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# Preliminary assessment of habitat characteristics of woodland caribou calving areas in the Claybelt region of Québec and Ontario, Canada

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Abstract: Woodland caribou (Rangifer tarandus caribou) require a diversity of forested habitats over large areas and may thus be particularly affected by the large-scale changes in the composition and age-class distribution of forest landscapes induced by the northern expansion of forest management. In this study we examine habitat characteristics associated to the use of calving areas by woodland caribou females and calves at different spatial scales. Thirty females were captured and collared with Argos satellite transmitters that allowed to locate 14 calving areas. Field surveys were conducted at each of these areas to measure the landscape composition of forest cover types and local vegetation characteristics that are used for both forage conditions and protection cover. At the scale of the calving area, univariate comparisons of the amount of forest cover types between sites with and without calves showed that the presence of calves was associated to mature black spruce forest with a high percent cover of terrestrial lichens. Within calving grounds, univariate comparisons showed that vegetation features like ericaceans and terrestrial lichens, that are important food resources for lactating females, were more abundant in calving areas where females were seen with a calf in mid-July than in areas where females were seen alone. The protection of the vegetation cover against predators was however similar between calving areas with or without a calf. Logistic regression results also indicated that vegetation characteristics associated to forage conditions were positively associated to calf presence on calving grounds. Our results suggest that foraging conditions should be given more attention in analyses on habitat requirements of woodland caribou.

**Key words**: food availability, habitat requirement, logistic regression, multi-resources analysis, multi-scale analysis, protection cover.

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## Introduction

A number of studies have already shown the impacts of forest management and other human activities on populations of woodland caribou (Cumming, 1992; Chubbs et al., 1993; Cumming & Beange, 1993; Smith et al., 2000). Forest management can have direct or indirect negative effects on caribou populations by displacing them (Darby & Duquette, 1986), by changing predator-prey dynamics (Bergerud & Elliot, 1986; James & Stuart-Smith, 2000) or, like fire, by affecting food availability (Klein, 1982; Darby & Duquette, 1986; Pruitt & Schaeffer, 1991). Since the late 1800s and the early 1900s , the historical range of woodland caribou has decreased (Bergerud, 1974; Racey & Armstrong, 2000; Courtois et al., 2001). Even though many hypotheses were made to explain the possible causes of this range restriction, it is hard to point out one unique factor (Racey & Armstrong, 2000). But still, low productivity of females (Bergerud, 1980), high rates of mortality of newborns within the first six weeks (Bergerud, 1974; Bergerud, 1980), and susceptibili-

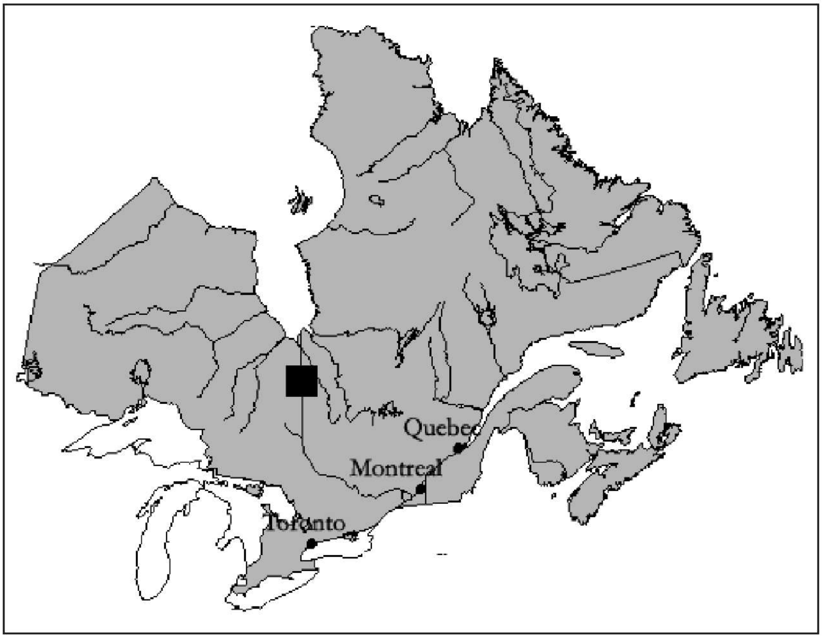


Fig. 1. Location of the study area within the Claybelt of Québec and Ontario.

ty of caribou toward disturbances (Chubbs et al., 1993; Cumming & Beange, 1993; Nellemann & Cameron, 1996; Dyer et al., 2001) make them a fragile species. Late winter and calving seasons are two critical mortality periods for woodland caribou (Bergerud, 1980). Wilson (2000) has recently shown the importance of forage conditions, particularly terrestrial lichens, in late winter habitat selection by woodland caribou. Information regarding forage conditions and protection cover used by female woodland caribou in calving areas is limited. Some studies have established relationships between food quality at the end of the gestation period and survival of calves (Rognmo et al., 1983; Post & Klein, 1999). At the landscape scale, during the calving period and in the summer, females of woodland caribou are associated with the abundance of old growth forests surrounded by wetlands (Hillis et al., 1998) or to islands in lakes (Bergerud, 1980). This combination of habitats should provide them with food (Paré, 1987) and protection against predators (Bergerud & Page, 1987).

In this study we characterised calving areas used by woodland caribou in the Claybelt region of Québec and Ontario. More specifically, we evaluated if sites where females were seen with their calf had different habitat features than those where females were alone. We hypothesise that the presence of offspring during spring and summer is related to both food resources and protective cover provided by habitat characteristics. Hence, we tested two predictions: (1) calving areas with females seen with their calf have a greater forage biomass than calving areas where females were seen alone, and (2) the protection cover in the understory of calving areas where females were seen with a calf is greater than in calving areas where females were seen alone.

## Methods

The study area is located in the northern Claybelt region between 49°15' and 50°53'N and from 81°14' to 78°36'W (Fig. 1). It is part of the black spruce-moss bioclimatic subzone (Saucier et al., 1998). The landscape is dominated by black spruce (*Picea mariana* [Mill.] B.S.P.) with an understory of mosses and *Sphagnum* spp. These forests have frequent wetlands and other non-commercially productive forests. Jack pine (*Pinus banksiana* Lamb.) forests with dense terrestrial lichen cover are also present. Topography for this region is essentially uniform and flat (Vincent & Hardy, 1977).

In the late winter of 1998 and 1999, capture and marking of individuals from the studied population was done. For two years, a total of 30 females were collared with Argos satellites platforms (Telonics Inc.) equipped with a mortality sensor. At the same time, blood samples were taken from adult females and laboratory analyses were conducted to verify for gestation status with the help of PSPB tests (Russell et al., 1998). The tests were positive for all samples from captured females (unpubl. data). Because the tests were conducted in late winter and foetal resorption is considered to be low (Bergerud, 1980), each positive test was assumed to lead to a birth. We also made the assumption that each year the gestation rate was similar, based on the small variation in pregnancy rates observed in North America (Bergerud, 1980; Courtois et al., 2002).

In mid-July 2000, aerial surveys were conducted to estimate the survival rate of calves. At that time, 16 collars were still functional, 14 were found and all these females were located near their calving areas. For the purpose of this study, the term "calving

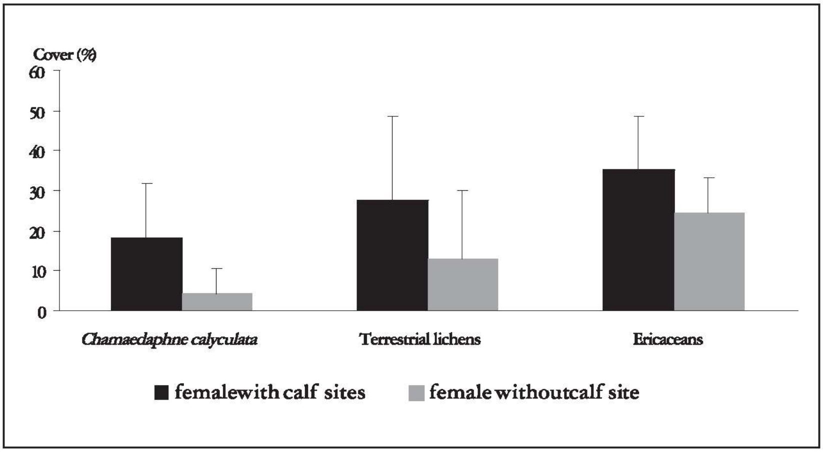


Fig. 2. Differences in mean percent cover (%) of leather leaf (Chamaedaphne calyculata) ($P=0.034$ ), terrestrial lichens ($P=0.159$ ) and other ericaceans ($P=0.224$) for the female with calf sites ($n=7$) and female without calf sites ($n=7$).

areas" represents areas utilised by females during the calving period, i.e., from mid-May to mid-June.

For each collared female, we generated minimum convex polygon home ranges that allowed the delineation of calving areas. These areas covered between 3 to 5 km² (Lantin, unpubl. data). By flying over the females, we were able to determine if the female was followed by a calf or not, looking both at the presence of calf at heel and female behaviour (tendency to stay near a specific place or to look back in the same direction). When no calf was seen with the female or no indication of its presence was observed at the time of the survey, the calf was assumed dead. Based on this criterion, 7 out of 14 females were followed by a calf in mid-July.

When flying over the calving area, the landscape composition of calving grounds was visually evaluated to determine the relative proportions of each habitat type: (1) wetlands, (2) closed canopy spruce forests with mosses, (3) medium to dense forests with mosses, (4) open spruce forests with mosses, (5) dense spruce forests with terrestrial lichens, (6) medium-to-dense forests with terrestrial lichens and (7) clear-cuts. This visual evaluation covered an area of approximately 5 km² (1.2 km radius) i.e., the entire calving ground.

Quantitative evaluation of vegetation was conducted within the portion of each calving area that comprised the highest concentration of locations. This ensured that the transects and sample plots were representative of the area used by the female during the calving and summer periods even though vegetation characteristics were measured in a single transect. Vegetation at the ground level was characterised for the 14 calving areas associated with female sight records. The sampling protocol used was adapted from a transect sampling procedure developed by the Société de la faune et des parcs du Québec from another study on woodland caribou in eastern Québec (Courtois, 1997).

One transect was located at each site. Vegetation measurements were taken at five rectangular plots (2 m X 10 m) equally spaced along the 130 m transect. Within each plot, vegetation measurements including the percent cover of (1) moss, (2) terrestrial lichens, (3) Sphagnum spp., (4) herbs (graminoïds and Carex sp.), (5) ericaceans, (6) bare ground, with fine woody material were made in a 1 m radius circular plot located within each 2 m X 10 m rectangular plot. The volume of terrestrial lichens was estimated using the method by Arseneault et al. (1997) that combines measures of height of the lichen mat and percent cover within the circular plots. Woody plants as food for ungulates were measured by counts of the number of coniferous and deciduous stems with twigs available to browse in the 2 by 10 m plots (i.e. twigs more then 5 cm length located between 30 cm and 3 m from the ground) (Shafer, 1963). Abundance of epiphytic lichens was measured on the five nearest trees from the end of the 2 m X 10 m plot by a visual estimation index between 1 and 5 (where 1 is the less abundant and 5 if the most). A visual estimate of canopy closure was made at every meter on a 10 m chain (Vales & Bunnell, 1988; Potvin et al., 1999). Measures of lateral cover obstruction were taken on a 200 cm by 30 cm board at 15 m from the beginning of the sampling plots at 0° and 270° (Nudds, 1977). Finally, the abundance of large downed woody debris (>10 cm DBH) was counted along a 10 m transect that crossed each 2 m X 10 m plot. Presence of lichens was recorded on each downed woody debris. Presence of lichens on downed woody debris was an indication of the time since the tree fell down. Hence, dead wood was categorised into old downed woody debris with lichens (ODWD) and recent downed woody debris without lichens (RDWD).

Statistical analyses were conducted on presence/absence of a living calf in each calving area. At the scale of the entire calving area, the composition and

Table 1. Results of Mann-Whitney U-test at $\alpha$=0.1 for differences in mean percent of forest cover types in the calving area [mean (standard deviation)] between sites with and without calves.

| Types of forests | female with calf | female without calf | P |
|---|---|---|---|
| Wetlands | 47.86 (29.84) | 26.43 (20.15) | 0.178 |
| Closed canopy spruce forest (>60%) with mosses | 5.71 (15.12) | 16.43 (18.87) | 0.157 |
| Medium to closed canopy spruce (31–60%) forest with mosses | 20.00 (30.41) | 29.29 (19.88) | 0.323 |
| Open spruce forest with mosses (<30%) | 7.14 (18.90) | 17.14 (29.84) | 0.476 |
| Dense spruce forests with terrestrial lichens | 10.71 (14.56) | 0.00 ( 0.00) | **0.062** |
| Medium to dense forest with terrestrial lichens | 8.57 (17.01) | 7.14 (18.90) | 0.657 |
| Clear-cuts | 0.00 ( 0.00) | 3.57 ( 6.27) | 0.142 |

amount of forest cover types were measured and Mann-Whitney U tests (Zar, 1999) were applied to test for differences in the landscape composition of calving grounds with and without a calf. Within calving areas, the transect became the sampling unit, and vegetation variables mean values over the 5 plots within each transect where used in all analyses. Differences in vegetation characteristics between sites with and without calves were assessed using Mann-Whitney U-tests (Zar, 1999). Given the small sample size in this study, P values where considered to be statistically significant at both $\alpha$=0.05 and $\alpha$=0.1 levels. Significance levels of 0.1 have been used in other studies involving small samples of observations of woodland caribou (Mahoney & Schaeffer, 2002). Finally, logistic regression with a stepwise procedure was used to identify the combination of vegetation characteristics that best predicted calf presence on females calving areas.

## Results

At the scale of the entire calving area, the composition and relative proportions of forest cover types did not differ between areas used by females with a calf and areas occupied by females without a calf for a P value of 0.05. However, at the P=0.1 level, the importance of mature black spruce forests with a dense cover of terrestrial lichens was significantly associated to calf presence in calving areas (Table 1).

When analyses were conducted at the transect scale at the P=0.05, only the cover of leather leaf (*Chamaedaphne calyculata* (L.) Moench.) was significantly different between female with calf sites and female without calf sites (Prob>|Z|=0.0398) (Fig. 2). Percent cover of terrestrial lichens and other ericaceans, were also more abundant in transects where females were seen with a calf, although this difference was not statistically significant at the P<0.05 level (Fig. 2). At a level where P=0.1, the percent cover of litter, the volume of terrestrial lichens, the abundance of ODWD with lichens, RDWD without lichens, percent conifer in the canopy and total canopy cover were all significant for differentiating the two groups of sites (Table 2). There were no significant differences for all the other variables at both P=0.05 and P=0.1 (Table 2).

A logistic regression analysis of calf presence in transects produced the following equation:

Logit $\text{calf}_{(\text{absent, present})}$ =3.3066+0.0546 • % cover of herbs+0.0472 • % cover of leather leaf-0.0741 • nb Larch-0.0557 • nb RDWD-0.0460 • nb shrubs. ($\chi^2$=4.3004; P=0.0381)

Again, results from the logistic regression indicated that calves were seen in sites where leather leaf was more abundant. The presence of herbs was also associated with the presence of calves. Larch (*Larix laricina* (Du Roi) K.Koch), and RDWD without lichens and shrubs (mostly from the genus *Salix* spp.) in the sites were negatively associated with calf presence.

## Discussion

Food resources may play an important role in the survival of calves in their first weeks of life (Skogland, 1985; Cameron et al., 1993; Post & Klein, 1999). Skogland (1985) argued that calf survival from reindeer populations could be influenced by nutritional conditions of females at the end of the gestation period and at the beginning of lactation. Our results show that calves presence is associated to several habitat features that are used as forage conditions by lactating females both at the scale of the calving area and within calving areas. Ericaceans, terrestrial lichens and herbs are part of caribou's spring and summer diet and may represent up to 60% of their diet (Simkin, 1965; Bergerud, 1970; Gaare & Skogland, 1975; Darby, 1979; Thompson & McCourt, 1981). These vegetation variables were

Table 2. Results of Mann-Whitney U-test, at $\alpha$=0.05 (bold with*) and $\alpha$=0.1 (bold), for mean values (standard deviation) of vegetation characteristics between sites with and without calves

| Sites´ characteristics | female without calf | female with calf | P |
|---|---|---|---|
| Mosses cover (%) | 60.86 (30.05) | 58.86 (21.26) | 0.654 |
| Terrestrial lichens (cm³) | 2.45 ( 3.54) | 6.77 ( 6.61) | **0.084** |
| Lichen cover (%) | 12.86 ( 6.42) | 27.43 ( 7.91) | 0.159 |
| Herbs (graminoïds and Carex spp.) cover (%) | 0.29 ( 0.49) | 1.57 ( 1.81) | 0.154 |
| Larch density (nb trees/ha) | 0.2 ( 0.12) | 0.00 ( 0.00) | 0.318 |
| *Ledum groenlandicum* cover (%) | 10.57 ( 7.48) | 9.29 ( 5.56) | 0.698 |
| *Chamaedaphne calyculata* cover (%) | 4.29 ( 6.07) | 18.29 (13.43) | **0.034*** |
| *Vaccinum* spp. cover (%) | 8.14 (11.91) | 4.00 ( 4.58) | 0.132 |
| *Kalmia angustifolia* cover (%) | 1.57 ( 0.98) | 3.57 ( 2.82) | 0.172 |
| Bareground cover (%) | 13.00 (10.20) | 3.00 ( 3.96) | **0.077** |
| Arboreal lichens (nb. Thalli) | 23.90 (14.99) | 28.40 (18.36) | 0.749 |
| Open canopy (%) | 52.3 (20.5) | 71.4 ( 1.92) | **0.096** |
| Coniferous canopy (%) | 47.1 (19.8) | 28.6 (19.2) | **0.096** |
| Lateral visibility 0-50 cm (%) | 22.86 (29.75) | 10.29 (10.61) | 0.440 |
| Lateral visibility 50-100 cm (%) | 52.57 (23.63) | 46.86 (28.00) | 0.797 |
| Lateral visibility 100-150 cm (%) | 68.86 (18.36) | 66.29 (21.21) | 0.798 |
| Lateral visibility 150-200 cm (%) | 67.43 (20.71) | 69.43 (21.22) | 0.370 |
| ODWD with lichens (nb. of logs/plot) | 0.17 ( 3.21) | 0.46 ( 0.32) | **0.082** |
| RDWD without lichens | 3.46 ( 3.21) | 0.89 ( 0.54) | **0.053** |

more abundant in sites with calves than in sites without calves using either univariate comparisons or logistic regression. Moreover, at the scale of the calving area, the only forest cover type that was associated to calves presence was spruce forests with terrestrial lichens, another indication of the possible importance of foraging conditions in woodland caribou habitat use during the calving period. One limitation in our results is whether or not lone females remain in the same area where their calf may have died. However, when we analysed our caribou locations during the calving period, the variation in locations was similar between the 14 females suggesting that females without a calf did not disperse over a long distance from the calving area (Lantin, unpubl. data).

The logistic regression model showed that calf presence was associated with availability of leather leaf and herbs. The leather leaf, as other ericaceans, is a plant species that is generally associated with higher biomass of terrestrial lichens (Kershaw & Rouse, 1971). It is found in relatively mesic peatland areas instead of bogs. Even though terrestrial lichen percent cover was less in sites without a calf it did not come out as a significant variable in the logistic regression analysis. The small size of our sample set (n=14) may be in part responsible for this lack of statistical significance with lichens abundance and we recognise that further research with a larger sample set and more sampling intensity should be conducted to adequately test if lichens abundance is biologically a significant variable in habitat use by caribou during the calving period.

The absence of calves in areas with Larch is not surprising given that, in our study area, this tree species is normally found on organic soils that are poorly drained and on which the process of paludification takes place (Girardin et al., 2001; Giroux et al., 2001). The build-up of thick moss and organic layers (Paré & Bergeron, 1995) do not provide good substrate conditions for terrestrial lichens because of the abundance of *Sphagnum* spp. that are effective competitors for ground lichens (Johnson, 1981; Boudreault et al., 2002). Well-drained sites, as the ones with *C. calyculata*, thus offer more abundant food resources to female caribou.

The results from the logistic regression also show a negative association between the abundance and volume of logs and shrubs, and the presence of calves. At first glance, structural heterogeneity of the understory characterised by more shrubs and downed deadwood should provide some protection cover against predators. On the other hand, chances to escape for a newborn caribou could be reduced by the presence of logs and downed woody debris and dense shrub cover. Accumulation of deadwood could generate obstacles on the ground that may cause deadly injuries (Baskin, 1983) and that may increase the time needed to securely escape from predators. Finally, visual obstruction variables (also known as lateral visibility), a set of habitat features that provide a key information on the protection cover of forest stands against predators, did not show statistically significant differences. Percent cover values of lateral visibility were indeed highly similar between sites with and without calves (Table 2).

Several studies suggested that predation is a key factor in woodland caribou population dynamics (e.g. Bergerud, 1974; Bergerud & Elliot, 1986; Seip, 1992; Rettie & Messier, 2000). Barten et al. (2001) hypothesised that calving site selection of caribou females is driven first by predator avoidance factors, resulting in a trade-off between these factors and forage conditions. Rettie & Messier (2000) suggested that habitat selection by woodland caribou follows a hierarchy of spatial scales where predator avoidance is linked with habitat selection at a landscape level whereas available forage habitat is associated to stand level habitat selection. Our study was not designed (used vs. unused random sites) to evaluate habitat selection of calving sites by female woodland caribou, nor to evaluate which habitat factors, between foraging conditions and protection cover, had the upper hand in such selection. Nevertheless, calving sites with the presence of a calf were associated more often with foraging condition variables than with protection cover against predator variables. That calf presence shows stronger associations with vegetation features characterising forage conditions at the local scale of calving sites may thus not be a surprise if the Rettie & Messier (2000) model of a hierarchical habitat selection process is indeed occurring for this species.

Whereas the literature on woodland caribou range reduction still emphasizes predation as a driving factor (Bergerud & Elliot, 1986; Bergerud & Page, 1987; Cumming, 1992; James & Stuart-Smith, 2000; Courtois et al., 2002), the effect of habitat suitability of forest cover types with regards to forage conditions has received less attention. This is probably because the availability of forage over the landscape has not traditionally been considered as a limiting factor (Bergerud, 1974). However, Dyer et al. (2001) have showed that the total habitat avoided by caribou greatly exceeds the physical footprint of industrial development (roads, wells, seismic lines) in Alberta. Even though this avoidance does not lead to a net loss of habitat, they conclude that infrastructures associated to industrial development seriously reduce availability of habitat for woodland caribou and that this may have consequences on their demographic response. A net loss of functional habitat for caribou because of a loss of forage may, however, occur with increased timber harvesting in the boreal forest combined with the persistence of natural disturbances such as large forest fires. Short timber rotation length in managed forests has been identified as one of the most important long-term effect of forest management on boreal forest ecosystems and their wildlife (Spies et al., 1994; Wallin et al., 1994, Thompson et al., 1995, Drapeau et al., 2000). Increases in the proportion of early-successional habitats and decreases in late seral habitats could influence forage conditions of woodland caribou over the landscape given that these forest cover types are used for winter forage. Reduced availability of lichen and other food resources following fire may also affect forage conditions for caribou at large scales (Klein, 1982; Morneau & Payette, 1989). Hence, cumulative effects of disturbances (human and natural) and the loss of late seral forest cover types may reduce forage conditions of woodland caribou and eventually affect its demography.

## Conclusion

Although, this investigation provides indirect and correlative data on the association of forage conditions with calf occurrence for a small sample set of calving areas, it nevertheless indicates that more attention should be paid to forage conditions in habitat use studies of woodland caribou. Predation may have been an important cause of mortality for several of our calves, variables associated to protection cover were not, however, as important as variables describing available forage when comparing calving areas with and without calves. Further studies on the variation in abundance and quality of forage should be conducted across forest cover types and throughout seasons to better assess habitat suitability for woodland caribou in forested environments. Such baseline data could then be incorporated into landscape level models assessing the effects of disturbances (natural and anthropogenic) that woodland caribou face under different development scenarios in the commercial boreal forest.

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