WINTER HABITAT USE BY MOOSE IN SOUTHEASTERN ALASKA: IMPLICATIONS FOR FOREST MANAGEMENT

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ABSTRACT: Habitat use by moose (*Alces alces*) was monitored via radio telemetry from November 1981 through April 1983, a period that included a low-snow and a high-snow winter. In the low-snow winter, moose used coniferous, mixed hardwood/conifer, and cut areas in proportion to availability, preferred deciduous stands, and avoided open areas. In the high-snow winter, moose altered their habitat use by utilizing coniferous and mixed stands significantly more, and deciduous and cut areas significantly less, than in the low-snow winter. Moose avoided snow >80 cm deep. Implications for forest management are discussed.

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The effect of timber management on moose populations has been debated for years, particularly in southeastern Alaska where logging of the coastal rain forest has the potential to influence small, isolated moose populations in the region's larger mainland river drainages. Clearcuttings have been reported as beneficial to moose populations (Bergerud and Manuel 1968, Markgren 1974, Ahlen 1975, Peek *et al.* 1976, Doerr *et al.* 1980) because they provide browse during autumn and low-snow winters; therefore, logging might be viewed as an important habitat management tool. However, use of coniferous stands by moose during deep snow conditions was reported by Telfer (1970), Van Ballenberghe and Peek (1971), Peek *et al.* (1976), Doerr *et al.* (1980), and Brusnyk and Gilbert (1983). A better understanding of habitat utilization by moose in areas subjected to clearcut logging is needed to facilitate effective forest planning and moose management.

STUDY AREA

The study area was located in the Chilkat River watershed in the northern portion of southeastern Alaska, near the community of Haines. Approximately 580 km^2 of summer range and 300 km^2 of winter range supported a stable population of between 400-500 moose. The topography of the study area was typical of the coastal mountain region of southeastern Alaska, and consisted of adjoining mountain valleys characterized by glacial features. The river valleys are narrow, deep, and V-shaped as a result of glacial action. The rivers are shallow, meandering, and silt-laden, and often terminate in large alluvial fans. Adjacent to the mouth of the Chilkat River was a large flat expanse formed by sediment deposited by tributary streams and by isostatic rebounding of the Chilkat delta following glacial retreat. The resultant scarring and deposition produced a wide variety of seral vegetative associations.

The vegetation on upland slopes of the study area was characterized by Sitka spruce-western hemlock (*Picea sitchensis-Tsuga heterophylla*) forest with a hardwood component of black cottonwood (*Populus trichocarpa*) and paper birch (*Betula papyrifera*), the abundance of which varied depending upon site quality. Drier slopes supported stands of lodgepole pine (*Pinus contorta*) mixed among hardwoods, interspersed with small heath (*Cassiope* spp.) meadows. Mountain hemlock (*Tsuga mertensiana*) was found at higher elevations. Lowland valleys contained a wide variety of vegetation communities ranging from pioneer communities of willow (*Salix* spp.) and alder (*Alnus* spp.) to young stands of climax spruce-hemlock forest and mature stands of cottonwood. Between 1960 and 1978 a total of 5116 ha (22 harvest areas, range 10-800 ha) of spruce and cottonwood stands on moose winter range, representing approximately 17% of available winter habitat, was clearcut (Alaska Dept. Natural Resources, unpublished data) and allowed to regenerate naturally.

METHODS

Twenty adult moose (4 males, 16 females) were immobilized in October 1981 with the aid of a helicopter. A mixture of etorphine and xylazine hydrochloride was used as the immobilizing agent. The drugs were administered via 10cc darts fired from a Palmer Cap-Chur gun. Diprenorphine was administered by hand as an antagonist. Each immobilized moose was fitted with a radio-instrumented collar (Telonics, Mesa, AZ).

From November 1981 through April 1982 and during the same period in 1982-83, aerial relocations of radio-instrumented moose were obtained approximately twice monthly, except in February 1982 when no flights were conducted due to poor weather. Relocations were recorded on 1:63,360 scale U.S.G.S. topographic maps. Whenever possible, radio-instrumented moose were located visually from the air.

Moose movements were monitored to determine the periods during which individuals occupied winter home ranges. Migratory moose (those with distinct summer and winter home ranges) were considered to be on winter range when movements stabilized around a central locus after a distinct deviation from a previous (summer) locus. Resident moose were considered to be on winter range when a majority of migratory moose had made the transition. The same reasoning was used to define movements back to summer range.

Habitats were placed into 5 general types (coniferous, deciduous, mixed hardwood/conifer, clearcuttings, and open areas). Coniferous types were defined as areas with a dominant coniferous overstory. Deciduous types were stands of merchantable hardwoods (e.g. paper birch, black cottonwood, or a combination thereof) and alder and willow thickets. Mixed hardwood/conifer stands contained codominant coniferous and deciduous species in the overstory, primarily spruce and black cottonwood. Clearcuttings were areas logged within the last 25 years. Open areas were frozen lakes, ponds, muskegs and rivers, as well as gravel bars and marshes.

Habitat availability was determined by randomly placing a dot grid overlay on cover type maps of the areas used by collared moose and determining the number of dots falling into a given habitat type. Differences between habitat use (relocations) and availability, and habitat use between years were tested by a Chi-square procedure (Marcum and Loftsgaarden 1980) which tested overall conformance of observed and expected values, and also generated simultaneous confidence intervals for each habitat type whereby it was possible to draw conclusions concerning preference/avoidance of specific types.

In February and March 1983 habitat utilization by moose in the lower Chilkat valley was sampled in a manner independent of aerial relocations. Randomly placed transects consisting of consecutive 10-x20-m plots were traversed in areas used by collared moose; 1948 total plots were examined. Data recorded for each plot included habitat type, number of fresh moose tracks, and snow depth (measured to the nearest 10 cm). Fresh tracks were defined as having sharp edges which had not been degraded by wind or sun, and were considered to be less than 48 hr old. Monthly snowfall data were obtained from the U. S. Dept. of Commerce climatological recording station in Haines, which was located on the boundary of the study area.

RESULTS

Total snowfall was 276 cm from October 1981-April 1982, and was 384 cm during the same period in 1982-83. The 15-yr mean annual snowfall for the period during which the Haines climatological station was operating (1973-87) was 336 cm. In addition to a difference in total snowfall between the 2 yrs, monthly differences were evident, with 73% (280 cm) of the total snowfall in the second winter occurring during January-March compared with 56% (155 cm) the first winter (Fig. 1).

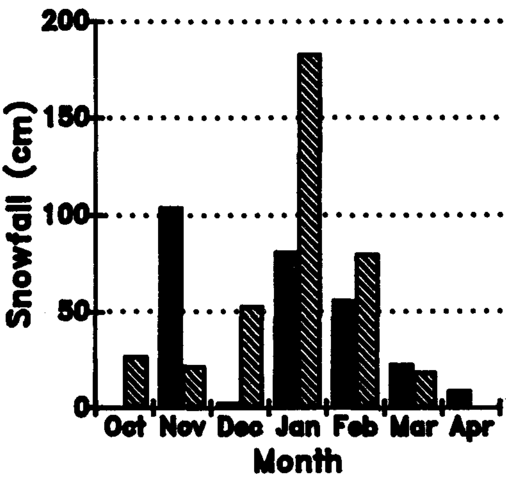

Fig. 1. Monthly snowfall recorded during the study at Haines, on the boundary of the study area, Chilkat valley, Alaska. Dark bars represent 1981-82, shaded bars represent 1982-83.

Radio-collared moose were relocated on winter range a total of 235 times during 1981-82 (20 moose) and 1982-83 (19 moose) combined. Mean dates of arrival on winter range were 10 January 1982 and 4 January 1983. Mean dates of last relocation on winter range were 25 March 1982 and 8 April 1983.

While on winter range, moose habitat use differed from availability in 1981-82 (X^2=48.0, d.f.=4, P<0.001) and in 1982-83 (X^2=39.2, d.f.=4, P<0.001). Also, habitat use in 1981-82 differed from that in 1982-83 (X^2=25.6, d.f.=4, P<0.001). In 1981-82 deciduous areas were preferred, coniferous, mixed, and cut areas were used in proportion to their availability, and open areas were avoided. In 1982-83 mixed stands were preferred, coniferous and deciduous stands were used as available, and cut and open areas were avoided. In 1982-83 coniferous and mixed stands were selected in greater proportion and deciduous and cut stands were used significantly less often than in 1981-82 (Table 1). Seasonal (Phillips *et al.* 1973, Irwin 1974, Peek *et al.* 1976) and annual (Peterson 1977) differences in use of habitats with an overstory canopy were reported for moose populations in other areas.

The significant increase in the use of coniferous habitat between the first and second winters may seem contradictory considering that this habitat type was used in relation to availability in both years (Table 1). However, these are 2 different standards of measure and are not inconsistent. The large (95%) simultaneous confidence intervals used in the analysis were conservative and failed to detect a difference between use and availability in coniferous stands. However, direct comparison of use in the 2 yrs revealed a statistically, and we believe biologically, significant increase.

Ground transects - February/March 1983

Measured snow depths ranged from 0-170 cm. Mean snow depths for habitat types ranged from 47-77 cm with cut areas exhibiting the greatest depths (Table 2). Of all fresh moose tracks encountered on the transects, only 3% were in snow depths of >80 cm (Fig. 2), whereas 18% of all plots had snow depths in this range. This estimate of maximum tolerable depth was consistent with observations by others (Kelsall 1969, Sweanor and Sandegren 1989). Plots containing fresh moose tracks were characterized by significantly lower snow depths than plots without tracks in all habitats except mixed hardwood/conifer (Table 2).

Table 1. Use, availability, and relative preference by moose for 5 habitat types on winter range, Chilkat River valley, southeastern Alaska, 1981-82 and 1982-83.

Year	Habitat type	*Percent use*	Percent availability	Relative preference ($P<0.01$)[a]
1981-82	coniferous	16	22	0
	deciduous	53	24	+
	open	13	38	--
	mixed	11	11	0
	cut	7	5	0
	n	101		
1982-83	coniferous	29	22	0[b]
	deciduous	31	24	0[c]
	open	17	38	--[d]
	mixed	22	11	+[b]
	cut	0	5	--[c]
	n	134		

[a] "+" indicates use was greater than availability, "--" indicates use less than availability, "0" indicates use not different than availability. Simultaneous confidence level = 95%.

[b] Use was significantly ($P<0.02$) greater in 1982-1983 than in 1981-1982. Simultaneous confidence level = 90%.

[c] Use was significantly ($P<0.02$) less in 1982-1983 than in 1981-1982.

[d] Use was not significantly ($P>0.02$) different between years.

Table 2. Measured snow depths (cm) in relation to presence or absence of fresh moose tracks on ground transect plots, Chilkat River valley, Alaska, 1983.

Habitat	With tracks			Without tracks			Overall		
type	Mean	SE	*n*	Mean	SE	*n*	Mean	SE	*n*
coniferous[a]	38	10	28	59	3	239	58	3	267
deciduous[a]	50	1	407	68	1	582	61	1	989
open[a]	37	3	113	51	4	197	47	2	310
mixed	50	13	54	57	4	220	56	3	274
cut[a]	64	13	29	81	8	79	77	6	108

[a] Means of plots with and without tracks are significantly different ($P<0.001$, *t*-test)

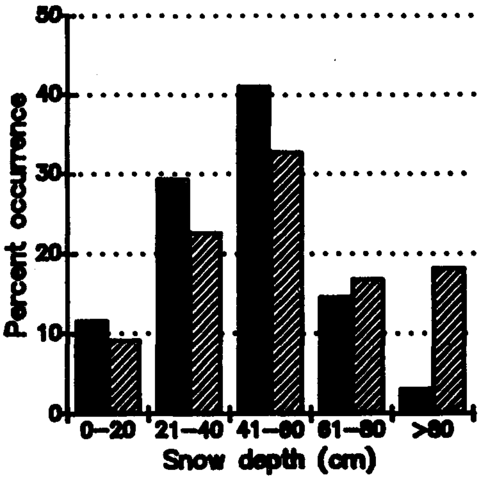

Fig. 2. Percentage of total moose tracks (dark bars, n=1472) that were encountered at various snow depths, and the percentage of plots (shaded bars, n=1948) with those snow depths, Chilkat valley, Alaska, February-March, 1983.

DISCUSSION

Changes in habitat use between the 2 yrs of study was indicative of the response of moose to deep snow. Increased use of coniferous and mixed stands, and concurrent decrease in use of deciduous and cut areas in the high-snow winter suggested that moose sought out habitats with a canopy for thermal cover and relief from deep snow. Eastman and Ritcey (1987) reported a similar shift in habitat use relative to snow in coastal British Columbia.

Distribution of moose tracks, although measured only during a portion of the second winter, provided some insight into habitat use. Although overall mean snow depths in coniferous, deciduous, and mixed habitats were similar, depth of tracked plots was less in coniferous than in deciduous and mixed types (Table 2), indicating that moose were more selective in their use of coniferous stands than in other types. Considering the paucity of browse in coniferous stands in this area (Hundertmark *et al.* 1983) it was apparent that coniferous stands were used primarily for shelter, with greater use exhibited in the more severe winter. Open areas were avoided in both years, despite having the lowest snow depths in 1983. These areas accumulated snow only after surface water froze and were often windswept, but by definition they contained little or no winter forage. Distribution of moose and tracks in open areas as observed during aerial surveys indicated that frozen, narrow river channels were used as travel corridors, bedding sites (particularly on sunny days), and as access to riparian vegetation but wider areas were not used. Similar observations were reported by Eastman and Ritcey (1987) and Joyal (1987). Cut areas had a mean snow depth which corresponded to the upper tolerance limit of moose, which likely explains the lack of relocations in these areas in 1982-83, but ground transects detected some use in areas of relatively lower snow depths (Table 2). Mixed stands may have been used more often in the high-snow winter because of the combination of shelter and forage available. Joyal (1987) reported that mixed stands in Quebec were important winter habitat when moose were restricted by deep snow and that the importance of coniferous cover increased with increasing snow depths.

The abundance of preferred browse found in recent clearcuttings in the same study area (Hundertmark *et al.* 1983) and in Thomas Bay, Alaska (Doerr *et al.* 1980) supports the contention that these areas can be beneficial to moose in autumn and mild winters. However, these areas decrease in value during periods of deep snow (Thompson and Euler 1987). Also, duration of availability of moose browse in second-growth stands in this area is unknown. Alaback (1982) reported that canopy closure in regrowth stands of spruce-hemlock in southeast Alaska eliminated browse for as much as 80% of the rotation. Analysis of browse following fire in a boreal forest ecosystem on the Kenai Peninsula indicated that production declined dramatically after approximately 20 years (Spencer and Hakala 1964, Oldemeyer and Regelin 1987). Also, excess removal of coniferous stands can reduce the availability of feeding/thermal cover on summer ranges.

Commercial timber management in areas subject to snow accumulations >80 cm can be compatible with moose management if precautions are taken to assure adequate availability and juxtaposition of shelter and foraging habitats. Preserving mixed stands as well as tracts of coniferous timber adjacent to deciduous feeding areas (Brusnyk and Gilbert 1983, Eastman and Ritcey 1987), would provide a suitable mixture of habitats to meet the needs of moose in most winters. In areas away from riparian and lowland feeding areas a more intensive management strategy could be implemented yet still be beneficial to moose if stand size, location and timing of harvest, and rotation age are planned such that recently harvested areas are always adjacent to mature stands (Harris 1984).

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