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HOME RANGE AND HABITAT USE OF SUBURBAN RED-SHOULDERED HAWKS IN SOUTHWESTERN OHIO

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ABSTRACT.—We measured the home ranges and habitat use of 11 Red-shouldered Hawks (*Buteo lineatus*) during the breeding season and 9 during the nonbreeding season in suburban Ohio, using standard telemetry techniques. Mean home ranges, calculated using the adaptive kernel method (95% isopleth), were 90 ha ± 11 SE during the breeding season, 189 ha ± 33 SE during the nonbreeding season, and 165 ha ± 24 SE for the annual home range. Males and females did not differ significantly in home range size. We examined habitat use by hawks by classifying the habitat where birds were observed perching. Habitat used by hawks differed significantly from that available within home ranges for all birds tested. Most Red-shouldered Hawks used riparian zones and pond edges more than expected, based on availability of such habitats within their home ranges; residential areas and lawns were used less than expected or in proportion to their availability. *Received 16 Jan. 2001, accepted 18 Dec. 2001.*

Raptors nesting in urban or suburban areas may benefit from increased food supply, decreased competition, and lowered predation compared to those in rural areas (Parker 1996, Tella et al. 1996, Love and Bird 2000), but may endure repeated human disturbance and risk of collision with vehicles (Love and Bird 2000). As a result, urban and suburban raptors may differ from rural conspecifics in regard to several population and ecological parameters, including survival, reproductive success, home range size, and habitat use (Rosenfield et al. 1995). Additionally, urban and suburban areas can provide a significant refuge for species facing habitat loss in more traditional areas. However, use of urban and suburban areas by some fairly common species, such as the Red-shouldered Hawk (*Buteo lineatus*), has been little studied.

Because of its restricted distribution (due to habitat loss) in Ohio, the Red-shouldered Hawk currently is designated a species of special interest (Ohio Dept. of Natural Resources pers. comm.) and is similarly classified in other midwestern and eastern states (Titus et al. 1989, Castrale 1991). Because habitat loss apparently contributed to the historic decline of Red-shouldered Hawk populations (Castrale 1991, Peterjohn and Rice 1991), urban and suburban areas may play an important role in conservation and management of this species, particularly if they provide adequate habitat for foraging, survival, and reproduction.

Although nest site selection and reproductive rate of urban and suburban Red-shouldered Hawks has been documented for the western subspecies (*B. l. elegans*; Bloom and McCrary 1996, Rottenborn 2000) and the eastern subspecies (*B. l. lineatus*; Dykstra et al. 2000a), published accounts of urban Red-shouldered Hawk home range size and habitat use is limited to data from two male hawks in southern California included in a larger telemetry study (Bloom and McCrary 1996). The urban males had much smaller home ranges than other males in the same study (Bloom and McCrary 1996), even though their home ranges contained mainly lawn, buildings, and exotic vegetation (Bloom et al. 1993). These limited data suggest that the urban landscape may have provided some benefit which allowed the birds to use a smaller area while still successfully raising young (Bloom et al. 1993).

The purpose of the present study was to examine the home range size and habitat use of suburban Red-shouldered Hawks in southwestern Ohio.

METHODS

Study area.—We studied Red-shouldered Hawks nesting in western Hamilton County in southwestern

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Ohio, approximately 15 km from downtown Cincinnati. The 20.0-km² study area (39° 12′ N, 84° 38′ W) was within the interior plateau ecoregion (Omernik 1987). Unglaciated during the last glacial period, this region is moderately hilly with many large and small streams that carved valleys and ravines. The study area consisted of tracts of relatively dense housing (5.1 houses/ha) surrounded by lawn and exotic plantings interspersed with areas of low density housing (1.2 houses/ha) with both lawn and forest, and small areas of privately held undeveloped forest. Most of the area was fragmented, with small (<1 ha) patches of various habitats being much more common than large (>15 ha) unbroken tracts. Generally, undeveloped forests were mostly on steep slopes bordering the two small streams, Briarly Creek and Sheed Creek. Native forests were dominated by upland oak-hickory (*Quercus* spp., *Carya* spp.) and beech-maple (*Fagus grandifolia*, *Acer saccharum*) associations. When present, riparian forest (mainly sycamores, *Platanus occidentalis*) was limited to a 2- to 10-m zone along the streams. No natural wetlands occurred within the study area, but there were many human-made small ponds. The area was selected because of the abundance of Red-shouldered Hawks along Briarly Creek (Dykstra et al. 2001). To our knowledge, there were 11 occupied Red-shouldered Hawk nests within the study area during 1998 and 13 during 1999, although the two additional nests found in 1999 may have been present during 1998. All nest locations were known from prior research (Dykstra et al. 2000a).

Trapping.—We trapped three male and three female Red-shouldered Hawks (including one mated pair) near nests before egg laying between 16 February 1998 and 19 March 1998; one additional male was trapped on 4 May 1998. During 1999, two females and three males (including one mated pair) were trapped before egg laying between 22 February and 23 March. All birds were trapped using a dho-gaza net with a Great Horned Owl (*Bubo virginianus*) lure (Bloom et al. 1992), or a bal-chatri trap baited with a mouse (Berger and Mueller 1959). Birds were fitted with backpack-mounted radio transmitters (Advanced Telemetry Systems, Inc., Isanti, Minnesota). Masses of the transmitters, antenna, and backpack attachment (Teflon straps and small leather keel plate) were 18 g for males, and 22 g for females, which was 3.1% of mean body mass. Birds were released 60–90 min after capture. All birds resumed normal activities shortly after release (as in McCrary 1981), and no problems associated with transmitters were detected.

Home range.—We tracked radio-marked birds from 18 March to 31 July 1998 and 25 February to 31 July 1999 (breeding season), and from 1 August 1998 to 31 January 1999 and 1 August 1999 to 31 January 2000 (nonbreeding season). Birds were followed 1–5 days per week and each bird was located 1–6 times/day. We located birds successively in roughly the same order, varying the first bird located so that birds were observed at different times of day. After we located a hawk, we recorded its position and did not relocate it again for ≥1 h (following Andersen and Rongstad 1989). The 1-h time period was chosen to minimize dependency between successive locations; 1 h was well longer than the amount of time required for a bird to fly from one end of a home range to the other (White and Garrott 1990).

Locations of radio-marked birds included visual sightings (24.8% of total data points) and triangulation and biangulation (herein "triangulation" for brevity) locations (75.2%). For triangulation, we determined hawk locations using 4-element, hand-held yagi antennas. With two researchers, two simultaneous bearings, or ≥3 bearings were taken from different established stations. With one researcher, ≥3 successive bearings were taken. No locations were made on birds in flight. Bearings were plotted on 1:24,000 USGS topographic maps, and a location was estimated using a transparent Universal Transverse Mercator (UTM) grid overlay. Direct observations of radio-marked birds also were plotted on these maps.

Habitat use.—When radio-marked hawks were observed perched, we classified the habitat in which the bird was perched as one of the following types: (1) upland deciduous forest, (2) upland coniferous forest (i.e., plantations), (3) riparian forest, (4) brush, (5) field, (6) lawn, (7) edge of pond, and (8) house or road. While following radio-marked birds, we occasionally saw unmarked birds at various locations, so during 1999 we recorded habitat for all Red-shouldered Hawks observed perched within the study area. We did not classify habitats at locations obtained by triangulation, because the highly fragmented nature of the study area created an unacceptable error rate for habitat classification.

The land cover types in the study area and in the hawk home ranges were evaluated using classified LANDSAT Thematic Mapper imagery (MRLC, USEPA-USGS). The MRLC data set is an Anderson Level 2 classification and depicts the study area as a set of 30 m × 30 m pixels classified into the following land cover types: (1) open water, (2) low intensity residential, (3) high intensity residential, (4) commercial and industrial, (5) deciduous forest, (6) coniferous forest, (7) mixed forest, (8) pasture and hayfield, (9) row crop, (10) lawn or park, (11) woody wetland, and (12) herbaceous wetland. These data were viewed and analyzed using an ArcView (ESRI, Redlands, California) geographic information system (GIS), with the Spatial Analyst Extension.

Data analysis.—Bearings were entered into the program Locate II (Nams 1990) to calculate bird locations, and calculated locations were checked and confirmed by comparison to the estimated locations plotted in the field. All direct observations and triangulation locations were included in the home ranges, which were calculated using the adaptive kernel method (AK) with 95% isopleth and a 50 × 50 grid (program CALHOME ver. 1994), and the minimum convex polygon method (MCP) for comparison with other studies. Core areas used by birds were calculated using the adaptive

kernel method with 50% isopleth and a 50 × 50 grid (CALHOME ver. 1994). Telemetry bearing error was calculated as mean standard deviation of bearings for all locations with ≥3 bearings, using LOCATE II (Nams 1990). Mean standard deviation was 4.9° for all birds during 1998 (n = 626 locations) and 4.5° for all birds during 1999 (n = 826).

The polygons defining the 95% AK home ranges and core areas were transferred to GIS and overlaid on the land cover grid. The type and amount of habitats within the home ranges was evaluated by using ''Tabulate Areas'' routine in the GIS Spatial Analyst. The number of residences within each home range also was counted. The overlap (shared area) between adjacent home ranges was calculated using an ''Intersect Polygons'' routine for breeding season and annual home ranges, using the larger home range to represent territories where both male and female were tracked (n = 3). Adjacent pairs of home ranges were defined as those in close proximity without having any intervening hawk territories between them; thus, some adjacent home ranges had no overlap. We combined data from 1998 and 1999, because 10 of the 11 territories occupied during 1998 also were occupied during 1999 (although six pairs moved to new nests, a mean distance of 278 m).

We tested whether hawks selected particular habitats within their home ranges and within the entire study area. The number of visual locations within each land cover category (excluding visual locations at nests) was compared to the amount of each land cover type within the home range, to determine whether habitats were used in proportion to their availability. To make the comparison, we combined some similar habitat types, because habitats defined by observers did not correspond precisely to that in the MRLC data set and because some habitat categories had low occurrence in the study area. For hawk visual locations, we combined upland deciduous forest, upland coniferous forest, and brush into FOREST; riparian forest and edge of pond into WET AREAS; houses and roads, and lawns into SUBURBAN; fields was left as FIELDS. For MRLC habitat types within home ranges and the study area, we combined deciduous forest, coniferous forest, and mixed forest into FOREST; open water and woody and herbaceous wetlands into WET AREAS; high and low intensity residential, lawns and parks, and commercial and industrial into SUBURBAN, and pastures and hay, and row crops into FIELDS. A check of several locations with known habitat types verified that these two habitat classification systems were comparable.

For five birds with >35 visual locations each, we compared the annual habitat use data to the habitat available within the bird's annual home range using the four habitat classifications above. Because the number of visual locations for most birds was relatively small, we combined visual locations for all birds (excluding visual locations at nests) and compared them to the mean annual home range and to the entire study area, which we defined as a rectangle encompassing all home ranges (following Thomas and Taylor 1990).

We tested whether home range size was correlated to the amount of any habitat type within home ranges. Proportions of habitat types within each home range were log transformed and compared with home range size using univariate linear regression.

Results are shown as mean ± SE. Male and female AK and MCP home range sizes were compared by Mann-Whitney U-tests. For birds for which both breeding and nonbreeding season home ranges were measured, we compared these in a paired fashion using Wilcoxon tests. Chi-square analysis was used to test whether habitat used by hawks differed from available habitat. When distributions of habitat type differed, we used Bonferroni Z-test to examine which habitats were used more or less often than expected (Neu et al. 1974, Byers et. al 1984). All statistical tests were conducted using Systat (Wilkinson 1988).

RESULTS

Home range.—We determined the breeding season home ranges of 11 birds at 9 active nests (i.e., contained eggs); 8 of these nests (9 marked birds) were successful (fledged ≥1 young) during the year we tracked those adults ($\bar{x}$ = 2.8 ± 0.2 young/successful nest). On 20 April 1998, after discovering that the eggs of one radio-marked female (F7) had been destroyed, presumably by a predator, we discontinued tracking her and instead tracked a male (M6) that had young in his nest. In 1999, the nest of a radio-marked female (F15) mated to a radio-marked male (M4) failed on 13 May, about two weeks into incubation; we continued to track both birds throughout that breeding season.

We determined the nonbreeding season home ranges of nine birds. Radio failure prevented tracking of some birds during the nonbreeding season, but subsequent resightings of these birds indicated that all Red-shouldered Hawks in our study area were nonmigratory (13 of 13 marked hawks remained in their breeding areas all year).

Home range size (Table 1) during the breeding season did not differ significantly between males and females (AK method: U = 15.0, P = 0.85; MCP method: U = 16.0, P = 0.71). Nonbreeding season home range sizes also did not differ significantly between males and females (AK method: U = 12.0, P = 0.62; MCP method: U = 10.0, P = 1.00). Similarly, annual home range sizes did not differ significantly between the sexes (AK

TABLE 1. Home ranges and core areas (ha) of Red-shouldered Hawks in southwestern Ohio, 1998–1999.

Season	Males $\bar{x} \pm$ SE (range)	Females $\bar{x} \pm$ SE (range)	All birds $\bar{x} \pm$ SE (range)
Breeding season			
n	7	4	11
Number of locations	108 ± 9 (80–155)	127 ± 14 (104–161)	115 ± 8 (80–161)
Number of days monitored	54 ± 4 (38–65)	58 ± 2 (56–63)	55 ± 3 (38–65)
AK[a] home range	92 ± 12 (56–161)	85 ± 22 (38–126)	90 ± 11 (38–161)
MCP[b] home range	65 ± 7 (41–98)	66 ± 24 (27–129)	65 ± 9 (27–129)
AK[c] core area	13 ± 3 (6–29)	4 ± 2 (1–9)	10 ± 2 (1–29)
Nonbreeding season			
n	5	4	9
Number of locations	114 ± 9 (81–137)	127 ± 7 (112–142)	120 ± 6 (81–142)
Number of days monitored	61 ± 4 (47–71)	67 ± 2 (62–72)	63 ± 3 (47–72)
AK[a] home range	196 ± 48 (87–347)	178 ± 52 (64–293)	189 ± 33 (87–347)
MCP[b] home range	133 ± 27 (66–205)	138 ± 37 (53–224)	135 ± 21 (53–224)
AK[c] core area	29 ± 7 (9–50)	24 ± 5 (13–37)	27 ± 4 (9–50)
Annual			
n	6	3	9
Number of locations	210 ± 20 (159–292)	263 ± 24 (216–296)	228 ± 17 (159–296)
Number of days monitored	109 ± 6 (100–132)	126 ± 5 (118–135)	115 ± 5 (100–135)
AK[a] home range	149 ± 31 (73–280)	195 ± 35 (127–240)	165 ± 24 (73–280)
MCP[b] home range	110 ± 23 (48–194)	163 ± 34 (109–227)	128 ± 20 (48–227)
AK[c] core area	21 ± 4 (9–35)	15 ± 3 (12–20)	19 ± 3 (9–35)

[a] 95% Adaptive Kernel technique using CALHOME.
[b] 95% Minimum Convex Polygon technique using CALHOME.
[c] 50% Adaptive Kernel technique using CALHOME.

method: $U = 5.0$, $P = 0.30$; MCP method: $U = 4.0$, $P = 0.20$). Nonbreeding season home ranges were significantly larger than breeding season home ranges for the eight birds tracked during both seasons (Wilcoxon test, $Z = 2.38$, $P = 0.017$).

The size of core areas (Table 1) differed slightly between males and females during the breeding season, when females remained primarily in the immediate vicinity of the nest (AK method: $U = 24.00$, $P = 0.058$). Core area size did not differ significantly between males and females during the nonbreeding season (AK method: $U = 11.0$, $P = 0.81$), nor for both seasons pooled (AK method: $U = 11.0$, $P = 0.61$).

Cumulative home range size was plotted on a biweekly basis for the nine birds with adequate data to calculate annual home range (Fig. 1). For most males, home range grew as more locations were obtained during early spring, stabilized when nestlings were in the nest, and increased slightly when nestlings were no longer dependent on adults (early in the nonbreeding season). For most females, home range was small throughout incubation and when chicks were young, at which time females tended to stay close to the nest. Home range grew markedly during late chick rearing and when chicks were no longer dependent (July to August).

Mean home range overlap between adjacent birds was 6.4 ± 3.2% during the breeding season (range: 0–19.9%, $n = 10$ sets of neighboring birds; area of overlap calculated as a percent of the larger home range). Annual home range overlap between adjacent birds was 11.3 ± 4.3% (range: 0–35.6%, $n = 7$).

Habitat use.—Percentages of habitat types within annual home ranges (Table 2) varied among individuals. Percentages of habitat types of breeding and nonbreeding season home ranges were similar to those of annual home ranges. Mean number of residences per breeding season home range was 169 ± 29 (range: 37–379) or 1.8 ± 0.2 buildings/ha (range: 1.0–3.2).

Habitats used by hawks (Table 2) differed from available habitat within each bird's home range for all five birds tested (Pearson chi-

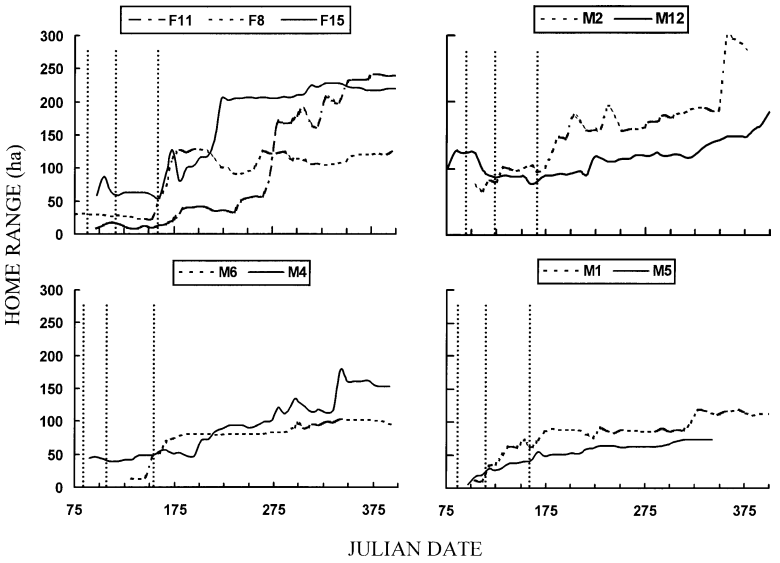

FIG. 1. Cumulative home range size for six male and three female Red-shouldered Hawks in southwestern Ohio, 1998–1999. Most birds were tracked from March or April through January of the following year. Vertical lines in each graph indicate approximate dates of onset of incubation, hatching, and fledging, respectively, for the nests of birds shown. The Julian date axis was extended past 365 days to account for tracking through January 31.

square distributions, $P < 0.05$ for all tests). Four of five birds used wet areas in greater proportion than availability, and all birds used suburban habitats less than ($n = 3$ birds) or in proportion to ($n = 2$ birds) availability. Forest areas were used in proportion to availability by four birds. Fields were used either more ($n = 3$) or less ($n = 2$) than availability. For all birds, habitat used differed from available habitat in the mean annual home range (Pearson chi-square distributions, $P < 0.05$ for all tests). Habitat used by all birds also differed significantly (all observations pooled, Pearson chi-square distribution, $P < 0.001$) from that available within the entire study area (Table 2). Annual home range size was not significantly related to the percentage of any habitat type within the home range (univariate linear regression, $P \geq 0.44$ for all tests).

DISCUSSION

Home range.—Home ranges of suburban Red-shouldered Hawks in southwestern Ohio were smaller than those of rural-nesting Red-shouldered Hawks of the eastern subspecies. Mean 95% MCP home ranges of 145 ha ($n =$

TABLE 2. Habitat selection by Red-shouldered Hawks in southwestern Ohio, 1998–1999.

Habitat type	Habitat available[a]		Habitat used[b]		Habitat selection[c]
	Annual home ranges (mean % ± SE)	Study Area (%)	Individuals observed >35 times (mean % ± SE)	All birds (%)	
Forest	40.9 ± 4.1	43.1	44.7 ± 3.9	49.2	+
Fields	8.8 ± 3.4	14.0	10.5 ± 4.4	13.1	
Wet areas	0.3 ± 0.1	0.4	19.4 ± 5.6	17.4	+
Suburban	50.0 ± 7.3	42.6	25.3 ± 4.1	20.3	−

[a] Percent coverage by four habitat types, based on ground-truthed LANDSAT Thematic Mapper imagery data for annual home ranges ($n = 9$) or the entire study area (20.0 km^2).

[b] Percent of observations of perched individuals, including 304 observations of five birds each located >35 times, and 482 total observations of marked and unmarked individuals.

[c] Habitat used greater than (+) or less than (−) its availability; see text for tests of significance.

4 males, breeding season; Howell and Chapman 1997), 118 ha (n = 2 males, breeding season; Parker 1986), and 202 ha (n = 3 males, latter half of breeding season; Senchak 1991) were reported for birds in Georgia, Missouri, and Maryland, respectively, compared to 65 ha for seven breeding season males in our study. Similarly, four females in our study had breeding season mean MCP home ranges of 66 ha, smaller than those reported for three females in Georgia ($\bar{x}$ = 96 ha; Howell and Chapman 1997), but slightly larger than those of two females in Maryland ($\bar{x}$ = 41 ha; Senchak 1991).

Red-shouldered Hawks of the western subspecies in southern California had home ranges more similar to birds in suburban southwestern Ohio. Mean 95% MCP home ranges of 90 ha (n = 7 males, mostly annual home ranges; Bloom et al. 1993) and 55 ha (n = 6 females, mostly annual home ranges; Bloom et al. 1993) were somewhat smaller than the 110-ha (n = 6 males) and 163-ha (n = 3 females) annual home ranges documented in our study.

The California study and the comparison of suburban Ohio birds with rural eastern Red-shouldered Hawks in other locations suggest that urban and suburban Red-shouldered Hawks have smaller home ranges than their counterparts in rural habitats, which may indicate that the urban and suburban habitat is at least adequate, and possibly better than, the more typical rural habitat (Bloom et al. 1993). Reproductive rate of suburban Red-shouldered Hawks in Ohio was similar to that of rural hawks in southern Ohio (Dykstra et al. 2000a), and reproductive rate of urban Red-shouldered Hawks was higher than that of rural birds in southern California (Bloom and McCrary 1996).

Suburban Red-shouldered Hawks in southwestern Ohio selected nesting sites that did not differ from those selected by rural birds of southcentral Ohio, except in characteristics related to the suburban nature of the study area (e.g., distance to buildings; Dykstra et al. 2000a). It is possible that some features of the suburban landscape benefitted the Red-shouldered Hawks in our study, allowing them to maintain smaller home ranges than rural birds. For example, suburban habitat might provide abundant prey because of the anthropogenic ponds and numerous bird feeders. We observed radio-marked birds hunting along the edges of such ponds and occasionally hunting at backyard bird feeders. Additionally, suburban landscapes may offer reduced competition from other raptor species such as Red-tailed Hawks (*Buteo jamaicensis*), which may be less likely to inhabit suburban regions (Bloom and McCrary 1996).

Home ranges of suburban Red-shouldered Hawks may have greater variance in size than those of rural hawks. Red-shouldered Hawks in our study area, particularly breeding season females, varied widely in home range size, compared to those in rural Georgia (Howell and Chapman 1997), and Missouri (Parker 1986). This variance may be due to differences in the habitat quality between suburban home ranges (as in Bloom et al. 1993), or the amount of unsuitable habitat (e.g., asphalt, buildings) within a home range. However, home range size was not correlated to percentage of available habitat for any habitat type. Some of the variance in home range size during the breeding season, particularly for females, may be related to how we defined the breeding season, i.e., the date when fledglings were no longer dependent on adults. We heard young begging for food as late as 24 July (CRD unpubl. data), but due to variation in laying, hatching and fledging dates, some birds may have had dependent young after July 31, while others might have been freed of dependent young earlier.

Habitat use.—Most suburban Red-shouldered Hawks in our study area selected riparian and pond edge habitats and some selected field habitats. Red-shouldered Hawks are known to use riparian, wetland, and other mesic habitats for nesting and foraging (Bednarz and Dinsmore 1981, Woodrey 1986, Bosakowski et al. 1992, Howell 1995, McLeod et al. 2000). In Georgia, home ranges of males often were centered around beaver (*Castor canadensis*) ponds or other pools or wet areas (Howell and Chapman 1997). Red-shouldered Hawks using fields in our study most often were perched along the edges of fields or, more rarely, in an isolated tree in the middle of a small field or pasture. Because Red-shouldered Hawks hunt mostly from perches, their use of large open spaces may be limited by perch availability (Bloom et al. 1993). The

importance of edge habitats to Red-shouldered Hawks, especially for foraging, has been suggested previously (Bednarz and Dinsmore 1982, Moorman and Chapman 1996). Edges of fields may have been the capture sites for small mammals, which comprised 29% of the diet (45 of 156 identified prey items) for 19 nests in southwestern Ohio (CRD unpubl. data). However, we note our habitat use data may be biased because we classified habitat only where we observed birds perched, which might skew the data toward more open habitats such as fields and lawns where birds could be detected most easily.

Individual Red-shouldered Hawks in our study differed in their use of habitat types. Some of the variance was related to habitat availability within each bird's home range. Bird F9 was observed in riparian and pond habitats 46% of the time during the breeding season, and its home range contained a 1.5-km reach of Briarly Creek and three ponds. The paired birds M1 and F11, in contrast, did not use riparian and pond habitats, because their home ranges contained little such habitat.

Habitat use may have been related to individual tolerance of humans and human disturbances. Bird M1 seemed to be the most tolerant of humans of the birds, with 49% residential habitat and 185 houses in its breeding season home range. Male M1 repeatedly perched in backyards near bird feeders, on playground equipment in a yard, and on utility lines next to a busy road (22% of sightings during the breeding season of M1 were in lawn or urban habitats). In contrast, its mate's (F11) home range was smaller and contained only 27% residential habitat. During the nonbreeding season, F11's home range expanded greatly, but most observations were in natural habitats, at locations distant from human disturbance. In California, some suburban Red-shouldered Hawks also demonstrated use of heavily modified habitats and tolerance of human disturbance, by nesting and foraging in areas with significant human activity such as parks (Bloom and McCrary 1996), or by nesting close to buildings and busy roads (Rottenborn 2000). One pair within our study area nested on the rooftop of a busy apartment building, and two pairs outside the study area nested on a gas grill on the deck of a private residence and on a residential rooftop (Hays 2000, Dykstra et al. 2000b).

Conservation.—Our study indicates that Red-shouldered Hawks successfully use moderately developed landscapes in southern Ohio, provided that adequate (approximately $\geq$40%) natural mature forest habitat remains. Red-shouldered Hawks may benefit from some features associated with development, such as ponds, small pastures, and bird feeding stations, which may provide prey. However, not all subpopulations of the eastern subspecies are as tolerant of human activity as are the hawks of southwestern Ohio. Red-shouldered Hawks preferentially selected nest sites far from human activity in New York (1300 m from nearest home; Johnson 1989) and New Jersey (1013 m from nearest human habitation and 812 m from nearest road; Bosakowski et al. 1992). In these areas, management for this species necessarily must be quite different. Hence, significant ecological data on specific subpopulations may be required to ensure sufficient protection for Red-shouldered Hawks in all locations in eastern North America.

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