Seasonal Diurnal Refugia Use by Raccoons in an Agricultural Landscape

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Abstract: We radio monitored 13 raccoons (*Procyon lotor*) from August 2010 through February 2012 in an agricultural region in northwest Tennessee to ascertain seasonal and gender differences in use of resting areas. Males were located 69 times and females were located 119 times. All den locations were in the ground, tree cavities, or brush piles. Male raccoons exhibited no significant difference in diurnal refugia use among seasons. Trees were used more than other resting areas during spring, summer, and fall, and were used to the same degree as ground dens during winter. Female raccoons exhibited significantly different diurnal refugia use among seasons ($X^2 = 16.70$, $P = 0.01$). Ground dens represented 69% of female locations during spring, but were not used during summer when tree cavities and brush piles represented 57% and 43% of locations, respectively. Removing brush piles and trees with cavities may lower carrying capacity of this species where it can have significant effect on profitability of agricultural operations.

Key words: raccoon, ground den, tree cavity, brush pile

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Raccoons are primarily nocturnal generalists that inhabit most states within the United States as well as in northern Mexico and southern Canada (Gehrt 2003). Numerous studies have been conducted on the ecology of raccoons, but few observed diurnal resting site selection (Rabinowitz and Pelton 1986, Endres and Smith 1993, Owen 2003, Henner et al. 2004, Beasley et al. 2006). Availability of den sites in fragmented landscapes such as agricultural areas may limit the distribution of raccoons (Beasley et al. 2006). Raccoons have been found to make use of ground burrows, brush piles, tree cavities, and buildings for dens (Rabinowitz and Pelton 1986, Endres and Smith 1993, Henner et al. 2004). Den site selection in relation to season and gender has received little examination (Rabinowitz and Pelton 1986, Endres and Smith 1993, Henner et al. 2004).

Henner et al. (2004) found that female raccoons in Mississippi utilized tree dens when rearing young, whereas males selected ground dens and brush piles to den. Several studies concluded that female raccoons primarily occupied tree cavities in the spring and summer while rearing young (Johnson 1970, Rabinowitz and Pelton 1986, Endres and Smith 1993, Owen 2003, Henner et al. 2004, Beasley et al. 2006).

Owen (2003) suggested that den abundance may not be the primary limiting factor of raccoon populations in an intensively managed forest, but preference for tree cavities as maternal sites by female raccoons could indeed, impact future raccoon recruitment if there were continued loss of large diameter trees without replacement in 40- to 60-year rotations in West Virginia.

Endres and Smith (1993) concluded that the overall use and selection of certain den types in central Tennessee reflected on the availability of dens habitat, but they also noticed a variation in den use across seasons and among raccoons of different age and sex. In relation to season, they found that rock dens were occupied most during winter, and ground burrows were mainly used during fall. In relation to gender, Endres and Smith (1993) noted that males most frequently occupied rock dens, whereas females used tree cavities more consistently than males. Kamler and Gipson (2003) observed that seasonal differences in habitat selection was evident for females, but not for males in northeastern Kansas. Rabinowitz and Pelton (1986) found that male raccoons in an extensively-forested area in eastern Tennessee showed no significant differences in use of den sites among seasons. They did find that females used more trees during the spring and summer, and during the winter they occupied more tree and rock dens than any other den site.

The selection of den sites could be due to raccoons selecting optimal temperature habitats. Endres and Smith (1993) and Rabinowitz and Pelton (1986) found that rock dens provided an optimal thermal microenvironment in the more temperature-severe months of summer and winter. Typically, rock dens were cooler in summer and warmer in winter than other day-bed types. Tree cavity use in winter was attributed to lack of availability of more suitable habitats.

A study in eastern Kansas by Gehrt and Spencer (1990) found that tree cavities were the dominant choice for denning by rac-

coons. They also determined that certain species of trees were selected over others, and many den sites were frequently used by other raccoons. It was also evident that communal denning was a common practice on one of their study areas.

Den sites should provide protection during pregnancy and parturition of young. Endres and Smith (1993) suggested that tree cavities provided greater protection from predators than ground dens and reduced conflict from other species that competed with raccoons for dens. Rabinowitz and Pelton (1986) stated that protection of den sites may be crucial during the birth of young.

Conover (2002) found that 25% of agricultural producers surveyed reported damage caused by raccoons; only deer were reported more frequently. Raccoons have increased in abundance in several regions during the past several decades (Pedlar 1994, Gehrt et al. 2002, Prange et al. 2003). Where populations are dense, damage to corn in particular can be extensive (Conover 1998, Humberg et al. 2007). Rivest and Bergeron (1981) reported that corn can comprise >50% of raccoon diet. Beasley and Rhodes (2008) identified an increase in corn depredation with an increase in raccoon abundance in Indiana.

The objective of our study was to characterize variation of diurnal resting sites between genders and among seasons in an area of intensive agriculture. Based on previous studies and the agriculturally dominated landscape of our study area, we hypothesized that there would be differences in den site selection among seasons and between genders. Raccoon distribution may ultimately be limited by availability of den sites, specifically dens for females to rear young (Henner et al. 2004, Beasley et al. 2006).

Study Area

We conducted this study on the 207 ha University of Tennessee at Martin (UTM) Field Laboratory in Weakley County in northwest Tennessee. This area is adjacent to the UTM campus and within the city limits of Martin, Tennessee, which has a population of approximately 10,500. The study area is characterized by approximately 66 ha (32%) of pasture dominated by tall fescue (*Schedonorus arundinaceus*) and Bermuda grass (*Cynodon dactylon*), 88 ha (42%) of row crop fields, and 53 ha (26%) of wooded and idle areas. The study area included two wooded tributaries of Cane Creek, an ephemeral stream, and several forested patches ≤5 ha in size. No forest management has occurred for several decades and this has resulted in a mixture of young, mature, and over-mature trees occupying most of the wooded areas. Cavities and snags appear to be abundant.

Methods

We captured raccoons using wire cage traps (Tomahawk Live Trap, Tomahawk, Wisconsin; Tennessee Wildlife Resources Agency Scientific Collection Permit 3592; the UTM Institutional Animal Care and Use Committee did not require a permit for this study) on the study area during two capture periods (August and September 2010 and May 2011). We baited traps with canned cat food. Each trap was placed in an area selected for high likelihood of trap success such as along creeks and field edges. We anesthetized captured raccoons with ketamine hydrochloride at 2.5–5.0 mg/kg and medetomidine at 2.5–5.0 mg/kg (Ketathesia, Butler Animal Health Supply, Dublin, Ohio and Dexdomitor, Orion Cooperation, Espoo, Finland). We fitted raccoons weighing ≥3.6 kg with 200-g radio transmitters (Advanced Telemetry Systems, Inc., Isanti, Minnesota) and returned them to sites of capture.

We tracked and located radio-equipped raccoons from August 2010 to February 2012. Upon locating equipped raccoons, temperature, location (Universal Transverse Mercator coordinates), and behaviors of any observed raccoons were recorded. Diurnal resting areas were classified as tree cavity, ground den, or brush pile. We defined den site fidelity as the location of an individual found in the same den site two or more times.

Data was entered into Microsoft Excel. We used chi square analysis to detect seasonal and gender differences in diurnal resting areas. We accepted $P \leq 0.05$ as statistically significant. December through February was classified as winter, March through May as spring, June through August as summer, and September through November as fall.

Results

Four male and nine female raccoons were located a total of 188 times during daylight hours from August 2010 through February 2012. The four male raccoons were captured and located 69 times, including 14 times during spring (11 in tree cavities, 3 in ground dens, 0 in brush piles), 9 during summer (5 in tree cavities, 2 in ground dens, 2 in brush piles), 36 during fall (24 in tree cavities, 9 in ground dens, 3 in brush piles), and 10 during winter (5 in tree cavities, 3 in ground dens, 2 in brush piles). The nine female raccoons were captured and located 119 times, including 32 times during spring (8 in tree cavities, 22 in ground dens, 2 in brush piles), 7 during summer (4 in tree cavities, 0 in ground dens, 3 in brush piles), 63 during fall (26 in tree cavities, 29 in ground dens, 8 in brush piles), and 17 during winter (9 in tree cavities, 5 in ground dens, 3 in brush piles). Chi-square analysis revealed that for male raccoons there was no significant difference in selection of den sites among seasons ($X^2 = 4.86$, $P = 0.56$) (Figure 1). However, there

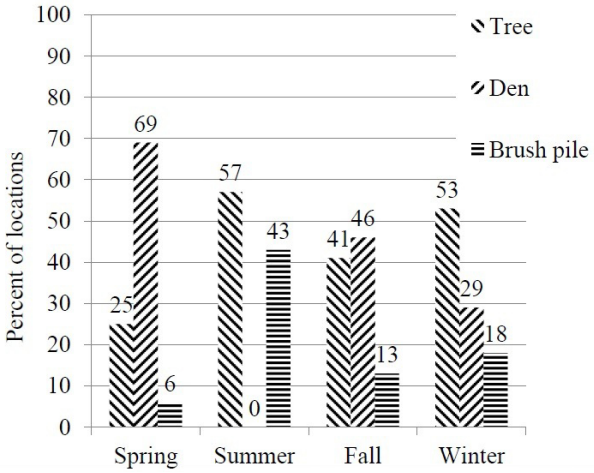

Figure 1. Habitat use among seasons by female raccoons, Weakley County, Tennessee, August 2010 to February 2012. Bars with stripes running downward and right represent locations in trees; bars with stripes running upward and left represent locations in ground dens; bars with horizontal stripes represent locations in brush piles.

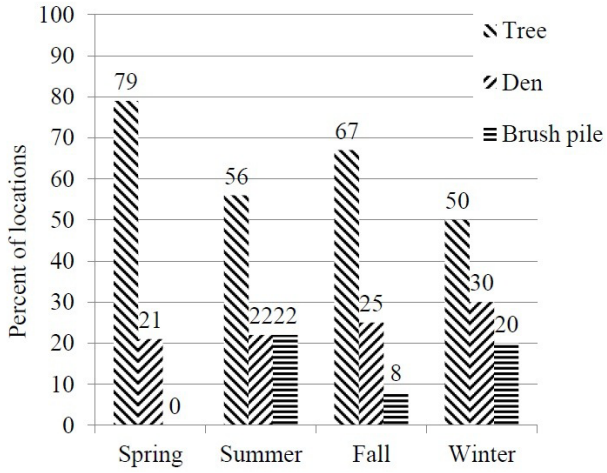

Figure 2. Habitat use among seasons by male raccoons, Weakley County, Tennessee, August 2010 to February 2012. Bars with stripes running downward and right represent locations in trees; bars with stripes running upward and left represent locations in ground dens; bars with horizontal stripes represent locations in brush piles.

was a difference in den site selection among seasons by female raccoons ($X^2 = 16.70$, $P = 0.01$) (Figure 2).

Raccoons were located in the following species or genera of trees: oak spp. (*Quercus* spp.) (65%), tuliptree (*Liriodendron tulipifera*) (19%), hickory spp. (*Carya* sp.) (6%), American elm (*Ulmus americana*) (2%), American sycamore (*Platanus occidentalis*) (2%), boxelder (*Acer negundo*) (2%), sweetgum (*Liquidambar styraciflua*) (2%), and eastern white pine (*Pinus strobus*) (2%).

Den site fidelity within seasons was observed in males and females during spring, fall, and winter. One male used a tree twice in the winter and a den twice in spring. A second male used a tree three times in the fall and another tree twice in the fall. A female used a tree twice in winter and a den twice in fall. A second female used a brushpile twice in spring and a tree five times in sping.

On seven separate occasions we found pairs of radio-equipped raccoons communally denning. There were no more than two raccoons recorded together at a time. We found females denning together (1 pair in spring) and with males (3 pairs in fall, 1 pair in summer); we did not observe males denning together. Accidentally, we observed two radio-equipped raccoons (1 male in spring, 1 female in fall) denning with non-collared raccoons.

Discussion

Our primary interest was in determining seasonal differences in diurnal refugia use by male and female raccoons in an agriculturally dominated landscape. Female raccoons in our study primarily used ground dens (69%) during spring when females are pregnant, but switched to trees (57%) and, secondarily, brush piles (43%), in summer when they are raising young. This is partially consistent with other studies that reported heavy use of tree cavities by females with young during spring and summer; however, we observed a higher selection of ground dens in spring than these same studies (Johnson 1970, Rabinowitz and Pelton 1986, Endres and Smith 1993, Owen 2003, Henner et al. 2004, Beasley et al. 2006). Raccoons typically mate between February and March, and the gestation period is approximately 63 days. Young remain with the mother in the den for approximately six to nine weeks (Gehrt 2003). Male raccoons usually do not participate in rearing young, and often are excluded by the female (Gehrt 2003, Kamler and Gipson 2003). Trees likely provide protection from predators (Endres and Smith 1993) and severe weather (Johnson 1970) when raising young. Endres and Smith (1993) attributed use of tree cavities by raccoons to the protection provided from predators and reduced interaction with other species that utilize ground dens and brush piles. Brush piles can be readily found in northwest Tennessee due to the clearing of fence rows or fallen trees in or along agricultural fields. These brush piles often become refugia for raccoons and other meso-mammals, such as opossums (*Didelphis virginianus*) and striped skunks (*Mephitis mephitis*) (Owen 2003). Raccoon use of brush piles in our study could be attributed to a limited availability of tree cavities; however, trees were the primary diurnal resting area used by both males (56%) and females (57%) in summer. If females excluded males from their dens during this period in our study as observed by Kamler and Gipson (2003) in Kansas, then heavy use of tree cavities by both genders in summer would suggest no significant lack of them. Perhaps brush piles in our study represented favorable, easily accessible, and relatively cool habitats for females with young during warm periods. Ex-

amination of relationships between diurnal resting areas and temperature could elucidate causes for use of these habitats. In West Tennessee, rock dens are not available, and intensive agriculture may limit availability of brush piles and trees of sufficient size for cavities habitable to raccoons. Ground dens created by other species, such as groundhogs (*Marmota monax*), can be found and are often inhabited by raccoons. Males in our study used tree cavities in all seasons; we detected no seasonal variation in diurnal refugia use, which coincided with the results of Kamler and Gipson (2003) and Rabinowitz and Pelton (1986).

Johnson (1970) recognized that hardwood forest comprised of mature oaks is essential for raccoon populations. Acorns can compose most of a raccoon's diet throughout the winter when planted food is unavailable (Johnson 1970). We found that 65% of trees utilized by raccoons for refugia were of the oak (*Quercus* spp.) family. Habitat with limited den trees that also provide a valuable winter food cache could possibly limit raccoon populations.

We observed den site fidelity during fall, winter, and spring. This could be attributable to winter den site fidelity or the inactivity of raccoons during colder months which was also observed in West Virginia by Owen (2003). Rabinowitz and Pelton (1986) observed greater reuse of dens by females during spring and summer when pregnancy and parturition influenced movement, which was consistent with a female raccoon in our study. The use of the same den site by two raccoons at different times was recorded only once during our study.

Raccoons were also observed utilizing the same den site at the same time. Den site fidelity and communal denning might suggest recognition of optimal den sites by raccoons or of limited den sites. Several studies concluded that communal denning was commonly practiced during winter when temperatures were well below freezing (Rabinowitz and Pelton 1986, Endres and Smith 1993, Owen 2003), but our data was not consistent with this finding. Gehrt and Spencer (1990) found communal denning common in eastern Kansas among different sexes and age classes of raccoons throughout the year. They suggested that raccoons may scent mark den sites which allows other raccoons to find suitable denning habitat.

Endres and Smith (1993) and Henner et al. (2004) determined den selection at certain times of the year was based on limited resources, such as food availability and water resources. Henner et al. (2004) also found that raccoons concentrated on forested edges along agricultural fields, roads, clear cuts, and streams. Beasley and Rhodes (2008) concluded that raccoon abundance on forested edges along cornfields resulted in crop damage due to lack of alternative food sources. Limiting density of potential den trees may result in reduction of carrying capacity of both male and female raccoons in areas where high raccoon densities cause loss in agricultural productivity. Limiting density of brush piles may further reduce carrying capacity of females that heavily utilize this habitat for rearing of young.

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Literature Cited

Beasley, J. C., T. L. Devault, M. I. Retamosa, and O. E. Rhodes, Jr. 2006. A hierarchical analysis of habitat selection by raccoons in Northern Indiana. Journal of Wildlife Management 71:1125–1133.

_____ and O. E. Rhodes Jr. 2008. Relationship between raccoon abundance and crop damage. Human-Wildlife Conflicts 2:248–259.

Conover, M. R. 1998. Perceptions of American agricultural producers about wildlife on their farms and ranches. Wildlife Society Bulletin 26:597–604.

_____. 2002. Resolving human-wildlife conflicts: the science of wildlife damage management. Lewis Publishers, Boca Raton, Florida.

Endres, K. M. and W. P. Smith. 1993. Influence of age, sex, season and availability on den selection by raccoons within the central basin of Tennessee. American Midland Naturalist 129:116–131.

Gehrt, S. D. 2003. Raccoon. Pages 611–634 in G. A. Feldhamer, B. C. Thompson, and J. A. Chapman, editors. Wild mammals of North America: biology, management, and conservation. John Hopkins University Press, Baltimore, Maryland.

_____ and D. L. Spencer. 1990. Raccoon denning behavior in eastern Kansas as determined from radio-telemetry. Transactions of the Kansas Academy of Science 93:71–78.

_____, G. F. Hubert, Jr., and J. A. Ellis. 2002. Long-term population trends of raccoons in Illinois. Wildlife Society Bulletin 30:457–463.

Henner, C. M., M. J. Chamberlain, B. D. Leopold, and L. W. Burger, Jr. 2004. A multi-resolution assessment of raccoon den selection. Journal of Wildlife Management 68:179–187.

Humberg, L. A., T. L. DeVault, B. J. MacGowan, J. C. Beasley, and O. E. Rhodes Jr. 2007. Crop depredation by wildlife in Northcentral Indiana. Proceedings of the National Wild Turkey Symposium 9:199–205.

Johnson, A. S. 1970. Biology of the Raccoon (*Procyon lotor*) in Alabama. Agricultural Experiement Station Auburn University Bulletin 402:1–148.

Kamler, J. F. and P. S. Gipson. 2003. Space and habitat use by male and female raccoons, *Procyon lotor*, in Kansas. Canadian Field Naturalist 117:218–223.

Owen, S. F. 2003. Ecology and management of raccoons within an intensively managed forest in the central Appalachians. PhD Dissertation. West Virginia University, Morgantown.

Pedlar, J. H. 1994. Variation in raccoon and skunk abundance along an agricultural intensity gradient across two spatial scales. Thesis. Carleton University, Ottawa, Ontario, Canada.

Prange, S., S. D. Gehrt, and E. P. Wiggers. 2003. Demographic factors contributing to high raccoon densities in urban landscapes. Journal of Wildlife Management 67:324–333.

Rabinowitz, A. R., and M. R. Pelton. 1986. Day-bed use by raccoons. Journal of Mammalogy 67:766–769.

Rivest, P. and J. M. Bergeron. 1981. Density, food habits, and economic importance of raccoons (*Procyon lotor*) in Quebec agrosystems. Canadian Journal of Zoology 59:1755–1762.