Use of Winter Dens by Porcupines, *Erethizon dorsatum,* in Wisconsin

MICHELLE SOMERS and RICHARD P. THIEL

Wisconsin Department of Natural Resources, Sandhill Wildlife Area, Box 156, Hwy X, Babcock, Wisconsin 54413 USA

Somers, Michelle, and Richard P. Thiel. 2007. Use of winter dens by Porcupines, *Erethizon dorsatum,* in Wisconsin. Canadian Field-Naturalist 122(1): 45-48.

Porcupine (*Erethizon dorsatum*) dens were monitored in Sandhill Wildlife Area in central Wisconsin between 1996-1997 and 2002-2003 to determine whether they displayed fidelity. Fidelity declined between years, with a higher proportion of Porcupines displaying fidelity to a specific den within a single winter than between winters. Yearlings displayed higher fidelity to den sites than adults. Fidelity was stronger among Porcupines occupying rock vs. tree dens. Familiarity with home spaces and onset of snowfall and snowfall depth also probably influence selection of dens.

Key Words: Porcupine, *Erethizon dorsatum*, winter, dens, denning behavior, den-site fidelity, Wisconsin.

The North American Porcupine's range extends throughout temperate and arctic regions of the continent; they are the most cold-adapted members of the family Erethizontidae (Roze 1987; DeMatteo and Harlow 1997). Porcupines inhabit highly seasonally productive environments, and they have developed physiological and behavioral adaptations for surviving the lean winter months (Clarke and Brander 1973; Roze 1987, 1989; Sweitzer and Berger 1993; DeMatteo and Harlow 1997).

Porcupines sometimes occupy dens as a behavioral strategy to cope with stresses in winter months (Roze 1987, 1989). Porcupines in Massachusetts generally den from October-November to April (Roze 1987, 1989; Griesemer et al. 1996; Griesemer et al. 1998). Porcupines in Roze's study exhibited denning behavior when temperatures were below 0°C in the presence of snow cover (Roze 1989). Roze (1989) suggested denning aided in thermoregulation. Indeed, Zimmerling (2005) presented evidence of thermoregulatory benefits to Porcupines denning within stumps and rock crevices.

Roze (1987) examined time periods, number of individual dens, and relative gregariousness of denning Porcupines as it relates to winter foraging. On average, animals changed dens every 23 days and shared dens 12% of the time. Porcupines in his study showed strong year-to-year den fidelity (Roze 1987). Zimmerling and Croft (2001) analyzed Porcupine selection of winter dens based on the distribution of selected local forage and reported an average of 1.75 Porcupines per winter den. Griesemer et al. (1996) reported 2 to 4 Porcupines using individual dens within a single mild winter but this dropped to 2.0 to 2.8 during a more severe winter, implying that winter weather influences the number of dens used by Porcupines during any single winter.

The present study summarizes den use by Porcupines studied in central Wisconsin between winters 1996-1997 and 2003-2004. Specifically we investigated whether resident Porcupines exhibited fidelity to individual dens, by measuring occupancy rates of dens within and between winters in our study area.

Methods

Porcupines were studied during eight consecutive winters (1996-1997 to 2003-2004) on the 36 km^2 Sandhill Wildlife Area (SWA) located in southwest Wood County, Wisconsin. Descriptions of SWA physiography and den search methods are provided by Natzke and Thiel (2007). Dens in this study included living hollow trees (tree dens) and rock talus (rock dens).

Dens were visited at irregular intervals each winter. We recorded den number, date, time, whether active and currently occupied at the time of each inspection. If the den was occupied the Porcupine was captured in a box trap, sedated using Telezol after Hale et al. (1994), and handled following protocols established by Wisconsin Department of Natural Resources Animal Care and Use Committee. Porcupines were sexed and aged as juvenile, yearling, or adult based on molariform dental eruption patterns (Kochersberger 1950). Each Porcupine was ear tagged, and beginning in 1998-1999, a passive integrated transponder tag (PIT) (©AVID Identification Systems, Inc.) was injected subcutaneously between the shoulder blades to uniquely identify it. In 1999 Porcupines captured in traps were scanned for the presence of a PIT tag and if identified, were weighed and released in the field. Thus data on each Porcupine included the den it occupied.

We define fidelity as an individual Porcupine occupying a single den over the specified period. The number of dens used by individual Porcupines and the number of Porcupines using an individual den were analyzed using three time periods: within a single winter, two consecutive winters, and three-consecutive winters. Permutations were used when analyzing the two-consecutive winter and three-consecutive winter periods. For instance, den G-6 was active in 1996-1997

through 2001-2002, and in 2003-2004. For the six-year period 1996-1997 through 2001-2002, we were able to use six permutations for the two-consecutive winter analysis, and five permutations for the three-consecutive winter analysis.

Results

An unknown but small number of marked Porcupines were not known to use winter dens. Dates Porcupines commenced using winter dens in autumn and abandoned winter dens in spring varied from year to year, and by individual Porcupine. Generally, denning behavior commenced in mid-November, and a majority of Porcupines were occupying dens by early December. Dens were abandoned in mid- to late March, although some use occurred sporadically into early April. A few individual Porcupines used dens occasionally throughout the summer. In most years, winter dens were occupied over a period of approximately 110 days.

We monitored 56 tree dens used by at least 49 individual Porcupines, accumulating 98 tree den-years of data. Only three tree dens were known to be occupied by two Porcupines simultaneously. Rock dens used in this analysis were limited to two talus slopes occupied by six individual Porcupines. Unlike tree dens, rock dens frequently housed more than one Porcupine.

In any single winter 66 percent of our monitored tree dens were active. Ten tree dens with data spanning six consecutive winters averaged 2.45 winters of active use by Porcupines. Fifteen percent were active in only a single winter, 50 percent in two winters, 20 percent in three winters, 10 percent in four winters, 0 percent in five winters, and six percent in six winters.

Among active tree dens monitored for a single winter, 84 percent ($n = 47$) were occupied by a single Porcupine, and 16 percent ($n = 9$) by two different Porcupines. For tree dens monitored over two consecutive winters, 26 percent were occupied by only one Porcupine ($n = 15/58$) and 74 percent ($n = 43/58$) by two individual Porcupines. For tree dens monitored three consecutive winters, 20 percent ($n = 4/20$) were occupied by a single Porcupine, 45 percent ($n = 9/20$) by two porcupines, 15 percent ($n = 3/20$) by three Porcupines, and 20 percent $n = 4/20$) by four Porcupines.

A mean of 1.2 Porcupines occupied each active tree den in single winters, 1.7 Porcupines per tree den over two consecutive winters, and 2.35 Porcupines per tree den over three consecutive winters. Differences between these means were significant (t-test, df: year 1 = 55; year 2 = 57; year 3 = 19, $P < 0.001$).

Data on the relative fidelity of Porcupines occupying tree dens was obtained from 46 individual Porcupines. Individual Porcupines averaged 1.3 dens used per single winter, 1.8 tree dens over two consecutive winters, and 2.1 dens per individual Porcupine over three consecutive winters. Differences between these means were significant (t-test, df: year 1 = 53; year 2 = 30; year 3 = 11, $P < 0.001$). By comparison, individual Porcupines ($n = 6$) used an average of 1.05 rock dens per single winter, 1.2 rock dens over two consecutive winters, and 1.3 rock dens over three consecutive winters, but samples were too small to perform any statistical tests.

Fidelity to tree dens within a single winter was analyzed by gender and by age group. There was no significant difference between males and females (81 vs. 66 percent) that displayed fidelity to dens ($\chi^2 = 1.49$; df = 1, $P \leq 1$). Juveniles and yearlings displayed significantly higher fidelity than adults (91 and 100 vs. 58 percent) ($\chi^2 = 7.56$, df = 1, $P \leq 0.01$).

Among individual Porcupines monitored in tree dens ($n = 20$), 75 percent ($n = 34/45$) displayed fidelity to a single tree den site in the single winter period, 35 percent ($n = 11/31$) over two consecutive winters, and 17 percent ($n = 2/12$) in the three consecutive winter period. Among individual Porcupines monitored in rock dens ($n = 6$ Porcupines) 94 percent ($n = 17/18$) displayed fidelity to a single rock talus site in the single winter, 78 percent ($n = 7/9$) in the two-consecutive winter periods, and 67 percent ($n = 4/6$) in the three-consecutive winter periods.

Fidelity to den site during a single winter was significantly higher for Porcupines occupying rock talus vs. tree dens ($\chi^2 = 4.5$; df = 1, $P \leq 0.05$). In both tree and rock dens, fidelity to den site decreased significantly between single winters and the three-consecutive winter periods ($\chi^2 = 22.22$; df = 3, $P \leq 0.001$).

Discussion

Winter denning behavior is not uniformly observed throughout the Porcupine's range. Oveson (1983) and Stricklan (1987) rarely observed Porcupines utilizing dens in their mountainous Utah study areas. Sweitzer and Berger (1992, 1993) and Sweitzer (1996) did not mention Porcupine use of winter dens in their Nevada studies. Stricklan (1987) observed that Porcupines in his Utah study area moved from roost to feed trees throughout the winter and their only attempt at thermoregulating was to orient their backs to the sun.

Zimmerling and Croft (2001) determined that den site selection in their British Columbia, study area was influenced by proximity to highly preferred tree forage species. Selection of dens based on the distribution of preferred forage likely does not exist in SWA because Porcupines in our study area show little or no foraging preferences (Thiel, unpublished data). Porcupines in the areas of Massachusetts studied by Griesemer et al. (1996) displayed little or no fidelity, but they did demonstrate that the number of Porcupines utilizing individual dens was related to the harshness of the winter. Fidelity displayed by resident Porcupines is likely affected by factors such as the number of suitable den sites within respective home ranges, competition for dens by other Porcupines (likely density-dependent) and other cavity-dwelling species,

the age structure of the Porcupine population, and Porcupine longevity.

Porcupine densities increased steadily from 2.5 Porcupines/km^2 in 1998-1999 to 4.7/km^2 in 2002-2003 (Thiel, unpublished data). Surveys conducted in 1998-1999 indicated that only 41 percent of tree cavities (n = 9/22) capable of housing a Porcupine were active that winter. Porcupine densities we observed did not affect availability but by 2002-2003 some competition for dens was likely, due to a doubling in the Porcupine population.

Limited radio-telemetry data (2 males: 4 females) indicate that a mean of 3.5 dens (range: 1-6) were found within individual Porcupine home ranges (size: mean = 64.8 hectares; range: 28-137 hectares), nearly twice the number actively used by Porcupines in an average winter (Thiel, unpublished data). Either den-site fidelity is operative or reduced mobility with the onset of snow limits access to distant den sites. We suspect the latter as snow cover is known to restrict winter movements and foraging (Roze 1987; Sweitzer 1996; Griesemer et al. 1996).

Porcupines do compete for winter den sites. We witnessed numerous instances where Porcupines "swapped" dens but we were unable to determine how much our trapping activities influenced this behavior. In several instances when we released a Porcupine 24 h after capture, we discovered its den was already occupied by another. We also witnessed several instances of Raccoons (*Procyon lotor*) unsuccessfully and successfully usurping dens while Porcupines were presumably foraging nearby. In these events, Porcupines were forced to seek alternative den sites which thus increased the number of dens used, obscuring den-site fidelity of those Porcupines that may be displayed by other Porcupines.

Yearling Porcupines seemed to show stronger fidelity than adults to a single den. Only two of seven (29 percent) adult Porcupines showed fidelity to a single den within a single winter period. In contrast three of four yearling Porcupines (75 percent) showed fidelity to a single den within the single winter period. Porcupines usually disperse and form home ranges as yearlings (Roze 1987). We speculate that yearlings may not be fully aware of potential den sites because they are probably less familiar with their newly established surroundings than are long-term resident adults.

Porcupine longevity has not been well studied (Earle and Kramm 1980). Presumably, the longer an animal lives and remains confined to a discrete living space (home range), the greater its familiarity will be with local resources, including den sites. Such animals will be in a better position to select and compete for a site best suited to their needs. Porcupines in our study area display impressive longevity: viz. 4 of 13 animals (31 percent) captured in the initial winter of tagging (1996-1997) were still present in the population eight winters later in 2004-2005. Given the longevity we witnessed, we would have expected Porcupines to display greater fidelity to den sites than they did. The number of dens occupied by individual Porcupines, and the number of individual Porcupines occupying single dens increased over subsequent winters. Despite this, three female Porcupines displayed fidelity to a specific den site that lasted 4, 6 and 8 years.

We agree with Roze (1987, 1989) that Porcupine use of dens is a behavioral strategy used to enhance survival during winter when cold temperatures and poor nutrient diet place great physiological stress on individuals. Over-winter mortality caused by starvation and predation in non-denning Porcupines studied in Nevada and Utah (Oveson 1983; Stricklan 1987; Sweitzer and Berger 1992, 1993; Sweitzer 1996) is as significant as over-winter starvation by denning Porcupines observed in Massachusetts by Hale and Fuller (1996) and in our study area (Thiel, unplublished data).

In our study area the urge to den each winter is strong. Occupancy of winter dens is influenced by age, availability and mostly interspecific competition. Fidelity to specific dens is strongest in young Porcupines and among Porcupines occupying rock talus. While individual Porcupines exhibit den preferences, the species does not display strong fidelity to single dens. It is our observation that in winters with little snow cover, Porcupines forage extensively. In winters with deep snow, their movements are restricted and this may restrict their choice of den sites. We agree with Roze (1987, 1989) that denning behavior is a strategy used by Porcupines to enhance over-winter survival. Further work is needed to understand more fully this aspect of Porcupine ecology.

Acknowledgments

We thank the 104 high school students who participated in the High School Independent Studies program and contributed to the collection of data used in this paper. Ellen Heilhecker and Matt Schuler assisted with statistical analyses. Employees Laura Huber and Josh Petersen managed aspects of the High School Independent Studies program and contributed significantly to the success of this study.

Literature Cited

Clarke, S. H., and **R. B. Brander.** 1973. Radiometeric determination of porcupine surface temperature under two conditions of overhead cover. Physiological Ecology 46: 230-237.

DeMatteo, K. E., and **H. J. Harlow.** 1997. Thermoregulatory responses of the North American porcupine (*Erethizon dorsatum bruneri*) to decreasing ambient temperature and increasing wind speed. Comparative Biochemical Physiology 116B: 339-346.

Earle, R. D., and **K. R. Kramm.** 1980. Techniques for age determination in the Canadian porcupine. Journal of Wildlife Management 44: 413-419.

Griesemer, S. J., **T. K. Fuller,** and **R. M. DeGraaf.** 1996. Denning patterns of porcupines, *Erethizon dorsatum*. Canadian Field-Naturalist 110: 634-737.

Griesemer, S. J., T. K. Fuller, and **R. M. Degraaf.** 1998. Habitat use by porcupines (*Erithizon dorsatum*) in central Massachusetts: effects of topography and forest composition. American Midland Naturalist 140: 271-279.

Hale, M. B., and **T. K. Fuller.** 1996. Porcupine (*Erethizon dorsatum*) demography in central Massachusetts. Canadian Journal of Zoology 74: 480-484.

Hale, M. B., S. J. Griesemer, and **T. K. Fuller.** 1994. Immobilization of porcupines with tiletamine hydrochloride and zolazapam hydrochloride (telazol). Journal of Wildlife Diseases 30: 429-431.

Kochersberger, R. C. 1950. A study to determine cranial and dental correlations with age and sex in the Canadian porcupine *Erithizon dorsatum dorsatum* (Linnaeus). Master of Arts thesis, University of Buffalo, Buffalo, New York. 34 pages.

Natzke, L. L., and **R. P. Thiel.** 2007. Characteristics of Porcupine, *Erethizon dorsatum,* winter den-sites in living trees in Wisconsin. Canadian Field-Naturalist 121(0): 000-000.

Oveson, M. C. 1983. Behavioral and metabolic adaptations of porcupines (*Erethizon dorsatum*) to winter stress. M.S. thesis, Brigham Young University, Provo, Utah. 20 pages.

Roze, U. 1987. Denning and winter range of the porcupine. Canadian Journal of Zoology 65: 981-986.

Roze, U. 1989. The North American porcupine. Smithsonian Institution Press, Washington D. C. 261 pages.

Sweitzer, R. A. 1996. Predation or starvation: consequences of foraging decisions by porcupines (*Erethizon dorsatum*). Journal of Mammalogy 77: 1068-1077.

Sweitzer, R. A., and **J. Berger.** 1992. Size-related effects of predation on habitat use and behavior of porcupines. Ecology 73:867-875.

Sweitzer, R. A., and **J. Berger.** 1993. Seasonal dynamics of mass and body conditions in Great Basin porcupines. Journal of Mammalogy 74:198-203.

Stricklan, D. 1987. Factors affecting dietary selection and movements of porcupines in Utah. M.S. thesis, Brigham Young University, Provo, Utah. 39 pages.

Zimmerling, T. N. 2005. The influence of thermal protection on winter den selection by porcupines, *Erethizon dorsatum*, in second-growth conifer forests. Canadian Field-Naturalist 119: 159-163.

Zimmerling, T. N., and **C. D. Croft.** 2001. Resource selection by porcupines: winter den site location and forage tree choices. Western Journal of Applied Forestry 16: 53-57.

Received 5 February 2007
Accepted 29 August 2008