

Den Site Selection by Raccoons in an Agricultural Landscape

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ABSTRACT

Raccoon (*Procyon lotor*) populations have increased dramatically throughout Illinois during the past 25 years causing concerns because they can be important nest predators and reservoirs for zoonotic diseases. We studied seasonal use of den sites by raccoons at Prairie Ridge State Natural Area in Jasper Co. IL. Our goals were to characterize den types and whether den use differed between sexes or age-classes, assess seasonal patterns of den use, and investigate whether raccoons shift dens to be near seasonal food patches. Twenty-four raccoons were radiocollared and tracked to 245 individual dens during January 2004-August 2005. Of these dens, 50% were in buildings, 27% in burrows, and 17% in tree cavities. Adults and juvenile females preferred buildings, particularly in winter; whereas, juvenile males preferred burrows and brush piles, particularly in summer. We found no evidence that raccoons shifted den sites in fall or winter to be near cornfields. However, dens were closer to wetlands in summer than in winter. Raccoons of both sexes used barns and sheds frequently in winter. Trapping at buildings could be an efficient method of controlling raccoon populations.

INTRODUCTION

Raccoon (*Procyon lotor*) populations may be at historic highs throughout much of their geographic range due in part to their opportunistic foraging behaviors and their efficiency in adapting to new anthropogenic habitats. In Illinois, the raccoon population has increased during the past 30 years and remains high due to increased habitat fragmentation and low harvest levels (Gehrt et al., 2002). Raccoons have the potential to cause ecologic and economic problems and recent population increases have exacerbated these problems. For example, raccoons are important nest predators in some landscapes, impacting ground- and shrub-nesting birds (Urban, 1970; Sargeant et al., 1995; Dijak and Thompson, 2000). Individuals also may carry diseases that are transmissible to humans and domestic animals, such as raccoon roundworm (*Baylisascaris procyonis*), rabies (*Lyssavirus rabies virus*), canine distemper (*Morbillivirus canine distemper virus*), and parvovirus (*Parvovirus murine minute virus*). Increased contact between raccoons and humans, prompted in part by exurban sprawl, poses a threat for the transmission of zoonotic diseases (Mitchell et al., 1999).

The availability of suitable den sites can influence the distribution and abundance of raccoons. Therefore, removing or restricting access to den sites may serve as a non-lethal

method of controlling overabundant populations. Raccoons den in burrows, tree cavities, buildings, and drainage tiles. Previous research has shown that den selection can be influenced by climate, availability, microclimates within dens, and the females' needs during parturition and rearing (Stains, 1961; Berner and Gysel, 1967; Endres and Smith, 1993; Henner et al., 2004). Raccoons are thought to prefer dens closer to food and water and those that offer protection from predators and hunters (Giles, 1942; Stuewer, 1943; Endres and Smith, 1993; however see Berner and Gysel, 1967 and Schnell, 1970).

Few studies have examined seasonal or gender-based den selection by raccoons. Therefore, our objectives were to investigate: (1) seasonal den use by raccoons in a rural Illinois landscape, (2) whether den use differs between sexes and age-classes, and (3) whether raccoons shift dens to be near seasonal food patches, particularly corn and wetlands. We hypothesized that dens used by adult females would differ from those used by males because females need more secure sites for raising young. We reasoned that tree cavities would be preferred for raising young because they restrict access by ground predators, such as canids. We also predicted that den types would differ seasonally because some types provide better insulation against the cold. Finally, we hypothesized that raccoons would prefer dens in close proximity to food and shift dens to be close to rich seasonal food patches, particularly corn.

STUDY AREA

This study was conducted on the 1,400-ha Prairie Ridge State Natural Area (PRSNA) and surrounding land in Jasper Co. IL. PRSNA is managed by the Illinois Department of Natural Resources (IDNR) primarily as habitat for the greater prairie chicken (*Tympanuchus cupido*), a state endangered species. PRSNA also provides nesting habitat for other state endangered and threatened avian species, such as the northern harrier (*Circus cyaneus*), upland sandpiper (*Bartramia longicauda*), and short-eared owl (*Asio flammeus*). The study area is a mix of grasslands and agricultural fields surrounding several small wetlands (<10 ha). The landscape surrounding PRSNA is dominated by corn-soybean agriculture including houses, barns, and sheds.

METHODS

Raccoons were captured using box traps from January through March 2004 and 2005, so that 10-15 raccoons were available for radiotracking at all times. Animals were anesthetized with Telazol (10 mg/kg). The weight, sex, and age of each raccoon were recorded. All were ear-tagged and selected individuals were fitted with radiocollars. Raccoons were released at the capture site after they had recovered from anesthesia. Trapping and handling protocols were approved by Eastern Illinois University's IACUC (protocol #04002).

Radiocollared animals were located weekly from January 2004 to August 2005 by homing using a directional antenna. Den locations were recorded in UTM coordinates using a GPS receiver and each den was classified as a tree cavity, burrow, building, brush pile, or open site. Open sites were those on the ground with relatively little cover, such as *Rubus* thickets or cornfields. Buildings included occupied and abandoned houses, barns, corn cribs and sheds.

To evaluate seasonality of den use, we divided the year into 4 seasons: spring (March-May), summer (June-August), fall (September-November), and winter (December-February). To test predictions that den selection was influenced by sex, age, or season, these variables were examined independently using X^2 -contingency tests (Samuels and Witmer 2002). In addition, we overlaid den coordinates onto a digitized cover map, then measured the distance from each den to the nearest wetland, stream and cornfield using ArcGIS. Seasonal differences in the distances from dens to cornfields and wetlands were tested using ANOVA at $\alpha = 0.05$ (Samuels and Witmer 2002).

RESULTS

We found 245 individual dens from 404 radiolocations of 12 male and 12 female raccoons. Den types included buildings (50%), ground burrows (27%), tree cavities (17%), brush piles (4%), and open sites (1%). Den types used by males differed from those used by females ($\chi^2 = 40.3$, $df = 4$, $P < 0.01$). Females generally preferred to den in buildings, whereas males used ground burrows and brush piles more frequently (Fig. 1).

Dens chosen by raccoons differed seasonally ($\chi^2 = 108.8$, $df = 12$, $P < 0.01$). Burrows were used most frequently in the summer, whereas buildings were used most frequently the rest of the year (Fig. 2). The use of tree cavities varied little throughout the year. Seasonal patterns in den use by males and females also were evident. Relative to males, females were more likely to use buildings in the winter and tree cavities in the spring. In contrast, males were more likely to use ground burrows in the winter.

We found no evidence that raccoons shifted their dens to be closer to mature cornfields ($F = 1.23$, $df = 3$, $P < 0.298$). The mean distance to corn did not differ among seasons when mature corn was available (fall and winter) and those when corn was not available (spring and summer; Fig. 3). However, dens were closer to wetlands and streams during the summer and fall and farther away in winter when water was often frozen ($F = 14.0$, $df = 3$, $P < 0.01$; Fig. 3). During periods of open water, raccoons often could be seen or heard splashing as they foraged along waterways.

DISCUSSION

Raccoons used a wide variety of den types on the PRSNA study area including buildings, ground burrows, tree cavities, and brush piles. Shirer and Fitch (1970) suggested that den use may be based on individual preferences, but our research and that of others suggest broader gender and seasonal patterns. Den selection on our study area appeared to be influenced by the sex and age of the individual, season, and proximity to wetlands. Females tended to use buildings more than males, whereas males were more likely to use burrows and brush piles. Nixon et al. (2001) reported that males used burrows more frequently in western Illinois, but the use of buildings did not differ between the sexes. Females tend to choose secure dens that are protected from weather and predators for rearing young, frequently using tree cavities as maternal dens (Schnell, 1970; Schneider et al., 1971; Endres and Smith, 1993). On PRSNA, an area comprised primarily of grasslands, females tended to use buildings as maternity dens apparently because of their relative abundance and accessibility. Fritzell (1978) also found that buildings were focal

points of raccoon activity; 7 of 10 litters born on his study area in North Dakota were raised in farmyards.

In contrast, males were more likely to use burrows and brushpiles. Raccoons are polygynous and males do not participate in rearing the young. Intersexual competition for secure dens may lead to males selecting dens that appeared to offer less protection from predators and weather. In addition, males have larger home ranges than females on PRSNA (Newbury, 2005) and this may provide greater opportunity to den farther away from humans and dogs.

Dens do not appear to be a limiting factor for raccoons on PRSNA. Individuals moved frequently from den to den, using an average of 15.1 (SE = 2.5, range = 6-31). In spite of this, adults used fewer dens than juveniles ($t = 2.31$, $P = 0.04$) and showed fidelity to particular dens that appeared to offer more protection than those used by juveniles. Juveniles showed less fidelity to particular dens and were more likely to occupy dens that they had not used previously. Mosillo et al. (1999) suggested that competition for dens could be a contributing factor to natal dispersal as adults force juveniles to use suboptimal dens. Dispersal occurs primarily among juvenile males, but a dominance hierarchy also is evident in females. A previous study (Judson et al., 1994) found that adult females with litters used buildings most often, but yearling females with litters were most likely to be found in vegetation on the ground. Furthermore, juveniles may have greater access to burrows because of their smaller size. The mean body mass of juveniles was 4.4 kg (SE = 0.3), whereas adults averaged 6.2 kg (SE = 0.3; $t = 4.2$, $P = 0.01$). In contrast to our results, Nixon et al. (2001) found that juveniles used buildings more often than adults and burrow use was not influenced by age.

Den selection changed seasonally, with pronounced shifts to buildings in the fall and winter coincidental with falling temperatures. Farm buildings on our study area appeared to be particularly favored when they provided warmth and stored grains. Glueck et al. (1988) noted that raccoons restrict their activities during cold weather and others have reported shelter-seeking behavior to avoid the cold (Berner and Gysel, 1967; Urban, 1970; Rabinowitz and Pelton, 1986; Nixon et al., 2001).

Burrows were used frequently in the summer on PRSNA, but less during the winter. Nixon et al. (2001) reported similar findings in western Illinois. Berner and Gysel (1967) showed that the microclimate of burrows tends to be stable: cooler in summer and warmer in winter compared to air temperature. We speculate that the shift from buildings to burrows may be influenced by increased human activity in and around farm buildings in spring and summer. On PRSNA, the use of tree cavities changed little among seasons, but use was highest in the spring during the perinatal period. This may suggest that females choose trees as protected dens for rearing young (Endres and Smith, 1993) or that raccoons spend more time resting in trees during the spring because they are foraging there for bird nests (Schnell 1970).

Corn can be an important food resource for raccoons in the fall and winter (Stuewer, 1943; Schneider et al., 1971; Sonenshine and Winslow, 1972) so it seems reasonable that raccoons may shift dens to be closer to cornfields when mature corn is available. However, we found no evidence of this. Pedlar et al. (1997) reported that raccoons only fre-

quented agricultural fields that were close to woodlots, but cornfields were so widespread on PRSNA that raccoons did not have to shift dens to have ready access to them. In contrast, raccoons apparently shifted dens to be close to wetlands during the summer and fall when these were used frequently for foraging. Favorite summer foods include invertebrates (particularly crayfish and amphibians (Sonenshine and Winslow 1972)). These appeared to be plentiful in the wetlands at PRSNA and our raccoons spent considerable time foraging in shallow water. Previous studies have reported an increase in raccoon use of wetlands in spring and summer (Schneider et al., 1971; Fritzell, 1978) and Henner et al. (2004) found that raccoons in Mississippi consistently selected dens near lakes and ponds.

In summary, we found that raccoons inhabiting PRSNA move frequently among dens throughout the year and believe that dens are not a limiting factor for this population. Fidelity to particular dens was most evident in winter, probably because winter is a period of low activity for raccoons. Furthermore, barns, sheds, and abandoned buildings were used frequently by raccoons, increasing the risk of disease transmission to humans, livestock, and pets. We suggest that buildings should be sealed and secured and abandoned structures should be removed to discourage use by raccoons. Finally, trapping to reduce nuisance raccoons is likely to be most effective when conducted in and around these structures during the winter months.

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Figure 1. Observed and expected use of den types by female (top) and male raccoons (bottom) at Prairie Ridge State Natural Area, January 2004 – August 2005.

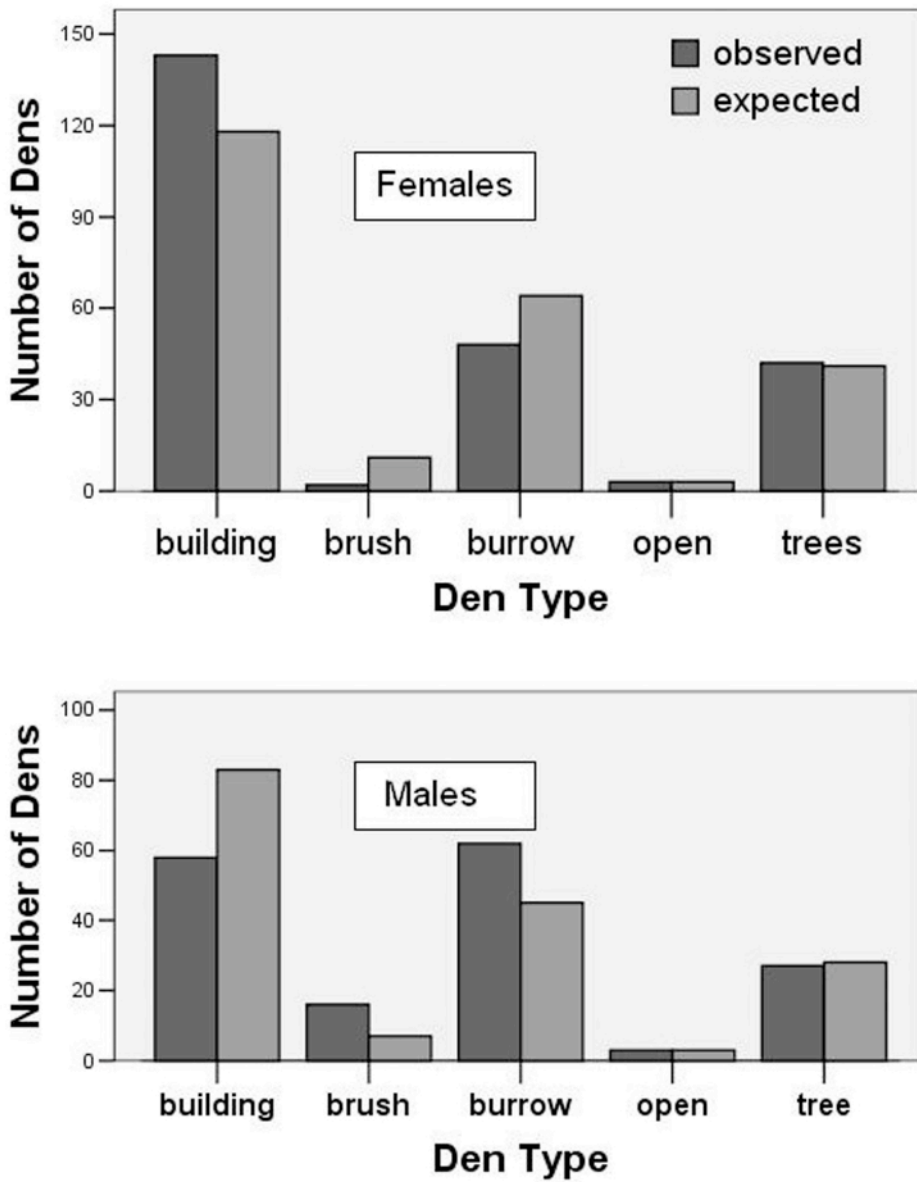


Figure 2. Raccoons preferred buildings as den sites in the winter, spring, and fall.

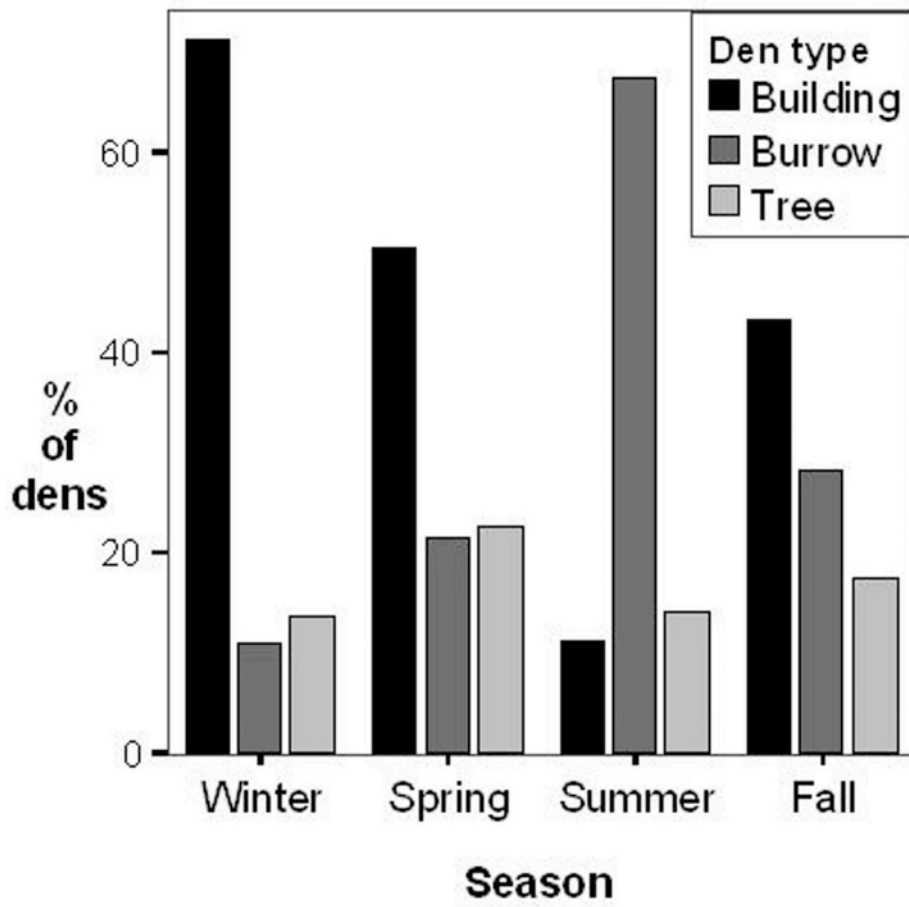


Figure 3. Seasonal distance of raccoon dens from cornfields (left) and wetlands (right).

