CHARACTERISTICS OF WINTER BED SITES OF MOOSE IN MICHIGAN

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ABSTRACT: Eighty-three bed sites of 4 adult male moose (*Alces alces*) and 3 adult females with calves were analyzed in winter 1987-88 to define vegetational and physical features chosen by members of a newly established population in Michigan. During early winter, moose bedded primarily in areas dominated by sugar maple (*Acer saccharum*). In late winter, sites containing eastern hemlock (*Tsuga canadensis*) were selected over other habitat types. Eighty-three percent of late winter cow beds were associated with conifer trees, where young hemlocks and balsam firs occurred in the shrub layer. All late winter calf beds (N = 18) examined were associated with hemlock and balsam fir. Shrubs at calf beds in late winter were dominated by sugar maple and red maple (*Acer rubrum*). Beds of bulls in late winter were primarily associated with an overstory of balsam fir and hemlock, where sugar maple, balsam fir, and red maple dominated the shrub layer. Canopy closure appeared unimportant in early winter, but in late winter bulls, cows, and calves chose denser canopy than could be attributed to chance, particularly in hemlock-dominated stands. In early winter, snow depths (<50 cm) did not influence bed site selection whereas in late winter, moose significantly chose areas with shallow snow for bed sites. Management recommendations to maintain late winter moose habitat include maintenance and creation of small stands of hemlock and balsam fir.

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In the winters of 1985 and 1987, 59 adult moose (*Alces alces*) were translocated from Algonquin Park, Ontario, to Marquette County, Michigan, in an attempt to reestablish a viable population in the state (Schmitt and Aho 1988). Long-term survival of the introduced population may depend upon freedom from significant levels of disease and poaching, and availability of suitable habitat.

Studies of winter bedding habitat of moose in northeastern North America suggest that coniferous cover is an important component of winter range (McNicol and Gilbert 1978, Des Meules 1964). Most researchers have found that moose move into increasingly heavy coniferous cover as winter progresses (Telfer 1970, Thompson and Vukelich 1981, Rolley and Keith 1980). In Upper Michigan, growing demands for hardwood fiber could result in removal of conifer trees to accommodate growth of more financially valuable deciduous species, primarily sugar maple (R. Aho, Michigan DNR, pers. comm.). Information on specific cover requirements of moose may be used to develop forest harvest policies that benefit moose populations in the transition zone between the temperate deciduous and the boreal coniferous forests.

The objectives of this study, conducted in the winter of 1987-88, were to answer the following questions about the habitat chosen by the newly established Michigan moose population: (1) Do moose select coniferous cover for winter bedding sites? (2) If so, which species of conifer are preferred? (3) Are bed sites chosen for canopy closure, snow depth, snow density, or a combination of these factors? (4) Do moose of different age and sex categories have different winter bedding requirements?

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STUDY AREA

The study area was located within a 2600 km^2 area lying between Marquette and L'Anse, Michigan, north of U.S. Highway 41 (Figure 1) which, based on information obtained by radio telemetry, is where 98 percent of the released moose remained. At the end of the winter, a minimum convex polygon (Jennrich and Turner 1969) was drawn around all bed site locations used in this study. The area within this polygon (the reduced study area) covered approximately 207 km^2 and was located in northwestern Marquette County and northeastern Baraga County. Vegetation in the uplands was classified by Kuchler (1964) as northern hardwoods-fir, consisting primarily of sugar maple, red maple (*Acer rubrum*), white birch (*Betula papyrifera*), and yellow birch (*Betula alleghaniensis*), with low-lying areas dominated by conifers such as balsam fir (*Abies balsamea*), black spruce (*Picea mariana*), and white cedar (*Thuja occidentalis*).

Elevation of the study area ranges from 182 to 568 m above sea level, and topography consists of irregular granite hills (< 100 m high) with a general east-west orientation, separated by swamps and lakes (Brooks *et al.* 1873). Soils are generally shallow, with rock formations frequently at the surface (Allen 1911).

The winter of 1987-88, when this study was conducted, was warmer than average. Snowfall of 738 cm was 135 cm above the mean (National Weather Service data), with accumulations up to 130 cm in mid-March.

METHODS

Selecting Moose and Defining Winter Periods

Study moose (4 bulls and 3 cows with 1 calf each) were selected randomly from among 50 radio-collared animals, with the condition that they were located in the broad study area and could be approached within 1 day by vehicle and foot travel. Beds of 4 other bulls traveling with some of the selected bulls were also analyzed. Eighty-three beds were analyzed of which there were 21 calf, 22 cow, 39 bull, and 1 of an adult moose of unknown

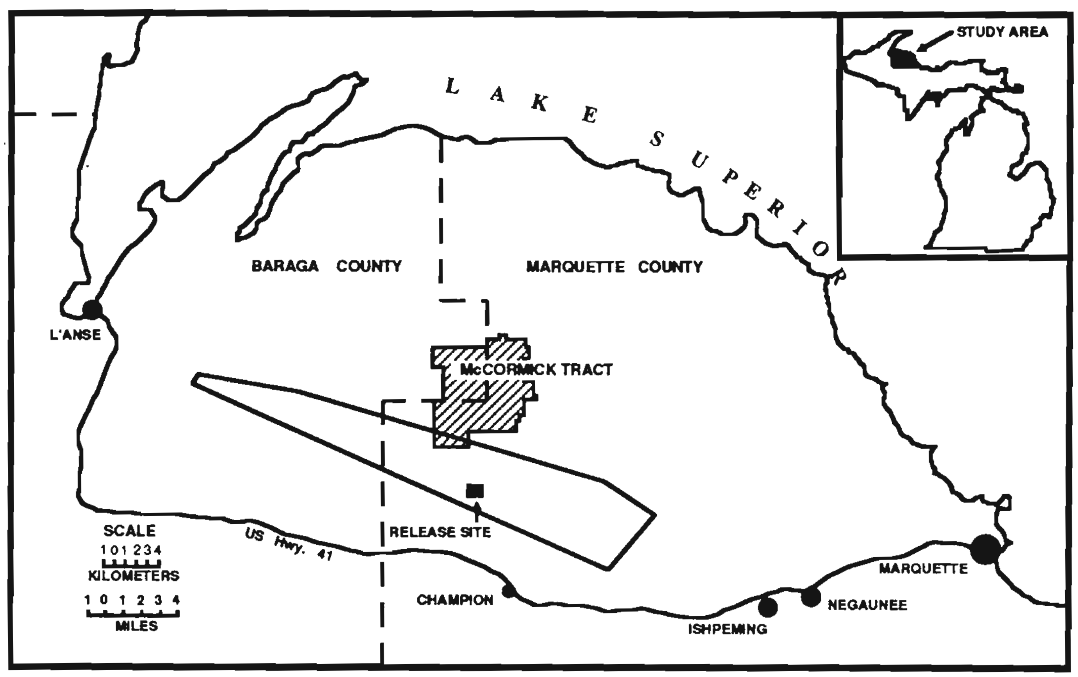

Fig. 1. Map of the study area in the Upper Peninsula of Michigan.

sex. The winter was divided into early (22 Dec - 17 Jan) and late (18 Jan - 26 Mar) periods. Late winter was considered to begin when snow depth exceeded 50 cm, representing 2/3 of the maximum depth through which moose can travel without serious impediment (Peterson 1955).

Locating Beds and Describing Vegetative and Physical Features

General locations of moose were identified by radio telemetry from an airplane about once a week. Exact locations were obtained from the ground, with the researcher on snowshoes following the radio signals until the moose were flushed or fresh tracks were found. Moose were back-tracked to the first fresh bed.

At each bed, trees and shrubs were sampled using the point-quarter method (Cottam and Curtis 1956), with the point located at the center of the bed. Features described included species composition, stem density, frequency, and diameter breast high (DBH) of trees (woody plants with DBH $\geq$ 10 cm), and species, density, and height of "shrubs" (woody plants with DBH < 10 cm and height $\geq$ 61 cm). Frequency was defined as (number of points at which a species occurred/total number of points) X 100. Similar data were collected from a paired site, located 185 m north of each bed site, from which similar data were collected for statistical comparisons. No paired data were recorded for calves' beds as their locations were not considered to be independent of their mother's bed sites.

Distance and direction of paired data sites were selected non-randomly because of the height of ridges (~100 m) and general east-west orientation of ridges. Comparisons of aspect and vegetation might reflect a specific and systematic selection by moose, especially for aspect and slope within a small area. To determine whether a selection of habitat within a broad area occurred, vegetation data from throughout the reduced study area were gathered at 46 random points, chosen randomly by coding the town, range and section numbers of each township (Arkin and Colton 1957). The 46 points represented 53% of section corners in the reduced study area.

Tested null hypotheses were that no differences occurred between moose beds, paired sites, and random sites in forest habitat type (tree species composition), tree density, tree species occurrence, shrub species, shrub density, early winter and late winter canopy cover, snow depths, and snow compaction. Statistical methods varied with particular hypotheses and will be described in the results.

Canopy closure to the nearest 1% was measured over beds and paired data sites using a forest densiometer (Lemmon 1957). Canopy closure readings were not taken at the stratified random points, because vegetation analysis at these sites was done in the spring when leaves were beginning to open.

Snow conditions analyzed at each bed site and paired data site were: snow depth, snow compaction, and bed depth in the snow. For each of these features, readings were taken in the 4 cardinal directions from the center of the bed, and averaged. Snow depth was measured by sinking a meter stick to the ground just outside of the bed. Compaction was measured just outside of the bed using a gauge (a 61-cm long, 2.5-cm diameter, lead-filled copper pipe adjusted to weigh 1.1 kg) (Verme 1968). Bed depth was measured as the vertical distance from the level of undisturbed snow next to the bed to the bottom of the bed.

Other Measurements

Other measurements made at bed sites and paired data sites were: inclination measured with a clinometer, aspect, determined by compass aimed downhill, and wind speed and direction, using an anemometer and a wind vane, respectively.

Vegetation Use and Preference

To test vegetational preferences of moose, the forest was divided into 5 types identified for trees and shrubs:

1. Hardwoods: sites at which only deciduous species appeared among the 4 trees in the point-quarter analysis.
2. Balsam fir: sites at which balsam fir occurred with any other species except hemlock.
3. Hemlock: sites at which at least one hemlock occurred with any other species except balsam fir.
4. Hemlock-Balsam fir: sites that incorporated at least one hemlock and one balsam fir.
5. Other conifers: sites at which at least one conifer occurred that was neither a balsam fir nor a hemlock.

The tree species that made up each group and their availability ranking are shown in Table 1. The availability ranking was determined according to the number of sites in the random data that belonged to each particular habitat type, with the most frequently occurring type receiving the highest ranking. Thus, "hardwood" and "balsam fir" were tied for first in availability, "other conifers" was third, etc.

Table 1. List of tree and shrub species composition of each habitat type, and availability based upon 46 random points.

Habitat Type	Availability Ranking	Species Included
Hardwood (any combination)	1.5	Sugar maple (*Acer saccharum*)
		Red maple (*A. rubrum*)
		Mountain maple (*A. spicatum*)
		Yellow birch (*Betula alleghaniensis*)
		White birch, (*B. papyrifera*)
		Pin cherry (*Prunus pensylvanicus*)
		Black cherry (*P. serotina*)
		Hazel (*Corylus rostrata*)
		Ash (*Fraxinus* spp.)
		Willow (*Salix* spp.)
		Serviceberry (*Amelanchier* spp.)
		Speckled alder (*Alnus rugosa*)
		American elder (*Sambucus canadensis*)
		Ironwood (*Ostrya virginiana*)
		Red oak (*Quercus rubra*)
		Aspen (*Populus* spp.)
Balsam fir	1.5	Balsam fir (*Abies balsamea*)
		Balsam fir + hardwood
		Balsam fir + other conifers
Other Conifers (any combination)	3	Black spruce (*Picea mariana*)
		White cedar (*Thuja occidentalis*)
		Tamarack (*Larix laricina*)
		Jack pine (*Pinus banksiana*)
		White pine (*P. strobus*)
		White spruce (*Picea glauca*)
Hemlock-Balsam fir	4	Hemlock (*Tsuga canadensis*) + Balsam fir
		Hemlock, Balsam fir and other conifers
Hemlock	5	Hemlock
		Hemlock + hardwood
		Hemlock + other conifers

RESULTS

Woody vegetation present on the study area was quantitatively characterized by samples taken at the 46 random points. Tree density was 710 trees/ha, with basal area of trees ≥ 10 cm DBH totaling 15.3 m^2/ha. Trees were dominated by sugar maple with 35% of the stems, followed by balsam fir, red maple, black spruce, yellow birch, white cedar, white spruce (*Picea glauca*), pin cherry (*Prunus pensylvanicus*), white pine (*Pinus strobus*), and aspens (*Populus tremuloides* and *P. grandidentata*). These 11 species made up 98.5% of the stems sampled. Shrubs occurred at a density of 4390 stems/ha, with the 10 leading species in decreasing abundance as follows: sugar maple, balsam fir, red maple, black spruce, pin cherry, black cherry (*Prunus serotina*), mountain maple (*Acer spicatum*), beaked hazel (*Corylus rostrata*), yellow birch, and white cedar. Eastern hemlock constituted only 0.5% of the tree stems and 1.5% of the stems in the shrub layer.

Vegetative Characteristics of Bed Sites

A test for preference of vegetation types (Johnson 1980) using all moose beds during the late winter period (Table 2) showed that the hemlock type was selected over all other types ($P < 0.05$), and that the balsam fir and balsam- hemlock types were significantly selected over the hardwoods type ($P < 0.05$). Likewise, moose showed a significant preference ($P < 0.05$) for locations in which shrubs consisted of hemlock, balsam fir, and balsam-hemlock types, and an avoidance of other conifer and hardwood shrub types (Table 2).

In early winter, sample sizes (N = 17) were too small to conduct preference tests, but 8 beds were associated with hardwoods, 4 with hemlock, 4 with balsam fir, and 1 with other conifers. In view of the low availability of conifers on the study area, there was an apparent selection for coniferous cover. However bed sites were located in relatively open habitats where conifer crowns had minimal effect on beds.

Cows moved into more evergreen cover with increased severity of winter. A decrease in usage of sugar maple in late winter was accompanied by increases in occurrence and density of hemlock and balsam fir (Table 3). Comparison of bed sites with paired data sites was done using a X^2 test comparing 6 vegetation categories, sugar maple, red maple, hemlock, balsam fir, birch-ash (*Fraxinus nigra*)-serviceberry (*Amelanchier* spp.), and spruce-

Table 2. Ranks of habitat types available and used at moose bed sites, trees and shrubs, winter 1987-88.

	Trees		Shrubs	
Habitat Type	Availability Rank	Use Rank	Availability Rank	Use Rank
Hardwood	1.5	3	2	4
Balsam fir	1.5	1.5	4	2
Other conifers	3	4.5	1	5
Hemlock-Balsam	4	4.5	3	3
Hemlock	5	1.5	5	1

Preference tests (Johnson 1980) on tree habitat showed significant preferences ($p < 0.05$) for hemlock over hemlock-balsam, balsam fir, hardwood, and other conifers, balsam fir over hardwood, hemlock, and hemlock-balsam over hardwood.

Preference tests on shrub habitat showed significant preferences ($p < 0.5$) in shrub types for hemlock over hardwood and other conifers, hemlock-balsam over hardwood and other conifers, and balsam over hardwood and other conifers.

Table 3. Comparison of sugar maple, hemlock, and balsam fir at early and late winter cow moose beds. (N - 4 early, 18 late)

	Period	
Feature	Early	Late
Trees		
Frequency (% Occurrence per bed site)		
Sugar maple	100	67
Hemlock	50	56
Balsam fir	0	33
Relative Density (% of stems)		
Sugar maple	75	25
Hemlock	13	25
Balsam fir	0	14
Density (Trees/ha)		
Sugar maple	243	151
Hemlock	40	151
Balsam fir	0	84

cedar. Results indicated selection of conifer trees, ($X^2 = 19.52$, 5 df $P < .01$), with hemlock and balsam fir the preferred species (Table 4).

Among shrubs, balsam occurred more abundantly at beds than at paired sites. Hemlock constituted only 8% of the stems near beds,but none were found at paired sites. No difference in relative density of sugar maple shrubs was found (Table 4). Nevertheless, a contingency test with all conifers pooled indicated a significantly larger proportion of conifer shrubs at beds than at paired sites ($X^2 = 11.57$, 1 df $P < .005$).

Shrubs at the bed sites were primarily sugar maple (41% of stems) with an average height of 2.9 $\pm$ 2.3 m, and balsam fir (35% of stems) with an average height of 2.1 $\pm$ 1.33 m. Balsam fir, with 24 stems *vs* 11 at paired sites, and hemlock, with 6 stems *vs* 0 at paired sites, contributed to a significant difference between species composition at bed sites *vs* paired data sites (Chi-square = 11.97, 4 df, $P < .05$).

Table 4. Comparison of relative density of trees and shrubs at late winter cow moose beds with paired data sites. (N = 18, 17)

	Bed	Paired Site
Trees (% of stems)		
Sugar maple	25	37
Hemlock	26	3
Balsam fir	15	7
Shrubs (% of stems)		
Sugar maple	41	41
Hemlock	8	0
Balsam fir	35	16

All 18 late winter calf beds were associated with conifers (Table 5), habitat similar to that at late winter cow beds. Density of deciduous trees declined from 456 in early winter to 318 trees/ha in late winter while conifers increased from 0 to 337 trees/ha, with hemlock making up 182 trees/ha. A contingency test indicated that frequencies of occurrence of tree species at bed sites were significantly different from those at paired data sites ($X^2 = 22.12$, 6 df, $P < .01$). Deciduous species were found less at bed sites than at paired sites (34 *vs* 48 stems), while hemlock was found to be more abundant at bed sites (20 *vs* 2 stems).

Bull Beds. Bulls showed fewer changes than cows and calves in bed site selection between early and late winter (Table 6). Considering three indicative species, sugar maple declined in frequency and relative density, balsam fir increased in frequency and relative density, but hemlock remained essentially the same in both frequency and relative density. Contingency tests comparing densities of trees and

Table 5. Comparison of tree density, frequency, and mean DBH at early winter (EW; N = 3) vs. late winter (LW; N = 18) calf bed sites.

Species	Density (stems/ha)		Frequency		DBH (cm)	
	EW	LW	EW	LW	EW	LW
Deciduous						
Sugar maple	380	191	100	71	21	29
Yellow birch	76	27	33	11	27	41
Red maple	0	82	0	39	--	32
White birch	0	18	0	6	--	32
Coniferous						
Hemlock	0	182	0	67	--	42
Balsam fir	0	55	0	22	--	12
Cedar	0	46	0	22	--	31
Slack spruce	0	36	0	11	--	28
White spruce	0	18	0	11	--	27

shrubs between bull bed sites and paired data sites revealed no significant differences (X^2 = 12.04, 8 df $P > .10$; $X^2 = 4.25$, 6 df $P > .50$, respectively).

Canopy Closure

An exceptional cold period occurred from 3-14 Jan, during which temperatures seldom rose above -17°C and minimums were near -38°C. During the first 10 days of this period, moose showed no noticeable change in habitat. On 12 Jan a storm resulted in increased snow depths from approximately 40 to 77 cm. Cow and calf beds measured 18 Jan showed an increase from approximately 30% (N = 7) to 74% (N = 18) canopy closure. This observation suggests that snow depth, not cold temperature, was the stimulus that caused the shift in vegetation use between early and late winter. No significant difference (single classification ANOVA, Sokal and Rohlf 1981) in canopy closure was found among the 4 cardinal directions regardless of which combination of animal groups were considered; all beds (N = 83, $P = .864$), cow beds only (N = 22, $P = .776$), calf beds only (N = 21, $P = .990$), or bull beds only (N = 39, $P = .820$).

Table 6. Comparison of vegetative features at bull beds, early (N = 10) *vs*. late winter. (N = 29)

Trees	Winter Period	
	Early	Late
Frequency (%)		
Sugar maple	100	59
Balsam fir	40	62
Hemlock	20	21
Relative Density (%)		
Sugar maple	67	29
Balsam fir	13	23
Hemlock	5	5
DBH (x +/- SD)		
Sugar maple	25.0 +/- 12.2 cm	27.0 +/- 8.0 cm
Balsam fir	14.0 +/- 5.1	16.1 +/- 5.2
Hemlock	23.0 +/- 0.3	60.5 +/- 14.9

Canopy closure was significantly greater, however, at bed sites (N = 83, 54.9 ± 25.5%) than at paired data sites (N = 61, 31.5 ± 14.2%), ($P < .001$). Similar results were found when cows ($P < .001$), calves ($P < .001$), and bulls ($P < .002$) were considered separately. This indicated that moose selected denser canopy closure than was generally available in their surroundings during the winter months.

In early winter, no significant differences were found in canopy closure between bed sites and paired sites. However, in late winter all 3 groups used significantly denser canopy closures. Calves used the heaviest canopy closure (74.0 ± 18.9%) followed by cows (65.6 ± 21.7%) and bulls (52.1 ± 22.9). It appeared that of the three animal groups, only the bulls selected bed sites that had a southerly exposure. Of 23 bull beds on sloping ground, 17 were located on hillsides facing south, from 91 - 269° ($P < .02$, binomial distribution, Sokal and Rohlf 1981).

Snow Depth

During the early winter, snow depth at the calf beds, cow beds, and bull beds averaged 42.6 ± 3.6, 40.8 ± 4.6, and 51.2 ± 12.8 cm, respectively. These depths were not significantly different from the 40.4 ± 4.8 cm found at the paired data sites for cows and calves or the 49.7 ± 20.2 cm found at the paired data sites for bulls. It appears that snow depth was probably not a factor determining bed selection in early winter.

In late winter, snow depth at cow beds averaged slightly greater than at beds of calves and bulls (Table 7). Depths at beds of all three animal groups were significantly less than their corresponding paired data points. Snow depths at the paired data sites exceeded the maximum depths through which an animal can travel without serious impediment (Peterson 1955, Pierce 1984).

DISCUSSION

Interpretation of Vegetation Usage

Bulls and cows with calves all made increased use of coniferous cover for bed sites from early to late winter. Cows and calves bedded in hemlock stands more often while bulls chose areas with balsam fir. Our data parallels results of other workers that moose tend to move from open hardwoods into increasingly heavier coniferous cover as winter progresses (Telfer 1970, Peterson 1977, McNicol 1976, Rolley and Keith 1980, Thompson and Vukelich 1981, Doerr 1983). An observed increase in the occurrence of red maple at beds in late winter probably occurred because of coincidental association of maple with balsam fir (Curtis 1959), rather than selection of red maple for browse by moose.

There are two possible reasons for bulls using balsam fir habitat more than hemlock habitat. First, while balsam fir does not provide as dense a canopy cover as hemlock, it does reduce snow depths to some extent while also providing a favored browse (Franzmann 1978). Balsam fir was also much more abundant than hemlock, and it may not have been energy efficient for bulls to search out the hemlock cover.

The difference in vegetation selected by cows with calves that we observed in Michigan agrees with results of researchers in other parts of North American moose range. Peek (1971), Peterson (1977), and Thompson and Vukelich (1981) all pointed out that cows with calves sought heavier cover than did other adult animals. Peterson (1977) and Thompson and Vukelich (1981) felt that this may have been due to predator, mainly wolf (*Canis lupus*), avoidance, while Peek (1971) suggested that it may be the calves' need for shallower snow that caused this shift.

Snow Depth and Canopy Closure

Canopy closure may have been the most important factor affecting the selection of a bedding site in late winter. Comparison of the 5 habitat types showed that preference rating varied directly with the amount of canopy

Table 7. Average snow depths (in cm) at late winter bed sites and paired data sites for all three animal groups.

Animal Group	N	Snow Depth-Beds	Snow Depths-Paired	*P*
Cows	18	62.5 ± 9.6	78.8 ± 15.7	<.001
Calves	18	58.3 ± 12.6	78.89 ± 15.7	<.001
Bulls	29	58.5 ± 15.7	73.7 ± 21.4	<.001

closure provided by the habitat (Table 8). Crete (1976) found that frequentation of habitat by moose varied according to the number of stems in the feeding stratum and the amount of canopy closure. He found that areas with an average of 36 - 56% canopy closure received the most concentrated use. It appears that bed site selection by cows in our study may have been influenced by the presence of their calves, and that the cows sought heavier cover for the calves, as suggested by Peek (1971), Peterson (1977), and Thompson and Vukelich (1981). We noted, however, that cow beds were often found on the fringes of the coniferous stands (usually hemlock), while the calf beds were usually located directly under the canopy of the conifers.

Selection for closed canopy between early and late winter would also suggest selection for larger trees. Mean diameters of 3 tree species, sugar maple, balsam fir, and hemlock, between early and late winter at bull beds only were compared by t-tests. Sample sizes in early winter for balsam fir and hemlock were too small (0 and 2), for calves and cows, respectively. Mean DBH of sugar maple between early and late winter bull beds were 25.0 ± 12.2 and 27.0 ± 8.0, and of balsam fir were 14.0 ± 5.1 and 16.1 ± 5.2 cm. Neither difference was significant ($P > 0.80$). Hemlock, however, with the only 2 trees in the early winter sample averaging 23.0 ± 0.3 cm, was significantly larger near late winter beds, with 11 trees averaging 60.5 ± 14.9 cm ($t = 24.28$, 11 df, $P < .001$). Maple canopy provides little interception of snow, while balsam fir in dense stands can act as a snow barrier, scattered trees with relatively narrow crowns, are not so effective. Moose in late winter probably selected areas beneath the spreading canopy of larger hemlocks, under which relief from deep snow was most likely to be found.

Bulls tended to bed in areas with less canopy closure than used by cows with calves. Moen (1973) indicated that the dark coat of the moose can absorb much of the solar radiation available and could reduce the thermal gradients in the animal's hair, thus reducing the heat loss through conduction.

Our findings indicated that moose selected sites with snow depths less than the impeding levels in late winter. Des Meules (1964) also found that in early winter, moose bed down where the soft snow is deeper, i.e., in recent cutover stands or hardwoods. He suggested that this is because the animals are using the snow's insulating properties to protect themselves from heat loss. He further suggested that the animals stay in that type of habitat until the snow depth reaches the point at which it begins to impede movement, and then move into heavier cover. He contended that the preferred snow condition for bedding is a layer of soft snow at least (51 - 61 cm) deep, with the upper tolerance level being the depth where movement is impeded. According to Peterson (1955), movement through snow becomes difficult when the belly of a moose begins to drag. Peterson (1955) also found that when snow depths reached 76.2 cm, moose moved into heavier cover where snow depths were less. Pierce (1984) found

Table 8. Preference ranking and average canopy closure for each of the five habitat types based on late winter bed sites (N = 66).

Habitat Type	N	Preference	% Canopy Closure
Hemlock	25	1	75.1 ± 3.1
Balsam-Hemlock	4	2	74.8 ± 4.3
Balsam fir	24	3	57.1 ± 5.0
Other Conifers	7	4	45.8 ± 6.9
Hardwood	6	5	33.9 ± 8.1

that Shiras moose (*Alces alces shirasi*) in north-central Idaho roamed at will until snow depths in open areas reached 70 cm. At that point they restricted their movements to the forested areas.

SUGGESTIONS FOR WINTER MOOSE HABITAT MANAGEMENT

Observations of bedding sites of bull moose and cows with calves indicated that recently introduced moose in Michigan exhibit similar habitat selection tendencies during the winter as do moose in other parts of the North American moose range. They occupied upland hardwood forest areas early in the winter and moved into heavier conifer cover as snow accumulation made traveling difficult. In the Upper Peninsula study area, the habitat preferred by moose for bedding in late winter was hemlock. Hemlock occurred in groups of a few large trees within larger uneven-aged sugar maple stands. Cows with calves appeared to require more hemlock cover owing to reduced snow depths compared to bulls.

The following habitat management suggestions are made for Michigan and other areas with similar climate and vegetation characteristics:

1. Small stands of hemlocks should be preserved or created among northern hardwoods dominated by sugar maple. This would provide habitat that meets both the nutritional and shelter needs of the moose, in particular cows with calves.
2. Dense stands of balsam fir should be preserved as long as they provide reachable browse. This species, while not as effective a canopy as hemlock, does apparently provide sufficient cover for bulls, at the same time providing a palatable food item.

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