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Habitats Used for Nesting by Cooper's Hawks (*Accipiter cooperii*) in Southern Illinois

Rachel M. Ehrlich and Lee C. Drickamer*
Department of Zoology
Southern Illinois University
Carbondale, IL 62901

*Address all correspondence concerning the manuscript to Dr. Drickamer.

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ABSTRACT

Sixteen Cooper's Hawk (*Accipiter cooperii*) nests were located in the Shawnee National Forest and surrounding areas of southern Illinois during breeding seasons in 1989 and 1990. Hawks were located by broadcasting recorded Cooper's Hawk alarm calls along selected transects in the National Forest and by reports from local falconers and ornithologists. Fourteen of the 16 nests (87.5%) were in pine stands. The preference for pine was significant: transect-found nests (Fisher's Exact Test, $n = 8$, $P = 0.007$); nests found off transects (Fisher's Exact Test, $n = 8$, $P = 0.041$); and overall (Fisher's Exact Test, $n = 16$, $P < 0.001$). Four factors apparently affected use of a stand by nesting Cooper's Hawks: stand type, stand density, stand age (as it affects density), and degree of fragmentation. Much of the Shawnee National Forest is deciduous (primarily oak-hickory), and pine stands tend to be of low tree density. Population estimates range from 100 to over 2500 nesting pairs of Cooper's Hawks, depending upon assumptions concerning habitat suitability.

INTRODUCTION

Cooper's Hawk (*Accipiter cooperii*) population numbers have declined recently from a variety of causes, including direct persecution by humans, loss of nesting habitat from deforestation, and detrimental effects of environmental contaminants such as PCBs, mercury, DDT, and DDE (Pattee et al. 1985; Prouty et al. 1982; Rosenfield and Anderson 1983; Snyder et al. 1973). Accurate population estimates of Cooper's Hawks are hampered by the secretive nature of the species (Johnson 1981; Kritz 1989).

Cooper's Hawks nest in southern Illinois; the only other accipiter nesting in the area is the rare Sharp-shinned Hawk (*Accipiter striatus*; (Bohlen 1978). Cooper's Hawks are intolerant of two other raptors, Great Horned Owls (*Bubo virginianus*; Wiley 1975) and Sharp- shinned Hawks (Bent 1937; Meng 1951).

Nesting habits of Cooper's Hawks are varied, and there is currently little agreement as to whether nest site preferences are for predominantly deciduous (Meng 1951; Titus and Mosher 1981; Apfelbaum and Seelbach1983; Rosenfield and Anderson 1983; Asay 1987) or evergreen trees (Bent 1937; Englert 1985; Kritz 1989). Despite being considered a forest interior species, Cooper's Hawks may nest as close as 6 m from forest edge (Englert 1985) and do not appear to be disturbed by limited human activity (Clark 1977). Cooper's Hawks prey predominantly on birds, although small mammals as large as young rabbits may be taken (Hamerstrom and Hamerstrom 1951; Meng 1951; Duncan 1966; Toland 1985).

Nest site preferences apparently differ among to geographic locations (Meng 1951). In Indiana, Cooper's Hawks nest in approximately equal numbers in pine and deciduous trees (Vogl 1988). In coniferous forests in northeastern Oregon they do not select the species of nest trees in proportion to their availability (Moore and Henny 1983), but they selectively nest in conifers. Nesting density is a factor in site selection; occupied Cooper's Hawk nests rarely occur closer than 1.6 km apart during the same breeding period (Meng 1951).

Cooper's Hawk nesting periods vary somewhat between geographic areas, but generally the nesting season (nest building - fledging) begins in April and ends in July (Bent 1937; Meng 1951; Kritz 1989). Nests are built at a heights of 5 to 18 m (Meng 1951) and are usually positioned in the upper third of a tree. In deciduous trees, nests are located in a crotch formed by three or more main branches, close to the central axis of the tree. In conifers, nests are built close to the trunk, with at least two branches serving as horizontal supports underneath the nest (Meng 1951). The need for at least two horizontal branches to support the nest, may account for the Cooper's Hawk's apparent preference for white pine (*Pinus strobus*; Apfelbaum and Seelbach 1983).

Cooper's Hawks rarely reuse the same nest (Meng 1951), but frequently reoccupy the same tree stand over several years. Reoccupancy rates of nest areas ranges from a high of 80% in California (Asay 1987) to a low of 21% in Oregon (Reynolds and Wight 1978). Kritz (1989) found a reoccupancy rate of 59% in Missouri, while Rosenfield and Anderson (1983) recorded a rate of 46% in Wisconsin.

The purposes of our study were: (1) to locate nests of Cooper's Hawks in the Shawnee National Forest and surrounding areas of southern Illinois; (2) to determine the general habitat characteristics of Cooper's Hawk nest sites in this region; (3) to estimate nesting densities of Cooper's Hawks for the various habitat types in the region; and (4) to provide an overall estimate of the number of pairs nesting in southern Illinois. These data are important because of the threatened status of the Cooper's Hawk in Illinois and the need to know if sufficient acceptable nesting habitat is available.

METHODS

Study Area

The study area encompassed all of southern Illinois (Figure 1), although transects were surveyed only in the Shawnee National Forest (Figure 2). Occupied nests elsewhere in southern Illinois, included in final nest counts, were located by falconers or ornithologists; we verified these sites by visiting the nests. The Shawnee National Forest encompasses 105,513 ha; most is woodland. The Forest is comprised primarily of oak-hickory (*Quercus* and *Carya* spp.) associations, but non-native southern pines (*Pinus* spp.) have been planted extensively. Planting of pine stands began in the 1930's as the land was acquired by the Forest Service, peaked by the late 1940's and early 1950's, and ceased in the late 1970's. The Shawnee National Forest is highly fragmented, with contiguous forested plots ranging in size from 0.8 km^2 to 25 km^2.

Field Methods and Analyses

For management purposes, the Shawnee National Forest is divided into 366 compartments by the U. S. Forest Service, based on boundaries such as roads, rivers, ranger district boundaries, and natural geological formations. Size and shape of the compartments are not uniform; average compartment size is about 290 ha. Of the total, 120 compartments were chosen for study; 60 compartments were surveyed each breeding season for two consecutive years (1989 and 1990), and no compartment was surveyed twice. Survey compartments were selected on the following bases: (1) An equal number of compartments were studied in the western half of Shawnee National Forest (Vienna and Elizabethtown Ranger Districts) and in the eastern half, (Murphysboro and Jonesboro Ranger Districts) (Figure 2). (2) The total number of transects walked per Ranger District was roughly proportional to the total number of compartments contained in the District. (3) A compartment had to be large enough to contain the entire transect. (4) A compartment had to consisted of enough continuously wooded habitat to contain the entire transect. (5) The transect plotted in a compartment had to be within 1 km of a vehicular access point. None of these criteria were mutually exclusive, so that several criteria may have applied to a given compartment to eliminate it from consideration. Together, the five criteria eliminated nearly 225 compartments from consideration. We should note, however, that only 11 compartments lacked sufficient wooded habitat, effectively eliminating the need to make any correction for this criterion when computing population estimates. Of the remaining 141 compartments, those selected for the survey were chosen at random. Twenty-six transects were surveyed in each of the smaller Ranger Districts, Murphysboro and Elizabethtown and 34 transects were surveyed in each of the larger Ranger Districts, Jonesboro and Vienna.

No assumptions were made about preferred habitats of nesting Cooper's Hawks to avoid biasing the results. The requirement that a transect be located within 1 km of an on-road vehicular access point may have introduced a bias in that the more remote areas of the Shawnee National Forest were not sampled, but since Cooper's Hawks are apparently quite capable of hunting (Clark 1977; Englert 1985) and nesting (Murphy et al. 1988) in and around areas of human habitation, we believe that any bias resulting from this requirement is small.

Cooper's Hawk nests were located along predetermined transects through the use of broadcast Cooper's Hawk calls and by following the responding adult back to the nest site (Rosenfield and Anderson 1983; Rosenfield et al. 1985, 1988). In a 1980 Maryland study, the number of Cooper's Hawk sightings during and after the broadcast of recorded calls (n = 10 Hawks sighted) was 400% greater than the number of sightings recorded when researchers simply stopped and made an audiovisual search (Fuller and Mosher 1981). Because only occupied nests were being counted, data collection was limited to the breeding season, mid-April through mid-July. The incubation period for Cooper's Hawks in southern Illinois occurs from mid-to-late May; during this time no transects were walked, as response to taped calls is very slight during incubation (Fuller and Mosher 1981; Rosenfield et al. 1988). A 1 km linear transect was walked once in each of the chosen compartments by a pair of researchers. At ten 100-meter intervals along each transect a tape of Cooper's Hawk calls was broadcast for three minutes using a cassette tape recorder at its highest volume; distortion of the call was minimal even at this setting. During the broadcast of calls, researchers remained stationary and conducted an audiovisual search for responding Hawks. When a Cooper's Hawk responded, an effort was made to visually locate its nest in the nearby vicinity by walking through the woods in the general direction from which the Hawk approached and left.

Transects were classified as having been walked through either pine or deciduous stands by determining what the most frequent tree species was at each of the 10 stations along the transect and summing the number of deciduous-type intervals relative to the number of pine-type intervals. By chance, no transect was walked in such a fashion as to produce an equal number of pine and deciduous intervals.

Once a nest was located, the following information was recorded: (1) composition of the stand in which the nest was located, (2) species of tree in which the nest was located, (3) diameter at breast height (DBH) of the nest tree, (4) approximate height of the nest tree, (5) approximate height of the nest, and (6) location of nest tree in relation to the rest of the stand.

A Fisher's Exact Test with an alpha level of 0.05 was used on nest location frequency data. No other statistical analyses were performed due to the small sample size of nests.

RESULTS

During the two field seasons, 16 occupied Cooper's Hawk nests were located; 7 in 1989 and 9 in 1990. Of these, 10 nests were located on Shawnee National Forest land, 2 on federally-owned land other than in the Shawnee National Forest, and 4 on state-owned land. No nests were found on private property, though the difficulty in obtaining permission to search private lands made such searches unfeasible. Eight of the 16 nests were located on transects; the others were found by falconers and ornithologists. In all instances where a Hawk responded to the call, a nest was located successfully. Nests located on transects were all found during the nestling-rearing period, in June and July; some nests located by falconers were discovered in the pre-incubation or incubation periods during April and May.

More transects were walked in deciduous stands than in pine stands (Table 1a). The majority of Cooper's Hawk nests, however, were located in pine stands (Table 1b). The apparent preference for pine stands by Cooper's Hawks in southern Illinois was statistically significant for those nests located on transect searches (Fisher's Exact Test: n = 8, P = 0.007), nests found elsewhere (Fisher's Exact Test: n = 8, P = 0.041), and overall (Fisher's Exact Test: n = 16, P < 0.001).

Of the nests found in pine stands, 13 were located in shortleaf pine (*Pinus echinata*) and one in an eastern white pine (*Pinus strobus*). Of the nests located in deciduous stands, one was in a maple (*Acer rubrum*), and the other was in a northern white oak (*Quercus alb*). The mean (± 1 S.E.) diameter at breast height (DBH) of nest trees was 36.6 ± 4.2 cm (range = 16.2 cm to 76.8 cm). Mean height of the nest tree was 15.8 ± 0.8 m (range = 10.7 m to 21.3 m). Mean height of nests in trees was 12.1 ± 0.5 m (range = 7.6 m to 15.2 m). All nests were located in the upper third of the tree.

The smallest and largest stands in which Cooper's Hawk nests were located were 3 ha and 25 ha respectively. The average area of stands with Cooper's Hawk nests was about 10 ha. Subjective visual analysis suggested nesting Cooper's Hawks preferred denser stands. The majority of the nests (n = 13) were centrally located within a stand; however, three of the nests were located on the edge of a stand, within 6 m of gravel roads. Three nests were located near (30 - 65 m) human habitation and seven nests were located near (30 - 65 m) sources of high human activity (e.g., churches, campsites, mines, major roads).

Cooper's Hawks may re-nest in the same stands or nearby stands in successive years. The two nests found in deciduous stands, in 1989 and 1990 were located in different stands but within 1 km of each other. On two occasions, nests located in pine stands by falconers in 1990 were less than 1 km from nests built in the same stands the previous year. In all three cases, relatively small distances between Cooper's Hawk nests from successive years suggested the return of the same nesting pair. Nests found in 1990 were considered independent of those found in 1989 due to lack of identification of individual Hawks.

DISCUSSION

Nest Site Selection

Cooper's Hawks nesting in southern Illinois exhibited a strong preference for pine stands. This finding is similar to that of Moore and Henny (1983) for this species in Oregon, but contrasts with Vogl's (1988) findings for Indiana where Cooper's Hawks nested in about equal numbers in pine and deciduous trees. Variation in Cooper's Hawks preference for pine stands may reflect geographical variation within the species. Kritz (1989) found that Cooper's Hawks in Missouri exhibited a strong preference for pine stands. However, most of the studies done to date on Cooper's Hawks have been conducted in western states, where the species nests more frequently in deciduous stands (Kritz 1989).

We suspect that the presence of Blue Jays (*Cyanocitta cristata*) may be a factor in the nest site selection of Cooper's Hawks. Like other accipiters, Cooper's Hawks prey predominantly on birds, including Blue Jays, that do not hesitate to sound an alarm call once a raptor is sighted. Alarm calls summon Blue Jays and other passerines in the area to mob raptors. Blue Jay mobbing behavior is persistent, usually ceasing only when the

predator departs. After we broadcast the Cooper's Hawk call, we were frequently followed, sometimes for the entire length of the transect, by vigilant Blue Jays. A Cooper's Hawk attempting to nest in such an environment would have a difficult time. Blue Jays may be reacting to a Cooper's Hawk in the vicinity of their nest, though they would not likely select nest sites near a Cooper's Hawk nest.

Blue Jays were present on 61.2% of all deciduous stand transects but only on 5.7% of pine stand transects in our study area. No Blue Jays were observed within 0.5 km of any Cooper's Hawk nests located during our study. It would be interesting to determine if the Cooper's Hawks in the western United States were similarly harassed by the western jays, particularly the Stellar's Jay (*Cyanocitta stelleri*). If such harassment occurs, it may account for the higher use of deciduous woods by western Cooper's Hawks, because Stellar's Jays prefer coniferous forests.

The height of nests located during our study was within the average range expected for Cooper's Hawks. Nests are usually built at a height of 11 to 14 m (Bent 1937), though nest sites ranging from 5 to 18 m above ground have been reported (Meng 1951). Nests for this species are usually located in the upper third of the nest tree (Bent 1937), as were all the Cooper's Hawk nests found during our study.

Broadcast Calls Technique

The technique used to call out the Hawks was similar to that used by Rosenfield and Anderson (1983) and Rosenfield et al. (1988). By leaving one observer at one of ten call stations along the transect while the second observer progressed to the next station or beyond, we were able to determine that calls broadcast by the tape recorder carried approximately 0.5 km, definitely as far as the next call station along the transect (0.1 km). The total area covered by calls broadcast on a single transect was thus about 0.55 km^2. As Cooper's Hawks defend a nesting territory of approximately 2 km^2, it was highly unlikely that more than one Hawk would be found per transect.

The effectiveness of the broadcast calls used in our study may have been hampered by a number of factors, including the high degree of background noise on the tape used; degradation and attenuation of the calls, especially in deciduous woods; and the activity of any nearby Cooper's Hawk at the time of broadcast. Only females responded to the calls; males were never seen, either alone or with a female. Each Cooper's Hawk responded to the taped calls only once, by flying silently toward the source of the calls and staying only a few seconds to determine that no threat existed. The Hawks came only as close as was needed to view the source of the calls; in denser stands the Hawks came within about 3 m of us, while in thinner stands they remained as far as 30 m away.

Population Estimates

Estimating the number of Cooper's Hawks in southern Illinois was approached in two ways, to estimate the maximum possible number and to provide a best estimate, based upon our knowledge of nesting habits in this region. An accurate estimate of the Cooper's Hawk population in southern Illinois is difficult to establish due to the lack of thorough data concerning stand density and degree of fragmentation of the forest. The majority of the Shawnee National Forest is deciduous (primarily oak-hickory = 64%) and the pine stands (18 %)tend to be of low stand density. Using data from the compartment

files, it is possible to determine that the average compartment could hold, on average, 13 adjacent but non-overlapping transects. Our success in locating Cooper's Hawks was eight Hawks per 120 transects. Using this rate, had we walked 13 transects in every compartment (n = 366 compartments X 13 transects/compartment = 4758 transects), we could have located approximately 320 nesting pairs of Cooper's Hawks in the Shawnee National Forest. This number would need to be increased by the number of Cooper's hawks nesting on state-owned and private lands.

Of the total available forest land in southern Illinois (Table 4), 46.4% is privately owned and 53.6% is owned by state and federal governments or is public land managed by government agencies (Iverson et al. 1989). If we extrapolate using the data above from the Shawnee National Forest and the proportion of forested land that it represents in southern Illinois (11%), we obtain an estimate of about 2700 as the maximum total population of nesting pairs of Cooper's Hawks.

A second estimate requires taking into account the relative proportion of the forested land that comprises habitat suitable for nesting by Cooper's Hawks. First, the estimate obtained from transect surveys should be reduced because Cooper's Hawks generally did not use deciduous forest and tended to avoid managed pine plantations with their low density stands. Using the compartment data, we estimate that there were approximately 10 times as many transects containing suitable pine forest as we traversed in our surveys. We thus project a total of about 80 pairs of nesting Cooper's Hawks in the Shawnee National Forest. State-owned lands in the region have been extensively searched by falconers, so the number of Hawks nesting on these lands is probably only about 3 - 5 times what we obtained from falconer's reports in 1989 and 1990. That is, there may be 25 - 40 pairs nesting on state-owned lands. The majority of privately owned land in southern Illinois is highly fragmented and/or involves little suitable pine. We thus estimate that a maximum of 10 - 20 pairs of Cooper's Hawks are likely nesting on private lands. Together, these numbers provide a total population estimate for the region, based upon the more conservative approach of using suitable habitat, of 115 - 140 nesting pairs.

The limiting factor for Cooper's Hawks in southern Illinois appears to be the number of dense pine stands, the preferred nesting habitat. However, more thorough data concerning nesting, hatching, and fledging success rates of this species in southern Illinois are needed before any long-term recommendations concerning habitat alterations or other significant management implications can be discussed.

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Table 1. Number of transects walked in the Shawnee National Forest, southern Illinois, in 1989 and 1990 according to whether the stand type was pine or deciduous. Numbers in parentheses indicate the percentage of total transects walked (a). Number of Cooper's Hawk nests located in southern Illinois in 1989 and 1990 by stand type. Numbers in parentheses indicate the percentage of total Cooper's Hawk nests found in each stand type (b).

(a) Transects Walked (N = 120)

	Pine	Deciduous
1989	20	40
1990	15	45
Total	35 (29%)	85 (71%)

(b) Nest Location by Stand Type (N = 16)

	Pine	Deciduous
1989	6	1
1990	6	1
Total	14 (88%)	2 (12%)

Figure 1. Southern Illinois counties included in the study area. All but Pulaski County contain Shawnee National Forest land.

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Figure 2. The four Ranger Districts of the Shawnee National Forest. The Elizabethtown and Vienna Ranger Districts were considered to be the eastern half of the Shawnee National Forest, while the Murphysboro and Jonesboro Ranger Districts were considered to be the western half of the Shawnee National Forest.

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