

# Den Use by Raccoons in Westcentral Illinois

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## ABSTRACT

Raccoons (*Procyon lotor*) were radio marked (N = 74) in west-central Illinois and followed to 431 denning sites (den selections = 259 female, 172 male). Tree cavities made up 52% of female den selections and 38% of male den selections while buildings made up 42% of female den selections and 37% of male selections. Burrows were not an important den option for either sex. Tree cavities were a summer and fall choice for denning while, in winter, farm buildings were preferred den sites for both sexes. Daily high and low temperatures average warmer when raccoons used burrows compared to when they used tree cavities for shelter.

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## INTRODUCTION

Raccoons are currently abundant throughout Illinois, the result of low exploitation by fur trappers and hunters and favorable habitats. The raccoon population has been at an all-time high in recent years (Bluett 2000), and interactions between raccoons and humans or their domestic pets have become a daily occurrence throughout Illinois. Because raccoons are carriers of a number of infectious diseases transmissible to humans and their domestic pets, den sites located close to human dwellings increase the opportunity for the spread of zoonotic diseases (Mitchell et al. 1999). In addition, raccoons do not hibernate and must depend on the fat accumulated during the summer and fall for energy in winter (Lotze and Anderson 1979). Thus, selection of a safe and relatively warm winter den is vital for their survival. In this report we document seasonal denning preferences of radio marked raccoons in westcentral Illinois.

## METHODS

We livetrapped raccoons between 1989 and 1992 in Adams and Brown counties located in westcentral Illinois. Our study areas were a 2,310-ha area of private farms consisting of a mix of row crops (59%), shrub and forest (25%), pasture and forage fields (15%), and ponds (0.006%), and the 644-ha Siloam Springs State Park (SSSP), a mix of second

growth oak-hickory forest (75%), pasture-forage (11%), and a few fields of sharecropped corn or soybeans (6%).

Livetrapped raccoons were sedated using ketaset (1.0 cc / 4.5 kg. body weight), sexed, ear tagged, and a premolar removed for cementum aging (Grau et al. 1970). Radio transmitters, operating at 165 and 166 MHz, were placed on a sample of each sex each year. Diurnal den use was determined by approaching radio marked raccoons close enough to ascertain den type and location. The following variables were used to examine possible environmental factors affecting tree cavity or ground burrow selection by radio marked raccoons. For ground burrows, we recorded the distance to water in 10 m increments, slope position (upper 1/3, middle 1/3, lower 1/3), distance to actively farmed fields in 10 m increments, crop type, slope aspect (cardinal direction), overstory type (forest type that comprises >50% of the overstory), and if in woody cover, distance to an opening of any type in 10 m increments. In addition to these environmental variables, for tree cavities, we recorded tree species, height of den in 10 m increments, tree DBH in cm, and whether the tree was dead or alive.

Numbered lines were laid N-S and E-W on a map of the study area. Eight lines totaling 11.9 km were randomly selected and walked from road-to-road and all ground burrows and tree cavities visible from the center of the transect line and large enough to shelter a raccoon were tallied (Burnham et al. 1980). The environmental characteristics measured for the burrows and tree cavities used by radio marked raccoons were then compared with burrows and tree cavities found along transects. Values of these variables were developed by grouping distances (0-25 m, 25-50 m, 50-75 m, etc.) and heights in 10 m increments. These variables were then compared using a G-test (Sokal and Rohlf 1969). An R x C contingency table analysis was used to compare den use between sexes and among seasons and age classes.

We recorded the mean maximum and mean minimum temperatures (°C) for each day (taken at Quincy, Illinois airport 44 km west of the study area) in which we located a den of a radio marked raccoon. We computed an average mean maximum and mean minimum temperature for when raccoons were using tree cavities, buildings, and ground burrows as shelters. The raccoon year was divided into periods bounded by important behavioral or physiological changes that potentially affect den use. The year was divided into winter (16 Dec-15 Mar), spring-summer (16 Mar-31 Oct), and fall (1 Nov-15 Dec).

## RESULTS AND DISCUSSION

A total of 35 males (14 juveniles, 2 yearlings, 19 adults) and 39 females (16 juveniles, 6 yearlings, 17 adults) were radio located for various lengths of time. These raccoons were located at 431 den sites, in trees (202 sites, 47%), buildings (172, 40%), burrows (31, 7%) and ground nests (26, 6%). For females, 73 den sites were located in winter, 114 during spring-summer, and 72 in the fall. For males, 71 were located in winter, 69 in summer, and 32 in the fall. Of 259 den locations for females, 112 (43%) were used by juveniles, 54 (21%) were used by yearlings and 93 (36%) were used by adult females. Fifty-nine percent of 172 male denning sites were used by juveniles, only 25 (15%) were used by yearlings, and 45 (26%) were used by adult raccoons (Table 1).

### Den Use

**Tree cavities**—Tree cavities and buildings were used by radio marked raccoons much more often than ground burrows or ground nests (Table 1). Tree cavities were used by radio marked raccoons significantly more often than expected in fall, less than expected in winter, and as expected in the summer ( $X^2 = 10.9$ ,  $df = 2$ ,  $P < 0.01$ ). Both adults and juvenile raccoons used tree cavities significantly more than expected, while yearling raccoons used trees cavities as expected ( $X^2 = 7.62$ ,  $df = 2$ ,  $P < 0.05$ ). Females used tree cavities more than expected, while males used tree cavities less than expected ( $X^2 = 4.41$ ,  $df = 1$ ,  $P < 0.05$ ).

Radio marked raccoons did not select tree cavities on the basis of slope position, or the type of opening (pasture or crop field) ( $P > 0.05$ ). They selected trees closer to a creek and avoided tree cavities found closer to a pond or ravine ( $G = 43.1$ ,  $df = 2$ ,  $P < 0.001$ ). Males were more likely to select a tree cavity on a lower slope than females, with females selecting tree cavities on a middle or upper slope ( $P > 0.40$ ). Tree dens used by raccoons averaged  $28 \pm 5$  m from water,  $129 \pm 12$  m from a crop field, and  $56 \pm 8$  m from an opening.

**Ground burrows**—Burrows were used most often in spring through fall and least in winter ( $X^2 = 10.6$ ,  $df = 2$ ,  $P < 0.01$ ). Burrow selection was not influenced by age ( $P > 0.05$ ). However, males were more likely to use burrows for diurnal shelter than were females ( $X^2 = 5.9$ ,  $df = 1$ ,  $P < 0.05$ ). Radio marked raccoons selected burrows close to permanent water in summer and fall and avoided burrows closer to intermittent water sources ( $G = 22.3$ ,  $df = 3$ ,  $P < 0.001$ ). They did not select burrows in relation to crop type growing in the nearest crop field. They selected ground burrows situated in bottoms more than expected and avoided burrows on middle and lower slopes ( $G = 26.1$ ,  $df = 3$ ,  $P < 0.001$ ). Raccoons preferred burrows with 2 entrances, avoided burrows with only a single entrance, and used burrows with more than 2 entrances as they occurred ( $G = 8.8$ ,  $df = 3$ ,  $P < 0.05$ ). Ground burrows used by raccoons averaged  $88 \pm 13$  m from water,  $60 \pm 4$  m from a crop field, and  $23 \pm 5$  m from any type of opening.

**Ground nests**—Ground nests were not important resting sites for females but were used occasionally by males in summer and fall ( $X^2 = 25.6$ ,  $df = 1$ ,  $P < 0.001$ ). Yearling males were more likely than adults or juveniles to use ground nests ( $X^2 = 32.4$ ,  $df = 2$ ,  $P < 0.001$ ) (Table 1).

**Buildings**—Buildings were most important as den sites in winter ( $X^2 = 27.4$ ,  $df = 2$ ,  $P < 0.001$ ). Buildings were most often used by juvenile raccoons and least often by adult raccoons ( $X^2 = 30.5$ ,  $df = 2$ ,  $P < 0.001$ ). Gender did not influence the use of buildings as den sites ( $P > 0.40$ ).

Average daily high and low temperatures were lower when raccoons used buildings for shelter compared with average temperatures when raccoons used tree cavities or burrows (Fig. 1). Tree cavity use occurred when mean temperatures were somewhat cooler than when burrows were occupied (Fig. 1).

Raccoons are flexible as to den selection throughout their range. In marshes or prairies with few trees they use burrows or muskrat houses for shelter (Dorney 1954, Fritzell

1978, Urban 1970). In urban habitats, use of human occupied buildings is high but tree cavities are still important shelters for raccoons (Hoffmann and Gottschang 1977, Hadidian et al. 1991). However, when available, tree dens are often favored over burrows (Shirer and Fitch 1970, Stuewer 1943, Urban 1970, Schneider et al. 1971, Scherfy and Chapman 1980). Even in winter, temperatures within tree cavities are considerably warmer than the ambient temperatures surrounding the tree (Stains 1961, Thorkelson and Maxwell 1974). In Illinois, tree cavities and farm buildings are the most important raccoon denning sites in winter. Mosillo et al. (1999) found that resident raccoons in north-central Illinois preferred tree cavities followed by farm buildings as denning sites similar to raccoon denning habits in westcentral Illinois. The use of buildings as denning sites during the colder months provides raccoons with excellent shelter at a time when they must conserve heat energy in order to survive the winter. Use of buildings does increase the opportunity for contact between raccoons and humans and/or their domestic livestock and pets. Thus, den selection may play an important role in facilitating the movement of disease organisms among these animals (Mitchell et al. 1999).

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Table 1. Number of denning sites used by radio marked raccoons located in westcentral Illinois, 1989-92.

Den Type	Females				Males			
	Season			Total	Season			Total
	Winter	Spr/Sum	Fall		Winter	Spr/Sum	Fall	
<b>JUVENILES</b>								
Tree cavity	29	11	9	49	20	7	7	34
Ground burrow	--	--	2	2	2	--	6	8
Building	44	5	12	61	42	8	10	60
Ground nest	--	--	--	--	--	--	--	--
Total	73	16	23	112	64	15	23	102
<b>YEARLINGS</b>								
Tree cavity	--	29	--	29	--	8	--	8
Ground burrow	--	--	--	--	--	5	--	5
Building	--	23	--	23	--	--	--	--
Ground nest	--	2	--	2	--	12	--	12
Total	--	54	--	54	--	25	--	25
<b>ADULTS</b>								
Tree cavity	--	10	48	58	2	19	3	24
Ground burrow	--	10	--	10	--	5	1	6
Building	--	23	1	24	3	--	1	4
Ground nest	--	1	--	1	2	5	4	11
Total	--	44	49	93	7	29	9	45

Figure 1. Mean daily high and low ambient temperatures for days when radio marked raccoons were located in den sites in westcentral Illinois, 1989-1992.



