CALVING AREAS OF MOOSE IN NORTHWESTERN MONTANA AND SOUTHEASTERN BRITISH COLUMBIA

M.A. Langley and D. H. Pletscher
Wildlife Biology Program, School of Forestry, University of Montana, Missoula, MT 59812

ABSTRACT: We located 13 moose (*Alces alces*) calving areas in mid-May to mid-June, 1990 and 1991, along the North Fork of the Flathead River in northwestern Montana and southeastern British Columbia, a region recently recolonized by wolves (*Canis lupus*) after an absence of about 50 years. Calving areas were sampled for habitat features as were random areas within the 95% harmonic mean home range of cow moose. Calving areas were characterized by less edge, greater hiding cover (more shrub cover), and more bare ground than random areas within moose home ranges. Calving areas did not differ significantly from random areas in distance to open roads, water, human habitation, or in elevation. These data may be used to provide a starting point from which land managers can work to maintain moose calving habitat.

ALCES VOL. 30 (1994) pp.127-135

Wolves recently recolonized northwestern Montana after an absence of about 50 years (Ream *et al.* 1991). Grizzly bears (*Ursus arctos*) and black bears (*U. americana*) also inhabit the area. Predation on moose, and especially their calves, by all of these species is well documented (Franzmann and Peterson 1978, Fritts and Mech 1981, Carbyn 1983, Messier and Crete 1985, Ballard *et al.* 1987). Moose have evolved with wolf and bear predation and their choices of calving areas should reflect this evolution. Calves should have a higher probability of survival if sufficient, high quality calving habitat is available. More knowledge about the habitat needs of calving moose would be useful in efforts to maintain these areas.

Studies of moose calving habitat often attempt to pinpoint the precise location or "site" of calving. While valuable information can be obtained in this way, current land management practices focus on larger blocks of land. We chose to evaluate calving "areas" or blocks of habitat which could potentially be maintained by land management agencies for this reason. Some studies of birth sites have concluded that hiding cover and proximity to forage and water are essential characteristics (Altmann 1958, 1963; Leptich and Gilbert 1986; Costain 1989).

Other researchers have documented that moose use small islands away from predators for calving (Seton 1927, Clarke 1936, Peterson 1955, Stephens and Peterson 1984). A study on the Kenai Peninsula found that calving areas were invariably close (< 200 m) to water whether or not they were on islands (Bailey and Bangs 1980). Other studies have not found that water or forage are important features of calving sites. Markgren (1969) found no indication of selection for forage or water though all the calving sites he studied were secluded from their surroundings. In an Alaskan study, calving sites were also in moderate to dense cover but were not close to water or good forage sources (Stringham 1974). A study in Ontario that looked at calving sites on islands and near water found tremendous variability and no clear indication of habitat preference (Addison *et al.* 1990). Further analysis of the Ontario data concluded that most sites were at high elevations relative to the surrounding terrain and that access to escape routes was preferred (Wilton and Garner 1991).

Studies in areas where clearcuts are common have found that moose use islands of cover (Cederlund *et al.* 1987) and rock outcrops (B. Dalton, Ontario Ministry of Natural Resources, pers. commun.) and do not stay in these areas for very long before moving out into the clearcuts themselves. These studies may reflect the variety of potential predator avoidance strategies of calving moose in different habitats. No studies of calving site or area selection have been done in the intermountain west.

Our objective was to compare characteristics of calving areas to other areas within annual moose home ranges to determine what specific habitat characteristics were preferred by calving moose along the Flathead River in northwestern Montana and southeastern British Columbia.

STUDY AREA

Our research was conducted on lands adjacent to the North Fork of the Flathead River in northwestern Montana and southeastern British Columbia (Flathead). In the United States, this area includes Glacier National Park (GNP) to the east of the river, with the Flathead National Forest (FNF) and various tracts of private land to the west. In Canada, the land on both sides of the river is owned by the British Columbia (BC) Provincial Government. Vegetation in the Flathead is a mixture of coniferous forests, wetlands and grasslands. The main coniferous species is lodgepole pine (*Pinus contorta*). The wetlands consist of a variety of forbs, sedges, and rushes with shrubs scattered throughout the area. Grasslands are dominated by rough fescue (*Festuca scabrella*) (Jenkins 1985). Clearcutting is the most common silvicultural technique used on both the FNF and in BC.

GNP is managed as a natural area and 92% of its area is managed as wilderness with limited human access (Martinka 1976). Snow depths vary considerably from year to year but the area is usually snow-covered from mid-November to mid-April (Singer 1979).

METHODS

Thirty-seven adult cow moose were darted from a helicopter and fitted with radio-collars during the winters of 1989-90 and 1990-91. Carfentanil was used to sedate the animals; each cow was tested for pregnancy by rectal palpation, aged, measured, and blood tested before the reversal agent, Naloxone was administered.

Calving area locations were determined through intensive monitoring of accessible and known to be pregnant moose cows from early May to mid-June. These animals were located daily using standard triangulation techniques; cessation of daily movement for at least 4 consecutive days was taken to indicate calving activity. We attempted to observe cows with calves from the air and on the ground shortly after parturition to confirm calving and to accurately locate calving areas. Ten of the 13 animals used in the analyses were sighted with their calves.

Calving areas were designated around the central calving area (best estimate of calving site) using a circle with an area of 16 ha (radius = 226 m). Ten 0.4 ha (0.1 acre) plots were sampled within each calving area. One plot was located at the center of the circle, 3 were located within a circular band between 71 and 143 m from plot center (30% of the total area) and 6 plots were located within a circular band between 144 and 226 m from plot center (60% of the total area). Exact plot locations were determined from a random number that fell within the limits detailed above. Data from these 10 plots were averaged to obtain single values for each calving area.

Ten plots were systematically designated within each moose's annual 95% harmonic mean home range to compare calving areas with available habitat. Two types of data were collected: position (Table 1), and vegetation structure and cover (Table 2). Slope and aspect were recorded in the field; the remaining position variables were obtained from USGS 7.5 minute quadrangle maps.

Table 1. Description of 6 position variables used to describe moose calving areas and habitat within annual moose home ranges. S and AS were collected in the field, the remaining variables were taken from USGS 7.5 minute quadrangle maps.

Variable	Description
EL	Elevation (m)
S	Slope (degrees)
AS	Aspect [1]
DRD	Distance to nearest road (m)
DWA	Distance to nearest water (m)
DHA	Distance to nearest human habitation (m)

[1]/Aspect was assigned using the following categories: 1) level or rolling; 2) north:337-22 degrees; 3) northeast:23-67 degrees; 4) east:68-112 degrees; 5) southeast:113-157 degrees; 6) south:158-202 degrees; 7) southwest:203-247 degrees; 8) west:248-292 degrees; 9) northwest:293-336 degrees (USDA 1987:4.42—25)

Thirty-one structure and cover variables were assessed during summer (Table 2). Basal area factor was calculated by counting the number of trees visible from plot center that had a width at breast height greater than the angle projected by a prism with factor 10 (USDA 1987:4.42. pg.31). Canopy cover was estimated ocularly for the plot and mean diameter at breast height (dbh) of the dominant tree layer was estimated for the plot after 2 or more trees were measured. Edge was considered present if a distinct change in successional stage could be seen from plot center. Hiding cover was estimated for the plot by averaging values from the 4 cardinal directions. Values were obtained by estimating what percent of a person at plot center could be seen by an observer standing at 30.5 m and 71.0 m from plot center (Krahmer 1989). Percent coverage was estimated for the area below 1 m from the ground and the area from 1 to 2 m from the ground. We estimated the 11 vegetation cover variables in each quadrant of the plot separately and then averaged these values to obtain one value for the entire plot. Potential natural community was determined according to Pfister *et al.* (1974). The actual number of trees in the plot were counted according to their dbh class and the number of snags, stumps, and moose pellet groups was also recorded.

Continuous variables were plotted to determine their distribution using normal probability plots (Wilkinson 1989). The natural log was taken of variables that were not normally distributed and their distribution reconsidered. Comparisons were made between normally distributed variables obtained from calving areas and available habitat plots using paired Student's t-tests. T-test values were considered significant at $P < 0.10$.

Categorical variables were compared between calving areas and available habitat plots using Chi-square tests for homogeneity. We combined similar categories prior to analysis in cases where > 20% of the category cells of a variable had < 5 observations. For variables with significant Chi-square values, we constructed Bonferroni z confidence intervals (Neu *et al.* 1974, Marcum and Loftsgaarden 1980, Byers *et al.* 1984) to determine which specific categories held significant differences between calving areas and available habitat plots. Chi-square test values were considered significant at $P < 0.10$.

RESULTS

Calving times and locations were deter-

Table 2. Alphabetic listing and description of vegetation structure and cover variables used to describe moose calving areas and habitat within annual moose home ranges. (See text for details unless noted below).

Variable	Description
ADHT	Average height of downfall (cm)
BAF	Basal Area Factor
CC	Canopy cover [1]
DBH	Mean diameter breast height of dominant tree layer
E	Presence or absence of edge [2]
GC	Ground cover [3]
HC1L	Hiding cover at 30.5 m below 1 m from ground [4]
HC1H	Hiding cover at 30.5 m between 1-2 m from ground [4]
HC2L	Hiding cover at 71.0 m below 1 m from ground [4]
HC2H	Hiding cover at 71.0 m between 1-2 m from ground [4]
LSH	Canopy cover for low shrubs (< 15.2 cm) [5]
MSH	Canopy cover for medium shrubs (15.2 - 137.2 cm) [5]
PNC	Potential natural community (Habitat type)
PP+	Canopy cover for pole size and larger trees (>12.4 cm dbh) [5]
SAP	Canopy cover for sapling sized trees (2.5 - 12.4 cm dbh) [5]
SEED	Canopy cover for seedling size trees (<2.5 cm dbh) [5]
SIGN	Number of moose pellet groups
SNAGS	Number of snags
SS	Slope shape [6]
STR	Structural class of vegetation within plot [7]
STUMP	Number of stumps
TDC	Total downfall cover [5]
TFC	Total forb and fern cover [5]
TGC	Total graminoid cover [5]
TSC	Total shrub cover [5]
TSH	Total shrub cover [5]
TTC	Total tree cover [5]
#P+	Number of trees larger than pole (> 22.6 cm dbh)
#P	Number of pole sized trees (12.4-22.6 cm dbh)
#SAP	Number of sapling sized trees (2.5-12.4 cm dbh)
#SEED	Number of seedling sized trees (< 2.5 cm dbh)

[1]/Canopy cover was estimated for the entire plot as an actual percentage value

[2]/Edge was recorded as either 1)present or 2)absent

[3]/Ground cover estimated for bare soil, gravel, rock, litter, wood, moss and basal vegetation. Percent coverage grouped into 1)0%; 2)>0-<1%; 3)1-<5%; 4)5-<15%; 5)15-<25%; 6)25-<35%; 7)35-<45%; 8)45-<55%; 9)55-<65%; 10)65-<75%; 11)75- <85%; 12)85-<95%; 13)95-100%; (USDA 1987:4.42, pg. 29)

[4]/Hiding cover was recorded as the percent of a person standing at plot center visible to an observer positioned as described in the text.

[5]/All cover estimates were made for each of four quadrants and then averaged for the whole plot. Percent coverage for all categories was estimated as 1)0%; 2)>0%-<5%; 3)5%-<25%; 4)25%-<55%; 5)55%-<75%; 6)75%-<95%; 7)>95%

[6]/Slope shape classified as 1)even or straight 2)convex 3)concave 4)patterned (USDA 1987:4.42, pg. 24)

[7]/Structure classified as: 0)nonvegetated or moss 1)herbaceous or herbaceous/tree seedling; 2)shrub or shrub/tree seedling; 3)sapling; 4)pole/sapling; 5)young mature trees; 6)old growth trees; 7)krumholtz trees (USDA 1987:4.42, pg. 32)

mined for 11 cows during the spring of 1990 and 2 cows during the spring of 1991. Calving began between May 13 and June 3 (mean = May 24) for all monitored cows. The average length of stay in one spot (estimated calving site) for calving cows was 6.2 days (SD = 2.1 days, range = 4-9 days).

Calving areas (*n* = 13) had significantly different aspects than available habitat (*n* = 130; $X^2 = 76.48$, df = 7, $P < 0.001$). Calving areas were more likely to be on Northwest, Northeast, and Southwest slopes than available habitat plots but these differences were not significant ($P > 0.10$). There were no other significant differences for position variables.

Calving areas had significantly more hiding cover from 30.5 m, both below 1 m (t = 2.053, 139 df, $P = 0.042$) and above 1 m from the ground (t = 2.203, 108 df, $P = 0.030$). Calving areas also had significantly more seedling-sized trees (t = 1.600, 141 df, $P = 0.099$), low shrub cover, tall shrub cover, and total shrub cover (Table 4). Significantly more calving areas had 25 - 55% total shrub cover than did available habitat. Edge was present significantly less often at calving areas than in available habitat (Table 4) and calving areas had significantly more moose sign (t = 2.667, 141 df, $P = 0.009$) than available habitat plots.

Seedling tree canopy cover and total tree canopy cover were significantly greater at calving areas than in available habitat with significantly more calving areas having 25 - 55% total tree cover. Calving areas had significantly more bare soil, gravel, rock, downed wood, moss, and basal vegetation than available habitat and significantly less litter and duff (Table 4). Significant differences were not found in any other vegetation and structure variables.

DISCUSSION

Coevolution of predator and prey has led to numerous, often subtle, changes in behavior

Table 3. Vegetation structure of moose calving areas and available habitat plots based on continuous structure variables.

	Calving Areas (n=13)		Available Areas (n=130)		
Variable[1]	Mean	SD	Mean	SD	P value
BAF	45.9	42.9	39.9	40.3	0.252
DBH (cm)	13.1	6.2	13.0	9.0	0.541
CC (%)	27.7	12.4	25.4	19.4	0.680
#P+	1.3	1.5	1.6	2.6	0.824
#P	10.6	0 .4	12.6	14.2	0.367
#SAP	54.0	68.0	39.1	43.9	0.219
#SEED	50.9	34.8	45.0	63.1	0.099
#SNAGS	2.7	6.0	5.2	10.5	0.508
#STUMPS	4.5	6.6	3.2	7.7	0.105
SIGN	2.0	2.3	0.9	1.8	0.009
HC1L	94.9	4.6	91.1	16.7	0.042
HC1H	91.2	7.9	86.8	20.8	0.030
HC2L	98.9	2.1	98.5	9.4	0.369
HC2H	98.6	2.9	97.8	10.6	0.304
ADHT	33.6	15.4	37.1	21.9	0.624

[1]/ Variables are defined in Table 2

Table 4. Vegetation structure and cover at moose calving areas and available habitat plots based on categorical variables.

Variable[1]	Calving Areas (n=13) Dominant Class(%)		Available Areas (n=130) Dominant Class(%)		X^2	P	df
E	absent	(92)	absent	(60)	5.28	0.021	1
GC-bare	1-<5%	(77)	>0-<1%	(64)	22.58	<0.001	4
GC-gravel	1-<5%	(54)	>0-<1%	(46)	20.69	<0.001	3
GC-rock	>0-<1%	(69)	0	(46)	14.52	0.006	4
GC-litter & duff	45-<55%	(23)	75-<85%	(37)	29.52	<0.001	7
	55-<65%	(23)					
GC-wood	5-<15%	(46)	1-<5%	(35)	13.82	0.008	4
GC-moss	1-<5%	(54)	1-<5%	(32)	9.44	0.093	5
GC-basal veg	15-<35%	(69)	5-<15%	(48)	16.64	<0.001	2
LSH	5-<25%	(61)	>0-<5%	(55)	8.07	0.045	3
MSH	5-<25%	(61)	5-<25%	(56)	2.11	0.715	4
PNC	Abla	(67)	Abla	(64)	0.63	0.889	3
PP+	5-<25%	(69)	5-<25%	(36)	7.15	0.128	4
SAP	5-<25%	(69)	5-<25%	(38)	5.75	0.331	5
SEED	5-<25%	(54)	>0-<5%	(58)	9.04	0.060	4
SS	Even	(100)	Even	(91)	1.19	0.275	1
STR	Sapling	(46)	Pole/sap	(38)	3.75	0.586	5
TDC	>0-<5%	(54)	>0-<5%	(50)	8.95	0.030	3
TFC	5-<25%	(61)	5-<25%	(42)	1.87	0.393	2
TGC	>0-<5%	(54)	>0-<5%	(44)	3.76	0.289	3
TSC	25-<55%	(69)	5-<25%	(41)	9.44	0.051	4
TSH	5-<25%	(61)	>0-<5%	(41)	16.80	0.002	4
TTC	25-<55%	(69)	5-<25%	(38)	7.08	0.069	3

[1]/ Variables are defined in Table 2.

that improve the chances for survival of prey individuals. Because predation is often heaviest on newborn and young individuals, strategies that reduce the chances for encounters between neonates and predators would confer a considerable selective advantage to these individuals. Selection of a safe area for birthing could potentially reduce predation risk if calving areas were either in areas where predators were rare, or in places that provided thick cover or a good vantage point from which predators could be sighted.

Stephens and Peterson (1984) found that moose with calves on Isle Royale, Michigan, chose habitat where the chance of encountering wolves was reduced. Moose in that study were much more likely to be found on small islets which wolves only visited in the winter when ice bridges provided easy access. More moose with calves were also observed near human camps, perhaps because wolves tended to avoid humans and thereby the moose as well. Wilton and Garner (1991) concluded that moose selected higher elevation sites with little cover and easy access to escape routes. They suggested that such sites allow early detection and escape from predators, unlike sites with dense vegetation or in depressions. Moose calves tend to follow their mothers and going downhill requires less energy than going uphill. Similarly, Bergerud *et al.* (1984) found that caribou (*Rangifer tarandus*) avoided neonate predation by moving to higher elevation sites specifically for calving. In our study, elevation was not significantly different at calving areas when compared to available habitat. However, our sample was limited to calving areas that were accessible from the ground. At least 9 other pregnant moose migrated to higher elevations where they spent most of the spring and summer months and could only be monitored by airplane. These 2 groups of cow moose may represent 2 different predator avoidance strategies employed by North Fork moose.

The importance of water to moose cows with calves appears clear in areas where islands, peninsulas or large water bodies are present (Seton 1927, Clarke 1936, Peterson 1955, Bailey and Bangs 1980, Stephens and Peterson 1984). The escape value of water to moose presumably makes such sites preferable. While considerable water existed in our study area, it was primarily in relatively small rivers and streams. Water was not significantly closer to calving areas than it was to available habitats, perhaps because the escape value of small water bodies with few islands is not significant.

Selection for dense cover has been seen in some calving site research (Altmann 1958, 1963; Stringham 1974, Leptich and Gilbert 1986, Costain 1989). In areas where the terrain is either flat or densely vegetated, such sites may be the best choice for moose with neonates. In our study, several significant variables indicate that moose selected areas with heavy cover. Calving areas had more hiding cover, more tree cover, more low and tall shrub cover, more basal vegetation, and a greater number of seedling trees. Thick vegetation would hide calves and perhaps cows, thus making them more difficult for predators to find.

Available forage may be important to calving moose (Altmann 1963, Leptich and Gilbert 1986) and palatable shrubs are common throughout the North Fork valley, especially in clearcut areas. Calving areas had more low, tall, and total shrub cover than elsewhere within moose home ranges; shrubs between 0.15 and 1.35 m were no more common at calving areas. Dense shrub cover could provide calving moose with both hiding cover and food, 2 potentially critical components of calving areas.

Twelve of the 13 calving areas had dense hiding cover. The vegetative characteristics of these areas strongly suggest that they had considerable hiding cover throughout the year. Seven of the moose used areas that had been clearcut since the 1940's. Four of these areas had significant coniferous regeneration and stumps were the only sign of what had occurred there. The 3 other clearcut areas were more recent and dominated by early seral stage growth. Five of the moose calved in thick forests that had not been cut. These uncut areas ranged from a seedling and sapling sized lodgepole stand to pole and greater than pole-sized spruce (*Picea* spp.) stands. The only calving area within Glacier National Park was in a marshy area with relatively little vegetative cover.

Considerable variability in calving sites was found by Markgren (1969) in Sweden, Addison *et al.* (1990) in Ontario, and in our study. However, significant hiding cover is important to North Fork moose, both at the calving site level and the 16 ha calving areas we examined. This suggests that land managers concerned with maintenance of preferred moose calving areas can do so at a spatial scale appropriate for many land management decisions. The calving areas analyzed in our study may also be appropriate considering the restricted areas calves use for their first 20 days (Altmann 1958).

In conclusion, our research indicated that moose along the North Fork select areas with large blocks of considerable cover for parturition. This should provide a starting point from which land managers can work to maintain moose calving habitat.

ACKNOWLEDGEMENTS

Support for this project was provided by Glacier National Park, a McIntire-Stennis grant, the Flathead National Forest, the British Columbia Wildlife Branch, and the Montana Department of Fish, Wildlife and Parks. W. Brewster, E. Bangs, R.Ream, A. Fontana, J. Cross, B. Campbell, D. Getz, B. Hird, D. Boyd, M. Fairchild, and N. Langley helped in many ways; volunteers M. Hodges, K. Podruzny, R. Jackson, L. Russ, M. Kastler, T. Parrott, and A. Robertson provided invaluable field assistance.

REFERENCES

ADDISON, E.M., J.D. SMITH, R.F. MCLAUGHLIN, D.J.H. FRASER, and D.G. JOACHIM. 1990. Calving sites of moose in central Ontario. Alces 26:142-153.

ALTMANN, M. 1958. Social integration of the moose calf. Anim. Behav. 6:155-159.

_______. 1963. Naturalistic studies of maternal care in moose and elk. Pages 233-253 *in* H.L. Rheingold, ed. Maternal behavior of mammals. J. Wiley, New York.

BAILEY, T.N., and E.E. BANGS. 1980. Moose calving areas and use on the Kenai National Moose Range, Alaska. Proc. N. Am. Moose Conf. Workshop 16:289-313.

BALLARD, W.B., J.S. WHITMAN, and C.L. GARDNER. 1987. Ecology of an exploited wolf population in south-central Alaska. Wildl. Monogr. 98. 82pp.

BERGERUD, A.T., H.E. BUTLER, and D.R. MILLER. 1984. Antipredator tactics of calving caribou: dispersion in mountains. Can. J. Zool. 62:1566-1575.

BYERS, C.R., R.K. STEINHORST, and P.R. KRAUSMAN. 1984. Clarification of a technique for analysis of utilization-availability data. J. Wildl. Manage. 48:1050-1053.

CARBYN, L.N. 1983. Wolf predation on elk in Riding Mountain National Park, Manitoba. J. Wildl. Manage. 47:963-976.

CEDERLUND, G., F. SANDEGREN, and K. LARSSON. 1987. Summer movements of female moose and dispersal of their offspring. J. Wildl. Manage. 51:342-352.

CLARKE, C.H. 1936. Moose seeks shelter for young. Can. Field- Nat. 50:67-68.

COSTAIN, B. 1989. Habitat use patterns and population trends among Shiras moose in a heavily logged region of northwest Montana. M.S. Thesis, Univ. of Montana, Missoula. 265pp.

EDGE, W.D. 1985. Habitat use and food habits of elk in western Montana: a multivariate approach. Ph.D. Dissertation. Univ. of Montana, Missoula. 75pp.

FRANZMANN, A.W., and R.O. PETERSON. 1978. Moose calf mortality assessment. Proc. N. Am. Moose Conf. Workshop 14:247-268.

FRITTS, S.H., and L.D. MECH. 1981. Dynamics, movement, and feeding ecology of a newly protected wolf population in northwestern Minnesota. Wildl. Monogr. 80. 79pp.

JENKINS, K.J. 1985. Winter habitat and niche relationships of sympatric cervids along the North Fork of the Flathead River, Montana. Ph.D. Dissertation, Univ. Idaho, Moscow. 183pp.

KRAHMER, R.W. 1989. Seasonal habitat relationships of white- tailed deer in northwestern Montana. M.S. Thesis, Univ. of Montana, Missoula. 104pp.

LEPTICH, D.J., and J.R. GILBERT. 1986. Characteristics of moose calving sites in northern Maine as determined by multivariate analysis: a preliminary investigation. Alces 22:69-81.

MARCUM, C.L., and D.O. LOFTSGAARDEN. 1980. A nonmapping technique for studying habitat preferences. J. Wildl. Manage. 44:963-968.

MARKGREN, G. 1969. Reproduction of

moose in Sweden. Viltrevy 6:1-299.

MARTINKA, C.J. 1976. Ungulate populations in relation to wilderness in Glacier National Park, MT. Trans. North Amer. Wildl. Nat. Res. Conf. 43:351-357.

MESSIER, F., and M. CRETE. 1985. Moose-wolf dynamics and the natural regulation of moose populations. Oecologia 65:503-512.

NEU, C.W., C.R. BYERS, and J.M. PEEK. 1974. A technique for analysis of utilization-availability data. J. Wildl. Manage. 38:541-545.

PETERSON, R.L. 1955. North American moose. U. Toronto Press, Toronto, Canada. 280pp.

PFISTER, R.D., B.L. KOVALCHIK, S.F. ARNO, and R.C. PRESBY. 1974. Forest habitat types of Montana Internt. For. Range Exp. Stn. North Reg., U.S. For. Serv., Missoula, Montana. 213pp.

REAM, R.R., M.W. FAIRCHILD, D.K. BOYD, and D.H. PLETSCHER. 1991. Population dynamics and home range changes in a colonizing wolf population. Pages 349-366 *in* R. Keiter and M. Boyce, eds. The Greater Yellowstone ecosystem: redefining America's wilderness heritage. Yale University Press.

SETON, E.T. 1927. Lives of game animals: Vol 3. Doubleday Doran, New York. 780pp.

SINGER, F.J. 1979. Habitat partitioning and wildfire relationships of cervids in Glacier National Park, Montana. J. Wildl. Manage. 43:437-444.

STEPHENS, P.W., and R.O. PETERSON. 1984. Wolf-avoidance strategies of moose. Hol. Ecol. 7:239-244.

STRINGHAM, S.F. 1974. Mother-infant relations in moose. Naturaliste can. 101:325-369.

USDA. 1987. Ecosystem classification handbook. R-1, Supp. 1, Chap. 4, U.S. Forest Service, Region 1. Missoula, Montana.

WILKINSON, L. 1989. SYSTAT: The System for Statistics. Systat, Inc., Evanston, IL.

WILTON, M.L., and D.L. GARNER. 1991. Preliminary findings regarding elevation as a major factor in moose calving site selection in southcentral Ontario, Canada. Alces 27:111-117.