# Winter Habitat and Browse Use by Snowshoe Hares, *Lepus americanus*, in a Marginal Habitat in Pennsylvania

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We examined habitat and woody browse use by Snowshoe Hares (*Lepus americanus*) in Pennsylvania northern hardwood clearcut stands during winter. Resident hares were found only in successfully regenerated stands, which contained higher seedling and sapling densities and more cover (e.g., stumps, slash) than unsuccessfully regenerated stands. Habitat use was positively correlated to several variables, including abundance of seedlings and saplings of all species combined and distance to slash piles. Conversely, habitat use was negatively related to abundance of tall (≥ 1.5 m) raspberry (*Rubus* spp.) and distance to other clearcut stands. Hares browsed 3.4% of the available woody twigs, feeding principally on *Rubus* spp., Striped Maple(*Acer pensylvanicum*), and Yellow Birch (*Betula alleghaniensis*). Although these stands are near the southern extent of the geographic range of Snowshoe Hares and probably represent marginal habitat for the species, habitat and browse use by hares in our study were not unlike that reported for hares elsewhere.

Key Words: Snowshoe Hare, *Lepus americanus*, clearcut stands, habitat, browse, Pennsylvania.

Snowshoe Hares (*Lepus americanus*) are common to northern boreal forests of North America, with populations extending south into higher elevations of the Rocky and Appalachian Mountains (Hall 1981; Carreker 1985). Many studies have dealt with hare populations occupying northern coniferous forests (e.g., Brocke 1975; Pietz and Tester 1983; Litvaitis et al. 1985), whereas relatively few have been conducted on populations in deciduous forests near the southern extent of their range (e.g., Dolbeer and Clark 1975; Sievert and Keith 1985). Information on habitat and browse use by Snowshoe Hares in southern and/or marginal habitats would provide important insight into the ecology and management of this species across its geographic range. habitat and browse use by Snowshoe Hares in northern hardwood clearcut stands have not been published to our knowledge. Our objective in the present study was to determine winter habitat and browse use by Snowshoe Hares in Pennsylvania northern hardwood clearcut stands, which likely represent a suitable but perhaps marginal habitat for Snowshoe Hares in southern latitudes.

## Study Area and Methods

The study was conducted on International (Hammermill) Paper Company lands (tract Potter 18), Potter Co., Pennsylvania, in the Black Cherry (*Prunus serotina*) — maple (*Acer* spp.) northern hardwood group (Marquis 1980). Six of 25 representative clearcut stands were selected for intensive study of habitat and browse use by hares in winter 1984-1985 according to percent successful regeneration, species composition, age, and size. The remaining 19 stands were visited once in winter 1984-1985 after a recent snowfall to search for evidence of hares (e.g., tracks, pellets). All stands were classified as successfully or unsuccessfully regenerated (hereafter termed successful and unsuccessful, respectively). A successful stand had at least 70% of 20 randomly selected regeneration plots (1.83-m radius) with two or more stems of desirable species ≥ 1.5-m tall (Marquis and Bjorkbom 1982). Of the six stands selected for intensive study, three were successful and three were unsuccessful. Of the 19 stands examined for hare evidence, 11 were successful and eight were unsuccessful. Desirable species included Black Cherry, Red Maple (*Acer rubrum*), and Sugar Maple (*Acer saccharum*), White Ash (*Fraxinus americana*), North America Tuliptree (*Liriodendron tulipifera*), Cucumber-tree Magnolia (*Magnolia acuminata*), Northern Red Oak (*Quercus rubra*), and Yellow Birch. The six stands were located on ridgetops, were logged between 1968 and 1978, and ranged from 9.1 to 20.2 ha in size. Each stand was surrounded by mature, northern hardwood forest.

Four 500-m transects were established in each of the six stands, with two in a 50-m wide edge zone and two in the center zone. Each transect was divided into 50-m linear sampling units. A trap station was placed in the middle of each unit, giving 40 trap stations per stand. Hares were captured in each stand during two, 10-day periods

(N = 2400 total trapnights) from mid-January to early April 1985 using collapsible, single-door Tomahawk live-traps (90 × 30 × 30 cm) baited with alfalfa and apples. Hares were marked with numbered, color-coded ear tags and numbered hindfoot tags. Sex, age (juvenile or adult), weight (g), hindfoot length (mm), and reproductive condition were recorded (Keith et al. 1968). A trap index was calculated for each 50-m sampling unit based on the total number of captures at a given trap station, where 1 = a trap station with one or more hare captures and 0 = a trap station with no captures.

Five or six track counts were made in each clearcut stand approximately 24 hours after a snowfall from January-early April 1985. The total number of tracks crossing or parallel (within 5 m) to each 50-m sampling unit were counted (modified from Conroy et al. 1979). In addition, the first trail or runway encountered in each 50-m sampling unit was followed for 5 m on either side of a transect to determine the presence of activity loci, which were either woody twigs browsed by hares or diurnal forms used by hares. The mean number of tracks and activity loci were summed to derive a track index for each 50-m sampling unit.

We counted fecal pellets after snowmelt in each clearcut stand in late April 1985. A 0.5-m radius plot was located 2 m from the center of each trap station in the four cardinal directions. The total number of pellets in the four plots was used to derive a pellet index for each 50-m sampling unit. Associations between activity indices (trap, track, and pellet) per sampling unit and regeneration status (successful, unsuccessful) of the stand containing a given unit were determined by *G* tests-of-independence (Sokal and Rohlf 1981).

Habitat variables were measured at each trap station from June to mid-August 1985 (Swihart and Yahner 1982; *see details in* Scott 1986). These included numbers of slash piles ($>$ 1-m$^2$), fallen logs ($>$ 1-m long, $\geq$ 7.5-cm diameter), stumps ($>$ 25-cm tall, and $>$ 7.5-cm diameter), and overstory trees (woody stem $>$ 1.5-m tall, $\geq$ 7.5-cm dbh) per species and all species combined in a 0.04-ha circular plot centered on a trap station; numbers of overstory trees and saplings (woody stem $>$ 1.5-m tall, $<$ 7.5-cm dbh) per species and all species combined in two, perpendicular 1-m wide transects centered on a trap station; numbers of seedlings (woody stems $<$ 1.5-m tall) in two, 1-m radius plots located 2 m north and east of the center of a trap station; canopy height (m) above a trap station; canopy coverage (%) taken from 20 ocular tube sightings along the two 1-m wide transects at a trap station; and distances (m) to the nearest slash pile, fallen log, stump, overstory tree, seedling or sapling clump ($>$ 10 stems/m$^2$), coniferous stand, and clearcut stand from a trap station.

Relationships between habitat variables and activity indices per 50-m sampling unit were examined using stepwise multiple regression (SAS, Inc. 1982) and logistic regression (BMDPLR: Engelman 1985). *P*-to-enter and remove for both types of regression analyses was 0.05.

Browse use by hares was quantified in May 1985 along five randomly selected transects in each stand. Eight, 1-m radius plots were established at 10-m intervals along each transect, giving 40 plots per stand. Within each plot, number of total twigs (browsed and unbrowsed), number of twigs browsed by hares, and diameter at point of browsing were recorded by woody species at 0-60 and 61-120 cm above mean snowdepth (23.8 cm in winter 1984-1985) (Keith et al. 1984). A twig was defined as any portion of a woody plant less than or equal to 10 mm in diameter.

Goodness-of-fit *G*-tests (Sokal and Rohlf 1981) were used to test if use of all woody browse species in a stand was as expected based on availability. Differences in expected use were determined by chi-square tests-of-independence after cells were collapsed around the species of interest (Pearre 1982).

## Results

We captured 12 Snowshoe Hares 48 times, and 40 (83%) of these captures were in the three successful stands. Based on 40 plots in each of the six stands, 75 to 88% had tracks and 70 to 73% had pellets in successful stands. In contrast, 0 to 38% had tracks and 8 to 20% had pellets in unsuccessful stands. Activity indices (trap, track, and pellet) were significantly ($P < 0.05$) higher in successful than in unsuccessful stands (Scott 1986). In the additional 19 stands examined for evidence of hares, tracks and/or pellets were found in nine stands; eight of these stands were classified as successful.

Habitat use based on the trap index was positively correlated with number of both seedlings and saplings, canopy height, and distance to slash (chi-square = 60.2, d.f. = 4; $P < 0.001$). The track index was positively correlated with numbers of Pin Cherry (*Prunus pensylvanica*) seedlings, saplings of all species combined, and Black Cherry overstory trees, and was negatively correlated with number of *Rubus* spp. and distance to the nearest clearcut stand ($R = 0.47$, $F = 40.7$, d.f. = 5, $P < 0.0001$). The pellet index was positively correlated with canopy height, and numbers of stumps, Black Cherry and Pin Cherry seedlings, saplings of all species combined, Black Cherry overstory trees, and was negatively related to distance to the nearest stand ($R = 0.42$, $F = 23.7$,

d.f. = 7,232; $P < 0.0001$). Additional details of regression models are presented in Scott (1986).

Hares browsed only within the 0-60 cm stratum, using between 0.5 and 10.3% of the available twigs per stand in this stratum. We found that *Rubus* spp., Striped Maple, and Yellow Birch were used significantly more than expected in all stands, and American Beech (*Fagus grandifolia*), Pin Cherry, Black Cherry, Red Maple, and Sugar Maple were used significantly less than expected.

## Discussion

Although coniferous stands generally are considered optimal habitat for Snowshoe Hares (e.g., Brocke 1975), successfully regenerated northern hardwood clearcut stands apparently represent important habitats for hares in southern latitudes with limited coniferous cover, as in Pennsylvania. Certain features of hardwood stands, such as high seedling and sapling densities, provided both food and cover for hares. Slash also may be important as shelter for hares from inclement weather or from predators (Aldous 1937; *but see* Conroy et al. 1979). Despite *Rubus* spp. being a preferred browse species, hares tended to avoid areas in stands with high densities of *Rubus* spp., presumably because these areas had little or no canopy cover and potentially greater predation risks (Dolbeer and Clark 1975; Buehler and Keith 1982; Wolfe et al. 1982).

Hares occurred in clearcut stands that were close (< 0.5 km) to other clearcut stands. These nearby clearcut stands probably were important to hares by providing alternate sources of food and cover throughout the year. Seasonal shifts in habitat use by hares in response to changes in food and cover have been noted in other geographical regions (Adams 1959; Wolff 1980). Thus, future population increases and geographic range expansion of hares in Pennsylvania may be contingent on the availability of suitable, nearby habitat (Sievert and Keith 1985).

Woody browse use by hares during winter in our study (e.g., *Rubus* spp., Striped Maple, and Yellow Birch) was similar to that noted for hares in northern hardwood stands in northwestern Pennsylvania (Brown 1984). Therefore, low densities of hares likely have a negligible effect on regeneration of desirable timber species in northern hardwood stands.

Extensive browse use by White-tailed Deer (*Odocoileus virginianus*) may have important negative consequences to the successful establishment of Snowshoe Hares in northern hardwoods. For example, introduced hares did not become established on release sites in central Pennsylvania where deer browsing was pronounced (Glazer 1959). Elimination of potential hare food and cover resources by high deer populations may be a major factor influencing range expansion by hares of previously occupied habitat and contribute to its status as a species of special concern in Pennsylvania (Dalby 1985).

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