Late-winter Habitat Use by Boreal Woodland Caribou (*Rangifer tarandus caribou*) in Northwestern Saskatchewan

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**Abstract**

In an effort to better assess the impact of future timber harvest on wildlife, and to develop pertinent recovery plans for endangered species in specific locations, habitat queries (searches to retrieve data from a vegetation database) may be used to identify polygons (homogenous areas for specific forest stand characteristics) used by a species. During the late winters of 2009, 2011 and 2012, I developed and tested queries to predict the distribution of Boreal Woodland Caribou (*Rangifer tarandus caribou*) habitat in Mistik Forest Management Agreement (FMA) area, in northwestern Saskatchewan. The objectives of this study were to 1) identify polygons with late-winter habitat potential according to forest stand composition and structural characteristics, 2) verify habitat use by Woodland Caribou, and 3) identify stands that should be protected in the future. In 2009, with a query based on generalities taken from Woodland Caribou habitat studies conducted in areas other than the Mistik FMA area, only 25% of track encounters (*n* = 8) occurred in polygons judged to be suitable for Woodland Caribou. After modifying the original query to include muskegs (treed bogs, treed fens, and treed swamps) that were ≤2 km apart, and upland stands that were ≤2 km from these muskegs, 76% and 93% of track encounters occurred in suitable polygons in 2011 (*n* = 46) and 2012 (*n* = 45), respectively. As predicted, the majority (61.5%) of 91 track encounters (≤2 Woodland Caribou/track encounter in most cases) occurred in muskegs, and nearly 25% were in late-successional, upland deciduous and mixed coniferous-deciduous stands located within 2 km from the edge of muskegs. Track encounters were significantly more frequent than expected in muskegs (*P*<0.02), and less frequent than expected in unsuitable polygons (*P*<0.01). They were significantly (*P*<0.05) more frequent in Tamarack (*Larix laricina*) stands with 21-40% canopy closure and 0-20 m-high trees, and in Tamarack stands with >40% canopy closure with 0-10 m-high trees. There were no track encounters in Black Spruce (*Picea mariana*) stands with 0-40% canopy closure and 0-20 m-high trees, and in Jack Pine (*Pinus banksiana*) pure or mixed coniferous stands. Track encounters were significantly less frequent than expected (*P*<0.01) in deciduous stands. In muskeg habitats used by Woodland Caribou, there was 1 track encounter/246 m of transect in 2011, and 1 track encounter/264 m of transect in 2012. Woodland Caribou track encounters were recorded at the beginning of transects, beside active roads and on pipelines, or further away depending on the distance of transects from roads and suitable muskeg habitat. The findings of this study led to a more effective rating of forest stands to predict the late-winter distribution of Boreal Woodland Caribou in Mistik FMA area. The index of track encounters/km of suitable muskeg habitat may be useful to assess the persistence of the Woodland Caribou population over time.

**Key Words:** Black Spruce, Boreal Woodland Caribou, *Rangifer tarandus caribou*, late-winter habitat, Saskatchewan, snowtracking, Tamarack.
INTRODUCTION

Woodland Caribou (*Rangifer tarandus caribou*) are distributed in the boreal forest across 9 ecozones (areas with similar geography, vegetation and animal life) in Canada (Environment Canada 2008). Several ecotypes of Woodland Caribou have been identified, i.e., boreal, forest tundra, northern mountain and southern mountain. In 2002, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) listed the Boreal Woodland Caribou ecotype as threatened (Thomas and Gray 2002). The Boreal Woodland Caribou is a forest-dwelling sedentary ecotype associated with large tracts of mature to old-growth coniferous forests, such as Jack Pine (*Pinus banksiana*), Black Spruce (*Picea mariana*) with abundant lichens, or muskegs (peatlands) intermixed with upland or hilly areas (Fuller and Keith 1981; Bradshaw *et al.* 1995; Stuart-Smith *et al.* 1997; Schneider *et al.* 2000; Szkorupa 2002; Smith 2004; McLoughlin *et al.* 2005; Saher 2005; Dalerum *et al.* 2007; Sheperd *et al.* 2007). Black Spruce and Tamarack (*Larix laricina*) are typical of poorly-drained peatland complexes in Boreal Woodland Caribou ranges (Edmonds 1988; James 1999; Smith *et al.* 2000; McLoughlin *et al.* 2003, Dalerum *et al.* 2007).

Environment Canada (2012) classified Boreal Woodland Caribou populations according to 51 ranges, i.e., geographic areas occupied by a group of individuals that are subject to similar environmental factors and threats (Thomas and Gray 2002). Environment Canada (2008) also classified populations of Boreal Woodland Caribou according to their self-sustainability. A self-sustaining Boreal Woodland Caribou population is defined as a local population that, on average, demonstrates stable or positive population growth over the short term, and is large enough to withstand stochastic events and persist over the long-term, without the need of ongoing intensive management. In the Boreal Plains Ecozone portion of Saskatchewan (Figure 1), Environment Canada (2008) rated the Woodland Caribou population “likely as not self-sustaining”. In the past, population-limiting factors were linked to habitat selection (Rettie and Messier 2000), and the major threat to Boreal Woodland Caribou would be increased predation that appears to be related to habitat changes. Therefore, knowing which habitats Woodland Caribou use during critical periods of the year is vital to the development of an effective recovery conservation program.

Little is known on habitats used by the Boreal Woodland Caribou population of the western portion of the Boreal Plains Ecozone of Saskatchewan, which includes the Mistik Forest Management Agreement (FMA) area. Based on studies conducted in areas adjacent to the Mistik FMA area, Woodland Caribou would prefer treed peatland complexes dominated by mature-old Black Spruce, Tamarack, and Black Spruce/Jack Pine stands rich in lichens, and would avoid clearcuts and open peatlands (Rettie and Messier 2000; Dzus 2001; Arsenaught *et al.* 2006). Considering that Woodland Caribou prefer lichen-rich areas, Saskatchewan Environment (2008) generally rated Black Spruce- and Jack Pine- dominated stands as highly suitable for the species, particularly when the trees were between 40 and 100 years old. Environment Canada (2012) described critical winter habitat for the Boreal Woodland Caribou population of the western portion of the Boreal Plains Ecozone of Saskatchewan as areas with treed peatland, treed bog and treed fen complexes with >50% peatland coverage with high abundance of lichens, mature (>50 years old) forests, and upland Black Spruce/Jack Pine forests, lowland Black Spruce, and young Jack Pine.

In an effort to better assess the impact of future timber harvest on wildlife, and to develop pertinent recovery plans for specific populations, habitat queries (searches to retrieve data from a vegetation database) may be developed with forest inventory vegetation datasets to identify polygons (i.e. homogenous areas for specific forest stand characteristics) used by species (e.g., Proulx 2006). Without knowing all the detailed characteristics of stands used by Woodland Caribou, the identification of these polygons allows foresters to predict, on the basis of forest inventory datasets, the potential distribution of Woodland Caribou habitat at landscape level, and avoid areas where the species may be encountered. If resources permit it, stands that are part of suitable and unused polygons may be investigated in greater details for their composition and structure (e.g., Proulx 2006).

From 2009 to 2012, I developed and tested queries to predict the distribution of Woodland Caribou late-winter habitat in Mistik FMA area. For purpose of this study, February was defined as late winter, a critical time period when bad weather and long deep freeze periods may become a major constraint for the species (Fancy and White 1987). Most adult Woodland Caribou mortality occurs at this time of year and in spring when the animals are energetically stressed (Farnell and McDonald 1988). However, identifying critical habitats for this period of year for the Mistik FMA area is not easy to do because of the lack of knowledge on habitat use. The characteristics of treed peatlands and treed bogs vary considerably according to many factors such as landscape position, origin, slope gradient, water table location, drainage, etc. (Smith *et al.* 2007). Also, structure may be a better predictor of lichen biomass and diversity than forest age (e.g., Lang *et al.* 1980; Pipp *et al.* 2001). In this paper, I explain the stepwise approach that I employed to identify polygons and forest stands used by Woodland Caribou of the Mistik FMA area in late winter. The objectives of this study were to 1) identify polygons with late-winter habitat potential according to forest stand composition and structural characteristics, 2) verify habitat use by Woodland Caribou, and 3) identify stands that should be protected in the future.

STUDY AREA

The Mistik FMA area is located in northwestern Saskatchewan, north of Meadow Lake (54° 07’ N, 108° 25’ W) and adjacent to the Alberta border (Figure 1). The area encompasses approximately 1.8 million ha of forests, water, and non-forested land. It is a mosaic of
upland deciduous and coniferous boreal forest, open and treed fens and bogs, and water. The area lies within the Boreal Plains Ecozone where White Spruce (*Picea glauca*), Black Spruce, Jack Pine and Tamarack are the dominant conifers (Environment Canada 2008). Approximately 5500 ha are harvested per year in the Mistik FMA area: 45% in pure hardwoods, 40% in mixedwoods (*Aspen (Populus tremuloides*)-White Spruce -Jack Pine), and 15% in softwoods (Jack Pine -White Spruce). The FMA area is subject to frequent fires which burn an average of 17000 ha per year, and relatively short fire cycles (Weir *et al.* 2000; Schulz 2008; A. Balisky, 2012, Mistik Management Ltd., personal communication).

# METHODS

## Queries and Predictive Distribution Maps

### 2009 Query

The first query, which was used during the 2009 field assessment, was based on generalities taken from Woodland Caribou habitat studies conducted in areas other than the Mistik FMA area (e.g., Stuart-Smith *et al.* 1997; Rettie and Messier 2000). Because detailed, quantitative information on stands used by the Woodland Caribou of the Mistik FMA area was lacking, the 2009 query was poorly developed (Table 1). In 2009, transect surveys also aimed to collect information on the distribution of Moose (*Alces alces*), American Marten (*Martes americana*) and Fisher (*Martes pennanti*), and less time was spent on the assessment of Woodland Caribou habitat. Data were sufficient, however, to indicate that the 2009 query was inadequate to predict the distribution of Woodland Caribou in late winter in the Mistik FMA area, and that it needed to be modified.

### 2011 and 2012 Queries

Following the 2009 field assessment, the original query was refined to include muskegs (treed bogs, treed fens and treed swamps) that were ≤2 km apart (instead of ≤1 km apart as in 2009), and upland stands that were ≤2 km from these muskegs (Table 1). Contrary to
winter 2009, the 2011 and 2012 survey transects focused on finding and assessing Woodland Caribou habitat, and more track encounters were recorded for yearly data analyses.

Predictive distribution maps

The Silvacom Group (Edmonton, Alberta) produced 1:225000 scale predictive Woodland Caribou late-winter habitat vector maps for snowtracking, and 1:15000 scale vector maps (Figure 2) for data analyses, using Saskatchewan Forest Inventory Vegetation datasets (Saskatchewan Environment 2004). The production of predictive maps was based on weight values that were subjectively allocated to criteria used in the queries. The sum of weights led to the classification of map polygons into suitable and unsuitable habitats.

Snowtracking

A random stratified approach was used to locate transects averaging ≥1-km long and ≥1 km-apart that were accessible by truck or snowmobile by the inventory team. An attempt was made to choose transects that crossed suitable and unsuitable habitats. Transects were plotted on predictive maps; UTM s were recorded at the beginning and the end of transects. When snowshoeing, the number and length of transects varied according to environmental conditions. Snowshoe transects crossed various habitat types; a hip chain was used to record linear distances along survey transects and to record changes in habitat types in order to verify that vegetation inventory datasets were representative of the real world.

One or many Woodland Caribou hoof prints at the same location could have been made by either one animal trampling the grounds while feeding on arboreal lichens or cratering for ground lichens, or by many animals travelling together. In most cases, tracks of 1-2 individuals crossed survey transects at a same location; however, there were cases where snow disturbance was extensive due to the presence of many tracks from different ungulate species, and I could not determine the number of Woodland Caribou. A track encounter could correspond to one or many animals crossing a transect at a same location. I recorded GPS locations and linear distances along transects for all track encounters. When tracks were found, they were investigated on both sides of transects in order to find clear hoof prints (Figure 3) and other signs such as hairs (which were identified in Alpha Wildlife Research & Management’s laboratory), cratering, etc. The combination of hoof print (shape, size, presence of dew claws) and trail (gait, distance between prints) characteristics were used to identify Woodland Caribou tracks and differentiate them from White-tailed Deer (*Odocoileus virginianus*), Elk (*Cervus elaphus*) and Moose.

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**Figure 2.** Example of a Woodland Caribou predictive map based on the query used in 2011 and 2012 in Mistik FMA area, northwestern Saskatchewan.

**Figure 3.** Comparison of Boreal Woodland Caribou tracks in winter (photographed by the author on a 2012 winter transect) and spring (photographed by Kevin Gillis, Mistik Management Ltd., on a dirt road where animals had recently crossed).
Woodland Caribou Track Distribution and Data Analyses

Woodland Caribou track encounters were classified according to suitable and unsuitable polygons, and according to forest stand characteristics. Field surveys in 2009 showed that muskegs were comprised of pure or mixed Black Spruce and Tamarack stands that varied considerably in structure and composition across landscapes. Because data showed that stand age did not impact significantly on habitat use by Woodland Caribou, and stand age is a poor indicator of lichen biomass and diversity (e.g., Lang et al. 1980, Pipp et al. 2001), the analysis of track distribution was largely centered on vegetation composition and structure, i.e., canopy closure and tree height which both impact on arboreal and terrestrial lichen growth and persistence (Ahti and Hepburn 1967; Carroll and Bliss 1982; Campbell and Coxson 2001). Habitat classes were based on vegetation composition (≥60% Black Spruce stands, >60% Tamarack stands, pure and mixed Jack Pine stands with <60% Black Spruce or Tamarack, and deciduous or mixed stands), canopy closure (0–20%, 21–40%, or >40%), and tree height (0–10 m, 11–20 m, or >20 m). Canopy closure values for deciduous stands referred to summer datasets. Canopy closure values for coniferous stands were representative of stand conditions throughout the year. Winter canopy closure data for mixed stands may be inaccurate depending on the proportion in conifers; in most cases, however, mixed stands were rich in deciduous species.

Because there was no significant difference between the frequencies of Woodland Caribou track encounters per polygon type and habitat class in 2011 and 2012, data from both years were pooled for a more comprehensive study of stand composition and structural elements. The proportions of polygon types (e.g., suitable vs. unsuitable) and habitat classes traversed by survey transects were used to determine the expected frequency of track encounters/polygon type or habitat class if such encounters were distributed randomly with respect to polygons or habitat types (Proulx and O’Doherty 2006). Habitat use (i.e., observed vs. expected frequency of track encounters) was tested with Chi-square statistics with Yates correction (Zar 1999). When >20% of cells had an expected frequency smaller than 5, or when any expected frequency was smaller than 1, data classes were combined (Cochran 1954). Then, habitat classes with similar characteristics, such as cover and successional stage were pooled. When Chi-square analyses suggested an overall significant difference between the distributions of observed and expected frequencies, comparisons of observed with expected frequencies for each habitat class or polygon were conducted using the G test for correlated proportions (Sokal and Rohlf 1981). The Fisher Exact Probability Test was used to compare observed with expected distributions for small sample sizes (Siegel 1956). Comparison of 2011 and 2012 track encounter frequencies per polygon type or habitat class was done with the Chi-square for two independent samples (Siegel 1956). Probability values ≤0.05 were considered statistically significant.

Distances of Woodland Caribou track encounters from linear features were measured on 1:15000 forestry maps. Frequency of track encounters per habitat type in the Mistik FMA area was determined only for muskeg habitats that were inhabited by Woodland Caribou in 2011 and 2012.

RESULTS

Environmental Conditions

Surveys were conducted in February 2009, 2011 and 2012. The range of temperatures was similar among years but, on average, the 2012 winter was slightly warmer (Table 2; also see Munro 2012). Snow precipitations and snow accumulations in openings and muskegs were lower in 2012 than in previous years. Nevertheless, each year, surveys were conducted during mild and harsh winter conditions (Table 2).

2009 Winter Survey

A total of 19601 m (30.2% in suitable polygons and 69.8% in unsuitable ones) were surveyed. Eight Woodland Caribou track encounters were recorded and only 25% of them were in suitable polygons. There was no difference between observed and expected frequencies of track encounters per polygon type (Fisher, P = 1.0).

The observed distributions of track encounters in stands of different ages (immature–young vs. mature–old) and of different cover types (coniferous vs. deciduous and mixed) were not significantly different from expected (Fisher, P = 1.0). Three (40%) of the track encounters were in deciduous stands.

2011 and 2012 Winter Surveys

In 2011, 20332 m (54.9% in suitable polygons and 45.2% in unsuitable polygons) were surveyed, and I recorded 46 track encounters. In 2012, 20367 m (67.7% in suitable polygons and 32.3% in unsuitable polygons) were surveyed, and I recorded 45 track encounters. Most track encounters consisted of ≤2 Woodland Caribou tracks in 2011 (87%) and 2012 (96%). Track encounters from both years were pooled because there was no significant difference between 2011 and 2012 Woodland Caribou track encounter frequencies in muskeg polygons, upland late-successional forest polygons located ≤2 km from the edge of muskegs, and unsuitable polygons ($\chi^2 = 4.7$, df: 2, $P>0.05$). There was no significant difference between 2011 and 2012 Woodland Caribou track encounter frequencies in stands with ≥60% black spruce, stands with ≥60% tamarack, and in other stand types (i.e., Jack Pine pure and mixed stands, deciduous and mixed stands) ($\chi^2 = 1.0$, df: 2, $P>0.05$). Finally, in 2011 and 2012, there was no significant difference between observed and expected track encounter frequencies according to stand age (stand age ≤3.0, P ≤0.05) or cover type ($\chi^2 ≤0.8$, df: 1, P> 0.05).

Frequency of Woodland Caribou Track Encounters Per Polygon Type

Out of the 91 track encounters, 61.5% were located in muskegs, and nearly 25% were in late-successional, upland deciduous and mixed coniferous-deciduous stands located ≤2 km from the edge of muskegs. Track encounters were significantly more frequent than expected in
muskeg polygons ($G = 6.6, P < 0.02$), and less frequent than expected in unsuitable polygons ($G = 8.2, P < 0.01$) (Figure 4).

**Frequency of Woodland Caribou Track Encounters Per Habitat Type**

During the 2011 and 2012 surveys, transects crossed major habitat types (e.g., Black Spruce- and Tamarack- dominated muskegs and upland stands; Figure 5). There was a significant difference between observed and expected frequencies of Woodland Caribou track encounters per habitat type ($X^2 = 67.6$, df: 12, $P < 0.001$) (Figure 6). Track encounters were significantly less frequent than expected in deciduous stands ($G = 5.3, P < 0.01$). No Woodland Caribou tracks were encountered in Black Spruce stands with 0-40% canopy closure and 0-20 m-high trees, and in pure and mixed Jack Pine stands. These categories accounted for nearly 25% of the chi-square value of 67.6. Track encounters were significantly more frequent in Tamarack stands with 21-40% canopy closure and 0-20 m-high trees ($G = 4.2, P < 0.05$), and in Tamarack stands with >40% canopy closure with 0-10 m-high trees ($G = 8.4, P < 0.01$). Track encounters were present in other habitat classes according to availability ($P > 0.05$) (Figure 6).

**Frequencies of Woodland Caribou Track Encounters in Muskegs**

In 2011 and 2012, Woodland Caribou track encounters were found in muskegs dominated by Tamarack or Black Spruce, and characterized by specific ranges of canopy closure and tree heights (Figure 6). In these muskegs, there was 1 track encounter/246 m of transect in late-winter 2011, and 1 track encounter/264 m of transect in late winter 2012. Altogether, the rate of track encounter was 1/256 m of transect across muskegs used by Woodland Caribou.

**Distances of Woodland Caribou Tracks from Linear Features**

In 2011 and 2012, Woodland Caribou track encounters were recorded at the beginning of transects, beside active roads and on pipelines (9 times in 2012), or further away, depending on where

<table>
<thead>
<tr>
<th>Survey conditions</th>
<th>2009</th>
<th>2011</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dates</td>
<td>5 - 28 February</td>
<td>3 - 25 February</td>
<td>31 January - 16 February</td>
</tr>
<tr>
<td>Number of transects</td>
<td>11</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>Total distance (m)</td>
<td>19601</td>
<td>20332</td>
<td>20367</td>
</tr>
<tr>
<td>Number of Woodland Caribou tracks</td>
<td>8</td>
<td>46</td>
<td>45</td>
</tr>
<tr>
<td>Environmental conditions recorded in the field</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Range of T° (°C)</td>
<td>0 to -25</td>
<td>2 to -30</td>
<td>4 to -30</td>
</tr>
<tr>
<td>Mean T° (°C)</td>
<td>-12.9</td>
<td>-11.7</td>
<td>-10.8</td>
</tr>
<tr>
<td>Snow depths in openings and muskegs (cm)</td>
<td>30-65</td>
<td>30-65</td>
<td>30-45</td>
</tr>
<tr>
<td>Environmental conditions recorded by Environment Canada in Meadow Lake</td>
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<td></td>
</tr>
<tr>
<td>Max T° (°C)</td>
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<td>-9.6</td>
<td>-4.0</td>
</tr>
<tr>
<td>Min T° (°C)</td>
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<td>-23.3</td>
<td>-17.6</td>
</tr>
<tr>
<td>Mean T° (°C)</td>
<td>-16.3</td>
<td>-16.5</td>
<td>-10.8</td>
</tr>
<tr>
<td>Snow precipitations (mm)</td>
<td>11.2</td>
<td>8</td>
<td>0</td>
</tr>
</tbody>
</table>
transects started relative to roads and suitable muskeg habitats. Average distances from linear features ranged from 74 to 837 m (Table 3).

**DISCUSSION**

This study showed that, in late winter, Boreal Woodland Caribou inhabiting the Mistik FMA area selected for specific Tamarack stands with >20% canopy closure (Figure 7), and also used Black Spruce stands with >40% canopy closure. This is in agreement with Rettie and Messier (2000) who found that, in central Saskatchewan, Woodland Caribou preferred open and treed muskegs. Research conducted in other boreal regions also reported that Woodland Caribou preferred lichen-rich treed fens and treed bogs dominated by Black Spruce and Tamarack (e.g., Bradshaw et al. 1995; Anderson 1999). However, in this study, muskegs comprised of Black Spruce stands with ≤40% canopy closure, and stands with >40% canopy closure and with >20 m-high trees, were not used by Woodland Caribou and should not be identified as valuable late-winter Woodland Caribou habitat (Figure 8). Also, while Woodland Caribou used some Black Spruce stands as per their availability, they preferred Tamarack stands. This finding differs from Rettie and Messier (2000), and from reviews of boreal Woodland Caribou habitat (e.g., Environment Canada 2008; Saskatchewan

Table 3. Distances of Woodland Caribou tracks from linear features in late winter 2011 and 2012, Mistik FMA area, northwestern Saskatchewan.

<table>
<thead>
<tr>
<th>Year</th>
<th>Distances (m) of Woodland Caribou track encounters from linear features</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Primary highway</td>
</tr>
<tr>
<td>2011</td>
<td></td>
</tr>
<tr>
<td>n</td>
<td>19</td>
</tr>
<tr>
<td>Minimum distance</td>
<td>5</td>
</tr>
<tr>
<td>Mean distance (standard deviation)</td>
<td>853.5 (341.9)</td>
</tr>
<tr>
<td>2012</td>
<td></td>
</tr>
<tr>
<td>n</td>
<td>11</td>
</tr>
<tr>
<td>Minimum distance</td>
<td>109</td>
</tr>
<tr>
<td>Mean distance (standard deviation)</td>
<td>635.6 (366)</td>
</tr>
</tbody>
</table>
Environment Canada’s (2012) recovery strategy did not differentiate muskegs on the basis of vegetation composition and tree height, and failed to identify Tamarack stands as preferred late-winter habitats for Boreal Woodland Caribou. Without a good understanding of late-winter habitat use by Woodland Caribou in the Mistik FMA area, an effective recovery strategy plan cannot be developed for this resident population.

This study also showed that nearly 30% of all track encounters occurred in late-successional upland stands that were adjacent to preferred muskegs; however, Woodland Caribou appeared to avoid deciduous stands, and to use mixed stands as per availability. Saskatchewan Environment (2008) indicated that Woodland Caribou habitat could be viewed as a mosaic of preferred habitat patches, interspersed with patches that serve only for dispersal and predator avoidance (Akcakaya 2001). In this study, adjacent late-successional upland stands appeared to be used by Woodland Caribou travelling between muskegs, particularly when such upland forests encompassed a coulee or lowlands interconnecting bogs and fens. However, field observations in 2011 indicated that, during very cold weather (e.g., -30°C), Woodland Caribou sought refuge under mixed canopy cover and cratered at the base of trees. Although these late-successional upland forests may not be preferred Woodland Caribou habitat, they may provide connectivity within and between landscapes. Finally, as was reported in Woodland Caribou habitat reviews (e.g., Environment Canada 2008), Boreal Woodland Caribou avoided early-successional stands resulting from logging or fire. It is noteworthy to mention that Black Spruce stands that were structurally immature with small trees and poor canopy cover, either because of disturbance or poor growing conditions, resembled early-successional stands resulting from logging and fire, and they were also avoided by Woodland Caribou.

**MANAGEMENT IMPLICATIONS**

This study led to a more effective rating of forest stands to predict the late-winter distribution of Boreal Woodland Caribou in Mistik...
FMA area. In 2009, only 25% of track encounters were found in polygons judged to be suitable for Woodland Caribou. With the query used in 2011 and 2012, however, the great majority of track encounters occurred in suitable polygons. Woodland Caribou track encounters that were found outside suitable habitats occurred in lichen-rich muskegs that were <80 years-old, and in upland stands that were >2 km away from the nearest muskegs. On the basis of the distribution of Woodland Caribou track encounters in habitat classes, and taking into account that Woodland Caribou movements may occur >2 km from muskegs, a new polygon rating system may be implemented (Table 4).

The new rating may benefit from further field research. For example, Saskatchewan Environment (2008) suggested that mature Jack Pine-dominated stands were used by Woodland Caribou. In this study, only 2.4 km of transects crossed pure and mixed Jack Pine stands, and I did not encounter Woodland Caribou tracks. In future surveys, an attempt should be made to inventory more pure Jack Pine stands. In the Mistik FMA area, however, Jack Pine is often found in association with Black Spruce in muskegs (Roger Nesdoly, 2012, Mistik Management Ltd., personal communication).

The new rating is advantageous because it is based on vegetation composition and stand structure rather than age. Therefore, it represents well the characteristics of local growing conditions for muskegs. Also, because the new rating system ranks different muskegs on the basis of Woodland Caribou preference, new predictive maps may indicate habitats with greater potential for the species. With this new rating system, polygons meeting late-winter Woodland Caribou habitat requirements would account for 90 out of the 91 track encounters of 2011 and 2012. Only one track encounter would be in an unsuitable polygon that corresponded to a pipeline right-of-way with a salt lick. The pipeline was located in between two mixed stands that were ≥80 years old and within 2.5 km of identified muskeg areas.

On the basis of the distribution of Woodland Caribou track encounters in late winters 2011 and 2012, it appears that Woodland Caribou are widely distributed across the Mistik FMA area. However, one needs to be cautious of the fact that some parts of the FMA area may have been under-represented in the sample due to access issues. Although the Mistik FMA area is subject to frequent and relatively large fires (e.g., Parisien et al. 2004; Mistik Management Ltd. 2012), and in spite of the presence of a forestry road network (Mistik Management Ltd. 2012), Woodland Caribou tracks were frequent in treed muskegs, i.e., ~ 1 track encounter/250 m of transect, on average, in late-winter 2011 and 2012. They were also found close to highways and inactive secondary roads, and along unused seismic lines. Tamarack-dominated muskegs are unsuitable for logging and road construction (Kevin Gillis, 2012, Mistik Management Ltd., personal communication). In late winter, at least, Woodland Caribou are less likely to be affected by human activities. The apparent preference of Woodland Caribou for Tamarack-dominated muskegs in late winter may be an advantage as most of them remain undisturbed by wildfire.

Precise enumeration of Boreal Woodland Caribou population sizes is a challenge and aerial surveys may be misleading (Environment Canada 2011). An index such as the rate of track encounters/km of

<table>
<thead>
<tr>
<th>Vegetation type</th>
<th>Suitability ranking</th>
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<tbody>
<tr>
<td>Muskeg stands (coniferous or mixed) with:</td>
<td></td>
</tr>
<tr>
<td>≥60% Tamarack + &gt;20% canopy closure + 0-20 m (included) - high trees</td>
<td>High – preferred by Woodland Caribou</td>
</tr>
<tr>
<td>Muskeg stands (coniferous or mixed) with:</td>
<td></td>
</tr>
<tr>
<td>≥60% Black Spruce + &gt;40% canopy closure + 0-20 m (included) - high trees</td>
<td>Good – used as per availability by Woodland Caribou</td>
</tr>
<tr>
<td>Or</td>
<td></td>
</tr>
<tr>
<td>≥60% Tamarack + 0-20% (included) canopy closure + 0-20 m (included) - high trees</td>
<td></td>
</tr>
<tr>
<td>Hardwood and Mixedwood (preferably) forests ≥80 years old within 2.5 km of identified muskeg areas (above)</td>
<td></td>
</tr>
<tr>
<td>All other vegetation types:</td>
<td>Unsuitable</td>
</tr>
<tr>
<td>≥60% Black Spruce + 0-40% canopy closure + all high trees</td>
<td></td>
</tr>
<tr>
<td>≥60% Black Spruce + &gt;40% canopy closure + 20 m - high trees</td>
<td></td>
</tr>
<tr>
<td>≥ Tamarack sites + trees &gt;20 m</td>
<td></td>
</tr>
<tr>
<td>Other conifer types where Black Spruce or Tamarack represented &lt;60% of the composition; pure Balsam Fir (Abies balsamea) or Jack Pine</td>
<td></td>
</tr>
</tbody>
</table>
suitable muskeg habitat may be useful to assess the persistence of the Woodland Caribou population over time in different regions of the Mistik FMA area. Independent of the real number of animals present in a population, a constant rate of track encounters/km of muskeg habitat would imply a constant use of habitat, and a similar density of animals, year after year. I recommend that snowtracking transects be annually surveyed in late winter across the whole Mistik FMA area. The distribution of Woodland Caribou according to forest types, and the frequency of Woodland Caribou track encounters/km of suitable muskeg habitat, should be recorded and compared to the new forest rating of this study (Table 4). Although it is known that Moose and Elk tend to move away from areas with heavily-used cross-country ski trails (Ferguson and Keith 1982), it is unlikely that snowshoeing transects distributed across landscapes would displace Woodland Caribou and affect their late-winter distribution.

This study showed that late-winter habitat used by Boreal Woodland Caribou in the Mistik FMA area was unaccounted for in the description of critical habitat by Environment Canada (2012). It is therefore possible that Environment Canada’s (2012) description of critical habitats for other times of year also need to be amended to produce effective conservation programs. I therefore recommend that queries and field tests be conducted during the calving and post-calving seasons, two more critical periods for the survival of Woodland Caribou. This study focused on late-winter habitat use by Woodland Caribou and did not take into consideration other factors that may impact negatively on the persistence of their populations. Evidence suggests that human-induced habitat alterations may result in an increase of Gray Wolf (Canis lupus) predation on Woodland Caribou. Even though Boreal Woodland Caribou were found in Tamarack-dominated muskegs that are less impacted by anthropogenic disturbance, nearby human activities and road networks could indirectly impact on these Woodland Caribou by facilitating movement of predators and providing favorable conditions for prey species such as White-tailed Deer and Moose (e.g., Seip 1992; Whittington et al. 2011). Predation on Woodland Caribou should therefore be investigated in the Mistik FMA area.

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LITERATURE CITED


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