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ACTIVITY AND HABITAT USE BY A BREEDING MALE COOPER'S HAWK IN A SUBURBAN AREA

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ABSTRACT.—In 1981, we monitored a radio-tagged breeding male Cooper's Hawk (*Accipiter cooperii*) in a central Wisconsin town during early nestling through post-fledging periods; about 150 hr of habitat use and activity data were collected. The hawk's seasonal home range was 784 ha, and six daily home ranges averaged 231 ha. Wooded residential, residential/business, and open areas were avoided and oak-pine woods and shrub savannah habitats were preferred. The hawk spent 88% of its daylight (non-roost) time in 12% of its home range area; a 50 ha area about 0.7 km from the nest accounted for 54%, 61%, and 58%, respectively, of the hawk's daylight time, roosts (N = 31 events), and monitored prey captures (N = 24). We also describe routine use of flight routes and suggest the importance of site familiarity to Cooper's Hawks.

Although the secretive nature of *Accipiter* hawks obstructs study of their activities and habitat needs (Fitch et al. 1946; Fischer 1986), such baseline data should prove useful to resource agencies charged with managing or assessing the status of the Cooper's Hawk (*Accipiter cooperii*) in the eastern U.S., where the species is listed as threatened or endangered by several states. Recently, Fischer (1986) reported on activity and habitat use of breeding *Accipiter* hawks, including Cooper's Hawks, in montane Utah. Although Cooper's Hawks may nest in suburban or urban areas (Stahlecker and Beach 1979; Palmer 1988:329), almost nothing is known about their nesting ecology in such situations. Here we present base information on behavior of a suburban-nesting male Cooper's Hawk.

STUDY AREA AND METHODS

The nest, containing three young, was in a 4.5 ha oak (*Quercus* spp.) and white pine (*Pinus strobus*) woodlot in residential Plover (pop. 5500), Portage County, Wisconsin (Fig. 1). We defined "residential" as dwellings, mostly single family houses ($\bar{x}$ = 2/ha) and adjacent habitat within 50 m. Area within the hawk's home range was composed of 37.3% residential (about ⅓ of which was wooded) and small businesses, 23.4% miscellaneous open areas (mainly transportation right-of-ways and small fields), 6.6% shrub savannah [fields reverted to grasses, forbs and shrub-stage jackpine (*P. banksiana*) and black cherry (*Prunus serotina*)], 10.1% red pine (*P. resinosa*) plantation, 19.3% oak-pine woods and 3.3% wooded riparian (mostly *Salix* spp., *Alnus rugosa*, and *Acer rubrum*) habitat.

On 5 June 1981 we trapped the male (>2 yr old) in a mist net (3 × 10 m) placed near the nest (Hamerstrom 1963), attached a 4-g radio-transmitter package (150 mHz) to a central rectrix (Kenward 1978) and banded the hawk (USFWS lock-on band). The transmitter fell off on 20 June, so we recaptured the hawk on 24 June and attached a new transmitter (6 g, <2% of the hawk's body weight) that functioned until late August, when the central rectrices molted. We telemetrically located the hawk almost daily (including roost observations) through early August, using a vehicle-mounted Yagi antenna. On seven full-days (dawn to dusk) and 10 part-days (2–8 hr, $\bar{x}$ = 4 hr 20 min), we monitored the hawk continuously. We easily followed and often saw the hawk because of extensive road access throughout the study area; seldom were we >400 m from the hawk.

We calculated home range by measuring the area within a polygon formed by a line connecting the outermost telemetric or visual observations. The hawk's seasonal home range thus encompassed all observations collected. Within the seasonal home range, we considered as available habitat all but the area added by a single, 1-km excursion outside the normal range of activity. We measured habitat area on an aerial photograph (1:7900) with a Numonics Graphics Calculator (Model 1224, Numonics Corporation, 418 Pierce Street, Landsdale, PA 19446).

From changes in radio signal direction and amplitude, we categorized the hawk as 1) active-hunting (AH: frequent movement, occasionally perching <10 min), or 2) inactive-perched (IP: stationary, without radio signal changes for >10 min) similar to Marquiss and Newton (1981) and based on duration of Cooper's Hawk perching

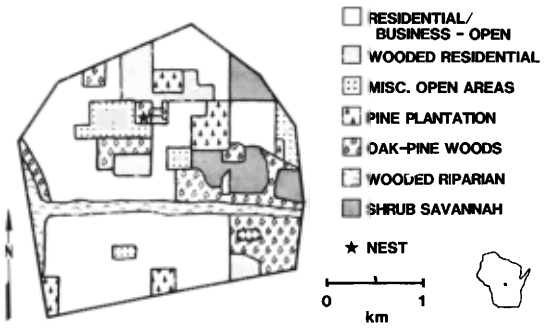

Figure 1. Habitats within the seasonal home range of a breeding male Cooper's Hawk in Plover, Wisconsin, 1981 (excludes area added by a 1-km excursion outside the normal range of activity).

bouts in Fischer (1986); visual observations helped to confirm these criteria. We calculated proportions of AH and IP time spent in each habitat during continuous monitoring (excluding prey deliveries and other visits to the nest) and compared to respective proportions of habitat available (Ivlev 1961). Habitat use could be assessed accurately only 78% of the time, because error polygons assigned to telemetry fixes sometimes were excessive (>2.5 ha, 17% of time), and we occasionally lost radio signal due to equipment failures or incorrect anticipation of the hawk's movement (5% of time); we assumed these losses of data to be independent of the hawk's use of habitats. Also, we did not completely observe all visits to the nest during continuous monitoring, but when visits included a steep descent into the nest woodlot and were of short duration, as those we verified as prey deliveries, we assumed that prey was delivered.

RESULTS AND DISCUSSION

We collected 105 visual and 379 usable telemetric observations during 150 hr of continuous monitoring and 74 spot-checks, 6 June–26 August. During these months, the hawk covered a nearly elliptical range of 2.8 × 4.3 km, an area <8 km^2. Late nestling and fledging period ranges were nearly ⅔ of the seasonal range, but ranges during day-long observations and other nesting periods were smaller (Table 1). Relatively small range sizes during the early nestling period and late summer may have been artifacts of lower sample size.

Oak-pine woods and shrub savannah were preferred habitats and residential/business and open areas were avoided during AH and IP time (Table 2). Cooper's Hawks in Utah similarly preferred oak-maple woodland and oak shrubland/grassland and avoided open montane slopes, but individual use of habitats varied considerably and appeared unrelated

Table 1. Home ranges (minimum perimeter polygon) of a breeding male Cooper's Hawk in Plover, Wisconsin, 1981.

HOME RANGE TYPE	DATES	N HR (OBS)[a]	HOME RANGE SIZE (HA)
Seasonal	6 Jun–26 Aug	180 (484)	784
(Nesting stage)			
Early nestling	6–19 Jun	23 (33)	193
Late nestling	25 Jun–5 Jul	53 (155)	451
Fledging	6–19 Jul	42 (145)	571
Post-fledging	20 Jul–3 Aug	42 (113)	274
Late summer	4–26 Aug	20 (38)	229
$\bar{X}$ (SD)			344 (144)
Daily[b]	1 Jul	16 (55)	185
	2 Jul	16 (39)	283
	17 Jul	16 (60)	294
	21 Jul	16 (41)	249
	30 Jul	16 (34)	177
	6 Aug	15 (26)	194
$\bar{X}$ (SD)			230 (47)

[a] Data from continuous monitoring and spot-checking were used to construct seasonal and nesting stage home ranges; observations (obs) were either visual or telemetric.

[b] A daily home range for 11 June, also a full day, was not constructed because few (N = 9) usable telemetry fixes were obtained.

to prey abundance (Fischer 1986). In this study wooded residential habitat also was avoided although used slightly. Pine plantation and wooded riparian were used in proportion to availability.

The hawk disproportionately used areas within its home range. During 54.2% of combined AH and IP time (57.9% and 50.0%, respectively), the hawk was in a 50 ha area composed of oak-pine woods, shrub savannah, and pine plantation, 0.7 km east-southeast of the nest. Based on prey deliveries that we observed in their entirety (N = 24), 58.3% of prey captures apparently also occurred in this area, in addition to 61.3% of roosts (N = 31 events). Other areas that, collectively, accounted for 33.4% of the hawk's daylight time and 22.4% of roost locations were: 1) 20 ha of pine plantation, shrub savannah, and wooded residential about 0.4 km northeast of the nest, 2) 15 ha of oak-pine woods, shrub savannah, and pine plantation 1.4 km east-southeast of the nest and 3) 10 ha of oak-pine woods and wooded residential 0.3 km south of the nest. The hawk spent 87.6% of its total daylight time (excluding nest visits)

Table 2. Habitat use, excluding nest visits and roosts, by a breeding male Cooper's Hawk in a central Wisconsin town, 1981.

		ACTIVE-HUNTING		INACTIVE-PERCHED	
HABITAT TYPE	PROPORTION (%) WITHIN THE HOME RANGE[a]	PROPORTION (%) OF TIME (N = 2937 MIN)	ELECTIVITY INDEX[b]	PROPORTION (%) OF TIME (N = 3193 MIN)	ELECTIVITY INDEX[b]
Residential/business	26.1	0.1	−0.99	0.0	−1.00
Wooded residential	11.2	2.1	−0.68	2.0	−0.81
Miscellaneous open areas	23.4	0.3	−0.98	0.0	−1.00
Pine plantation	10.1	14.4	+0.18	17.1	+0.26
Oak-pine woods	19.3	57.8	+0.50	53.8	+0.47
Wooded riparian	3.3	5.9	+0.28	3.8	+0.07
Shrub savannah	6.6	19.4	+0.49	23.2	+0.56

[a] Home range based on a minimum perimeter polygon including all observations except a single trip >1 km from the normal range.
[b] Electivity index (Ivlev 1961) = (a − b)/(a + b) where a = proportion of time spent in each habitat and b = proportion of each habitat within the home range; index values range from −1.00 (maximum avoidance) to +1.00 (maximum preference), with a value of 0 suggesting no selection.

at the above four areas, which together composed about 12% of home range area.

The hawk did not roost in habitats in proportion to their availability (N = 31 events, $\chi^2 = 103.5$, $P < 0.001$); most roosts were in pine plantation (61.3%) and oak-pine woods (32.2%). Pine plantations appear to provide secure roost habitat for Wisconsin Cooper's Hawks, just as they afford protection for nest sites (Rosenfield and Anderson 1983). Excluding a roost at the nest, roosts occurred 120–1980 m ($\bar{x}$ = 765, S.D. = 375) from the nest.

Two routes were used for nearly all prey deliveries (N = 24) and subsequent nest departures (N = 26) observed in their entirety. On route A from wooded areas >0.5 km east of the nest, the hawk (carrying prey) ascended in circles, alternating flapping and soaring, to a height of 30–100 m, then maintained this altitude and flew over an oak-pine woodlot/shrub savannah area 0.8 km southeast of the nest. The hawk then travelled directly northwest over houses and a small (6 ha) field, before stooping (45°) into the nest woods. A nest departure along route A followed an opposite sequence. On route B, the hawk departed from the nest (or delivered prey) by travelling in direct flight 1–12 m above a field south of the nest woods to (or from) an oak-pine woodlot 160 m south of the nest to perch temporarily (1–5 min) before flying within wooded habitat. Route A was used for 70.8% of prey deliveries but only 34.6% of nest departures, whereas route B was used for 12.5% of prey deliveries and 57.7% of nest departures. Although *Accipiter* hawks may sometimes forage high in the air (e.g., Clark 1977; Marquiss and Newton 1981), we believe high altitude flight was used for prey deliveries and (less often) nest departures, to avoid mobbing by passerines, which nearly always occurred at low-altitude (<30 m) flight over woodland or open areas and to avoid a residential area that separated the nest from foraging habitat.

Excluding prey deliveries and other nest visits, the hawk was within 1 km of the nest during 58.1% and 65.6% of AH and IP time, respectively, even though <5% of total time was spent at 0.26–0.50 km (Fig. 2), where little preferred habitat was available (Fig. 1). Including prey deliveries, the hawk spent 10.8% of total daylight time at the nest. We did not record

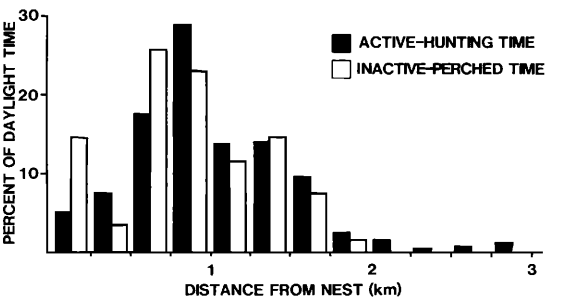

Figure 2. Daylight (non-roost) time spent by a male Cooper's Hawk at varying distances from its nest in Plover, Wisconsin, excluding prey deliveries and other nest visits.

the hawk >2 km from the nest during IP, and only 1% of AH time was spent >2 km away. The farthest distance from the nest recorded was 3.1 km, during a brief (45 min) excursion. Maximum distances travelled daily from the nest (mostly 1–2 km) coincide with the mean distance between nests (1.6 km) on a nearby (30 km) rural area (Meng and Rosenfield, *in* Palmer 1988:334).

Prey delivery rate ranged from 0.38/hr in the late nestling period to 0.06/hr during post-fledging ($\bar{x}$ = 0.17; S.D. = 0.22). Kennedy and Johnson (1986) also found that prey delivery peaked during the late nestling period. Rates of 0.34–0.45/hr (both adults combined) were found at other Wisconsin Cooper's Hawk nests (R. N. Rosenfield and J. Bielefeldt, pers. comm.). Cooper's Hawk pairs in California delivered up to 0.56 prey items (mostly lizards)/hr (Fitch et al. 1946); when young neared fledging, females began to deliver most prey. In our study the male spent 1–48 min ($\bar{x}$ = 9.8; S.D. = 10.9) at the nest during prey deliveries (N = 39). However, 51.3% of these visits lasted <5 min; the longest prey delivery visits (33, 37 and 48 min) occurred during the early nestling period. Other nest visits (N = 7) lasted at least 20–310 min ($\bar{x}$ = 67; S.D. = 108), including two occasions when the hawk visited the nest immediately after leaving its roost in the morning.

The hawk was AH about half of its daylight (non-roost) time. During early morning (roost departure–0915 H CDT), late morning (0916–1315 H), afternoon (1316–1715 H) and evening (1716 H until entering the roost), the hawk was AH 54.0%, 53.0%, 55.8%, and 49.4%, respectively, of the time. Breeding male Cooper's Hawks in Utah are relatively inactive during early morning, perhaps because their main prey are inactive (Fischer 1986), while those in California forage mainly in mid-morning and late afternoon (Fitch et al. 1946). In our study proportions of AH time during early morning to evening varied little during late nestling through post-fledging periods (data during the early nestling period and late summer were too few for comparison), except that the hawk was more active (76.5% AH) in the evening during fledging. IP periods lasted up to 5 hr; relatively short (15–40 min) IP periods followed nest departures after prey deliveries, while longer ones occurred during steady rainfall.

Routine use of the same areas and specific flight routes suggests the importance of site familiarity to Cooper's Hawks and may explain in part the fidelity of males to nest areas over a number of years (R. N. Rosenfield and J. Bielefeldt, pers. comm.). Our study quantified aspects of a suburban environment that satisfied nesting needs of a Cooper's Hawk; as suburban and urban areas increase, we urge researchers to further document such needs.

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