nature Reserve, northeastern China, with the result that the species was found to occupy more localities than previously thought (Deng et al. 2004). The population was estimated at a maximum of 30 breeding pairs in Zuojia Nature Reserve and 1000 breeding pairs in northeastern China in 1991 (Feng et al. 1991).

Northern Goshawks breed in a variety of forest types in northeast China, and are usually associated with mature and old-growth forest structures (Gao 2002). In most areas, they occur sympatrically with Grey-faced Buzzards. The habitat associations for sympatric *Accipiter* species (Reynolds et al. 1982, Reynolds and Meslow 1984), sympatric *Buteo* species (Schmutz et al. 1980), and sympatric *Accipiter* and *Buteo* species (La Sorte et al. 2004) have been investigated in both Europe and in North America. However, the relationship and habitat associations of sympatric Grey-faced Buzzards and Northern Goshawks have not been studied.

In recent years, much of the forests of northeast China, including a great deal of the Grey-faced Buzzard's historical range across Neimenggu, Jilin, Liaoning, and Heilongjiang provinces, have been destroyed by conversion to commercial coniferous plantations or agricultural lands. The Grey-faced Buzzard has disappeared from several counties in Jilin province during the last 20 years (Deng et al. 1997). In Zuojia Nature Reserve, the population of the Grey-faced Buzzard declined from 60 breeding pairs in the early 1980s to 30 breeding pairs in 2002 (Gao 2002). On the other hand, the population of Northern Goshawks is apparently stable in this area. In this study, I investigated the potential reasons for such disparity and whether it might be explained by differences in breeding habitat preferences between the two species. Thus, I examined the habitat associations of sympatric Grey-faced Buzzards and Northern Goshawks during the breeding season at two spatial scales.

STUDY AREA

The study area, ca. 184 km² in size, was located in the Zuojia Nature Reserve, and included the Tumenling 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 m above sea level. The climate is east monsoon, characterized by hot, dry summers and cold, snowy winters. Vegetation consists of secondary forests, and the seven primary tree species were Mongolian oaks (*Quercus mongolica*), Dahurian birchs (*Betula davurica*), Manchurian linden (*Tilia mandschurica*), Japanese elm (*Ulmus japonica*), Scotch pine (*Pinus sylvestris*), Korean larches (*Pinus koraiensis*) and Masson pine (*Pinus massoniana*; Deng et al. 2003). 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*), and honeysuckles (*Lonicera* spp.) dominated the shrub layer. The study site also includes various types of open habitats, such as agriculture, water bodies and towns.

METHODS

Nest Locations. I surveyed the study area at least three times/yr before or just after the birds laid eggs, between 1995–1999. I attempted to locate all buzzard and goshawk nests within the study area, by using systematic searches of potential nest substrates to locate nests. After the end of the breeding season, I collected vegetation and topographic measurements. A total of 20 Grey-faced Buzzard nests and 15 Northern Goshawk nests were found in the Zuojia and Tumenling mountains, 1995–1999. Nest site habitat characteristics for 12 of the 20 Grey-faced Buzzard nests have already been published (Deng et al. 2003).

Local Scale Habitat Variables. To examine breeding habitat associations at the local scale, I measured nest tree features and variables related to vegetation structure and topography within 18-m radius circles (0.1 ha) centered at nest trees (Deng et al. 2003).

I categorized the forest type (conifer, if the proportion of conifers was >70%; mixed conifer/broadleaf, if the proportions of conifer and broadleaf were near equal; broadleaf, if the proportion of broadleaf was >70%) and slope position (lower, middle, upper third) at each site and measured habitat characteristics. At each plot center, I estimated slope aspect with a compass and slope angle (%) with a clinometer. I measured tree DBH (diameter at breast height, cm) with calipers, and tree height with a clinometer. In addition, I recorded the number of tree species, number of individual shrubs, and the number of individual overstory trees. Trees were defined as any woody vegetation with DBH >10 cm and height >2 m; shrubs were defined as any woody vegetation that did not meet these criteria.

Landscape Scale Habitat Variables. I defined landscape scale habitat associations as the spatial pattern of landscape features contained within 1800-m radius circles (1017 ha) centered at nest sites. I selected this scale because it encompassed the estimated territory size for Grey-faced Buzzards and Northern Goshawks in the study area (Deng et al. 1997, Gao 2002).

At this scale, I measured forest patch size and the distance from the nest trees to the nearest forest edge, source of water, forest road, and permanent human disturbance (i.e., a constant anthropogenic feature such as an occupied house, frequently used street, or active forestry center). I also determined the area covered by water and open areas (meadows, farmlands, clearings) as well as the number of permanent human disturbances within the plot. I used topography maps and vegetation maps (1:20 000) to measure these parameters.

To investigate the environmental features selected or avoided by Grey-faced Buzzards and Northern Goshawks, I selected 15 random locations to be compared with goshawk nests and 20 random locations to be compared with buzzard nests for both the local and landscape scales. These random plots were located in a randomly-selected cardinal direction, at a random distance ≤1000 m from each nest tree. The same variables recorded at occupied nests were also measured at random plots both at the local and landscape scales.

Data Analysis. I used logarithmic and square-root transformations to normalize variables and equalize variances when variables deviated from normal distributions. For analyses, I only used those variables which approximated a normal distribution and had comparable variances between groups, either before or after transformation.

I used *t*-tests to examine intergroup differences of habitat variables (Zar 1999). I compared forest types and slope position using chi-square analyses. I estimated the mean slope aspect of the Grey-faced Buzzard and Northern Goshawk nests using circular statistics (Batschelet 1981), and compared slope aspects of the two species using a Watson-Williams test (Zar 1999).

I used a stepwise discriminant analysis (DA) procedure to compare buzzard breeding habitats with random locations, goshawk breeding habitats with random locations, and buzzard breeding habitats with goshawk breeding habitats. Results were considered significant if $P < 0.05$.

RESULTS

Comparison of Grey-faced Buzzard Nest Sites to Random Sites. Grey-faced Buzzard nest sites had slightly taller trees with greater DBH than did the random plots. Nest sites had a northerly mean slope aspect and were located on steep slopes with dense shrubs, compared to random plots. (Table 1). On the landscape scale, buzzards were associated with relatively large forest patch size, less open area, fewer permanent disturbances, and relatively greater distances to the nearest forest edge and the nearest permanent disturbance (Table 1).

Comparison of Northern Goshawk Nest Sites to Random Sites. Goshawks selected nest trees that were significantly taller than random site trees. (Table 1). In addition, shrubs were denser in nest plots than in random plots (Table 1). On the landscape scale, goshawk nest sites contained fewer permanent disturbances and were relatively greater distances from the nearest forest edge and the nearest permanent disturbance than were the random sites.

Comparison of Grey-faced Buzzard Nests to Northern Goshawk Nests. The distribution of forest types at Grey-faced Buzzard breeding sites differed from that of Northern Goshawks' sites ($\chi^2 = 15.62$, df = 2, $P < 0.05$), with most of the buzzard nests located in the mixed-conifer/broadleaf forest type (Fig. 1). Position of nest sites on the slope also differed between the two species ($\chi^2 = 11.26$, df = 2, $P < 0.01$). Most buzzard nest sites (75%, $N = 20$) were located on the upper third of the slope while most of the goshawk nest sites were on the lower portion of the slope (67%, $N = 15$, Fig. 2).

Grey-faced Buzzards' nest trees had smaller DBH and lower crown height than goshawk nest trees (DBH: $t = 3.15$, $P = 0.002$; crown height: $t = 1.94$, $P = 0.03$). Buzzards nested on steep slopes with northerly (mean aspect = 7.80°, mean vector length = 0.53, angular deviation = 70.50°) mean slope aspect, while goshawks nested on gentler slopes with no aspect directionality (slope angle: $t = 2.03$, $P = 0.031$; slope direction: $t = 0.93$, $P = 0.41$). Nest plots of Grey-faced Buzzards were characterized by larger forest patch size, smaller amounts of open areas, and dense shrubs, compared to goshawk nest plots (forest patch: $t = 2.58$, $P = 0.02$; amount of open area: $t = 1.99$, $P = 0.03$; number of shrubs: $t = 1.87$, $P = 0.03$). In contrast, goshawk nest plots were closer to the nearest forest edge and contained more permanent disturbances (distance to the nearest forest edge: $t = 3.13$, $P = 0.001$; number of permanent disturbances in the plot: $t = 2.21$, $P = 0.02$).

Results of multivariate stepwise discriminant analyses were very similar to those obtained by univariate analyses, and are not presented here.

DISCUSSION

The environmental features selected by Grey-faced Buzzards and Northern Goshawks differed at both the spatial scales analyzed. Grey-faced Buzzards were mostly found on the upper third of north-facing slopes. Previous studies on other raptor species have shown preference for certain portions of the slope but usually without much consistency across species (e.g., McIntyre and Adams 1999, Nijman et al. 2000).

The habitat-associations at the local scale can be interpreted with respect to the breeding behavior of each of the two species. Typically, Grey-faced Buzzards enter nests from above the canopy and North-

Table 1. Habitat variables measured at breeding sites of Grey-faced Buzzards, Northern Goshawks, and random plots in northeast China, 1995–1999. Values are mean ± 1 SD.

Variable	Grey-faced Buzzard ($N = 20$)	Random Sample ($N = 20$)	P	Northern Goshawk ($N = 15$)	Random Sample ($N = 15$)	P
Local scale						
Tree height (m)	14.8 ± 3.1	12.6 ± 3.1	0.002	12.3 ± 2.2	10.1 ± 2.2	0.001
Diameter at breast height (DBH, cm)	29.1 ± 3.4	22.2 ± 4.7	0.041	35.2 ± 4.4	21.9 ± 8.3	
Crown height (m)	4.8 ± 1.3	5.3 ± 1.6	0.153	7.2 ± 1.6	4.5 ± 1.8	0.084
Slope direction (°)	310.0 ± 45.3	156.5 ± 67.0	0.001	179.5 ± 85.6	125.0 ± 51.5	0.095
Slope angle (°)	40.5 ± 7.5	9.8 ± 2.5	0.004	11.5 ± 7.2	18.5 ± 9.6	0.063
Number of tree species	9.3 ± 3.8	9.5 ± 4.4	0.561	8.5 ± 4.4	7.7 ± 2.6	0.089
Number of overstory trees	36.7 ± 15.5	34.8 ± 7.4	0.214	30.8 ± 9.5	25.4 ± 11.1	0.159
Number of shrubs	426.4 ± 160.2	151.2 ± 98.4	0.001	188.2 ± 110.0	114.5 ± 79.2	0.021
Landscape scale						
Breeding forest patch size (ha)	15.9 ± 7.5	7.8 ± 3.7	0.025	7.5 ± 7.1	6.4 ± 2.0	0.360
Water areas in the plot (ha)	0.8 ± 0.3	1.4 ± 0.6	0.315	1.2 ± 0.5	1.9 ± 0.9	0.654
Open areas in the plot (ha)	1.6 ± 0.7	2.9 ± 0.9	0.038	5.7 ± 1.2	4.8 ± 1.4	0.747
Distance to nearest forest track (m)	58.7 ± 24.2	75.5 ± 47.3	0.078	84.3 ± 30.6	114.5 ± 47.5	0.095
Distance to nearest source of water (m)	303.8 ± 99.0	273.4 ± 181.0	0.847	267.5 ± 132.3	189.3 ± 102.5	0.088
Distance to nearest permanent disturbance (m)	514.2 ± 201.7	356.8 ± 142.5	0.006	411.9 ± 221.0	124.0 ± 45.8	0.018
Distance to nearest forest edge (m)	181.2 ± 127.3	92.5 ± 96.4	0.001	68.6 ± 28.2	48.6 ± 27.3	0.025
Number of permanent disturbances in the plot	0.26 ± 0.08	0.32 ± 0.11	0.003	0.89 ± 0.65	1.13 ± 0.66	0.041

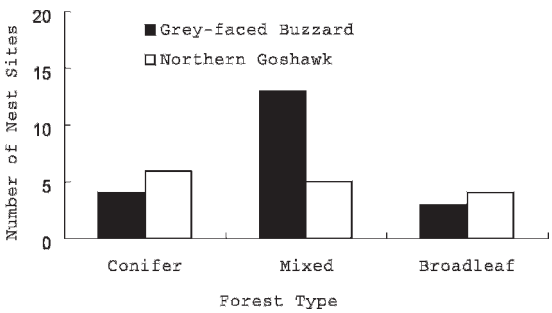

Figure 1. Number of Grey-faced Buzzard and Northern Goshawk nest sites in each of three forest types in Zuojia Natural Reserve, northeast China, 1995–1999. Mixed = conifer/broadleaf mixed forest.

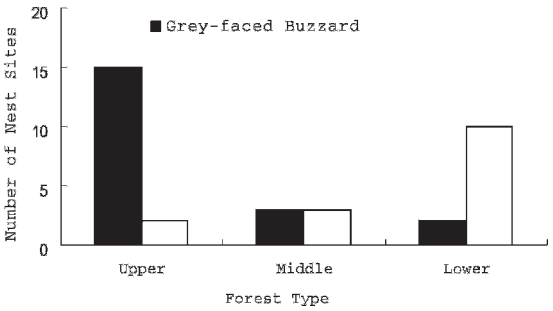

Figure 2. Number of Grey-faced Buzzard and Northern Goshawk nest sites by location along the mountain slope in Zuojia Natural Reserve, northeast China, 1995–1999.

ern Goshawks enter nests below the canopy. Nests located on the upper third of a steep, north-facing slope would probably allow easy access to the nest from above. Also, such location may reduce solar radiation and allow a broad view of the surrounding area. In contrast, Northern Goshawks built their nests in larger trees located on the lower portions of gentle slopes. This result was consistent with previous studies documenting selection of mature trees by Northern Goshawks (e.g., Speiser and Bosakowski 1987, Hayward and Escano 1989, Squires and Ruggiero 1996). La Sorte et al. (2004) suggested that these nest site characteristics would probably allow easy access to the nest, unhindered movement through the surrounding forest, and a suitable microclimate for the offspring.

At the landscape scale, Grey-faced Buzzards were associated with large forest patch size, large distances to the forest edge and lower levels of human disturbance near the nest. These results suggest that the Grey-faced Buzzard may be an area-sensitive species, preferring deep and large forest patches and requiring isolation from human disturbance. In fact, its nest sites were found mostly in dense forests, where little disturbance of any kind occurred and where there may have been a greater density and diversity of prey species than in edge areas (Kojima 1982, Ricketts and Ritchison 2000). However, in my study, forests roads often represented the main openings in deep contiguous forests. In such dense forests, logging roads may aid the buzzards by providing open flyways (Deng et al. 2003). On several occasions, I observed buzzards flying, perching, and plucking prey along logging roads in the study area. Speiser and Bosakowski et al. (1987) found that goshawks often nested near logging roads in North America. Raptors often nest near logging roads or other woodland openings that may allow easy access to and from the nest. Although the Northern Goshawk has been described as a very area-sensitive species, in this study it was found to select nest sites in relatively close proximity to roads and other open areas. Robbins et al. (1989) reported that some Northern Goshawk populations have managed to colonize large cities. My results indicated that Grey-faced Buzzards in northeast China were more sensitive to human disturbance than were Northern Goshawks.

ACKNOWLEDGMENTS

I thank Ke-qin Zhang, He-lin Feng, Liu Yang, Yan-hui Li, Ren-kai Song, Lu-ye Tang, and Ya-mei Yu for help in the field. Wei-dong Luo and Bao-xue Zhang were very patient in helping with data collection. Earlier drafts of this manuscript were improved by comments from Wei Gao. The staff of Zuojia Natural Protection Area provided many facilities during the study period. I also acknowledge the financial support of the National Natural Science Foundation of China (No. 30470300). I thank F. Sergio and three anonymous referees for their helpful remarks on the manuscript.

LITERATURE CITED

BATSCHELET, E. 1981. Circular statistics in biology. Academic Press, San Francisco, CA U.S.A.

BERTNESS, M.D. AND R. CALLAWAY. 1994. Positive interactions in communities. *Trends Ecol. Evol.* 9:191–193.

CHENG, T.H. 1987. A synopsis of the avifauna of China. Science Press, Beijing, China.

CODY, M.L. 1985. Habitat selection in birds. Academic Press, New York, NY U.S.A.

DENG, W.H., X. WANG, AND W. GAO. 1997. Breeding habitat selection of the Grey-faced Buzzard Eagle. *J. Northeast Norm. Univ.* 9:57–61.

———, W. GAO, AND G.M. ZHENG. 2003. Nest and roost habitat characteristics of the Grey-faced Buzzard in northeastern China. *J. Raptor Res.* 37:228–235.

———, ———, AND J. ZHAO. 2004. Breeding biology of the Grey-faced Buzzard (*Butastur indicus*) in northeastern China. *J. Raptor Res.* 38:263–269.

FENG, H.L., G.Q. XIANG, AND K.Q. HANG. 1991. Observation on breeding Grey-faced Buzzard Eagle. Pages 164–165 *in* W. Gao [ED.], Chinese Avian Studies, No. 3, Chinese Science Press, Beijing, China.

GAO, W. 2002. Ecology of falcon order in China. Chinese Science Press, Beijing, China.

HAYWARD, G.D. AND R.E. ESCANO. 1989. Goshawk nest-site characteristics in western Montana and northern Idaho. *Condor* 91:476–479.

KREBS, J.R. AND N.B. DAVIES. 1993. An introduction to behavioural ecology. Blackwell, London, U.K.

KOJIMA, Y. 1982. Territory and territorial behavior of the Grey-faced Buzzard Eagle *Butastur indicus*. *Tori* 30:117–147.

KRÜGER, O. 2002. Interactions between Common Buzzard *Buteo buteo* and goshawk *Accipiter gentilis*: trade-offs revealed by a field experiment. *Oikos* 96:441–452.

LA SORTE, F.A., R.W. MANNAN, R.T. REYNOLDS, AND T.G. GRUBB. 2004. Habitat associations of sympatric Red-tailed Hawks and Northern Goshawks on the Kaibab Plateau. *J. Wildl. Manage.* 68:307–317.

MCINTYRE, C.L. AND L.G. ADAMS. 1999. Reproductive characteristics of migratory Golden Eagles in Denali National Park, Alaska. *Condor* 101:115–123.

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.

REYNOLDS, R.T., E.C. MESLOW, AND H.M. WRIGHT. 1982. Nesting habitat of coexisting Accipiters in Oregon. *J. Wildl. Manage.* 46:124–138.

——— AND E.C. MESLOW. 1984. Partitioning of food and niche characteristics of coexisting *Accipiter* during breeding. *Auk* 101:761–779.

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.

ROBBINS, C.S., D.K. DAWSON, AND B.A. DOWELL. 1989. Habitat area requirements of breeding forest birds of Middle Atlantic states. *Wildl. Monogr.* 103:1–33.

SCHMUTZ, J.K., S.M. SCHMUTZ, AND D.A. BOAG. 1980. Coexistence of three species of hawks (*Buteo* spp.) in the prairie-parkland ecotone. *Can. J. Zool.* 58:1075–1089.

SCHOENER, T.W. 1983. Field experiments on interspecific competition. *Am. Nat.* 122:240–285.

SERGIO, F., L. MARCHESI, AND P. PEDRINI. 2003. Spatial refugia and the coexistence of a diurnal raptor with its intraguild owl predator. *J. Anim. Ecol.* 72:232–245.

SPEISER, R. AND T. BOSAKOWSKI. 1987. Nest-site selection by Northern Goshawks in northern New Jersey and southeastern New York. *Condor* 89:387–394.

SQUIRES, J.R. AND R.T. RUGGIERO. 1996. Nest-site preference of Northern Goshawks in south central Wyoming. *J. Wildl. Manage.* 60:170–177.

ZAR, J.H. 1999. Biostatistical analysis. Prentice-Hall, Englewood Cliffs, NJ U.S.A.

Received 24 January 2006; accepted 12 August 2006
Associate Editor: Fabrizio Sergio