Characteristics of Porcupine, *Erethizon dorsatum,* Winter Den-sites in Living Trees in Wisconsin

LORI L. NATZKE and RICHARD P. THIEL

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

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Although Porcupines (*Erethizon dorsatum*) denned in a variety of structures in Sandhill Wildlife Area, Wood County, Wisconsin, hollow living trees predominated (67 percent). Diameter at breast height of den trees was significantly greater than that of trees in the surrounding forest, and den openings in living hollow trees were nearly twice the circumference of Porcupines. Porcupines probably do not prefer certain tree species over others; rather, they select species more prone to heart rot with cavities large enough to house a Porcupine.

Key Words: Porcupine, *Erethizon dorsatum*, dens, winter dens, tree dens, den characteristics, Wisconsin.

The North American Porcupine (*Erethizon dorsatum*) has developed certain thermoregulatory and behavioral adaptations to survive the extremes of winter weather in continental North America (Clarke and Brander 1973; Dodge 1982; Oveson 1983; Roze 1987, 1989; Sweitzer 1996; DeMatteo and Harlow 1997). Although numerous studies have mentioned the importance of denning behavior among Porcupines, and a few identified the types of den structures (Roze 1987; Griesemer et al. 1996, 1998) or selection of dens in proximity to highly preferred forage trees (Zimmerling and Croft 2001), none have described physical aspects of dens utilized by Porcupines (Roze 1984, 1987; Dodge 1982 among others).

Studying porcupines in Massachusetts, Roze (1987) found that 69 percent of the dens used by Porcupines were in rock outcrops, 21 percent in living hollow trees, 6 percent in outbuildings and 5 percent were in hollow logs. Griesemer et al. (1998), who also studied denning porcupines in Massachusetts, observed that 28 percent were found in rock caves, 47 percent in cavities of living trees, 14 percent in hollow logs, and less than 3 percent in other structures. Griesemer et al. (1998) found that selection of den sites depended on topography, especially as it related to availability of rock outcrops Roze (1987) suggested that dens offered protection from both convectional and radiational heat loss, and thus aided in over-winter survival. Griesemer

TABLE 1. Differences between Porcupine den trees and tree species in random forested plots.

	Red Oak	White Oak	Black Oak	Big-toothed Aspen	White Pine
Plot %	48	13	25	12	2
% Dens	1	19	10	1	17
Mean DBH in Plots	33.0	27.4	37.2	27.9	39.2
Mean Den DBH	56.9	53.8	61.2	52.7	70.5

et al. (1998) identified protection from predation as another benefit of denning. Other studies focusing on over-winter survival strategies of Porcupines in the western United States (Sweitzer and Berger 1992; Sweitzer and Berger 1993, 1996) involved populations in which denning was rare. These authors did not mention whether adequate den structures were available and not used, or whether none existed. In this paper we describe several physical characteristics of living tree dens used by Porcupines in central Wisconsin between winters 1996-1997 and 2002-2003.

Methods

Porcupines were studied on a 2026-hectare tract in the southern half of the 36 km^2 Sandhill Wildlife Area (SWA) located in southwest Wood County, Wisconsin between the winters of 1996-1997 and 2002-2003. SWA consists of 50 percent upland forests predominated by stands of oak (*Quercus* spp.) and aspen (*Populus* spp.) and 50 percent marshland habitats (Kubisiak et al. 2001). These forests originated following a major forest fire that swept through the region in the autumn of 1930. They were approximately 65-70 years old in autumn 2000. They have been subjected to managed timber extraction since the 1960s (Grange 1948; Kubisiak et al. 2001). Porcupines were extirpated in SWA and began recolonizing the area in the mid-1970s (Thiel, unpublished notes).

Dens were located annually between November and March by systematically searching all upland-forested habitats (953 hectares) for the presence of Porcupine snow trails and/or the presence of dens in the absence of snow. Dens were defined as cavities that were capable of totally concealing a Porcupine. Shelters were defined as cupped depressions that provided shelter from wind but left the Porcupine exposed.

Dens were classified as living hollow trees, rock outcrop, tree roots, hollow logs, culverts, or holes in the ground. An active den was defined as having fresh droppings and/or tracks at the entry. A den was considered occupied if a Porcupine was seen within or if tracks led into but not out and a Porcupine responded to tapping on the exterior of the den. The following physical characteristics were recorded at each living hollow tree den: (1) species, (2) diameter at breast height (DBH) (tree circumference 1.2 m from the ground), and (3) the greatest length and width of den entrances, measured in cm. Each den was assigned an identification number, plotted on a map, and descriptive information was entered into a spreadsheet. Inventoried dens were visited two or more times each winter, as were newly discovered dens, to determine occupancy.

Porcupines were captured at dens and aged and sexed following methods described by Somers and Thiel (2007). Chest circumference of captured porcupines was measured immediately distal to the forelegs and compared to mathematically derived circumferences of den openings based on measurements of greatest length and width taken at right angles to one another. Data were broken down into various age-sex categories.

Timber cruises of forested habitats were conducted in March of 1997, 2000, and 2003 on randomly selected 0.0025 hectare study plots. The percent frequency of dominant tree species (after Curtis 1959) and DBH of all trees in each study plot was compared to the dataset from Porcupine dens in hollow living trees.

Results

Porcupines used sixty-three dens and seven shelters during the winter months in our study area between 1996-1997 and 2002-2003. Although shelters constituted 10 percent (7/70) of the structures used by Porcupines, they were not used consistently or for any length of time both within and between winters and they were excluded from further analysis. Amongst dens, 67 percent were living hollow trees, 9.5 percent were tree roots, 6.3 percent were in ground holes and 4.8 percent were in rock outcroppings and logs, respectively.

The DBH's of living den trees ranged from 40 cm (White Oak) to 90 cm (Black Oak). The DBH's of den trees were significantly greater than the DBH's of each of the respective tree species within the forest (t-test, df = 4, $P < 0$ .000004). Mean den tree DBH's, by all species except Red Oak, *Quercus borealis*, (t-test, df = 3, $P < 0.16$), were significantly larger than the respective tree species' means within forested plots (White Oak, *Quercus alba,* t-test, df = 13, $P < 0.003$; White Pine, *Pinus strobus,* t-test, df = 1, $P < 0.02$; Black Oak, *Quercus velutina,* t-test, df = 13, $P < 0.001$; Big-toothed Aspen, *Populus, grandidentata*, t-test, df = 1, $P < 0.04$) (Table 1).

Den opening circumferences averaged 99.7 cm (range 43.2-286.5 cm), and Porcupine chest girths averaged 46.2 cm (range 28.5-61.7 cm). We found no significant differences between Porcupine chest girths and the circumference of den openings among any

combination of age and sex ($R^2 = 0.23359$; ANOVA, $P < .33147$). Only three of the 42 dens in the cavities of living trees were spacious enough to house two Porcupines simultaneously.

Discussion

Porcupines in our study area selected from a variety of den structures, none of which were randomly distributed or equally available. Only 4.8 percent of the dens were rock outcroppings, yet 38 percent of study area Porcupines utilized them (Thiel, unpublished data). We report the highest incidence of living hollow trees used as dens among studies where Porcupine denning structures were mentioned (Roze 1987; Griesemer et al. 1996, 1998).

We are unaware of any documented instance of Porcupines excavating cavities in living trees. Therefore den-sites used by Porcupines in living trees are dependant upon tree species with greater incidences of rotted and hollowed cavities large enough to conceal Porcupines. In our study site White Oak, Black Oak and White Pine provided such cavities while Red Oak and big-toothed aspen generally did not (Table 1).

Zimmerling (2005) found that logs provided less insulation than other structures. If different denning structures vary in thermoregulatory benefits, then structures with better thermoregulatory properties will be occupied competitively, depending on Porcupine (and other species) densities and the relative occurrence of the better insulative structures (Somers and Thiel 2007). We found suggestive evidence of such competition between juvenile and adult Porcupines in SWA with juveniles showing a lower incidence in occupying hollow living trees than adults.

We surmise that in most managed forests in the Upper Great Lakes, where rock outcroppings are relatively rare, Porcupine use of hollow living trees will be high. In forests subject to timber extraction, hollow living trees should not be culled where Porcupine occurrence is valued.

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