

## HUNTING BEHAVIOR OF AND SPACE USE BY EASTERN SCREECH-OWLS DURING THE BREEDING SEASON

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**ABSTRACT.**—The hunting behavior of and space use by radio-tagged Eastern Screech-Owls (*Otus asio*; three pairs, one unmated male, and four fledglings) were observed in central Kentucky from March–June 1999. Screech-owls perched at a mean height of 2.2 m. The mean giving up time was 340.2 sec, while the mean time until initiating an attack was 361.4 sec. Owls attacked prey located a mean distance of 2.27 m from perches, and the mean distance between successive perches was 10.33 m. Male screech-owls perched higher in taller trees during the fledgling period, and these higher perches were apparently used when hunting insects. Male screech-owls also hunted in different areas of their ranges during different breeding periods, possibly to take advantage of temporarily abundant prey and avoid prey depletion. During the fledgling period, the hunting ranges of paired male and female screech-owls overlapped, but males and females did not hunt in areas of overlap at the same time.

**KEY WORDS:** *Eastern Screech-Owl*; *Otus asio*; *hunting behavior*; *perch time*; *range use*; *breeding season*.

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Comportamiento de caza y uso de espacio de *Otus asio* durante la estación reproductiva

**RESUMEN.**—El comportamiento de caza y uso del espacio de *Otus asio* dotados con radio transmisores (tres parejas, un macho solitario y cuatro volantones) fue observado el centro de Kentucky desde marzo–junio 1999. Los búhos se posaron en perchas a un altura de 2.2 m. El tiempo de espera fue de 340.2 sec, mientras que el tiempo medio hasta el inicio de un ataque fue de 361.4 sec. Los búhos atacaron a presas localizadas a una distancia media de 2.27 m de las perchas y a un distancia media entre perchas sucesivas de 10.33 m. Los machos se ubicaron en las perchas más altas de árboles grandes, aparentemente estas fueron utilizadas para la caza de insectos. Los machos también cazaron en áreas distintas a sus rangos durante las diferentes etapas de su reproducción, posiblemente para aprovechar la abundancia temporal de presas y evitar agotarlas. Durante el período del crecimiento del plumaje, los rangos de caza de las parejas se traslaparon pero los machos y hembras no cazaron en áreas de traslape al mismo tiempo.

[Traducción de César Márquez]

Eastern Screech-Owls (*Otus asio*) are found throughout eastern North America and have been the subject of many studies (e.g., Belthoff et al. 1993, Sparks et al. 1994, Duguay et al. 1997). However, as with other nocturnal predators, direct observations are difficult and, as a result, little is known about the hunting behavior of screech-owls. In one study, Abbruzzese and Ritchison (1997) observed the hunting behavior of Eastern Screech-Owls in central Kentucky and found no differences between males and females during the nonbreeding season.

As the breeding season approaches, males and females in many owl species exhibit a division of labor (Reynolds and Linkhart 1987). The reproductive success of male raptors may depend on their ability to supply food for mates and offspring throughout the breeding season, beginning with courtship and continuing through the post-fledging period. Once young are able to thermoregulate and manipulate prey, females resume hunting and assist the male in provisioning nestlings and fledglings (Hovis et al. 1985, Gehlbach 1994). The changing roles of male and female screech-owls during the breeding season may influence their hunting behavior. Our objective with this study was to examine how changing food demands and the changing roles of male and female Eastern Screech-Owls might influence hunting behavior and space use during the breeding season.

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## METHODS AND MATERIALS

The hunting behavior of Eastern Screech-Owls (three breeding pairs, an unpaired male, and four fledglings) was studied from 5 March–8 June 1999 at the Central Kentucky Wildlife Management Area, located 17 km southeast of Richmond, Madison County, Kentucky. Adult screech-owls were captured by checking nest boxes or by luring them into mist nets using the playback of bounce songs (Ritchison et al. 1988). Captured owls were fitted with 5–6 gm (about 3–4% of screech-owl body mass) radio-transmitters with activity switches (Wildlife Materials, Inc., Carbondale, IL) attached backpack style (Smith and Gilbert 1981). Yellow reflective tape (about  $5 \times 1$  cm) was attached to the antennas of the transmitters to make it easier to locate hunting owls. Owls were allowed 1 wk to become accustomed to the transmitters before observations began. Several days prior to anticipated fledging dates, nestlings ( $N = 13$  in three nests) were banded with a numbered aluminum leg band, and four (two from one nest and one each from the other two nests) were fitted with radio-transmitters.

One or two radio-tagged owls were observed each night and general locations were determined using a receiver (TR-2, Telonics Inc., Mesa, AZ) and a hand-held, two-element yagi antenna. Specific locations of owls were determined using a red-tinted flashlight. Owls were assumed to be hunting when their attention appeared to be focused on the ground (probably searching for ground-based prey) or on nearby vegetation (probably searching for birds or insects) or flying insects. When hunting, owls also exhibited frequent head movements. In addition, hunting fledglings, in contrast to non-hunting fledglings, were always perched several meters away from siblings.

Observations were made at least four times per week. Observation periods started shortly after sunset and were usually 3–4 hr in duration. We typically watched owls from a distance of 8–12 m. Adult females were difficult to observe during the nestling period because they often responded aggressively. Once females began hunting further away from nest sites (about 1 wk after young fledged), our presence seemed to have little effect on their behavior. As a result, only female hunting perches located during the fledgling period were used in analyses of hunting behavior. The breeding status of each pair was categorized as: pre-nesting, egg-laying/incubation, nestling, or fledgling.

During focal owl observations, we tape-recorded all information and perches and attack sites were marked with flagging (placed several meters away) for later analysis. Perch times were classified as either giving-up time (the owl flew to another perch without initiating an attack) or time until attack. These times were only determined when we either observed owls landing on a perch or could estimate landing time based on a change in a transmitter's pulse rate (all transmitters had activity switches).

Within 2 wk, we returned to perches and measured perch height, substrate (tree, shrub, or vine) height, the distance from the tree trunk to the perch, and the diameter at breast height (DBH) of the perch tree. We also noted tree species and measured the distance to the next perch. If successive perches were more than 50 m apart,

we determined the distance using ArcView 3.1 (Environmental Systems Research Institute, Redlands, CA).

The location of each perch was recorded in Universal Transverse Mercator (UTM) coordinates using Global Positioning System (GPS) receivers (Garmin XLS). To determine the size of the areas used by owls, we produced 100%-minimum-convex polygons (MCP) using ArcView 3.1 with the Spatial Tools and Animal Movement extensions. We also measured the distance from each perch to the nest in each territory.

Repeated measures analysis of variance was used to examine the possible effects of breeding period on the hunting behavior of male screech-owls. Small sample sizes precluded comparison of male hunting behavior to that of females and fledglings. All analyses were conducted using the Statistical Analysis System (SAS Institute 1989). All values are presented as mean  $\pm$  standard error. Individual owls are referred to by the last three digits of their (or their mate's or parents') radio-transmitter frequency.

## RESULTS

Eastern Screech-Owls ( $N = 4$  males, 3 females, and 4 fledglings of unknown sex) were observed for a total of 182 hr on 55 nights from 5 March–8 June 1999. Overall, these owls perched at a mean height of  $2.20 \pm 0.08$  m ( $N = 304$  perches) in trees with a mean height of  $5.63 \pm 0.24$  m ( $N = 301$  perches) and mean DBH of  $0.12 \pm 0.01$  m ( $N = 301$  perches; Table 1). Owls ( $N = 11$ ) perched a mean distance of  $0.51 \pm 0.05$  m ( $N = 302$  perches) from the main trunk of perch trees or snags. Forty different plant species were used as perches by screech-owls, with snags (21.6%), American ash (11.1%, *Fraxinus americana*), and American sycamore (7.8%, *Platanus occidentalis*) used most frequently.

The mean giving-up time ( $N = 231$  perches of 9 owls) was  $340.2 \pm 18.7$  sec, while the mean time until initiating an attack ( $N = 18$  perches of 6 owls) was  $361.4 \pm 32.0$  sec. Owls ( $N = 6$ ) attacked prey located a mean distance of  $2.27 \pm 0.28$  m from perches ( $N = 21$ ). The mean distance between successive perches was  $10.33 \pm 1.42$  m ( $N = 65$  perch changes by 9 owls).

We observed 21 attacks by screech-owls, with 11 successful and 10 unsuccessful. Eight of 18 attacks by males were successful, resulting in the capture of three birds, one small mammal, two crayfish (*Cambarus* spp.), and two insects. Attacks by females ( $N = 2$ ) and fledglings ( $N = 1$ ) on insects were all successful.

Although adult females and their young were only observed hunting during the fledgling period, two males were observed during the pre-nesting,

Table 1. Perch characteristics and hunting behavior of male, female, and fledgling (unknown sex) Eastern Screech-Owls. Values are presented as mean ± one standard error. Sample sizes are in parentheses.

	MALES (N = 4)	FEMALES (N = 3)	FLEDGLINGS (N = 4)
Perch height (m)	1.93 ± 0.07 (258)	3.50 ± 0.36 (22)	3.99 ± 0.34 (24)
Tree height (m)	4.70 ± 0.22 (255)	9.79 ± 0.92 (22)	11.67 ± 0.79 (24)
Distance from tree trunk (m)	0.42 ± 0.05 (256)	0.97 ± 0.27 (22)	0.97 ± 0.23 (24)
Tree DBH (m)	0.10 ± 0.01 (255)	0.19 ± 0.03 (22)	0.23 ± 0.05 (24)
Distance to next perch (m)	11.07 ± 1.72 (53)	2.25 ± 0.48 (2)	8.75 ± 1.53 (10)
Attack distance (m)	2.32 ± 0.30 (18)	0.75 ± 0.25 (2)	2.5 (1)
Giving-up time (sec)	355.5 ± 20.4 (201)	183.2 ± 62.4 (13)	279.9 ± 52.0 (17)
Attack time (sec)	381.3 ± 32.3 (16)	150 (1)	255 (1)

egg-laying/incubation, nestling, and fledgling periods and a third male was observed during all but the pre-nesting period. Analysis of the hunting behavior of these males revealed that mean perch height ( $F_{3,5} = 14.85, P = 0.006$ ) and tree height ( $F_{3,5} = 7.99, P = 0.024$ ) varied among periods (Fig. 1), with males perching higher in taller trees during the fledgling period (Tukey's test,  $P < 0.05$ ). We found no differences among breeding periods in other variables, including DBH of perch trees ( $F_{3,5} = 2.43, P = 0.18$ ), distance of perches from the main trunk ( $F_{3,5} = 3.5, P = 0.11$ ), giving-up time ( $F_{3,5} = 0.71, P = 0.59$ ), and distance between successive perches ( $F_{2,3} = 2.07, P = 0.27$ ). Sample sizes were too small to examine possible differenc-

es among periods in either attack time or attack distance.

For male screech-owls, the mean distance of hunting perches from nest sites did not differ ( $F_{3,5} = 0.1, P = 0.95$ ) among breeding periods. Similarly, the size of male hunting ranges did not vary ( $F_{3,5} = 4.13, P = 0.056$ ) among breeding periods. However, specific hunting areas used by male screech-owls did vary among breeding periods. For example, male 957 hunted primarily in the northeastern portion of his territory during the pre-nesting period, but in the southwestern section during the egg-laying/incubation period. During the nestling period, male 957 hunted primarily in the southeastern section of his territory and, during the fledgling period, again used the southwestern section (Fig. 2).

Based on a limited number of observations, the

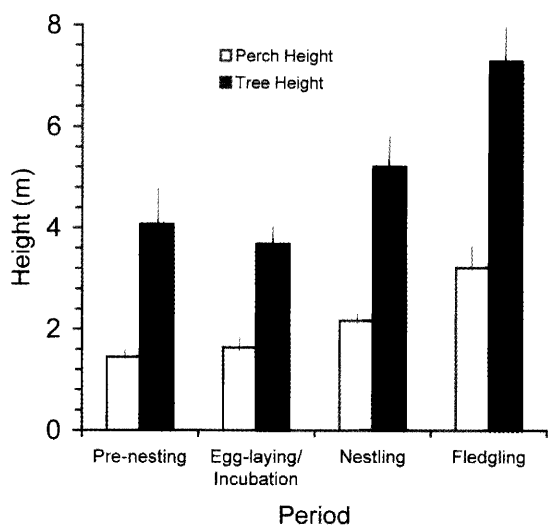


Figure 1. Variation among breeding periods in mean perch heights of and trees used by male Eastern Screech-Owls.

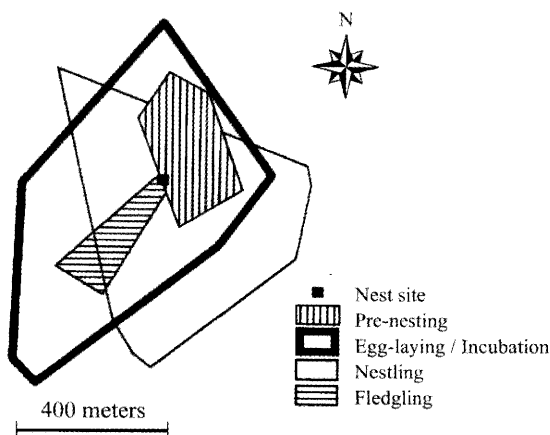


Figure 2. Variation in areas used by screech-owl male 957 during different breeding periods in central Kentucky.

sizes of hunting ranges of the three adult female screech-owls during the fledgling period were 7.0 ha (two observation periods, five perches), 9.4 ha (two observation periods, 12 perches), and 12.2 ha (five observation periods, 10 perches), respectively. During the fledgling period, the hunting range of male 957 completely encompassed that of his mate, while the ranges of males 997 and 037 included 87% and 59% of the hunting ranges of females 997 and 037, respectively. Although ranges overlapped, paired males and females were not observed hunting in the same locations on the same night.

Fledglings ( $N = 4$  from three different broods) were observed during 10 observation periods (from the day of fledging through 29 d post-fledging). Young owls were first observed hunting 26 d after fledging. The first (and only observed) successful attack by a fledgling was 27 d after fledging.

#### DISCUSSION

Eastern Screech-Owls in our study perched at a mean height of 2.2 m. Similarly, Gehlbach (1994) found that Eastern Screech-Owls in suburban Waco, Texas, hunted from perches at a mean height of 2.6 m. However, at the same location where we conducted our study, Abbruzzese and Ritchison (1997) reported a mean perch height of 1.66 m for screech-owls during the non-breeding season. The higher mean perch height in our study may be due to seasonal differences in the types of prey being hunted and seasonal differences in vegetation height. During the non-breeding season, screech-owls in central Kentucky appeared to be hunting primarily crayfish and small mammals (Abbruzzese 1996). In contrast, screech-owls in our study often appeared to be hunting for insects, and owls may perch higher when hunting insects to increase the visual search area and to scan areas above vegetation for flying insects. For example, Village (1990) noted that Eurasian Kestrels (*Falco tinnunculus*) chose higher perches when hunting invertebrates because such perches provide larger scanning areas than low perches.

During the breeding season, vegetation is taller and thicker than during the non-breeding season and, in response, screech-owls may perch higher. Similarly, Morrison (1980) found that Loggerhead Shrikes (*Lanius ludovicianus*) selected higher perches during the summer than during the winter because such perches provide a wider field of view in taller, more dense summer vegetation.

Other nocturnal owls hunt from perches at heights similar to those used by screech-owls in our study. For example, Boreal Owls (*Aegolius funereus*) have been reported to hunt from perches at mean heights of 1.7 m (Norberg 1987) and 3.1 m (Bye et al. 1992). Lower perches may provide a better view of ground-dwelling prey in areas where low-growing cover and shrubs obscure much of the ground (Norberg 1987). In addition, low perches may allow owls to better locate prey using acoustic cues (Norberg 1987, Abbruzzese 1996).

The mean giving-up time for screech-owls in our study was 340.2 sec (or 5.7 min). Abbruzzese and Ritchison (1997) reported a mean giving-up time of 278.9 sec (4.6 min) for Eastern Screech-Owls during the non-breeding season, while Gehlbach (1994) found that screech-owls hunting primarily insects had a mean giving-up time of just 72 sec (1.2 min). Gehlbach (1994) suggested that prey abundance influences giving-up times, with owls able to assess areas of dense prey more quickly. Differences in the type of prey being hunted may also influence giving-up times. For example, Bye et al. (1992) suggested that owls need more time to search for small mammals than other prey because their movements are difficult to detect.

The mean time before initiating an attack by screech-owls in our study was 361.4 sec (or 6 min), similar in duration to the mean giving-up time (340.2 sec). During the non-breeding season, Abbruzzese and Ritchison (1997) also reported no difference between giving up and attack times for screech-owls, and suggested that predators detecting invertebrate prey do not wait long before initiating an attack because such prey are relatively easy to capture. In addition, we observed screech-owls capturing or attempting to capture flying insects on several occasions. Because flying prey can quickly move out of range, owls likely attack such prey shortly after detection. In contrast, Bye et al. (1992) suggested that Boreal Owls had longer attack, or detection, times because they waited longer before initiating attacks on small mammals. Owls attacking small mammals may wait longer because such prey are difficult to capture (Toland 1987, Bye et al. 1992, Atkinson and Cade 1993). Hayward and Hayward (1993) noted that, after detecting prey, Boreal Owls sometimes waited 10 min or more if a prey item was not in a vulnerable position.

Paired males in our study perched higher in taller trees during the fledgling period than during

the pre-nesting and egg-laying/incubation periods. This increase in perch height may have been due to a change in the type of prey being hunted. Male screech-owls appeared to hunt primarily small mammals and crayfish during the pre-nesting and egg-laying/incubation periods, but were only observed hunting insects during the fledgling period. Although this switch may have been due in part to changes in availability, other factors may have also contributed. Gehlbach (1994) suggested that male screech-owls provision females with large prey items during the pre-nesting period because females require substantial amounts of energy to produce a clutch of eggs. However, during the nestling and fledgling periods, male screech-owls may provide their young with smaller, more easily-handled prey like insects (Gehlbach 1994). McClain (1997) found that adult screech-owls delivered primarily small prey items (including beetles [Coleoptera] and moths [Lepidoptera]) to nestlings.

Male screech-owls in our study were observed hunting in different parts of their ranges during different breeding periods. One possible reason for such shifts may be to take advantage of temporarily abundant prey. For example, Gehlbach (1994) observed that screech-owls sometimes made repeated trips to and from concentrations of invertebrates such as emerging cicadas (Cicadidae) and earthworms (Lumbricidae). Village (1990) noted that raptors sometimes return to hunting sites where prey have been captured. Similarly, we sometimes observed male screech-owls make repeated visits to the edges of temporary pools and intermittent streams, possibly searching for crayfish that were sometimes abundant at such locations (pers. observ.). Abbruzzese (1996) also reported that screech-owls in central Kentucky frequently hunted for crayfish. Another reason why male screech-owls might hunt in different areas at different times is to avoid depletion of prey resources. For example, Village (1990) found that the hunting ranges of Eurasian Kestrels were not used uniformly and that kestrels were familiar with their territories and the prey resources, as shown by the use of the same hunting locations on successive days.

The hunting ranges of paired male and female Eastern Screech-Owls in our study overlapped, particularly around nest sites. However, our observations also suggest that members of a breeding pair did not use the same hunting locations on the

same nights. Other investigators have also found that paired male and female raptors forage in different areas probably to avoid competition and prey depletion (Newton 1986, Craig et al. 1988, Village 1990, Gehlbach 1994). Gehlbach (1994) observed that male and female screech-owls leaving nest sites on hunting forays usually flew in different directions. Similarly, male and female Eurasian Sparrowhawks (*Accipiter nisus*) typically hunt in different directions from the nest (Newton 1986, Selas and Rafoss 1999).

We first observed hunting by fledgling screech-owls 26 d after fledging. However, we only observed the four radio-tagged fledglings on four occasions during the period from 16–26 d post-fledging (on days 16, 19, 22, and 26). Gehlbach (1994) reported that young screech-owls attempt to capture insect prey just 9–14 d after fledging and are able to feed themselves regularly 3–4 wk after fledging.

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