# WINTER BED-SITE SELECTION BY WHITE-TAILED DEER IN CENTRAL ONTARIO

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Winter habitat selection by white-tailed deer (*Odocoileus virginianus*) in northern portions of its range has been studied at several levels for a number of years (Gill 1966). Early classifications were based on forest type (Webb 1940, Christensen 1962), whereas later studies have recognized that distinct habitats fulfill different functions in an area suitable for deer. Feeding and shelter areas were differentiated by Telfer (1967) and Huot (1974), and Armstrong et al. (1983) also included travel lanes and day-bedding areas.

During winter, white-tailed deer usually bed at night in closed forests near coniferous trees (Robinson 1960, Euler and Thurston 1980). Day-bedding sites are in areas exposed to the sun (Verme 1966, Nowosad 1968, Armstrong et al. 1983). As both types of bed sites seem to be necessary in a winter concentration area (Stocker and Gilbert 1977), it is important to be able to recognize areas meeting both sets of habitat requirements. Our objective was to determine habitat characteristics of white-tailed deer bedding sites in central Ontario to aid in identification and management of critical winter habitats.

## STUDY AREAS

Fieldwork was conducted in 2 winter concentration areas in central Ontario: Lake Muskoka in the Regional Municipality of Muskoka (45°02′N, 79°30′W) and Percy-Haliburton Lakes in Haliburton County (45°13′N, 78°22′W). Some fieldwork was done near Walker Lake in Muskoka. These deer concentration areas were generally composed of coniferous shorelines and backshore coniferous ridges separated by deciduous forests and linked by small lakes and coniferous swamps. Common deciduous trees included sugar maple (*Acer saccharum*), northern red oak (*Quercus rubra*), and yellow birch (*Betula alleghaniensis*), and major coniferous species were Canada hemlock (*Tsuga canadensis*), white pine (*Pinus strobus*), and northern white cedar (*Thuja occidentalis*).

## METHODS

Fieldwork was conducted between 27 January and 10 March 1978 and between 8 January and 9 March 1979. Investigations of night beds were made in the early morning after a night of relatively severe weather conditions (minimum temperature at least −10 C with some wind). Beds were located by backtracking from fresh tracks and using observations of sign in relation to snow accumulation. Day-bedding sites used during sunny, mild days in mid- to late winter were similarly located. These 2 bedding types were selected to represent the range of bedding conditions expected. Sites were individually numbered and marked. Measurements taken were percent conifer composition of the nearest 4 trees (point-quarter technique), species, diameter at breast height, distance to the nearest tree, distances to the tips of the nearest live and dead branches, vertical depth of the bed, slope aspect, slope position (from 1 on lowland to 6 on

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Table 1. Day- and night-bedding sites of white-tailed deer in central Ontario.

| Variable | Bedding sites: Day ($N = 97$) $\bar{x}$ | SD | Night ($N = 326$) $\bar{x}$ | SD | $P$ |
|---|---|---|---|---|---|
| Number of active beds | 3.1 | 1.9 | 2.7 | 1.7 | <0.05 |
| Total number of beds | 5.3 | 4.9 | 5.0 | 4.2 | >0.05 |
| Coniferous composition, % | 11.3 | 22.2 | 76.2 | 24.7 | <0.001 |
| Distance to nearest tree, m | 1.7 | 1.5 | 0.9 | 0.6 | <0.001 |
| Diameter of nearest tree, cm | 17.5 | 8.6 | 23.3 | 12.1 | <0.001 |
| Distance to nearest live branch, m | 2.1 | 2.4 | 2.4 | 1.1 | >0.05 |
| Distance to nearest dead branch, m | 1.9 | 2.2 | 1.2 | 0.7 | <0.001 |
| Depth of bed, cm | 18.7 | 6.5 | 22.0 | 8.9 | <0.001 |
| Position | 4.6 | 1.5 | 4.4 | 1.5 | >0.05 |
| Overhead cover, % | 12.8 | 19.8 | 84.7 | 18.7 | <0.001 |
| Sine aspect | −0.18 | 0.76 | 0.04 | 0.74 | <0.01 |
| Cosine aspect | 0.08 | 0.63 | 0.06 | 0.67 | >0.05 |
| Snow depth, cm[a] | 75.7 | 16.1 | 35.9 | 11.9 | <0.001 |
| Vegetation volume, %[a] | 4.1 | 4.7 | 58.8 | 20.2 | <0.001 |
| Direction nearest tree[a] | 176.0 | 116.9 | 195.7 | 103.1 | >0.05 |

[a] Recorded only for 1979 sites.

hilltop plateau), percent overhead cover (1 × 1-m plot), evidence of recent browsing, number of beds in a group, and number of fresh beds in a group. Data on habitat were analyzed by principal components analysis (PCA) and discriminant function analysis (DFA) (Dixon 1975). The PCA was used to identify habitat variables that accounted for the greatest variance in the data. The DFA was used to select those variables that differed most between day and night beds (Beale et al. 1967, Holland 1969, James 1971).

## RESULTS

We located and analyzed habitat data for 326 night beds and 97 day beds during the 2 study periods (Table 1). Most night beds (90%) were near coniferous trees, particularly Canada hemlock, whereas most day beds (91%) were close to deciduous trees, mainly sugar maple, white oak (*Quercus alba*), and northern red oak. Whereas most day sites were on south- (55%) or west-facing (27%) slopes, most night beds were on north- (42%) or south-facing (29%) slopes. Most beds of both types were high up on slopes. Night beds were generally closer to trees; 66% were ≤1 m from the closest tree, as opposed to 31% of the day beds.

The DFA indicated that day- and night-bedding sites could be differentiated on the basis of percent overhead cover and conifer composition (computed weights −0.0422 and −0.0160, respectively). Using these 2 variables, 94.3% of all sites ($N = 423$) were correctly classified ($F = 618.4$).

The 1st principal component accounted for 24.8% of the variance in the bed-site data, and was positively correlated with overhead cover and conifer composition and negatively correlated with distance to the nearest tree (Table 2). The 2nd component was most strongly correlated with distances to the nearest live and dead branches, and accounted for 16.9% of the variance. The 3rd component was positively correlated with position and negatively correlated with the sine and cosine of aspect. These 1st 3 principal compo-

Table 2. Principal component analysis of day- and night-bedding sites of white-tailed deer based on habitat variables.

| Variable | Component | | |
|---|---|---|---|
| | 1 (25)[a] | 2 (42) | 3 (54) |
| Overhead cover, % | 0.900 | 0 | 0 |
| Conifer composition, % | 0.867 | 0 | 0 |
| Distance to nearest tree, m | −0.560 | 0.377 | 0 |
| Distance to nearest live branch, m | 0 | 0.756 | 0 |
| Distance to nearest dead branch, m | −0.404 | 0.635 | 0 |
| Diameter of nearest tree, cm | 0.349 | 0.530 | 0 |
| Position | 0 | 0 | 0.684 |
| Cosine aspect | 0 | 0 | −0.562 |
| Sine aspect | 0 | 0 | −0.504 |

[a] Cumulative percentage of variance explained. Columns appear in decreasing order of variance explained. Loadings less than 0.25 have been replaced by 0.

nents represented 53.9% of the variance in the data.

Evidence of browsing was observed at 84 night beds (25.7%) and 63 day beds (64.9%), a significant association between presence of browsing and type of site ($\chi^2 = 50.7$, df = 1, $P < 0.05$). Although quantitative data were not recorded, several night-bed locations were used during both winters. No re-use of day beds in successive winters was observed.

## DISCUSSION

Night beds selected by white-tailed deer in Ontario were similar to those chosen in other studies (Robinson 1960, Gill 1966, Verme 1966, Euler and Thurston 1980). Beds were surrounded by several coniferous trees, under a dense, deep canopy, near the bole of a coniferous tree, and close to low branches. Together, these factors would combine to conserve energy, as they minimize wind flow, radiant heat loss, and thermal spread (Verme 1966, Ozoga 1968). Reduced snow accumulation reduces its insulative value, but facilitates travel. Many of the night-bedding sites were used repeatedly during the winter, and in some cases over successive winters, suggesting specific habitat selection.

The lower conifer composition and overhead cover of day beds, combined with their topographic position, independence of tree distance, and southern and western orientation served to increase insolation, thereby reducing deer energy expenditure during late winter. As late winter can be a critical time for deer, minimization of energy expenditures by optimization of day and night bedding-site locations should increase survival and recruitment (Kucera 1976, Verme 1978).

The DFA identified the habitat conditions required for bedding under extreme conditions. Deer bedding under less extreme conditions would occupy positions within the continuum of conifer composition and overhead cover described by the DFA. The dual nature of bedding sites should be considered when assessing habitat quality or use (Nowosad 1968, Gates and Harman 1980).

Snow depth at day-bed sites was much greater than at night bed sites due to lack of cover. Day beds were shallower than night sites and they were not used as consistently or for as long a period. Deep snow necessitates that day-bedding areas be adjacent to travel lanes maintained under dense cover. This has previously been shown to be the case in central Ontario winter concentration areas (Armstrong et al. 1983). Heavy crust conditions, snowmobile trails, and roads were used to gain access to some day-bedding areas further from cover. In undisturbed locations deer also bedded during the day on the leeward side of islands and the mainland. Day-bedding sites were more consistently used for browsing than were night sites, although overall browsing pressure was light (Armstrong et al. 1983).

Similar active bed group sizes suggest that group characteristics do not differ appreciably during night and day bedding activities (2.7 and 3.1, respectively). Group sizes were similar to those in Quebec and Virginia during January (2.9) (Coe 1974, Huot 1974).

Most day and night beds were high up on slopes. Others have considered ridge tops favorable only for day sites (Stocker and Gilbert 1977). In central Ontario, coniferous-dominated ridges provide both travel lanes and night-bedding areas. Night beds were located on north-facing slopes where much of the hemlock cover was concentrated. North-facing sites provide suitable microclimatic conditions, indicating that aspect is not as important a consideration for night beds in this area as it is in Quebec, where deer avoided northerly-facing slopes for bedding (Huot 1974).

The variance from the PCA for all bedding sites was grouped along 3 main axes describing habitat diversity according to the amount and adjacency of overhead cover, vertical cover (tree size, distance to tree and branch), and compass orientation. The presence of such diversity in a wintering area requires both topographic relief and floral diversity. These concentration areas provide a type of wintering habitat much different from the lowland coniferous areas often used elsewhere (Verme 1966, Rongstad and Tester 1969, Larson et al. 1978). Both day- and night-bedding sites are used by deer in central Ontario and management activities should attempt to ensure their presence, availability, and optimum distribution.

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## ERUPTION PATTERNS OF SELECTED TEETH IN THREE NORTH AMERICAN MOOSE POPULATIONS

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There is little published information on timing of tooth eruption in North American moose (*Alces alces*). Peterson (1955) provides the only description based on a small sample of mandibles from Ontario. During studies of gray wolf (*Canis lupus*)–moose relationships on the Kenai Peninsula, Alaska and Isle Royale, Michigan, substantial differences in tooth eruption between the 2 moose populations were evident. Virtually all wolf-killed Isle Royale moose calves examined after January (8 months old) had permanent first incisors ($I_1$), whereas no wild moose calves from the Kenai had permanent $I_1$'s before April (10 months old). Tooth eruption was highly variable even within a population. Five captive moose calves from the Kenai feeding ad libitum on a balanced ration exhibited a tooth eruption sequence far advanced over their wild counterparts.

Robinette et al. (1977) found that incisor eruption in a mule deer (*Odocoileus hemionus*) cohort was delayed following a severe winter. This suggested that tooth eruption might be a useful index to moose condition, especially within a single population where genetic differences are minimized. The objectives of this paper are to examine timing of tooth eruption for 3 moose populations and assess the potential usefulness of tooth eruption as an index to moose condition.

## STUDY AREA AND METHODS

Tooth eruption of calf moose was examined in winter in the Nelchina Basin and Kenai Peninsula, Alaska during 1976–79 and from 1971 to 1982 at Isle Royale National Park, Michigan. Calves in the Nelchina Basin ($N = 96$) were examined live after being immobilized with etorphine hydrochloride (M-99) (D-M Pharmaceuticals, Inc., Rockville, Md.) (W. B. Ballard and C. L. Gardner, unpubl. rep., Alaska Dep. Fish and Game Fed. Aid Proj.