SEASONAL HABITAT USE BY MOOSE ON MANAGED FOREST LANDS IN NORTHERN MAINE

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ABSTRACT: Seasonal home range sizes and habitat use patterns for adult moose (*Alces alces*) on managed forest lands in northern Maine were studied from January 1983 through September 1984 using radio telemetry. Thirty-seven moose (14 M:23 F) were located 786 times using aerial telemetry, 246 times by triangulation, and 26 times by direct observation. A median home range of 7.1 km^2 was observed during the winter of 1983 in which snow did not appear to restrict moose movements. During the winter of 1984, snow depths exceeded 70 cm for most of the winter and the median home range was only 1.5 km^2. Summer home ranges varied from 5-126 km^2, but were typically between 15-30 km^2. The median fall home range was approximately 3 km^2. In 1984, most moose occupied the same seasonal home ranges used in 1983. Seasonal home ranges for most moose either overlapped or were within approximately 7 km of each other. Throughout the year moose spent the majority of their time at elevations below 367 m, which in northern Maine is the transition zone from spruce-fir (*Picea spp.-Abies balsamea*) dominated forests below to sugar maple (*Acer saccharum*), beech (*Fagus grandifolia*), and yellow birch (*Betula alleghaniensis*) forests at higher elevations. During summer, moose preferred to use lowlands below 305 m that included ponds, streams, and rivers used for feeding on aquatic plants, and cows spent a greater proportion of their time in these areas than bulls did. During fall and winter, moose were found most often in areas that had been logged within the previous 10-30 years that had abundant supplies of browse and uncut stands of mature spruce and fir that could be used for shelter. Habitat use in summer included these same areas, but expanded to include hardwood-dominated areas that had been logged, aquatic areas, and lowland black spruce (*Picea mariana*) and northern white cedar (*Thuja occidentalis*) forests. The results of this study indicate that moose habitat on managed forests in Maine can be readily defined and that moose habitat management activities could be coordinated with existing forest management practices. The most important points that should be considered include protecting aquatic feeding areas, the temporal and spatial distribution of 10-30 year old cuts, management of hardwood regeneration within these cuts, and the amount of residual softwood available for shelter.

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Radio-tracking studies have produced varying estimates of seasonal home range sizes for moose (*Alces alces*). This variation has been attributed to the distribution of seasonally preferred habitats, environmental conditions, population structure and density, the age and sex of the individual, and variation in individual behavior (LeResche 1974, Lynch and Morgantini 1984). Habitat use patterns have also been shown to vary in response to these factors.

Maine is near the southern limit of the moose's range in eastern North America, although moose populations have recently expanded into parts of southern New England. Most of northern Maine is owned by industrial forest products companies that manage their lands for softwood pulp and hardwood and softwood sawlogs. Past forest practices on these lands have created large expanses of productive moose habitat. Throughout Maine's moose range there are no known wolf (*Canis lupus*) populations. In addition, hunting, which was reopened in

1980 after 45 years of closed seasons, was limited to 1,000 permits per year at the time of this study. This unique set of circumstances -- large moose populations, no wolves, and low hunting pressure -- provides an interesting contrast to conditions throughout the rest of the moose's circumboreal range.

We sought to measure the size of seasonal home ranges for adult moose and determine if there are significant migrations between seasonal home ranges on managed forest lands in northern Maine using radio telemetry. We also wished to define the seasonal patterns of habitat use by adult moose on these lands. This broadly-focused study was complemented by a more intensive study of summer habitat use (Leptich and Gilbert 1989) and followed studies of winter habitat use and food habits (Burgason 1977, Stone 1977, Schoultz 1978, Cioffi 1981, Monthey 1984) and summer home range and habitat use (Crossley and Gilbert 1983, Crossley 1985) on managed forest lands. A study similar to ours was also conducted by Dunn (1976) in Baxter State Park, which is not intensively managed for forest products.

STUDY AREA

The study was conducted in northern Maine in the vicinities of Mooseleuk and St. Croix Lakes (Fig. 1). Mooseleuk Lake (46°31'N, 68°55'W) is approximately 53 km west of Ashland and 68 km north of Katahdin Peak in Baxter State Park. St. Croix Lake (46°18'N, 68°12'W) is 58 km to the southeast of Mooseleuk Lake. The region is dominated by gently rolling hills interspersed with forested swamps, shallow ponds, bogs, and a few sharply-rising ridges. Elevations range from approximately 260 m in ponds and wetlands to 750 m on ridge-tops. Mean annual snowfall is 284 cm and mean annual precipitation totals 99 cm. January mean minimum and maximum temperatures are -17°C and -5°C, respectively, whereas July means are 11°C and 27°C (Ruffner 1978).

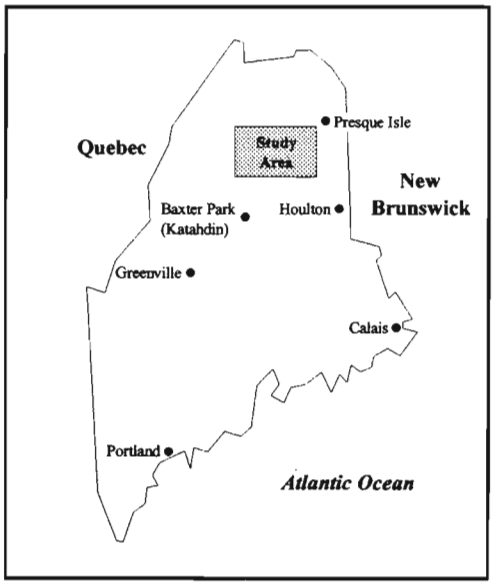

Fig. 1. Location of the study area.

Northern Maine is in the spruce-fir/northern-hardwoods zone described by Westveld *et al.* (1956). Lower elevations and ridgetops are typically vegetated by softwood species and hillsides are dominated by hardwood species. Principal upland conifer species include white spruce (*Picea glauca*), red spruce (*P. rubens*), red pine (*Pinus resinosa*), and balsam fir (*Abies balsamea*). Black spruce (*Picea mariana*), northern white cedar (*Thuja occidentalis*), tamarack (*Larix laricina*), willow (*Salix* spp.), and alder (*Alnus* spp.) are found in lowland areas and on poorly-drained uplands. White pine (*Pinus strobus*) is sparsely distributed throughout the study area. American beech (*Fagus grandifolia*), sugar maple (*Acer saccharum*), white ash (*Fraxinus americana*), and yellow birch (*Betula alleghaniensis*) are late-seral hardwoods usually found on well-drained uplands. Disturbed sites are typically colonized by paper birch (*Betula papyrifera*), quaking aspen (*Populus tremuloides*), bigtooth aspen (*P. grandidentata*), red maple (*Acer rubrum*), pin cherry (*Prunus pennsylvanica*), and raspberry (*Rubus* spp.).

Shallow, deeply silted, mesotrophic

ponds, ranging in depth from 0.5 to 5.0 m, are scattered throughout the study area and are used extensively by moose in the summer for feeding on aquatic plants (Crossley 1985). Common aquatic plants are pondweeds (*Potamogeton* spp.), yellow water lily (*Nuphar variegatum*), northern arrowhead (*Sagittaria cuneata*), naiads (*Najas flexilis*), floating leaved burreed (*Sparganium angustifolium*), common bladderwort (*Utricularia vulgaris*), water milfoil (*Myriophyllum* spp.), slender spikerush (*Eleocharis acicularis*), and white water buttercup (*Ranunculus aquatilis*) (Crossley 1985).

Most of the study area is owned by industrial forest products companies that manage their lands for pulpwood and sawlog production. In the first half of the century logs were held in ponds and then transported via streams and rivers. A network of unpaved roads was then created to allow logs to be removed by trucks. There are no wolf populations in Maine, although a single adult was killed in 1993 in an area to the south of the study area. Black bears (*Ursus americanus*) are common and are believed to occasionally prey upon moose calves. Coyotes (*Canis latrans*) are also common but are not thought to be a significant source of predation on moose.

METHODS

Adult moose were captured in Mooseleuk Lake, Bartlett Pond, and Leonard Pond, on the Mooseleuk Lake portion of the study area, and in St. Croix Lake during the summer of 1983 using the boat and noose-pole system (Dunn 1976, Crossley 1985). A Bell 47G5A helicopter was also used to herd some moose from shallow to deep water. Each swimming moose was fitted with a 490-g transmitter fastened to a 5-cm butyl collar with a circumference range of 63-127 cm (Telonics, Inc. Mesa, AZ). The collar was fastened with a 5-cm steel harness buckle attached to the end of the collar with nylon webbing (Crossley 1985). Transmitters operated in the 149-152 MHz range. Thirteen moose (3 M:10 F) collared by Crossley (1985) in 1981 and 1982 were also included in this study.

Transmitter-equipped moose were located 2 to 4 times per month from January 1983 through September 1984 using either a Cessna 172 or Piper Super Cub (Addison *et al.* 1980). Once an animal was located, the plane circled above the relocation site at an elevation of approximately 150 m until the moose was seen or the specific stand it was in could be defined. While circling the moose, the forest stand structure and composition was characterized and the location was plotted on a U.S.G.S. 7.5-minute orthophoto quadrangle. Habitat descriptions collected at the time of relocation were used to supplement data obtained from recent forest stand type maps available in paper company geographic information systems (GIS). During the summer of 1983, transmitter-equipped moose were also located by triangulation using a hand-held, two-element antenna (Heezen and Tester 1967). At least three bearings, obtained within a 15-minute period and crossing within a 0.25-ha square, were obtained for each triangulated location. All bearings were plotted as taken on U.S.G.S. 7.5-minute orthophoto quadrangles and moose locations were recorded using the Universal Transverse Mercator (UTM) system. These locations were used to calculate home range size only and were not used in the analysis of habitat use. Only locations obtained at least 24 hours apart, which were presumed to be independent, were included in the analyses reported here.

Home range sizes were estimated using the minimum area of a convex polygon method (Mohr 1947) for 3 seasons: winter (1 January-20 April), summer (21 April-17 September), and fall/early-winter (18 September-31 December). The minimum area method provides a general characterization of

home range sizes and has been used on numerous studies of moose home range. We used this method to allow comparison with these earlier results and because the broadly-focused nature of our study did not result in sufficient numbers of relocations to use more quantitative methods. In addition, a complementary, intensive study of summer moose home ranges was in progress on the same study area (Leptich and Gilbert 1989). Points that appeared to be outliers from the established home range, which we defined as a brief (1-2 day) excursion to an area outside the normal range that was never revisited, were excluded from home range size calculations. In addition, only moose that were monitored for an entire season were included in the home range size calculations. A moose was not used in the calculation of summer home ranges, for example, if it was caught in the middle of the summer.

Relationships among seasonal home ranges were described by the degree of overlap among pairs of each moose's three seasonal home ranges. Fidelity to seasonal home ranges was also measured by the overlap between each moose's 1983 and 1984 home range for each season. The straight-line distance between locations separated by approximately 24 hours was also recorded from triangulated moose locations during the summer of 1983.

Terrain and habitat data were collected for each point where moose were located during aerial monitoring (i.e., triangulated observations were not included) and for a random sample of points on the Mooseleuk Lake portion of the study area (Marcum and Loftsgaarden 1980). The boundary of the study area for these analyses was defined by plotting all the locations obtained for moose captured in this portion of the study area and connecting the outer points to form a convex polygon. Seven-hundred-ninety-one (approximately equal to the number of relocations on the Mooseleuk Lake portion of the study area) random points (1.34/km^2) were used to measure availability of terrain and habitat factors within this 590-km^2 study area. Elevation, slope, aspect, and distance to aquatic feeding areas were obtained from U.S.G.S. 15-minute topographic maps. Aquatic feeding sites were defined as any pond, lake, or slow-moving river at least 1 ha in size. Habitat data were collected by entering the UTM coordinates of the moose location into the paper company GIS containing recent stand type maps, which was then used to determine the dominant forest community within a 1 ha square centered on the UTM coordinates of the location.

Use of each terrain and habitat factor was first compared between male and female moose within each season, by year, using chi-square analysis. If no differences ($P > 0.05$) in use of terrain and habitat factors between male and female moose were found, data from the sexes were pooled in subsequent analyses. Terrain and habitat use between years within each season, and between seasons within each year, were also compared using chi-square analysis. Use of terrain and habitat factors in relation to their availabilities was evaluated using the techniques of Marcum and Loftsgaarden (1980).

RESULTS

Capture and Monitoring

Twenty-four adult moose (11 M:13 F) were captured during the summer of 1983. Including the moose collared by Crossley (1985), there were 37 (14 M:23 F) study animals. Two males were killed in the 1983 hunting season, 1 male and 1 female dropped their transmitters, 2 10-year old males died of presumably natural causes, and transmitters on 2 females apparently failed. Study animals were located 786 times using aerial telemetry, 246 times by triangulation, and 26 times by direct observation. Moose on the Mooseleuk Lake portion of the study area were located 532 times using aerial teleme-

try. Approximately 95 percent of the moose relocated by aerial telemetry during fall and winter were visually observed and 85 percent of the summer relocations were visually confirmed. If an animal could not be seen, the relocation site was circled at a low elevation (ca 150 m) until observers were certain which stand the moose was in.

Seasonal Home Ranges

Winter. -- Winter home ranges were significantly larger in 1983 than in 1984 (Mann-Whitney test, $P < 0.001$) (Table 1) in response to reduced snow accumulation in 1983. Snow depths during 1983 were only slightly restrictive to moose movements, as defined by Coady (1974), whereas in 1984 snow hampered moose for much of the winter (Thompson 1987). Winter movements were minimal in both years and consisted of intensive use within small areas (<2 ha) as observed at the time of aerial relocation. At the time of relocation, moose were generally within a few 100 m of their previous location and numerous tracks and beds were apparent. When movements did occur they were usually less than 1 km and to a new area of intensive use (i.e., once in a new area, the moose repeated the pattern of remaining in a very small area for weeks or months). Differences in winter home range sizes between male and female moose were insignificant in both years (Mann-Whitney test, $P > 0.05$). In addition, individual differences in home range size were due to distances between areas of intensive use and did not seem to result from some individuals moving about more than others.

Summer. -- Summer home ranges were significantly larger in 1983 than in 1984 (Mann-Whitney test, $P < 0.05$), probably due to the lower number of locations per animal in 1984. Summer home ranges, therefore, are probably most accurately represented by 1983 observations. Differences in summer home range size between males and females were insignificant (Mann-Whitney test, $P > 0.05$). Most moose were relatively sedentary, spending most of the summer in a 15-30 km^2 area. A few moose, however, had home ranges between 40-50 km^2 and a young bull had a home range of up to 126 km^2. Moose that didn't reside in proximity to an aquatic feeding area typically had 2 centers of activity in the home range that were visually evident as clusters of locations, with few, if any, observations in between, within the minimum area polygon. One activity center was within a

Table 1. Seasonal home range sizes (km^2) for adult moose in northern Maine.

Year	Season	Sex	Home Range Size			No.	Mean No.
			Low	High	Median	Moose	Observations
1983	Winter	Bull	1.1	12.8	5.2	4	5.0
		Cow	1.0	21.5	7.1	10	5.6
	Summer	Bull	26.4	45.5	28.0	3	26.0
		Cow	15.0	126.3	32.3	9	18.4
	Fall	Bull	0.3	41.1	6.8	9	3.9
		Cow	0.2	41.4	2.6	17	3.6
1984	Winter	Bull	0.3	2.9	1.9	4	5.8
		Cow	0.2	9.2	1.4	10	6.0
	Summer	Bull	6.7	120.5	22.7	9	8.2
		Cow	5.5	108.2	17.3	20	10.1

forested upland and the other was focused on an aquatic feeding area. Most of a moose's time was spent in the forest and trips to the aquatic feeding areas, lasting from 1 to several days, were made on a somewhat regular basis. Trips to ponds were typically made in a single night and were rarely detected by telemetry (i.e., the moose would be in an upland in the afternoon and in a pond several km away the next morning). This behavior pattern was studied more intensively on the same study area by Leptich and Gilbert (1989).

Twenty-four-hour movements ranged from 0-12.9 km with a mean of 1.7 km (N = 134 for 27 individuals). When moose remained in a forested area or associated with an aquatic feeding site, 24-hour movements averaged 1.2 km (N = 116 for 27 individuals). A significantly larger mean distance of 4.6 km (t-test, $P < 0.05$, N = 18 for 12 individuals), however, was observed when moves involved going to or from an aquatic feeding site. There was no difference in distances moved between males and females (t-test, $P > 0.05$).

Fall/Early-Winter. -- The small number of relocations per animal obtained during this season probably resulted in an incomplete record of moose movements and precludes detailed analysis of fall/early-winter movements of moose in Maine. In general, though, with the exception of two moose (1 M:1 F) that had home ranges of 41 km^2, it appears that most moose were relatively sedentary. In addition, the difference in size between male and female home ranges was insignificant (Mann-Whitney test, $P > 0.05$).

Annual Home Ranges

A high degree of overlap was observed among all seasonal home ranges for most moose and there was no evidence of truly migratory behavior. We would define migratory behavior as long-distance movements that take an animal from one type of habitat to an area with substantially different habitat conditions. When ranges were disjunct, for example, the distance between them was short (mean = 7.1 km, N = 12). In the majority of cases (30 out of 37) moose were also found in the seasonal range used the previous year, and when the same range was not used, the distance between ranges was short (mean = 5.2 km, N = 7). In addition, 6 out of the 7 disjunct ranges occurred in winter when moose were found in small intensive use areas within a larger wintering area used by many moose (i.e., 1983 and 1984 winter home ranges were typically within a few km of each other).

Seasonal Habitat Use

Winter. -- Moose typically wintered in spruce-fir forests and mixed softwood-hardwood stands (mixed stands with a greater softwood component) that occur at the lower elevations in the study area (Fig. 2). Mid-elevation areas (ca. 367-427 m), which are typically vegetated by hardwood-dominated forests, were used less than expected based on their availability in the study area (Bonferroni-Z, $P = 0.05$). Slopes were used in proportion to their availabilities during the winter (Fig. 3). Moose used all aspects throughout the winter, but spent the greatest amount of time on slopes that faced south and west (Fig. 4). North-facing slopes were used less than expected based on their availability in the study area (Bonferroni-Z, $P = 0.05$).

Moose spent the greatest amount of time in softwood and mixed softwood-hardwood stands in winter, avoiding hardwood and mixed hardwood-softwood stands (Fig. 5). In addition, softwood-hardwood stands were used in far greater proportions than they occur within the study area (Bonferroni-Z, $P = 0.05$). Within softwood and softwood-hardwood stands, spruce-fir forests received the greatest amount of use and black spruce and cedar stands, which are found within forested wetlands, were avoided (Bonferroni-

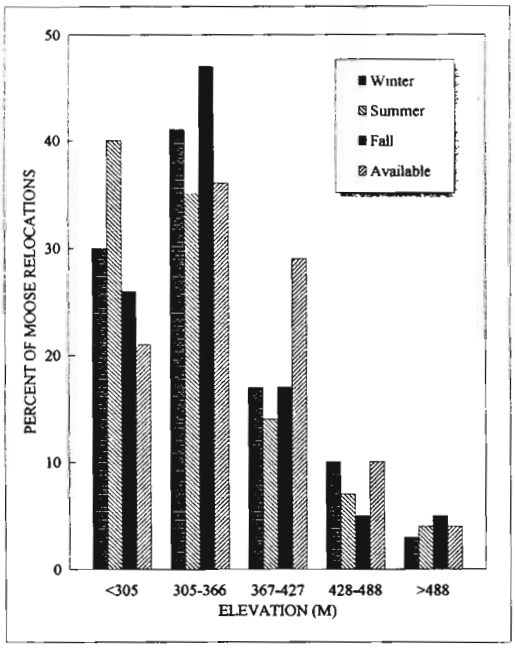

Fig. 2. Seasonal moose use of available elevations. Winter n = 147; Summer n = 304; Fall n = 81; Available n = 791.

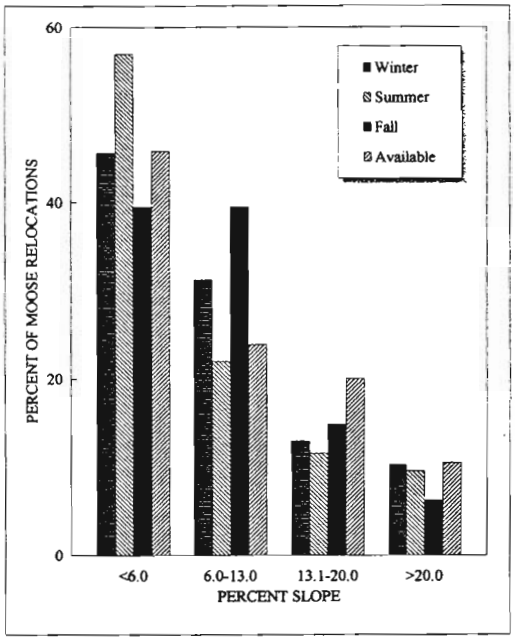

Fig. 3. Seasonal moose use of available slopes. Winter n = 147; Summer n = 304; Fall n = 81; Available n = 791.

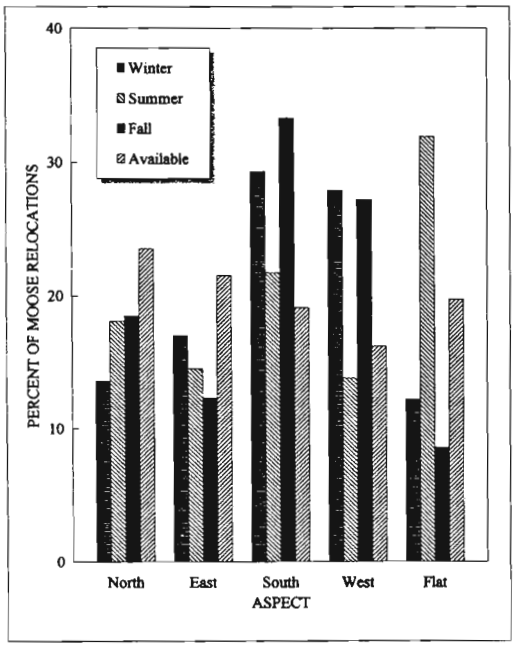

Fig. 4. Seasonal moose use of available aspects. Winter n = 147; Summer n = 304; Fall n = 81; Available n = 791.

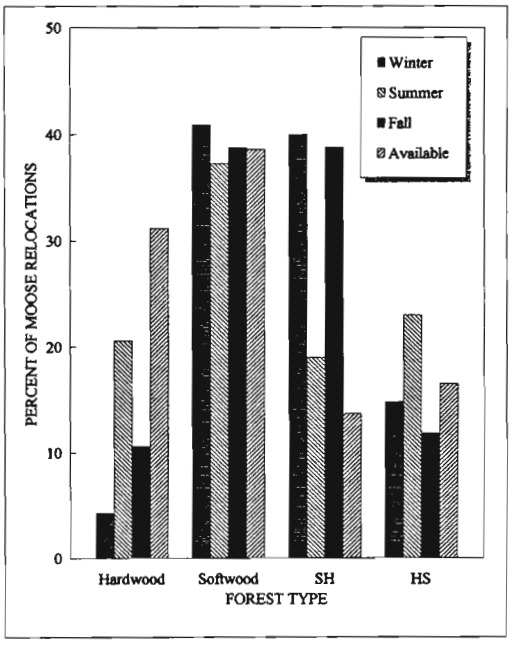

Fig. 5. Seasonal moose use of available forest types. Winter n = 115; Summer n = 252; Fall n = 81; Available n = 751.

Z, P = 0.05) (Fig. 6).

Eighty-seven percent of all winter observations of moose were in areas that had been logged. In fact, the majority of the radio-collared moose were found in extensive areas that had been logged from 10-30 years before our study. Large numbers of uncollared moose were also seen in these wintering areas. These sites were characterized by extensive networks of graded skid trails, which the moose travelled upon, areas with abundant browse, and small and large patches of residual softwood stands (stands that were not harvested). It appeared that in many areas moose were maintaining low shrub communities through their intensive browsing. Residual softwood stands appeared to be important and were used more frequently on the coldest and windiest days, when moose were often observed bedded next to a large conifer. A few moose wintered in areas that had been logged from 40-60 years before our study. These areas were similar to the other wintering areas, but the sites available for browsing were much smaller and fewer non-collared moose were observed. Logged areas without some residual softwood cover were not used by our radio-collared moose.

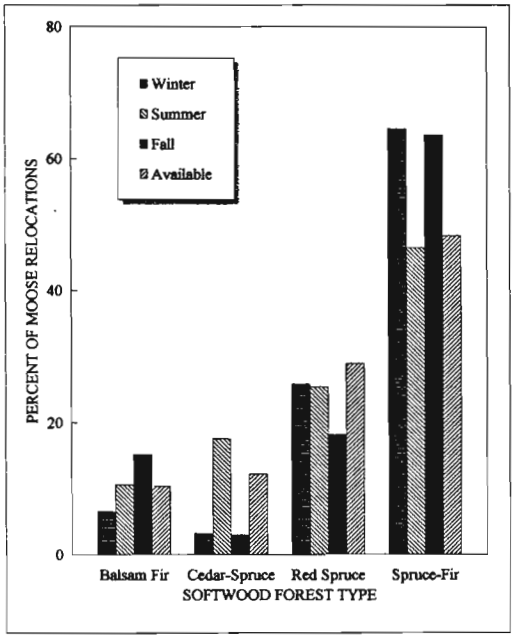

Fig. 6. Seasonal moose use of available softwood forest types. Winter n = 93; Summer n = 142; Fall n = 66; Available n = 393.

Summer. – Moose continued to use the mid to lower elevation portions of the study area in summer, but they spent an increasing amount of time at the lowest elevations. Use of the lowest elevation areas (<305 m), which includes aquatic feeding areas, was in greater proportion than the availability of these areas, and cows spent more time in them than bulls did (Bonferroni-Z, P = 0.05). Moose also used areas within 0.5 km of an aquatic feeding area in greater proportions than these sites occurred in the study area. Flat-sloped areas (<6 percent) were also found to be preferentially used in summer (Bonferroni-Z, P = 0.05).

In summer, moose continued to use softwood stands a great deal, but they also moved into hardwood and hardwood-softwood stands with a corresponding decrease in the use of softwood-hardwood stands. Within the softwood stand type, there was an increase in the use of black spruce and cedar stands, which are found around many aquatic feeding areas. Only 57 percent of the summer observations of radio-collared moose were within logged areas.

Fall/Early-Winter. – During fall/early-winter moose moved out of lowland areas and into the mid-elevation portions of the study area. Although they were found in the general areas that would eventually be used in winter, there was a tendency for moose to be found at slightly higher elevations and on steeper slopes in fall/early-winter. As in winter, slopes that faced south and west received the greatest amount of use. Fall habitat use within forested cover types, including logged areas (75 percent of all observations), was very similar to patterns observed during winter. There was, however, less an affinity for residual softwood cover during

fall compared to winter observations.

DISCUSSION

The restricted patterns of winter habitat use and the small winter home range sizes that we observed appear to be similar to other portions of the moose's range (e.g., van Ballenberghe and Peek 1971, Phillips *et al.* 1973, Addison *et al.* 1980, McNicol and Gilbert 1980, Thompson and Vukelich 1981). Exceptions can occur, however, when resources are dispersed and snow depths are not restrictive (Lynch and Morgantini 1984). Summer home ranges of about 15-30 km^2 appear to be common for moose and have been observed in Minnesota (Phillips *et al.* 1973) and Alberta (Haugh and Keith 1981, Mytton and Keith 1981, Lynch and Morgantini 1984). Moose in some areas, such as Alaska, have larger summer home ranges that can average 56 km^2 in size (Taylor and Ballard 1979).

Some moose in our study traveled relatively long distances between upland areas and aquatic feeding sites, and consequently had larger home ranges. This has been previously reported in Maine (Crossley 1985 and Leptich and Gilbert 1989) and elsewhere (Phillips *et al.* 1973, Fraser *et al.* 1980). Other moose had larger home ranges that encompassed several aquatic feeding sites and upland areas that were known to be used by other moose. These wide-ranging individuals may have been using areas that they first visited with their mother and continue to use, despite the availability of similar and closer habitats, out of tradition (LeResche 1974). It is also possible that some of these individuals are monitoring trends in resource availability throughout a large area (Amstrup and Beecham 1976, Crossley and Gilbert 1983).

Overlap of seasonal home ranges appears to be common in moose (Phillips *et al.* 1973, Dunn 1976, Best *et al.* 1978, Doerr 1983, Lynch and Morgantini 1984, Cederlund *et al.* 1987, Cederlund and Okarma 1988), but exceptions have been reported, even within the same regions (e.g., Phillips *et al.* 1973, Crossley and Gilbert 1983). Seasonally required habitats are in close proximity to each other in northern Maine and there are no significant changes in climate related to physical gradients, suggesting that there are no incentives for moose to migrate. Fidelity to seasonal home ranges also appears to be common (e.g., Cederlund *et al.* 1987, Cederlund and Okarma 1988) and may relate to the role of tradition in moose habitat use (LeResche 1974). Exceptions have been reported, however, but usually regarding winter ranges (Crete 1980) where differences in weather from 1 winter to the next can profoundly influence moose habitat use (Chamberlin 1972, Coady 1974, Peek *et al.* 1976, McNicol and Gilbert 1980, Welsh *et al.* 1980).

The age at which a logged area becomes optimal for moose is a subject that is often only indirectly addressed. Most authors give a generalized range of less than 20 years (e.g., Peek *et al.* 1976) and restrict their studies to stands of this age (Telfer 1974, Eastman 1974, Usher 1977, Wolf and Zasada 1979, McNicol and Gilbert 1980, Monthey 1984). Some studies, however, suggest that moose may prefer logged areas over 20 years of age because of the relatively greater cover component (Burgason 1977, Thompson and Vukelich 1981). Our results suggest that logged areas that are 10-30 years old support more moose, particularly in winter, than younger or older stands.

Evaluating the need for conifer stands as winter shelter is complicated by the adaptability of moose to a wide range of habitats and environmental conditions. Some research indicates that within logged areas the winter distribution of moose is primarily a function of the availability of browse (Brassard *et al.* 1974, Kearney 1975, Crete 1976, Nowlin 1978, Telfer 1978, Schoultz 1978), whereas

others stress the importance of a mix of cover and open areas for feeding (Chamberlin 1972, Eastman 1974, Peek *et al.* 1976, Hamilton *et al.* 1980, Cioffi 1981, Brusnyk and Gilbert 1983, Monthey 1984). Hamilton *et al.* (1980) found no relationship between winter browsing intensity in northern Ontario logged areas and distance from uncut forest edge, but when cover was defined to include residual stands within the cut, they demonstrated that most browsing occurred within 80 m of cover. Thompson and Vukelich (1981) found that moose in Ontario browsed an average of 60 m from cover during early winter, but were an average of only 12 m from cover during late winter, when snow depths reached 65 cm. Stone (1977) found that browsing intensity in logged areas in Maine was a function of the layout of trails used to skid logs during harvesting and was not related to the size of the logged area or the availability of residual conifer cover. Cioffi (1981) and Monthey (1984), however, in their Maine studies, found that moose use of residual conifer stands was a function of snow conditions, with use increasing as snow depth increased. Our observations during a winter with and a winter without restrictive snow depths, and other recent studies (e.g., Mastenbrook and Cumming 1989, Hundertmark *et al.* 1990), support Chamberlin's (1972) contention that moose wintering areas are usually large, and use of any particular portion of the area by individual moose depends upon environmental conditions.

MANAGEMENT CONSIDERATIONS

Given that moose in Maine do not migrate significant distances and show fidelity to their seasonal home ranges, it is reasonable to focus management efforts on meeting all the seasonal habitat requirements for moose within small land units. Aquatic feeding sites appear to be important habitat requirements, therefore, each management unit should have at least one aquatic feeding area within its boundary. Preferred upland habitats are found within softwood and softwood-hardwood stands located above cedar-spruce-fir forested wetlands and below hardwood-dominated hillsides. The spatial and temporal distribution of 10-30 year old logged areas within these stands, and the distribution of residual softwood within logged areas, should be carefully considered within each management unit. The distribution of these sites on south and west facing slopes is important to wintering moose. Finally, the habitat value of forested wetlands, higher elevation softwood stands, and hardwood stands should not be ignored.

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