Winter habitat associations of a low-density moose (Alces americanus) population in central Labrador

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Winter Habitat Associations of a Low-Density Moose (*Alces americanus*) Population in Central Labrador

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Abstract - *Alces americanus* (Moose) are relatively new to Labrador, having only colonized the area in the late 1940s, and little is known about this population. We conducted large-scale aerial surveys for Moose in a 122,000-km^2 area during winter 2000 and in a 29,900-km^2 area in winter 2001. Moose densities were low in each area (1.6–3.0 Moose per 100 km^2). Bull:cow ratios were nearly even and calf:cow ratios were relatively high, indicative of a population exposed to little hunting or predation pressure. Twinning rates were low, suggesting low range productivity. Moose used riparian areas and hardwood stands in higher proportion than their availability in winter ($P < 0.05$). Open habitats (conifer-lichen woodlands, bogs and fens, burned forest, and barren areas) were used in lower proportion than their availability. These data may provide the basis for developing habitat suitability maps for Moose in late winter across central Labrador.

Introduction

Alces americanus (Clinton) (Moose) were not known to occur in Labrador until recently, arriving only in the last half century. Twelve Moose (7 cows and 5 bulls) from the island of Newfoundland were introduced to the south coast of Labrador in 1953 (Mercer and Kitchen 1968). According to historical accounts of residents (Chubbs and Schaefer 1997, Mercer and Kitchen 1968) and Innu traditional knowledge (D. Ashini, Innu Nation, Sheshatshiu, NL, Canada, pers. comm.), colonization of Moose into Labrador also occurred via range expansion from adjacent regions of Québec, beginning in 1949 (Harper 1961). Analyses of DNA samples (n = 39) collected from Moose near Goose Bay, Labrador, confirmed that they were more closely related to Moose populations in Ontario than they were to those from Newfoundland (Broders et al. 1999). These analyses suggest that

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the current Moose population in Labrador is most likely the result of natural range expansion through eastern Québec, rather than a result of the 1953 introduction attempt.

The extreme snow cover observed in much of central Labrador (>300 cm; Brown and Theberge 1990) is likely a key factor in the slow expansion of the Moose population (Dodds 1974), as snow depths of >70 cm have been reported to impede travel of Moose (reviewed by Coady 1974). Much of central Labrador is open terrain, composed of extensive string bogs, conifer-lichen woodlands, barren hilltops, and burned areas, and relatively little of the landscape is composed of closed-canopy, conifer-dominated forest, which is used for shelter by Moose in winter (Brassard et al. 1974). By 1977, Moose populations were apparently large enough to prompt the opening of an annual licensed harvest in Labrador. Karns (1998), citing local authorities, reported the Moose population in Labrador increased from an estimated 750 animals in 1960 to an estimated 5000 animals in 1990, but those numbers were unconfirmed.

Little is known of the density or distribution of Moose in central Labrador apart from the results of a few aerial surveys of small sampling areas (i.e., most <5000 km^2; Chubbs and Schaefer 1997, Dalton 1986, Trimper et al. 1996). In 1980, Phillips (1983) provided the most extensive aerial survey of Moose across central Labrador to date, estimating Moose densities in 4 areas ranging in size from 2330 km^2 to 29,800 km^2. Trimper et al. (1996) surveyed Moose populations in the region, focusing on select river valleys known to harbor Moose in winter. Chubbs and Schaefer (1997) documented the range expansion in Labrador and population growth of Moose within moose management areas (MMA), where Moose hunting was permitted. Most recently, Newbury et al. (2007) documented winter browse use by Moose to be highest on willows (*Salix* spp.) and *Betula papyrifera* Marsh. (White Birch) in 20- and 30-year-old regenerating clear-cut stands.These studies concluded that Moose populations were at low densities (≤10 per 100 km^2) and localized.

During the late winter of 2000 and 2001, we recorded all observations of Moose or their tracks during aerial surveys designed to enumerate *Rangifer tarandus* (Gmelin) (Woodland Caribou). We report on the winter density, population structure, and habitat use of Moose across a broad area of Labrador south of 54°N, including a small portion of adjacent Québec.

Methods

Study area

Our study was conducted in a 122,000-km^2 area of central Labrador and adjacent Québec (Fig. 1), during February and March 2000 and in a 29,900-km^2 area of central Labrador in March 2001. The two study areas were adjacent and largely non-overlapping. The study area was within the Low Sub-Arctic Eco-climatic Province and was predominantly taiga in character. Summers were warm and short; winters were cold with snow cover extending from October until late May or early-June. Mean February and March temperatures at Churchill Falls, Labrador, were -19.7 ºC and -13.2 ºC, respectively (Ecoregions Working Group 1989). Snow depths reached 500 cm and were among the greatest in eastern North America (Brown and Theberge 1990). Barren hilltops, open conifer-lichen woodlands, extensive string bogs, treed bogs, burned areas, numerous water bodies, and densely forested river valleys constituted the broad habitat types within the study area. Common tree species included *Picea mariana* (P. Mill) (Black Spruce), *Picea glauca* (Moench) (White Spruce), *Abies balsamea* (L.) P. Mill. (Balsam Fir), *Larix laricina* (Du Roi) K. Koch (Tamarack), White Birch, and *Populus tremuloides* Michx. (Trembling Aspen). Deciduous-dominated forests were common in deeply incised river valleys. Mosses (*Sphagnum* spp.) and lichens (*Cladonia* spp. and *Cladina* spp.) were the dominant ground cover in upland areas. Riparian areas were shrubby, with dominant species being willows, birch (*Betula* spp.), and alders (*Alnus* spp.). *Canis lupus* L. (Gray Wolf) and *Ursus americanus* Pallas (American Black Bear) were present in the study areas. Wolf densities were unknown, but appeared to be low, with most packs incidentally observed having between 3 and 7 wolves (Dalton 1986; T.S. Jung et al., unpubl. data). Wolf predation of Woodland Caribou and *Castor canadensis* Kuhl (American Beaver) was commonly observed, but we rarely observed Moose killed by wolves in the study area

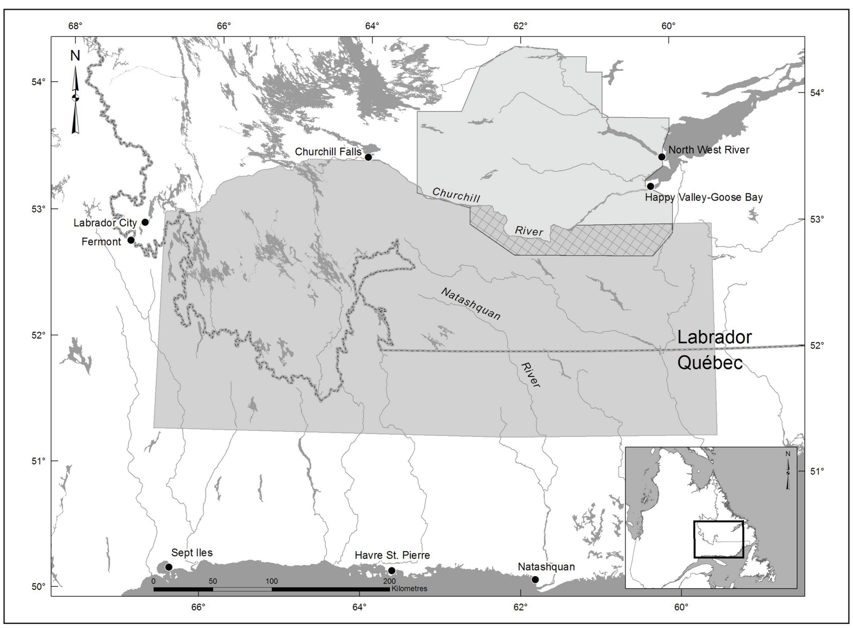

Figure 1. Area surveyed for Moose in central Labrador and adjacent Québec, winter 2000 (bottom polygon) and in central Labrador in winter 2001 (top polygon). Hatched area indicates the area of overlap between the study areas. Location of the study areas in northeastern Canada (inset).

(T.S. Jung et al., pers. observ.). Human habitation, buildings, and roads in the study area were concentrated near the few communities.

Aerial surveys

We used parallel, aerial strip transects, rather than block-based methods, because the former are more suitable for reconnaissance work, where large areas are surveyed and Moose densities are low (Timmerman and Buss 1998). In February and March 2000, we systematically surveyed 12% of the larger area by flying 127 transects, spaced 10–15 km apart. In March 2001, we systematically surveyed 13% of the smaller area by flying 32 transects, spaced 7.5 km apart.

Sampling followed general protocols for line-transect surveys (e.g., Anderson et al. 1979, Caughley 1977, Dalton 1990, Timmermann 1974). We used Bell 206L and Enstrom 480B helicopters because helicopter surveys yield more accurate data than do fixed-wing surveys (Smits et al. 1994). We flew 175 m above ground level at ground speeds between 90 and 120 km/hr, covering a minimum of 500 m on both sides of the aircraft, although distances >500 m were almost always observed given the open canopy of the forest. To obtain accurate density estimates, we plotted both Moose observations and the actual flight paths flown during the aerial survey. Plotting of flight paths was accomplished using a global positioning system (GPS; Trimble GeoExplorer3; Trimble, Sunnyvale, CA) to record the aircraft's position every 5 sec, as line-attribute data. These data were later differentially corrected and entered into a geographic information system (GIS; ArcView GIS 3.2; ESRI, Redmonds, CA). The visibility of snow tracks is dependent upon viewing conditions, thus transects were flown only on sunny days, generally between 10:00 and 17:00 (ADT). Snow conditions were excellent during all surveys. The field crew consisted of the pilot, a navigator/recorder, and two observers. The pilot navigated using an onboard GPS and coordinates from pre-mapped transects.

Upon sighting Moose tracks, we searched for the Moose for a maximum of 5 minutes and classified all Moose observed by sex and age. Calves were identified by body size; sex was determined based on the presence or absence of a vulva patch, antler pedicles, or a calf at heel (Mitchell 1970). We calculated bull:cow ratios, calf:cow ratios, and twinning rates across all transects within each study area. Locations of Moose were marked with a GPS and imported into ArcView GIS as point data. To estimate Moose density, we adjusted the number of Moose observed by applying a sightability correction factor of 1.6, as calculated by Chubbs and Schaefer (1997) for MMAs within our survey areas.

At each Moose observation, we classified the habitat into 1 of 7 types: barren hilltops, bogs and fens, burned areas, closed canopy conifer forest, open conifer-lichen woodlands, hardwood forest, and riparian areas. To estimate the relative availability of these habitat types, we recorded the habitat types observed directly below the helicopter every 3 minutes while flying on transect. We used contingency table analysis to test for differences between use and availability of the habitat types. Each survey area was analyzed separately to account for yearly or spatial differences. Because habitat use did not differ between the 2 years (see Results below), we pooled data for further analyses to improve sample sizes. We used the statistical procedure for comparing use versus availability data developed by Neu et al. (1974), and clarified by Byers et al. (1984), to determine habitat preferences of Moose.

Results

Moose density and population structure

We counted 143 Moose in 2000, resulting in an estimated 229 Moose in the 14,585-km^2 area surveyed (1.6/100 km^2). We counted 72 Moose in 2001, resulting in an estimated 115 Moose in the 3840-km^2 area surveyed (3.0/100 km^2). In 2000, the bull:cow ratio was 0.96, and the calf:cow ratio was 0.79, with an observed twinning rate of 17%. In 2001, the bull:cow ratio was 1.08 and the calf:cow ratio was 0.5 with an observed twinning rate of 8%.

In addition, 6 wolves and 43 observations of wolf tracks were observed in the area surveyed in 2000. In 2001, 10 wolves and 20 observations of wolf tracks were made. Wolf tracks were observed across the study areas, with the notable exception of west of the Natashquan River, where very few wolf tracks were observed. The distribution of wolf tracks approximated the distribution of Woodland Caribou in the study areas (T.S. Jung et al., unpubl. data).

Moose distribution by habitat class

We often observed concentrations of Moose in river valleys and adjacent hillsides, particularly along the Churchill River and the Natashquan River (Fig. 1). Moose were not randomly distributed among available habitat types in either year (2000: $\chi^2_6 = 1785$, $P < 0.001$; 2001: $\chi^2_6 = 697$, $P < 0.001$; Fig. 2). Moose were observed more often in riparian areas and intolerant hardwood stands, and less often in string bogs, open conifer-lichen woodlands, and barren hilltops, than expected based on the availability of those habitat types (Fig. 2). They used closed-canopy conifer forests and burned forest in relative proportion to their availability on the landscape (Fig. 2).

Discussion

Moose density and population structure

Moose were widely distributed in Labrador south of 54°N, but in low densities (1.6–3.0/100 km^2). Our use of the strip-transect method may have underestimated densities compared to actual counts using block-sampling schemes (Timmermann 1974, Timmermann and Buss 1998), but we believe that our data accurately represented the density and habitat use of this population. Due to the relatively low numbers of Moose observed in our surveys, caution should be exercised in interpreting our demographic data.

We did not survey areas with particular concentrations of Moose, such as in MMUs, so we expected lower densities than reported by those that focused their efforts on MMAs or habitats with relatively high suitability for Moose. In 1980, Phillips (1983) reported densities of 1.5, 1.6, and 4.4 Moose per 100 km^2 in 3 areas. In adjacent eastern Québec, Brassard et al. (1974) noted that Moose densities were low, likely due to extremely deep snow cover. In 1986, Dalton (1986) reported densities of 4.3 to 7.4 per 100 km^2 for MMAs. Chubbs and Schaefer (1997) reported Moose densities in 1994 of 8.5 to 16.8 per 100 km^2 in the same MMAs. In our extensive survey area, the majority of the landscape would have been stratified as low density, based on apparent habitat suitability. This poorer suitability of habitat for Moose resulted in a substantially lower overall density than that reported for Labrador MMAs by Chubbs and Schaefer (1997).

Sex-ratios observed were nearly even in both surveys and are consistent with other northern areas with little to no hunting pressure on bulls. Chubbs and Schaefer (1997) observed a range of bull:cow ratios of 0.7–0.9 in their 1994 survey of MMAs. The higher bull:cow ratios observed in our surveys compared to Chubbs and Schaefer (1997) are consistent with the large study area, which is largely inaccessible to hunting.

Late-winter calf:cow ratios were high relative to other areas in northern Canada, but twinning rates were lower (Brassard et al. 1974, Crête and Courtois 1997, Ferguson et al. 2000, Pimlott 1959), suggesting that predation rates were low in these survey years. Chubbs and Schaefer (1997)

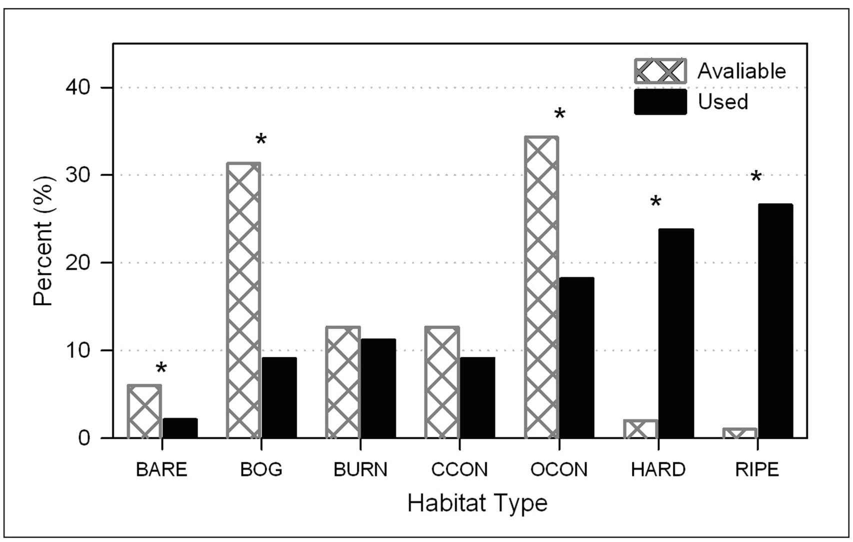

Figure 2. Frequency of habitat types used by Moose (solid bars) and those available (hatched bars) in winter in central Labrador, 2000 and 2001. Use of habitat types with an asterisk (*) was significantly different than their availability, using the Bonferroni-adjusted confidence interval method of Neu et al. (1974). Habitat type codes are as follows: BARE = barren land, BOG = bogs and fens, BURN = burned forest, CCON = closed-canopy conifer-dominated forest, OCON = open conifer-lichen woodlands; HARD = hardwood-dominated forest, and RIPE = riparian zone.

reported calf:cow ratios of 0.30–0.67. High calf:cow ratios may reflect low calf-predation rates, particularly by Black Bears (Gasaway et al. 1992). These ratios are also consistent with the low density of Moose observed, as wolves, another common calf predator, likely could not be sustained on such a low-density population. High variability in calf:cow ratios among areas and years may reflect the effects of low habitat productivity (Crête and Courtois 1997). Phillips (1983), working in areas believed to be "good" for Moose, found a twinning rate of 33.3%, but this was based on small sample size. Low twinning rates have been suggested to be a reliable indicator of poor range quality (Albright and Keith 1987, Gasaway et al. 1992), and despite high calf:cow ratios, our observed twinning rates are among the lowest observed for Moose in North America (Schwartz 1998).

Moose distribution by habitat class

Moose in central Labrador were observed in higher than expected numbers in riparian and, to a lesser extent, in intolerant hardwood forest. Although no winter yarding areas were observed, the selection of riparian and hardwood forest areas reflected findings reported elsewhere (e.g., Brassard et al. 1974, Chubbs and Schaefer 1997, Doerr 1983, Newbury et al. 2007, Proulx 1983, Proulx and Kariz 2005, Stenhouse et al. 1995, Suring and Sterne 1998, Trimper et al. 1996). Winter distribution of Moose likely reflected the combination of limited high-quality winter forage and sites that conferred thermal and snow-depth advantages. It should be noted, however, that our surveys were only done on sunny days and may not accurately reflect Moose habitat choices during poor weather or at night.

Riparian areas are likely of particular importance to Moose in late winter primarily because of the availability of high-quality forage species such as willow and birch. Further, on relatively warm and sunny days, Moose will bed in these shrub communities, deriving passive thermal warming and protection from the wind (Peek 1998). Riparian shrub communities in the boreal forest of central Labrador were often bordered by a strip of closed-canopy, conifer-dominated forest, usually dominated by large White Spruce. More than 80% of the survey area was taiga in character and comprised of relatively open habitats; closed-canopy conifer forests, such as those associated with river-valley bottoms and lakeshores, were somewhat rare (Fig. 2). Moose likely used these closed-canopy forests for bedding and shelter, or in inclement weather, although we did not survey during poor weather conditions or at night. Closed-canopy forest presumably had lower snow depths and conferred thermal advantages to Moose, compared to more open habitats. Early work elsewhere has highlighted the importance of the juxtaposition of food and shelter in late winter (reviewed by Thompson and Stewart 1998). The combination of shrub communities and closed-canopy forests found in riparian areas may have provided an ideal habitat mosaic for Moose in central Labrador.

Hardwood stands were another key habitat type used disproportionately by Moose in our survey areas. These stands were largely on south-facing hillsides, and Moose likely gained important thermal benefits by bedding in these sites on sunny winter days (Peek 1998, Proulx 1983). Browse, particularly young Balsam Fir and White Birch, provided important winter forage in these stands. Although available forage and perhaps predation risk may have been important contributing factors to Moose choice of these stands, the increased thermal advantage was the most obvious benefit Moose derived from this habitat type.

Our data provides a basis for understanding Moose distribution in winter in central Labrador, and can be used to develop large-scale habitat-suitability maps across the region. Shrubby riparian areas bordered by closed-canopy, conifer-dominated forests, or south-facing hillsides dominated by hardwoods, represented areas of high habitat suitability for Moose in central Labrador. Although Moose were not observed yarding in these areas, impacts to these habitats or the wintering Moose within them could have disproportionately large effects on the regional Moose population. Suitable habitats along, and adjacent to, the Churchill River and Natashquan River should be recognized for their high value in supporting a low-density Moose population in Labrador.

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