# Forestry maps as an information source for description of moose winter yards

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One hundred and twenty-one moose (*Alces alces*) winter yards were located in February 1975 in La Vérendrye Fish and Game Reserve, Quebec. At this time of winter, they occupied a mean area of 0.44 km². The yards were established on various slopes or on mountain tops without preference to a particular exposure. This habitat is situated on gentle slopes of less than 11% inclination, and at an altitude less than 46 m above bodies of water considered as components of summer habitats. Discriminant analysis showed that the habitat used by moose differs from unused sites only by a lack of bodies of water and shade-intolerant stands. The typical winter yard corresponds to a mosaic of mature and disturbed stands varying in structure and age and provides both cover and food. It is dominated by white birch (*Betula papyrifera*) associated with conifers. Forestry maps alone cannot identify all parameters for a suitable site but coupled with topographic maps they can, for some years, localise potential sites to be protected from logging.

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L'étude porte sur 121 quartiers d'hiver d'orignaux (*Alces alces*) localisés au mois de février 1975 dans la Réserve de La Vérendrye, Québec. A cette époque de l'hiver, ils occupent une superficie moyenne de 0.44 km². L'orignal établit son quartier d'hiver sur les différents versants ou sur les sommets des montagnes sans préférence pour une exposition particulière. Cet habitat est situé sur des pentes faibles, inférieures à 11% d'inclinaison et à moins de 46 m d'altitude au-dessus des grands plans d'eau considérés comme composants de l'habitat d'été. L'analyse discriminante démontra que l'habitat de l'orignal ne se différencie des endroits non utilisés que par une absence des plans d'eau, et de peuplements tolérant l'ombre.

Le quartier d'hiver modèle correspond à une mosaïque de peuplements mûrs et de peuplements perturbés qui varient en structure et en âge et qui fournissent à la fois le couvert et la nourriture. Il est caractérisé par des peuplements mélangés, dominés par le bouleau blanc (*Betula papyrifera*) associés à des résineux. Les cartes forestières seules n'ont pu cerner tous les paramètres d'un quartier d'hiver modèle mais couplées aux cartes topographiques elles sont un outil capable de localiser les sites potentiels à préserver de la coupe à court ou moyen terme.



## Introduction

Moose are becoming more important economically and recreationally in Quebec. A growing number of visitors in the fish and game reserves hope to observe moose; furthermore, in 1978, more than 100 000 hunters bought licences to hunt moose (Bouchard and Gauthier 1979). However, the harvest has remained relatively stable over the last 15 years, gradually decreasing the relative hunting success. A moose population decrease has been suggested, and a greater knowledge of the habitat and its management could help to rectify this situation, reported to be similar also in Ontario.

In Quebec, some studies were done on a limited number of winter yards and the results were summarized by Brassard *et al.* (1974). Later, Crête and Bedard (1975) and Joyal (1976) studied the food layer of the moose habitat. Crête (1977) and Poliquin *et al.* (1977) have suggested that it is the food layer which attracts the moose. However, Vallée *et al.* (1976) showed that, at least from the quantitative point of view, the food, when accessible, is not a limiting factor for the moose in southern Quebec. A gap in knowledge about the importance of the protection layer exists, and since the cost of field work, in particular aircraft, climbs continuously, we evaluated forestry maps as a tool for predicting potential sites in order to protect them against overcutting.

The first aim of the study, then, was to determine, with only the aid of forestry maps, the characteristics of a winter yard model, based on physical and vegetational aspects of the forest zone 3 of Brassard *et al.* (1974), considered to be the best zone for moose in Quebec (2.6 animals per 10 km²). In addition, we wanted to determine if moose use the range randomly in late winter or if they choose sites with respect to the protection layer. Finally, we wanted to see if, by using only the forestry maps, the quality of forest stands as potential moose winter yards could be evaluated in eastern Canada in habitats similar to Quebec forest zone 3.

## Study area

La Vérendrye Reserve, with an area of 13 000 km², is situated approximately 300 km northwest of Montreal. The relief is slightly undulated with altitudes ranging from 200 to 500 m. In the southern part, the forest belongs to the Great Lakes – St. Lawrence Region and in the north, to the Boreal Region (Rowe 1972). The dominant species are balsam fir (*Abies balsamea*),

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black spruce (*Picea mariana*), white birch (*Betula papyrifera*), trembling aspen (*Populus tremuloides*), yellow birch (*Betula alleghaniensis*), and in the southern part, sugar maple (*Acer saccharum*) and red maple (*Acer rubrum*). The average length of winter is 150 days (Wilson 1971) and there is a mean snow depth of 75 cm during February and March (Soucy 1971).

In the nineteenth century, caribou (*Rangifer tarandus*) were abundant. Lumbering and fires seem to have been the main factors that were responsible for the disappearance of this ungulate and encouraged the rapid growth of the moose population in this region (Joyal 1976). Brassard *et al.* (1974) evaluated the moose population density of the reserve at 2.6/10 km$^2$.

## Methods

In 1975, the Ministère du Tourisme, de la Chasse et de la Pêche du Québec, undertook a study on moose population dynamics in the La Vérendrye Reserve. The inventory was done according to the method described by the Quebec Inventory Committee of the Ministère du Tourisme, de la Chasse et de la Pêche (1973), and was carried out in 20 plots of 26 km$^2$ using a Bell Ranger jet helicopter. The 20 plots were inventoried from 4 to 12 February, at which time there was an average depth of 76 cm of uncrusted snow, a sufficient accumulation to influence the movement of moose (Nasimovitch 1955; DesMeules 1964). Within these plots, 121 winter yards were located. The areas of these winter yards and their forest stands were obtained by planimetry. The exposures of winter yards were based upon six orientation classes (N, NE, NW, S, SE, SW) and a seventh without exposure (summits, valleys). Their frequencies were then compared with those of 121 control blocks, chosen at random, and were studied by a chi-square test. The slope ($S$) was calculated as a percentage from topographic maps at a scale of 1 : 50 000 according to the following formula

$$S = (M - m)/H$$

where $M$ and $m$ are the maximum and minimum altitudes of the winter habitat, respectively, and $H$ is the length of the horizontal line drawn perpendicularly between $M$ and $m$. Assuming the minimum altitude of the summer habitat corresponds to that of the large bodies of water, we calculated the altitudinal movement between summer and winter habitats as being the difference between the altitude of the winter yards and those of the large bodies of water in the area (Dunn 1976).

To know whether moose utilized the range randomly, we compared 71 winter yards chosen at random with 72 control blocks, also chosen randomly, on a grid. The control blocks were situated outside the winter yards and were equal in dimension. For the purpose of comparison, we studied the 49 variables related to the vegetation of the region according to the classification of the Ministère des Terres et Forêts du Québec (1975) and which are described on the Quebec forestry maps at a scale of 1 : 20 000. These variables are the stand type density, height indices, growth stages, stand structure, and kind of perturbation. Moreover, two physical variables were considered, the areas of the bodies of water and the roads. Aspect, slope, and altitude, considered in the study of the 121 winter yards, were not used in the comparison of the winter yards and control blocks because of the space limitations of the computer program. A Bruning aerograph chart (No. 4850) was used to determine, by the dot-count method, the surfaces of the other variables within a winter yard or a control block, with a percentage error equal to 5%.

Winter yards and control blocks were compared with a stepwise discriminant analysis (Klecka 1975). This analysis is a multivariate statistical technique that allows one to describe, differentiate, and classify elements characterized by a set of $p$ variables. In this analysis, we looked for a linear combination of $p$ variables that best separated the "winter yard" group from the "control block" group and that characterized winter yards in relation to control blocks. The selection of the significant variables by computer was done with the aid of an $F$-test, which refers to the inter- and intra-group variance ratios. According to the linear combination of the variables determined by computer, the winter yards (group 1) and the control blocks (group 2) were classified in their original group or in the other group.

## Results

### *Physical characteristics of the winter yards*

In February, the mean area of the 121 winter yards was 0.44 km$^2$. Most yards were in the 0.30–0.40 km$^2$ class and more than 80% of the winter yards had an area less than 0.60 km$^2$ (Fig. 1*a*). The southeast slope was the exposure with the highest relative frequency followed closely by the northwest and southwest slopes (Fig. 1*b*). However, a chi-square test showed that the frequency distribution for the exposures of the winter yards was like the one obtained for 121 control blocks, that is to say, a theoretical distribution for each aspect ($P > 0.05$). The moose had no marked preference for any particular exposure. More than 75% of the 148 slopes determined in the 121 winter yards had an inclination of less than 11% (Fig. 1*c*). Eighty percent of the winter yards were situated less than 45 m above the lowest points of the studied area (Fig. 1*d*). There was a mean altitudinal difference of 31.7 m between the winter yards and what was considered to be the summer habitat. Therefore, altitudinal movements of moose to winter range is minimal; besides, almost 18% of the winter yards are at the same altitude.

### *Comparison of the winter yards and the control blocks*

Only three significant variables were retained through the discriminant analysis ($P < 0.05$). These variables were the areas of the bodies of water, the sugar maple – yellow birch stands, and the yellow birch stands. The frequency distribution of group 1 (winter yards) and 2 (control blocks) on the discriminant axis is represented in Fig. 2. The "winter yard" group refers to the negative part of the axis, below the rejection–acceptance region, since the positive part is occupied by the "control block" group. Given that the discriminant analysis is the result of the linear combination of the three significant variables, undoubtedly the coordinates of the winter yards and control blocks on the discriminant axis are equally functions of the value of the three significant variables that we have determined. Therefore, a winter yard with large sugar maple – yellow birch stands or yellow birch stands or with a large presence of water is "rejected" by the computer, that is to say that its coordinates are

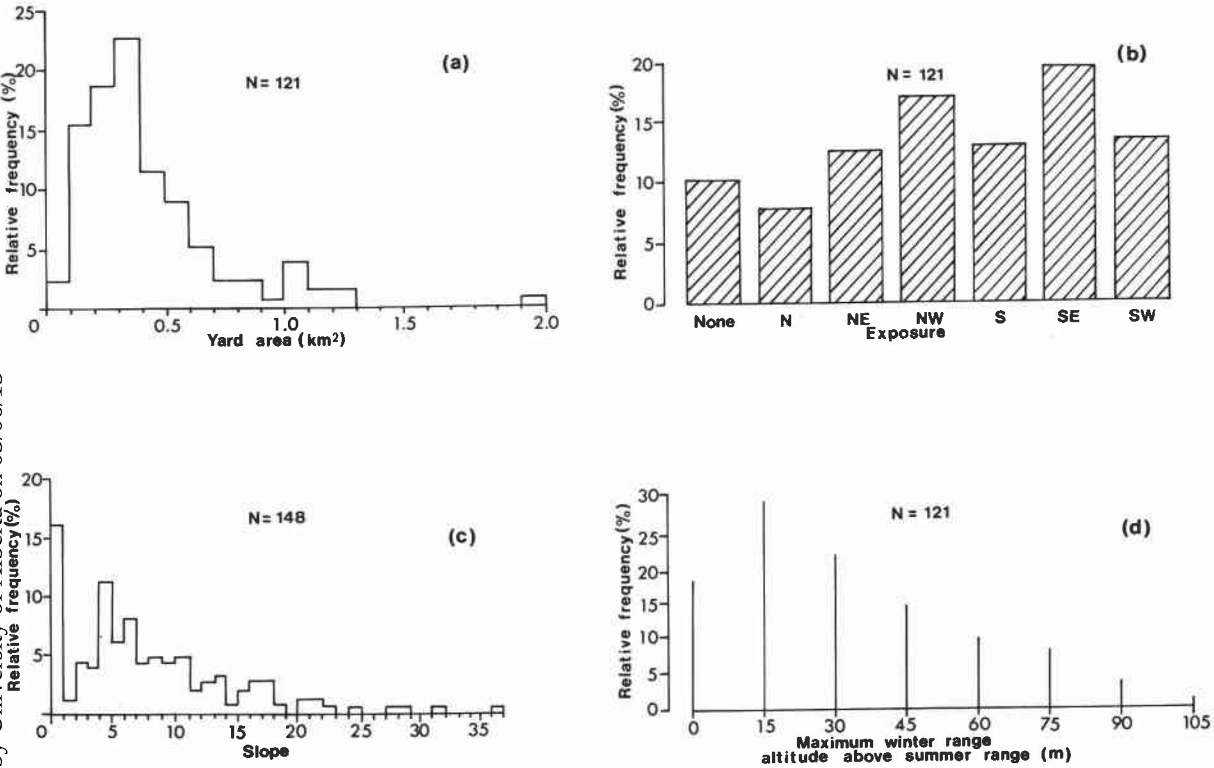


FIG. 1. Relative frequencies in the 121 winter yards of (*a*) the area classes, (*b*) the exposures, (*c*) the slope classes, (*d*) the altitudinal differences between summer and winter range, in La Vérendrye Fish and Game Reserve, Quebec. Determinations were made in February.

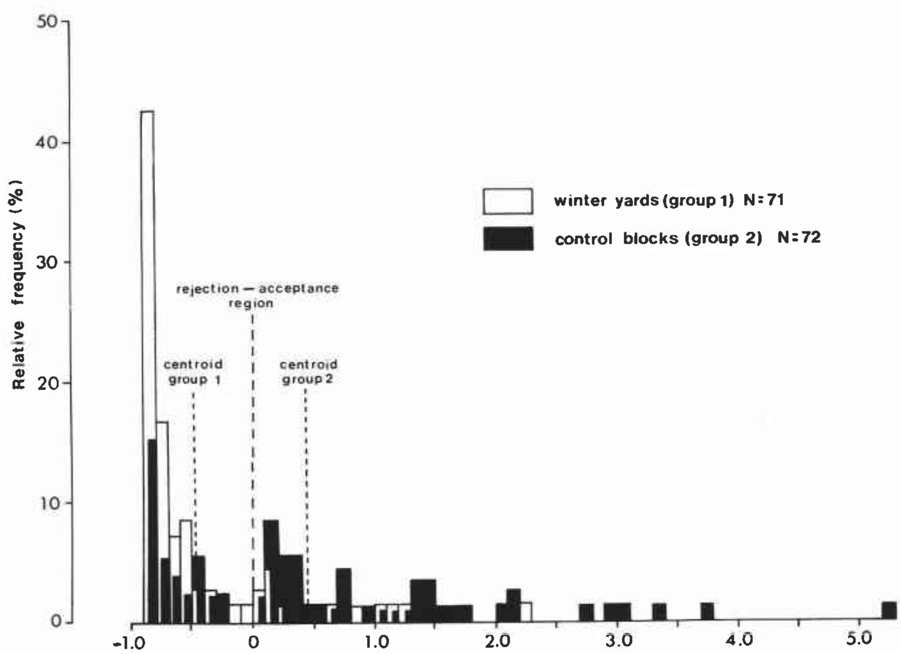


FIG. 2. Frequency distribution of the winter yards (group 1) and control blocks (group 2) on the discriminant axis in La Vérendrye Fish and Game Reserve, Quebec.

now on the positive part of the axis, above the acceptance–rejection region. The composition of this "rejected" winter range is therefore more similar to that of a control block than to that of the majority of the winter yards. The opposite is also true. Figure 2 shows that this process of "rejection" produces a large overlapping of the two groups. This result suggests that an important similarity exists in the composition of some winter yards and some control blocks. Indeed, 17% of the 71 winter yards had a composition similar to that of control blocks and are situated above the acceptance–rejection region.

TABLE 1. Relative importance of forest types in the typical winter yard in February 1975 in La Vérendrye Fish and Game Reserve, Quebec

| Forest types | Relative area (%) |
|---|---|
| Mixed | 51 |
| Coniferous | 18 |
| Deciduous | 20 |
| Nonwoody | 11 |
| Total | 100 |

*The typical winter yard of forest zone 3*

The other 48 variables studied in this statistical test are thus shared by the two groups and none of them are characteristic of either. Consequently, the tree layer of moose winter yards is similar to that of the entire forest region studied except that sugar maple – yellow birch stands and yellow birch stands, two of the dominant species, are absent. The proportion of the remaining variables in a typical winter yard was determined by the description of the most characteristic winter yards of the studied region. The highest frequencies of the winter yards are in the two coordinate classes −0.7 to −0.8 and −0.8 to −0.9 found at the extreme left of Fig. 2. Indeed, more than 70% of the winter habitats that have remained in their original group (below the acceptance–rejection region) are found in these classes. They have a mean area of 0.41 km². Moreover, from 4 to 12 February 1975, according to the measured variables, those were the sites which had less similarities with the control blocks and consequently, that had less probability of being classified as control blocks. The description of the winter yards of these classes, taken altogether, represents the typical moose winter yard of La Vérendrye Reserve and forest zone 3.

In this typical yard, the mixed stands predominate, followed by deciduous and coniferous stands (Table 1). More than 11% of the habitat is unforested owing to roads, bare, semibare, and humid lands, and perturbations such as total cuts. Coniferous stands are known to provide a good cover; 18% of the yard area has a good protection layer. Over 31% of the habitat area is without coniferous stands because of nonforested portions and deciduous stands. Based on the height and density indices from the Ministère des Terres et Forêts du Québec (1975), the majority of stands of all types have a canopy ranging from 41 to 80% and a height between 9 and 21 m.

In the mixed stands, shade-intolerant white birch and trembling aspen associated with conifers predominate. Considering that the climax of forest zone 3 is defined as a white birch – balsam fir – white spruce association (Lafond and Ladouceur 1968), this association should be the most frequent one among the mixed stands. Conifers were mostly represented by black spruce or black spruce – balsam fir stands. Pure balsam fir stands were rare. Finally, white birch and trembling aspen are the species that make up the deciduous stands and sugar maple – yellow birch stands and yellow birch stands are absent in this model.

The typical habitat of moose is therefore made up of a mosaic of mature and young stands (Table 2). In the mature stand the irregular structure is predominant, covering 28.5% of the winter site area, while the regeneration stage only forms a small percentage.

Logging was the most important type of perturbation. Partial cutting is slightly more important than clearcutting. These two types of logging covered 18% of the typical winter yard. Fire and severe insect epidemics were found in only one winter yard.

## Discussion

Owing to the short sampling period for data collection, we found the area used by moose as winter habitat to be small. Moreover, with an accumulation of more than 75 cm of snow, animals' movements were restricted and, consequently, the moose winter yard becomes relatively small (Goddard 1970; Telfer 1970; Phillips *et al.* 1973).

Prescott (1968) and Audy (1974) stated that a southern exposure is important for wintering moose. On the other hand, Telfer (1968) and Rivard (1979) feel that moose use slopes of all aspects without preference. Our results also indicate that moose showed little preference for any one particular slope, confirming that aspect is not critical for the animal in late winter. Use of slopes by moose during winter has rarely been studied. Audy

TABLE 2. Relative areas of growth stages and perturbation in the typical winter yard (0.41 km²) in February 1975 in La Vérendrye Fish and Game Reserve

| Growth stage | Relative area (%) | Perturbation | Relative area (%) |
|---|---|---|---|
| Regeneration | 6.62 | Fire | 0.86 |
| Young | 35.38 | Total cut | 7.97 |
| Mature, regular | 10.17 | Partial cut | 10.07 |
| Mature, multilayered | 8.84 | Windfall | — |
| Mature, irregular | 28.50 | Insect epidemy | 0.19 |
| Unidentified | 9.99 | None | 80.91 |
| Total | 100.00 | | 100.00 |



(1974) found that moose winter yards are situated on slopes with an average inclination of 6.5%. Poliquin *et al.* (1977) found moose on slopes that averaged 3% and less. Our data also show that winter yards are located on gentle slopes According to Crête (1977) the presence of moose on such slopes is due to high soil moisture which is associated with a greater abundance of conifers. However, with such slopes, the moose can easily wander about its habitat except when hindered by snow. Therefore, we believe that the advantage of gentle slopes lies in the reduced energy expenditures.

In Maine, under climatic and topographic conditions similar to forest zone 3, Dunn (1976) found that moose moved uphill from summer to winter habitat. He found that bulls, cows and calves, and calfless cows moved to sites that were, respectively, 4, 38, and 25 m higher in elevation. However, the mean altitude difference of 31.7 m between the winter habitat and large bodies of water is a maximal mean difference. Indeed, the altitudinal difference between the winter yards and the nearby marshes is smaller, even negligible.

Even if moose do not winter in stands dominated by shade-tolerant species, they will accept a protection layer with a broad range of proportion, composition, and structure. They can therefore use sites which, according to the variables studied, seem less favorable. These results agree with those of Telfer (1970), Kearney and Gilbert (1976), and Poliquin *et al.* (1977) which showed that moose choose their winter habitat more by the food layer than the protection layers.

Lafond and Ladouceur (1968) state that in the white birch – balsam fir stands, the most important plant association in the typical yard, balsam fir saplings and mountain maple (*Acer spicatum*) are numerous. Accordingly, those species are important in the winter diet of moose, since Joyal (1976) showed that they were the two most important food species (dry weight) in two winter yards of La Vérendrye Reserve. Balsam fir twigs would have the highest nutritive value in winter (Aubry 1980).

In a typical winter yard, forest cover and tree height were highly variable, strongly confirming the results of habitat studies by Audy (1974), Dunn (1976), and Poliquin *et al.* (1977). The 18% coniferous canopy provides patches of dense horizontal cover that will intercept snow, and the variations in tree height in the mature forest stands furnish the animal with a vertical cover against the wind. Together, these two covers provide moose with the means to conserve energy in spite of the winter cold. However, results show that moose do not overwinter in a forest offering a continuous protection layer. Less than 19% of the typical winter yard area has a continuous coniferous cover. This agrees with Telfer (1968) which shows that moose do not require cover stands to be uniformly dense over large areas.

Our results, based on forestry maps only, are not really new, but coupled with physiographic characteristics found on topographic maps, they permit the identification of good potential sites without costly field work. For instance, a sound forest management in forest zone 3 and similar regions could use the results of this study and protect potential sites corresponding to the typical late-winter yard from excessive logging.

This potential site is a mosaic of mature and immature mixed stands, preferably dominated by a white or yellow birch – balsam fir stand known to offer an important understory of balsam fir saplings and mountain maple. The mosaic must have a high diversity in structure, including more than 18% of coniferous canopy and height ranging from 9 to 21 m. This site is less than 0.5 km², situated on a slope of less than 10%, without any particular aspect, but not higher than 50 m above large bodies of water.

Logging is beneficial for moose (Telfer 1974), but extensive clear-cutting seems disastrous for moose population dynamics (F. Girard, unpublished data). Systematic protection of suitable sites should be considered in law enforcement.

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