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THE WINTER ROOSTING BEHAVIOR OF EASTERN SCREECH-OWLS IN CENTRAL KENTUCKY

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ABSTRACT.—The winter roosting behavior of Eastern Screech-owls (*Otus asio*) in central Kentucky was examined from October 1993–March 1994. Eleven owls used 69 roost sites 563 times, with 29 boxes used 308 times, 25 cavities used 226 times and 15 limbs used 29 times. Most natural cavities were in black locusts (*Robinia pseudoacacia*), southern red oaks (*Quercus falcata*) and snags; boxes were located in 15 different species of trees. All conifer limb roosts were in eastern redcedars (*Juniperus virginiana*). Frequent use of boxes and cavities during winter is probably the result of owls seeking favorable microclimates and concealment from predators. Screech-owls roosted in conifers more frequently when temperatures were above freezing and in boxes and cavities more frequently on days with rain, drizzle, or snow, supporting the conclusion that roosting owls seek favorable microclimates. Owls used each roost site an average of seven times. Female screech-owls were more likely to use boxes and males more likely to use cavities and conifer limbs. The suitability of boxes as potential nest sites may be one reason for their frequent use as roost sites by females.

KEY WORDS: *Eastern Screech-owl;* Otus asio; *roosting behavior; cavities; winter.*

La conducta de búhos (*Otus asio*) en centro Kentucky durante el tiempo de percha en el invierno

RESUMEN.—La conducta de búhos (*Otus asio*) durante el invierno en el tiempo de percha en centro Kentucky fue examinado en Octubre 1993–Marzo 1994. Once búhos usaron 69 sitios de percha 563 veces, con 29 cajas usadas 308 veces, 25 cavidades usadas 226 veces y 15 ramas usadas 29 veces. Las mas natural cavidades fueron en *Robinia pseudoacacia, Quercus falcata* y tocones, y cajas fueron localizadas en 15 diferente especies de árboles. Las ramas de coniferos para percha estabán en *Juniperus virginiana.* La frecuencia de uso de cajas y cavidades durante el invierno es probablemente el resulto de búhos buscando microclimas favorable y lugares para esconderse de depredadores. Búhos estabán en percha en coniferos con mas frecuencia cuando temperaturas estabán arriba de helando y en cajas y cavidades con mas frecuencia en días con lluvia, llovizna y nieve, soportando la conclusión que búhos en percha buscan microclimas favorables. Búhos usaron cada sitio de percha un normal de siete veces. Hembras eran mas probable usar cajas y machos eran mas probable usar cavidades y ramas de coniferos. La conveniencia de cajas como sitios de nido puede ser una razón para su uso con regular como sitios de percha para hembras.

[Traducción de Raúl De La Garza, Jr.]

Many aspects of the behavior and ecology of Eastern Screech-owls (*Otus asio*) have been examined (e.g., Van Camp and Henny 1975, Belthoff and Ritchison 1989, Gehlbach 1994), including their roosting behavior. Belthoff and Ritchison (1990a) monitored adult and juvenile screech-owls during the summer (May–July) in central Kentucky and found that vines (or branches covered to varying degrees with vines), cedars and open limbs of deciduous trees were used as roost sites. These sites apparently provided concealment from predators and favorable microclimates (Belthoff and Ritchison 1990a). Smith et al. (1987) reported that use of roost sites by screech-owls varied with season, with open limbs used during the summer and cavities used more often during the fall, winter and spring. Other investigators have also noted that screech-owls use cavities for roosting (Merson et al. 1983, Gehlbach 1994).

Although previous work has shown that screech-owls use different types of roost sites (e.g., open limbs and cavities), less is known about the environmental factors that influence selection of roost

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sites or about features of roost sites that might be important in roost-site selection by screech-owls. The objective of our study was to examine roost-site selection by Eastern Screech-owls during late fall and winter (October–March) in central Kentucky. Specifically, we examined characteristics of roost sites used by screech-owls, possible relationships between certain environmental conditions and roost-site selection, and compared frequently used sites with little used and unused sites in an attempt to determine which features might be important in roost-site selection.

METHODS

The roosting behavior of screech-owls was monitored from 11 October 1993–19 March 1994 at the Central Kentucky Wildlife Management Area, 17 km southeast of Richmond, Kentucky. This area consists of small deciduous woodlots and thickets interspersed with cultivated fields and old fields (Sparks 1990, Sparks et al. 1994). Beginning on 11 October, owls were captured from nest boxes and fitted with radiotransmitters (Wildlife Materials, Carbondale, Illinois). Radio-marked owls were located at least four times each week. Each time owls were located, we noted the temperature (above or below 0° C) and categorized sky conditions as clear or partly cloudy, overcast or overcast with precipitation.

Each roost site was categorized as either a natural cavity, deciduous limb, conifer limb or nest box. For limb roosts, we noted tree species, roost height, tree height, diameter at breast height (dbh), roost orientation (position of owl relative to main bole), distance from main bole, distance from nearest permanent water and distance from the edge of the woodlot. For cavities and boxes, we noted tree species, tree height, dbh and diameter at cavity height, distance from nearest permanent water and distance from the edge of the woodlot. Characteristics were also measured for all boxes and accessible cavities, including cavity entrance dimensions (height and width), cavity depth (total and from bottom of cavity to entrance), inside diameter (distance from entrance to back wall) and entrance orientation. Tree, roost and cavity heights were determined with a clinometer.

To determine which features of natural cavities might influence roost-site selection, we compared the characteristics of 14 frequently used (≥8 times) cavities with 14 cavities in which owls were not observed roosting. To select unused cavities, we conducted 14 random line transects through woodlots used by our radio-tagged owls and chose the first cavity detected within 10 m on either side of the transect. Unused cavities selected for comparison with used cavities had to be large enough to permit entry by screech-owls (opening >8 cm in height and width).

For both used and unused natural cavities, we measured the previously listed cavity characteristics plus characteristics of vegetation surrounding the tree (James and Shugart 1970). For trees >8 cm dbh located within a 0.04 ha circular plot centered on the cavity tree, we recorded tree species, dbh and height. Shrub density and height were estimated by making two perpendicular transects within the plot and counting and measuring the diameter and height of all woody stems <8 cm dbh within 1 m of each transect. Percent tree canopy and ground cover were estimated by sampling 10 points along transects in each of the four cardinal directions from the roost tree Percent understory cover was measured along the same transects using the line-intercept method (Brower et al 1977).

All analyses were performed using the Statistical Analysis System (SAS Institute 1989). Because we made repeated observations of the same owls, repeated measures analysis of variance was used to compare characteristics (roost height, tree height, dbh and distance to edge and water) of different types of roosts (conifer limb, natural cavity and nest box). Multivariate analysis of variance was used to compare characteristics of used and unused cavities, characteristics of little used and frequently used cavities and characteristics of cavities used by males and females. Cavity entrance orientation was analyzed using circular statistics to test the null hypothesis that orientation was random. Wilcoxon rank sum tests (which correspond to Mann-Whitney *U*-tests; SAS Institute 1989) were used to examine possible differences in the roosting behavior of males and females. Chi-square goodness-of-fit tests were used to examine differences in frequency of use of the various types of roosts over time (months) and with different environmental conditions (temperature, wind velocity and sky conditions). Results are presented as mean ±1 SD.

RESULTS

We monitored roosting behavior of 11 radio-marked owls (3 males and 8 females). Sex was determined by observations of behavior either during previous breeding seasons (for previously banded owls) or the following season. Only two radio-marked owls were paired. The female of this pair was only monitored for 14 days and, therefore, no comparison of the roosting behavior of these owls was possible. Female and male owls were monitored for an average of 96.8 ± 48.9 days and 131.7 ± 22.7 days, respectively. Overall, owls used 69 different roosts 563 times. We located an average of 51.2 ± 19.9 roosts per owl ($\bar{x}$ = 47.5 ± 22.4 for females; $\bar{x}$ = 61 ± 4.6 for males). Six boxes and five natural cavities were used at different times by two owls (either by each member of a pair or owls with adjacent ranges). We located an average of 93.8 ± 53.0 roosts each month, ranging from 33 in October to 189 in December.

Variation among Roost Types. The 69 roost sites included 29 boxes, 25 natural cavities and 15 limbs. Fourteen limb roosts were in conifers and one was in a deciduous tree. The deciduous limb roost was only used twice and is not considered further. Owls used boxes 308 times, natural cavities 226 times and conifer limbs 27 times.

Conifer roost trees were located closer to the edge of woodlots than trees with boxes and natural cavities ($F_{2,12}$ = 5.14, P = 0.02). Conifer roosts were a mean distance of 5.31 ± 4.57 m from edges while boxes and natural cavities averaged 18.89 ± 11.94 m and 18.81 ± 20.75 m, respectively, from edges. We found no differences among roost types in mean distance from water ($F_{2,12}$ = 0.51, P = 0.61), with mean distances ranging from 69.5 ± 77.6 m for boxes to 107.2 ± 127.9 m for conifers. Roost height (e.g., the height of owls in conifers or the height of the cavity entrance for boxes and natural cavities) did not vary among the three sites ($F_{2,10}$ = 0.51, P = 0.62), with mean heights of 5.7 ± 2.4 m for conifers, 5.9 ± 1.5 m for boxes and 6.2 ± 2.3 m for cavities.

The mean diameter (height) of box and cavity entrances differed ($F_{1,6}$ = 51.7, P = 0.0004) as did the mean depth (distance from the top of the cavity to the bottom) ($F_{1,6}$ = 9.98, P = 0.0196), with natural cavities being deeper ($\bar{x}$ = 90.6 ± 75.5 cm for cavities vs. 41.1 ± 13.74 cm for boxes) and having taller entrances ($\bar{x}$ = 20.4 ± 12.5 cm for cavities vs. 8.2 ± 1.6 cm for boxes). In addition, differences in the mean cavity depth (distance from the bottom of the entrance hole to the bottom of the cavity) and the mean width of cavity entrances approached significance (cavity depth: $F_{1,6}$ = 5.32, P = 0.06; cavity entrance width: $F_{1,6}$ = 3.55, P = 0.11). No differences were found either in the diameter of trees at the level of the cavity ($F_{1,6}$ = 0.14, P = 0.72) or in the diameter of the cavity ($F_{1,6}$ = 0.28, P = 0.62).

The 29 boxes used by roosting screech-owls were located in 15 species of trees, with most in sycamores (*Platanus occidentalis*). The 25 natural cavities used by owls were in 12 species of trees. Most natural cavities were in black locusts (*Robinia pseudoacacia*), snags and southern red oaks (*Quercus falcata*). All 14 conifer roosts were in eastern redcedars (*Juniperus virginiana*).

Variation among Individuals and Between Sexes. The 11 owls used an average of 7.2 ± 3.9 different roost sites (range = 4–18). We found no correlation between the number of roost sites used and the number of days that an owl was located (Spearman rank correlation; r_s = 0.4, P = 0.22). Each roost site was used an average of 7.0 ± 11.6 times (range = 1–66).

We found no difference between males and females in the mean number of different roost sites used (z = 1.34, P = 0.18; $\bar{x}$ = 10.7 ± 6.4 for males and 6.0 ± 1.9 for females) or the mean number of times that particular roost sites were used (z = 1.08, P = 0.28; $\bar{x}$ = 5.7 ± 7.9 times for males and 7.9 ± 13.7 times for females). Males and females differed in the use of different roost types (χ^2 = 13.1, df = 2, P = 0.001). Females were more likely to use boxes while males were more likely to use conifers and natural cavities (Fig. 1).

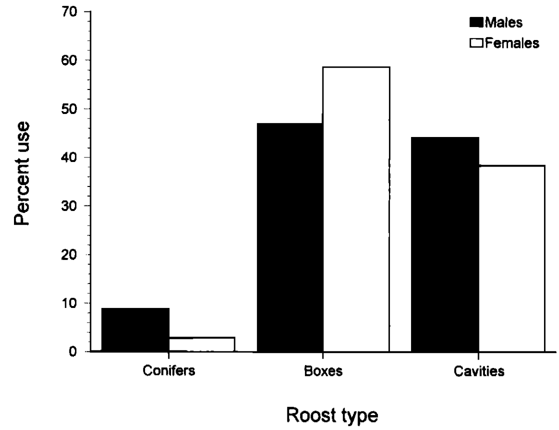

Figure 1. Use of different roost types by male and female Eastern Screech-owls.

Dimensions of roost trees and natural cavities used by males and females did not differ (Wilk's Lambda = 0.41, F = 1.63, P = 0.24). Although there was no overall difference (i.e., multivariate) between natural cavities used by males and females, the mean height of cavities above ground (one-way ANOVA; $F_{1,16}$ = 6.24, P = 0.024) and the mean diameter (height) of entrances (one-way ANOVA; $F_{1,16}$ = 7.63, P = 0.014) used by males and females did differ. The mean height of natural cavities was 4.68 ± 1.97 m (N = 11) for males and 7.40 ± 1.89 m for females (N = 13). For cavity entrances, the mean diameter (height) was 28.13 ± 14.15 cm for males (N = 8) and 14.25 ± 6.60 cm for females (N = 10).

Variation among Months. Use of conifer limbs, boxes and natural cavities varied among months (χ^2 = 20.2, df = 10, P = 0.028). Conifers were used more often in February and March (Fig. 2). Use of boxes was greatest in November and lowest in February while use of natural cavities was greatest in December and lowest in March (Fig. 2).

Environmental Conditions and Roosting Behavior. Owls used boxes and natural cavities more on overcast days and days with precipitation (drizzle,

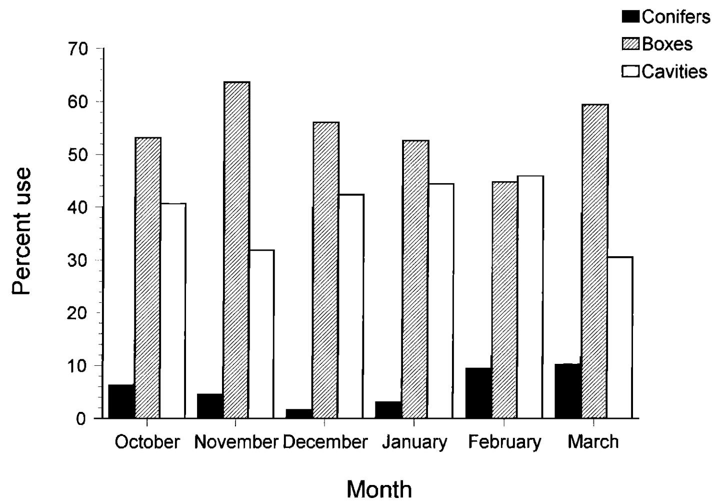

Figure 2. Variation in use of different roost types among months.

rain or snow; $\chi^2 = 12.3$, df = 4, $P = 0.015$; Fig. 3). Owls were more likely to use conifers on clear or partly cloudy days (Fig. 3). Natural cavities were used more when temperatures were below freezing, and conifers were used more when temperatures were above freezing ($\chi^2 = 8.14$, df = 2, $P = 0.017$).

Characteristics of Used versus Unused Natural Cavities. We found no differences between used and unused sites either in the dimensions of roost trees and cavities (Wilk's Lambda = 0.60, F = 1.24, $P = 0.34$) or in the characteristics of surrounding vegetation (Wilk's Lambda = 0.79, F = 0.53, $P = 0.83$). The mean entrance orientation (direction) of used and unused roost cavities/boxes was 174 degrees ($r = 0.438$) and 354 degrees ($r = 0.149$), respectively. Neither sample exhibited significant directionality (Rayleigh's z-test; used: $z = 2.69$, $P > 0.05$; unused: $z = 0.27$, $P > 0.5$). Similarly, there was no significant difference between used and un-

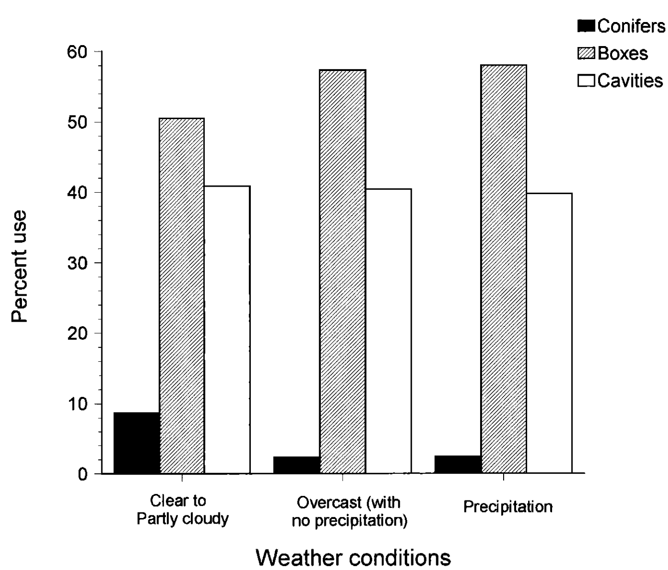

Figure 3. Variation in use of different roost types with different weather conditions.

used sites in mean entrance orientation (Watson's test; U2 = 0.068, $P > 0.5$).

Characteristics of Frequently Used versus Infrequently Used Natural Cavities and Boxes. For natural cavities, roost tree and cavity means for frequently used ($N \geq 8$) and infrequently used ($N \leq 7$) sites did not differ (Wilk's Lambda = 0.75, F = 1.18, $P = 0.34$). Similarly, for natural cavities and roost boxes combined, roost tree and cavity means for frequently and infrequently used sites did not differ (Wilk's Lambda = 0.76, F = 1.36, $P = 0.23$).

DISCUSSION

Screech-owls in our study used nest boxes and natural cavities more frequently than open limbs during the period from October–March. In contrast, Belthoff and Ritchison (1990a) found that screech-owls in the same study area roosted almost exclusively in open sites during summer (May–July). Previous investigators have also reported seasonal changes in types of roosts used (Smith et al. 1987, Gehlbach 1994). The shift from open sites in summer to boxes and cavities in winter is probably the result of owls seeking favorable microclimates and better concealment from predators. Hayward and Garton (1984) found that Western Screech-owls (*Otus kennicottii*) roosted only in conifers during late winter and early spring (prior to leaf out) and suggested that concealment was the most important factor in roost-site selection. These authors suggested that screech-owls roosted in cavities "only when sufficient protective cover for concealment is not available" and further noted that cavity-roosting owls would be protected from aerial predators but might be vulnerable to predation by arboreal mammals (Hayward and Garton 1984). Roosting in conifers might provide adequate concealment from hawks and other owls plus the opportunity to escape approaching mammalian predators (Hayward and Garton 1984).

Gehlbach (1994) found that use of boxes by screech-owls during December in central Texas corresponded significantly to mean air temperature and suggested that thermoregulation was the primary factor in roost-site selection. Further, he (1994) observed three male screech-owls during the period from November–February and found that mean ambient temperatures were lower when these males were in boxes and higher when in conifer roosts (junipers). Similarly, we found that ambient temperatures were usually above freezing when screech-owls used conifers for roosting, and that owls were more likely to use conifers in February and March when temperatures are beginning to increase.

Eastern Screech-owls in our study roosted in boxes more than in natural cavities. Availability may have been one reason for the greater use of boxes. However, differences in microclimate may have been another factor, i.e., screech-owls may have used boxes more frequently during winter to reduce thermoregulatory costs (see McComb and Noble 1981).

We found that the height of roost sites in conifers did not differ from the height of the entrance holes of boxes and cavities used by roosting owls. Gehlbach (1994) reported similar results and found that open roosts were an average of 3.8 m high while entrances of boxes and cavities were an average of 3.1 m high.

The height of roost sites might be influenced by the risks of predation. For example, Nilsson (1984) found a lower rate of predation on nest cavities located higher in trees for six species of birds and Albano (1992) found that Carolina Chickadees (*Parus carolinensis*) nesting in lower cavities suffered higher rates of predation. Thus, screech-owls may not use roost sites below some minimum height because of the increased risk of predation. In addition, Gehlbach (1994) suggested that screech-owls refrain from using very high roost sites, possibly because such sites may be more exposed to the elements and flying up to higher roosts would require more energy (Collias and Collias 1984, Korol and Hutto 1984).

Individual screech-owls used an average of more than seven different roost sites during our study. Smith et al. (1987) observed that "an owl may use a roost site for several days . . . then move to a new site." Merson et al. (1983) also reported that screech-owls used a variety of roost sites. Using different roost sites may reduce the chances of predation (Belthoff and Ritchison 1990a). Screech-owls in our study area sometimes lose boxes and cavities to other species such as eastern gray squirrels (*Sciurus carolinensis*) and southern flying squirrels (*Glaucomys volans*), and occasional reuse by owls might also reduce the chances that cavities will be usurped by these other species.

Screech-owls in our study used each roost site an average of seven times. Other investigators have reported the repeated use of certain roost sites by screech-owls (Merson et al. 1983, Smith et al. 1987, Gehlbach 1994) and other species of owls (e.g., Barrows 1981, Bosakowski 1984, Hayward and Garton 1984). In contrast, Belthoff and Ritchison (1990a) found that screech-owls usually did not use the same roost site on successive days during the post-fledging period (May–July), possibly indicating that many suitable sites are available (Belthoff and Ritchison 1990a). In contrast, reduced cover from leaf fall during the autumn months plus the possible need to use sites providing favorable microclimates limits the number of suitable roost sites available during the winter (Belthoff and Ritchison 1990a). Such limits may contribute to the repeated use of particular roost sites (boxes and cavities) during the winter.

We found differences in the roosting behavior of male and female screech-owls. In contrast, Belthoff and Ritchison (1990a) found no differences in the characteristics of open roost sites used by male and female screech-owls. At least two factors may have contributed to differences in the roosting behavior of males and females. First, the availability of the different types of roosts may have varied among the ranges of males and females. Second, the suitability of boxes or cavities used by female screech-owls may be based in part on their potential as nest sites. Perhaps as a result, cavities used by female screech-owls were higher and had smaller entrances than those used by males. As discussed previously, higher cavities suffer lower rates of predation and may be preferred by nesting females. In addition, nesting screech-owls may avoid cavities with large entrances (Belthoff and Ritchison 1990b) because cavities with smaller entrances will exclude some potential nest predators (Sonerud 1985).

We found no significant differences between characteristics of used and unused cavities or between frequently and infrequently used cavities, suggesting that screech-owls exhibit little selectivity in their choice of roost cavities. Smith et al. (1987) also reached this conclusion and, regarding the use of roost cavities by screech-owls, stated that "the sizes of both the cavity entrance and the interior were quite variable. . . ." Smith et al. (1987) also noted that the entrances of some roost sites were elongated slits while others were large openings created when the tops of trees or limbs had broken off.

In contrast, Belthoff and Ritchison (1990b) found that Eastern Screech-owls were selective in their use of nest cavities, perhaps because variation in the characteristics of nest cavities may influence the risks of predation. The apparent tendency of screech-owls to be less selective in the use of roost cavities suggests that the risks of predation may be lower during the nonbreeding season. At least one group of potential predators, snakes, (Bent 1938) is either less active or not active during the nonbreeding season. In addition, nestling screech-owls are more vulnerable to predation than adults. Therefore, adult owls must select nest cavities that minimize the risks of predation. During the nonbreeding season, less vulnerable adults may not be as selective because they are better able to defend themselves and to escape from potential predators.

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LITERATURE CITED

ALBANO, D.J. 1992. Nesting mortality of Carolina Chickadees breeding in natural cavities. *Condor* 94:371–382.

BARROWS, C. 1981. Roost selection by Spotted Owls: an adaptation to heat stress. *Condor* 83:302–309.

BELTHOFF, J.R. AND G. RITCHISON. 1989. Natal dispersal of Eastern Screech-owls. *Condor* 91:254–265.

———. 1990a. Roosting behavior of postfledging Eastern Screech-owls. *Auk* 107:567–579.

———. 1990b. Nest-site selection by Eastern Screech-owls in central Kentucky. *Condor* 92:982–990.

BENT, A.C. 1938. Life histories of North American birds of prey, Part 2. Smithsonian Inst. U.S. Natl. Mus. Bull. 170, Washington, DC U.S.A.

BOSAKOWSKI, T. 1984. Roost selection and behavior of the Long-eared Owl (*Asio otus*) wintering in New Jersey. *Raptor Res.* 18:137–142.

BROWER, J.E., J.H. ZAR AND C.N. VON ENDE. 1977. Field and laboratory methods for general ecology. Wm. C. Brown Publishers, Dubuque, IA U.S.A.

COLLIAS, N.E. AND E.C. COLLIAS. 1984. Nest building and bird behavior. Princeton Univ. Press, Princeton, NJ U.S.A.

GEHLBACH, F.R. 1994. The Eastern Screech Owl: life history, ecology, and behavior in the suburbs and countryside. Texas A&M Univ. Press, College Station, TX U.S.A.

HAYWARD, G.D. AND E.O. GARTON. 1984. Roost habitat selection by three small forest owls. *Wilson Bull.* 96: 690–692.

JAMES, F.C. AND H.H. SHUGART, JR. 1970. A quantitative method of habitat description. *Audubon Field Notes* 24: 727–736.

KOROL, J.J. AND R.L. HUTTO. 1984. Factors affecting nest site location in Gila Woodpeckers. *Condor* 86:73–78.

MCCOMB, W.C. AND R.E. NOBLE. 1981. Microclimates of nest boxes and natural cavities in bottomland hardwoods. *J. Wildl. Manage.* 45:284–289.

MERSON, M.H., L.D. LETA AND R.E. BYERS. 1983. Observations on roosting sites of screech-owls. *J. Field Ornithol.* 54:419–421.

NILSSON, S.G. 1984. The evolution of nest-site selection by hole-nesting birds: the importance of nest predation and competition. *Ornis Scand.* 15:167–175.

SAS INSTITUTE. 1989. SAS user's guide: statistics, 1989 ed. SAS Institute, Cary, NC U.S.A.

SMITH, D.G., A. DEVINE AND R. GILBERT. 1987. Screech-owl roost site selection. *Birding* 19:6–15.

SONERUD, G.A. 1985. Risk of nest predation in three species of hole nesting owls: influence on choice of nesting habitat and incubation behavior. *Ornis Scand.* 16: 261–269.

SPARKS, E.J. 1990. The spatiotemporal ecology of adult and juvenile Eastern Screech-owls in central Kentucky. M.S. thesis, Eastern Kentucky Univ., Richmond, KY U.S.A.

———, J.R. BELTHOFF AND G. RITCHISON. 1994. Habitat use by Eastern Screech-owls in central Kentucky. *J. Field Ornithol.* 65:83–95.

VAN CAMP, L. AND C.J. HENNY. 1975. The screech-owl: its life history and population ecology in northern Ohio. N. Amer. Fauna No. 71, U.S. Fish and Wildl. Ser., Washington, DC U.S.A.

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