Wolverine, Marten, & Fisher Habitat Use in Supply Block F within the PGTSA

by

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EXECUTIVE SUMMARY

This study was carried out from 2 February to 3 March, 2006 in Supply Block F of the Prince George TSA. It aimed to assess predictive winter habitat models for American marten (Martes americana), fisher (Martes pennanti) and wolverine (Gulo gulo), and to inventory species living in sympatry with these mustelid. A total of 14,955 m were inventoried across polygons of diverse quality, as determined by the different habitat models developed for the above-noted species. Seventeen marten tracks were recorded, all in excellent-quality polygons. The observed frequency of tracks per polygon type was significantly different ($P < 0.001$) from random. These polygons corresponded to late-successional, coniferous and coniferous-deciduous stands, with 40-65% canopy closure, tree dbh >29 cm, and basal area ranging from 30 to 40 $m^2$/ha. Eleven fisher tracks were recorded in excellent- (10 tracks) and high- (2 tracks) quality polygons. Because of the small sample size, a significant difference could not be established between polygon types ($P = 0.2$). From a structural point of view, these polygons corresponded to young (6 tracks) and mature (6 tracks) stands. No wolverine tracks were found. A total of 706 tracks of furbearers and ungulates were also recorded in Supply Block F. Species diversity and richness were similar between polygon types, but excellent-quality polygons for marten distinguished themselves from other types by the exclusive presence of highly discriminate species such as marten, fisher and woodpeckers. Because marten is much more selective than fisher in the selection of its winter habitats, it is suggested that its model be used over that of fisher for the identification of leave areas in managed landscapes. In order to take into consideration annual variations in environmental conditions and species distributions, it is recommend that marten and fisher track inventories be repeated in winter 2007, in the eastern and northern portions of Supply Block F.
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1.0 BACKGROUND

Since 2000, Canfor invested in the development of predictive distribution maps for indicator species (e.g., American marten [Martes americana]; Proulx et al. 2006) to better manage late-successional stands in Tree Farm Licence 30. Work has also been conducted on species at risk. Within a multi-phase project, Proulx (2003a; Phase I) identified parameters to be used in the development of predictive winter distribution maps for fisher (Martes pennanti) and wolverine (Gulo gulo). Proulx (2003b; Phase II) developed these maps and provided a preliminary assessment of their capability to predict species distributions in the field. He also compared the distribution of species at risk among themselves, and with that of American marten. Proulx (2004a; 2005a; Phase III) verified the ability of these maps to predict the distribution of fisher and wolverine. All these projects resulted in the validation of queries to predict the winter distribution of coarse- and fine-filter species, and the development of areas commonly used in winter by American marten, fisher and wolverine (see Proulx 2005b). These projects also described typical winter habitats for these species. Proulx’s work showed that it was possible to use the Vegetation Resource Inventory (VRI) database to predict the distribution of species, and identify stands that may be protected as old-growth management areas, connectivity corridors, reserves, etc. However, Proulx et al. (2005a) pointed out that queries used in the development of predictive maps in TFL 30, on the east side of Prince George Forest District, should be verified in regions where environmental conditions are different.

This project is the 1st year of field verification of American marten, fisher, and wolverine queries on the west side of Prince George Forest District, in Supply Block F, which differs significantly from TFL 30 due to the presence of extensive lodgepole pine (Pinus contorta) pine stands, generally milder winter conditions (e.g., warmer and less snow), extensive road network, and greater forest fragmentation due to intensive logging activities to harvest pine stands infested by mountain pine beetle (Dendroctonus ponderosae).

This project focused on wolverine, American marten, and fisher. However, in an effort to better understand wildlife distribution in Supply Block F, the presence of sympatric species (identified below) was also recorded.

**Furbearers**
Knowledge about the distribution of furbearers within an ecosystem is particularly informative from a biodiversity point of view because:

- Furbearers have a variety of habitat requirements.
- Several furbearers are at the top of their food chain and their presence is indicative of a productive habitat.
- Furbearers are present all year round and are indicative of the seasonal carrying capacity and level of connectivity of habitats.
- The requirements of high profile species such as American marten are well understood and can be used to gauge habitats quality for birds and other vertebrates requiring old/mature coniferous, deciduous and mixed forests, complex ground structure, and regenerated habitats with dense shrub cover and coarse woody debris.

For furbearers, the critical season corresponds to winter, when animals must face harsh environmental conditions and reduced food supplies. Species of interest are:

- Late-successional stages:
  - American marten (Proulx et al. 2006)
- Mid- and late-successional stages:
Fisher (Proulx 2006)
Squirrels (*Tamiasciurus hudsonicus* and *Glaucomys sabrinus*) (Proulx 2005c)
Wolverine (*Gulo gulo*) (Proulx 2005a)

- Mosaic of successional stages:
  - Weasels (*Mustela* spp.) (Proulx 2005d)
  - Snowshoe hare (*Lepus americanus*) (Proulx 2005d)
  - Lynx (*Lynx canadensis*) (Proulx 2005d)
  - Red fox (*Vulpes vulpes*) (Proulx 2005d)
  - Coyote (*Canis latrans*) (Proulx 2005d)
  - Wolf (*Canis lupus*) (Proulx 2005d)

### Ungulates

One of the goals of the new Forest and Range Practices Act (FRPA) of British Columbia is to ensure that forest cover and forage will be conserved over an area necessary for winter survival of ungulate species, recognizing regional variance in the ecology of the ungulate species. In the proposed study area, species of interest will be:

- Late-successional stages:
  - Deer (*Odocoileus* spp.) (Proulx et al. 2005b)

- Mosaic of successional stages:
  - Moose (Proulx and Kariz 2005)
  - Wapiti (*Cervus elaphus*) (Peek 2003)

### Woodpeckers

Woodpeckers belong to a guild of forest birds known as “primary cavity excavators”. They play an important role within forest ecosystems. The cavities they excavate are often used by “secondary cavity users”, including small ducks, owls and raptors, many passerines, and mammals such as bats and squirrels (RIC 1999b). They also drill sap wells that provide nourishment for a wide variety of species (e.g., hummingbirds, warblers, chipmunks and various insects). Furthermore, the significance of woodpeckers in the regulation of forest insect pests is widely recognized (Koplin 1969; Bergvinson and Borden 1992, Machmer and Steeger 1995).

#### 1.1 Objectives

The objectives of this project were to:

1. Compare the predicted winter distributions of American marten, fisher, and wolverine to inventories carried out in the field;
2. If marten, fisher, and wolverine predicted distributions differ from field observations, amend queries to develop of more realistic distribution maps.
3. Overlap American marten, fisher and wolverine distribution maps to identify areas that are commonly used by all species.
4. Inventory furbearer, ungulate and woodpecker species living in sympatry with American marten, fisher and wolverine.

#### 1.2 Expectations
It is expected that:

1. Queries developed in TFL 30 will be valuable tools to predict the winter distribution of marten, fisher and wolverine in Supply Block F.
2. There will be a significant overlap between the type and distribution of late-successional stands used by American marten, fisher, and wolverine.
3. Species requiring structurally complex stands with food and cover will be found in stands used by marten.
4. Species requiring mid- and late-successional stands in proximity to early-successional stands (e.g., moose – *Alces alces*) will be found in landscapes similar to those used by fisher.

### 2.0 PROJECT AREA

Supply Block F encompasses approximately 700,000 ha within the Sub-boreal Spruce Biogeoclimatic Zone. Hybrid white spruce (*Picea engelmannii* x *glauca*) and subalpine fir (*Abies lasiocarpa*) are the dominant climax tree species. Lodgepole pine is common in mature forests in the drier parts of the zone, and both lodgepole and trembling aspen (*Populus tremuloides*) pioneer the extensive early-successional stands (Meidinger et al. 1991). Douglas-fir (*Pseudotsuga menziesii*) occurs on dry, warm, rich sites and as a consistent, although small, component of many mesic forests, especially in the southeastern part of the zone. Black spruce (*Picea mariana*) also occurs occasionally in climax upland forest (Meidinger et al. 1991).  

### 3.0 METHODOLOGY

#### 3.1 Standards


#### 3.2 Fur-bearers & Ungulates - Snowtracking

##### 3.2.1 Queries

Proulx’s (2003b) queries for fisher and wolverine were used to predict the distribution of these species in Supply Block F. In the case of American marten, however, because the species is less flexible than fisher and wolverine, and selects for late-successional forests with high structural complexity (Proulx et al. 2006), the query was slightly modified to take into account extensive beetle-killed lodgepole pine stands (Table 1).

##### 3.2.2 Distribution maps

VRI and TRIM datasets were used to develop independent distribution maps for American marten, fisher, and wolverine. It was originally intended to produce an overview map with superposed distributions of marten, fisher, and wolverine. However, predictive maps for wolverine suggested that the species would not be found across the landscape, except in an inaccessible region near Naltesby Lake. Also, field inventories showed that where habitat was good for marten, it was also good for fisher. However, fisher habitat was not always inhabited by marten, e.g. pure pine stands were avoided. That is to say that an overview map showing areas that are used by both marten and
fisher would correspond to a marten map distribution. For this reason, it was decided to not develop an overview map this year.

Table 1. Queries used to develop predictive distribution maps for marten, fisher and wolverine.

<table>
<thead>
<tr>
<th>Criterion</th>
<th>American marten</th>
<th>Fisher</th>
<th>Wolverine</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Query</td>
<td>Weight (points)</td>
<td>Query</td>
</tr>
<tr>
<td></td>
<td>Presence</td>
<td>Absence</td>
<td>Presence</td>
</tr>
<tr>
<td>Biogeoclimatic zone</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Forest type</td>
<td>Coniferous, mixedwood Reject pure Sb and Pl stands.</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Age (years)</td>
<td>≥80</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>61-80</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>81-100</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>101-120</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>≥121</td>
<td>5</td>
<td>-</td>
</tr>
<tr>
<td>Structural stage</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Crown closure</td>
<td>≥30%</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Basal area</td>
<td>≥20m²/ha in trees with &gt;</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Ddbh (cm)</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Snags</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Shrub cover (%)</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>5-20</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>20-40</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>&gt;40</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Soil</td>
<td>Mesic</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Disturbance</td>
<td>Cutblock (except IU logging &lt; 1970) or road. Rejected</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Acceptable</td>
<td>Cutblock</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>0.01-0.6</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>0.601-0.75</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>0.751-1.25</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.251-2</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

Quality Ranking

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>14-18</th>
<th>25-30</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>4</td>
<td>11-13</td>
<td>19-24</td>
</tr>
<tr>
<td>Medium</td>
<td>3</td>
<td>6-10*</td>
<td>15-18</td>
</tr>
<tr>
<td>Low</td>
<td>≤2</td>
<td>&lt;6</td>
<td>&lt;15</td>
</tr>
</tbody>
</table>

*During this year’s survey, medium-quality polygons for fisher were virtually inexistent in the regions inventoried.
3.2.3 Snowtracking

Inventories of American marten, fisher, and wolverine tracks were carried out from 2 February to 3 March, 2006, a most critical time of year for survival when prey are relatively rare and weather is harsh. Methodology took into consideration RIC’s (1998) presence/not detected surveys. However, it was been significantly modified to meet Proulx et al.’s (2006) protocol, which was found valid to test predictive distribution maps, and Proulx and O’Doherty (2006) state-of-the-art protocol on snowtracking.

A random stratified approach (this approach is necessary in order to choose at random transects that must be easily accessible by the inventory team) was used to locate 17 transects that ranged from 500 to 1075 m in length, were ≥1 km apart, and were distributed among high-, medium-, and low-quality polygons (Figure 1). Transects were plotted on predictive maps, and starting points were tied by compass bearings and distance to distinctive topographic features. Transects were snowshoed using a compass, 1:20:000 maps, and a hip chain to record linear distances. We record only well-defined tracks, those not melted or deformed, not filled with crusty snow, and judged to be fresh, i.e., since the last snowfall (subjective assessment based on the experience of the researchers). Due to the similarity between fisher and American marten footprints (Halfpenny et al. 1995), when mustelid tracks were encountered, they will be investigated on both sides of transects and within forest stands to find the best tracks available. The combination of footprint (size, presence/absence of toe prints) and trail (gait, distance between jumps, and dragging of the feet) characteristics were used to identify all tracks (Murie 1975, Rezendes 1992, Halfpenny et al. 1995). Tracks of white-tailed deer (*Odocoileus virginianus*) and mule deer (*Odocoileus hemionus*) cannot be distinguished accurately in the field and were therefore combined (Murie 1975). Tracks of red squirrel (*Tamiasciurus hudsonicus*) and northern flying squirrel (*Glaucomys sabrinus*) cannot be differentiated from each other. Similarly, all weasel (*Mustela* spp.) tracks were pooled together without distinction at the species level. Linear distance along a survey transect was determined using a hip chain, and was recorded each time there is a change in habitat type (Table 2). Notes on habitat characteristics along transect were collected to validate the VRI classification of polygons, and track positions relative to polygons.

Autocorrelation is often present in ecological data and may not be totally avoided (Legendre 1993, Proulx and O’Doherty 2006). It potentially occurs during analysis of track survey data because of the uncertainty in whether one or more animals have made the tracks being counted. However, it is sometimes difficult to confirm that a series of tracks along a transect belong to the same animal (de Vos 1951) as home ranges overlap (Buskirk and Ruggiero 1994), and winter dispersal movements are known to occur (Clark and Campbell 1976). Proulx (2004a) observed that tracks of 2 different animals could sometimes be as close as 100 m from each other along a same transect. To minimize spatial autocorrelation, a minimum spacing of tracks and a minimum spacing of transects were used for marten and fisher (Proulx and O’Doherty 2006, Proulx 2006, Proulx et al. 2006). Tracks < 100 m apart but in two different polygons were also recorded (Proulx et al. 2006). In the case of herbivores, all tracks will be recorded as per Proulx and Kariz (2005).

3.3 Woodpeckers

Woodpeckers encountered along transects were identified and recorded.
Figure 1. Location of inventory transects in Supply block F, February, March 2006.
Table 2. Forest types and stages of forest ecosystem development in TFL # 30, British Columbia (after RIC 1998b).

<table>
<thead>
<tr>
<th>Forest type</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deciduous</td>
<td>Crown closure ≥ 10%, deciduous species &gt; 75%</td>
</tr>
<tr>
<td>Coniferous</td>
<td>Crown closure ≥ 10%, coniferous species &gt; 75%</td>
</tr>
<tr>
<td>Pure</td>
<td>When ≥ 80% of the coniferous cover is provided by one species.</td>
</tr>
<tr>
<td>Mixed</td>
<td>When the coniferous cover is provided by more than one species, neither species ≥ 80%.</td>
</tr>
<tr>
<td>Coniferous-deciduous</td>
<td>Crown closure ≥ 10%, neither type &gt; 75%</td>
</tr>
<tr>
<td>Ecosystem Development</td>
<td>Description</td>
</tr>
<tr>
<td>Opening without vegetation</td>
<td>Open areas without vegetation, such as roads, frozen ponds, and gravel pits.</td>
</tr>
<tr>
<td>Opening with vegetation</td>
<td>Recent clearcuts, usually not planted, fields and areas with little or no trees, and sparse or dense understory.</td>
</tr>
<tr>
<td>Immature 1</td>
<td>New forest community following a natural or anthropogenic disturbance, with trees &lt; 2 m high.</td>
</tr>
<tr>
<td>Immature 2</td>
<td>New forest community following a natural or anthropogenic disturbance, with trees ≥ 2 m high.</td>
</tr>
<tr>
<td>Pole</td>
<td>Thick stands of pole trees (7.5 to 12.4 cm dbh), usually with little understory. Trees compete with one another and other plants for light, water, nutrients, and space to the point where most other vegetation and many trees become suppressed and die.</td>
</tr>
<tr>
<td>Young forest</td>
<td>Achievement of dominance by some trees and death of other trees leads to reduced competition that allows understory plants to become established. The forest canopy has begun differentiation into distinct layers. Vigorous growth and a more open and multi-storied stand than in the pole stage.</td>
</tr>
<tr>
<td>Mature forest</td>
<td>Even canopy of mature trees, with or without coarse woody debris down and leaning logs. Understories are well developed as the canopy opens up. A second cycle of shade tolerant trees may have become established.</td>
</tr>
<tr>
<td>Old forest</td>
<td>Old, structurally complex stands composed mainly of shade-tolerant and regenerating tree species. Mortality of tall and large canopy trees, canopy gaps, large snags, and large downed woody debris material.</td>
</tr>
<tr>
<td>Old forest open</td>
<td>Old forest stands interspersed with openings with vegetation.</td>
</tr>
</tbody>
</table>

3.4 Data analyses

The proportion of polygon types traversed by survey transects was used to determine the expected frequency of track intersects/habitat class or by polygon type (e.g., excellent-high vs. medium-low quality) if tracks were distributed randomly with respect to polygon types (Proulx 2006, Proulx et al. 2006). For each species, habitat use (i.e., observed vs. expected frequency of track intercepts) was tested with Chi-square statistics (Siegel 1956). When chi-square analyses suggested an overall significant difference between the distribution of observed and expected frequencies, comparisons of observed to expected frequencies for each habitat class or polygon will be conducted using the G test for correlated proportions (Sokal and Rohlf 1981). The Fisher exact probability test was used to compare observed to expected distributions when sample size was < 20 (Siegel 1956). Probability values ≤ 0.05 will be considered statistically significant.
An index of similarity of communities (e.g., furbearer) was calculated for seral stages using marten polygon types where excellent- and high- quality polygons corresponded to late-successional stages, medium-quality polygons corresponded to young stands, and low-quality polygons were immature stands (Proulx et al. 2006). The index of similarity was calculated with the following equation:

\[ S : \frac{2C}{A + B} \]

where \( A \) is the number of species in Sample A, \( B \) is the number of species in Sample B, and \( C \) is the number of species common to both samples (Odum 1971).

Species richness was determined with the Shannon-Wiener function:

\[ H = -\sum_{i=1}^{s} (p_i \log_2 p_i) \]

where \( s \) is the number of species, and \( p_i \) is the proportion of total sample belonging to \( i \)th species (Krebs 1978).

4.0 RESULTS

4.1 Environmental Conditions & Transect Distribution

Temperatures ranged from -12 to 2 °C. Inventories were conducted \( \leq 48 \) hours since a snowfall or flurries. A total of 14,955 m were inventoried across diverse polygons (Table 3).

<table>
<thead>
<tr>
<th>Polygon quality</th>
<th>Inventory lengths (m)/habitat model</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Marten</td>
</tr>
<tr>
<td>Excellent</td>
<td>7,842</td>
</tr>
<tr>
<td>High</td>
<td>785</td>
</tr>
<tr>
<td>Medium</td>
<td>1,529</td>
</tr>
<tr>
<td>Low</td>
<td>4,799</td>
</tr>
<tr>
<td>Total</td>
<td></td>
</tr>
</tbody>
</table>

4.2 Evaluation of American marten predictive distribution traps

4.2.1 Frequency of Marten Tracks per Polygon Type

A total of 17 marten tracks were encountered during the survey, all in excellent-quality polygons. The observed frequency of tracks per polygon type was significantly different \( (P < 0.001) \) from random. Although Supply Block F is a landscape that is rich in late-successional, pure pine stands, marten tracks were absent from these stands.
4.2.2 Attributes of Polygons with Marten Tracks

All tracks were in ≥102 year-old conifer-dominated stands with 40-65% canopy closure, tree dbh >29 cm, and basal area ranging from 30 to 40 m²/ha. Data on structural stages was not available. However, shrub cover ranged from 0 to 20% (Table 4).

Table 4. Stand characteristics at marten track locations.

<table>
<thead>
<tr>
<th>Track n #</th>
<th>Stand composition (%)</th>
<th>Age (yrs)</th>
<th>Canopy closure (%)</th>
<th>Basal area (m²/ha)</th>
<th>Dbh (cm)</th>
<th>% shrub cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>70Pl20Sw10At</td>
<td>132</td>
<td>65</td>
<td>50</td>
<td>30</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>70Sw20Pi10Sb</td>
<td>152</td>
<td>40</td>
<td>40</td>
<td>38</td>
<td>20</td>
</tr>
<tr>
<td>3</td>
<td>60Sw20Pi10Fd10At</td>
<td>152</td>
<td>65</td>
<td>55</td>
<td>36</td>
<td>10</td>
</tr>
<tr>
<td>4</td>
<td>60Sw10Fd10Pi</td>
<td>132</td>
<td>60</td>
<td>55</td>
<td>36</td>
<td>10</td>
</tr>
<tr>
<td>5</td>
<td>60Pi20Sw10At10Fd</td>
<td>152</td>
<td>40</td>
<td>40</td>
<td>38</td>
<td>20</td>
</tr>
<tr>
<td>6</td>
<td>75Fd20Pi5Sw</td>
<td>160</td>
<td>40</td>
<td>30</td>
<td>40</td>
<td>5</td>
</tr>
<tr>
<td>7</td>
<td>75Fd20Pi5Sw</td>
<td>160</td>
<td>40</td>
<td>30</td>
<td>40</td>
<td>5</td>
</tr>
<tr>
<td>8</td>
<td>60Pi20Sw20At</td>
<td>132</td>
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<tr>
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<td>56</td>
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<td>3</td>
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<tr>
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<td>102</td>
<td>60</td>
<td>93</td>
<td>31</td>
<td>10</td>
</tr>
<tr>
<td>17</td>
<td>50Sw30F10Pi10At</td>
<td>102</td>
<td>60</td>
<td>93</td>
<td>31</td>
<td>10</td>
</tr>
</tbody>
</table>

4.2.3 Frequency of Marten Tracks per Habitat Type

All 17 tracks were in mature-old stands. The observed frequency of tracks per habitat type was significantly different from random ($\chi^2 = 9.45$, df:1, $P < 0.01$) from random. Tracks were significantly less abundant than expected in immature-young stands ($G = 7.4$, df:1, $P < 0.01$).

4.2.4 Inventory of other Animal Tracks vs. Polygons Used by Marten

A total of 718 tracks of furbearers and other ungulates were recorded: 347 squirrel, 207 snowshoe hare (Lepus americanus), 10 weasel, 3 lynx, 12 fisher, 2 fox (Vulpes vulpes), 41 coyote (Canis latrans), 2 wolf (Canis lupus), 60 moose (Alces alces), 31 deer (Odocoileus spp.), and 3 elk (Cervus elaphus).

Most squirrel, marten, fisher, and canid tracks were in excellent-quality polygons, i.e., in late-successional stands (Figure 2). Tracks of snowshoe hares and weasels were relatively more abundant in low-quality polygons. Moose and deer tracks were more abundant in excellent- and medium-quality polygons (Figure 2).
4.2.3.1  Squirrel

The observed frequency of squirrel tracks per polygon type was significantly different ($\chi^2 = 61.93$, df:1, $P < 0.001$) from random. Tracks were significantly more abundant than expected in excellent-quality polygons (G = 11.34, df:1, $P < 0.001$), and significantly less abundant than expected in low-quality polygons (G = 21.0, df:1, $P < 0.001$).

4.2.3.2  Snowshoe hare

The observed frequency of snowshoe hare tracks per polygon type was significantly different ($\chi^2 = 50.64$, df:1, $P < 0.001$) from random. Tracks were significantly more abundant than expected in medium- and low-quality polygons (G $\geq$4.30, df:1, $P < 0.05$), and significantly less abundant than expected in excellent- and high-quality polygons (G = 11.0, df:1, $P < 0.001$).

Figure 2. Abundance of animal tracks other than marten in high-, medium-, and low-quality polygons.
4.2.3.3 Weasel

The observed frequency of weasel tracks was not significantly different from random ($P = 0.37$).

4.2.3.4 Fisher

The observed frequency of fisher tracks was not significantly different from random ($P = 1.0$) (see Section 4.3).

4.2.3.5 Moose

Although the majority of tracks were in excellent- and medium-quality stands (Figure 2), the observed frequency of moose tracks was not significantly different from random ($\chi^2 = 3.82$, df:1, $P < 0.05$).

4.2.3.6 Deer

The observed frequency of deer tracks was not significantly different from random ($\chi^2 = 3.82$, df:1, $P < 0.05$).

4.2.3.7 Coyote

The observed frequency of coyote tracks was significantly different random ($\chi^2 = 7.12$, df:1, $P < 0.01$). Coyote tracks were less abundant than expected in low-quality habitats ($G = 6.7$, df: 1, $P < 0.01$).

4.2.3.8 Other tracks

Tracks of fox, wolf and lynx were not numerous enough to carry out a statistical analysis of their distribution.

4.2.4 Index of Similarity (Mammal Species) between Marten Polygons

The index of similarity was determined for excellent-quality polygons vs. medium- and low-quality polygons pooled together. Twelve and 9 species were recorded in excellent and medium-low-quality polygons, respectively. The index of similarity was 76% between the two groups, which had eight species in common. Excellent-quality polygons differed from the medium-low-quality polygons by the unique presence of martens, fox, wolf and elk.

4.2.5 Species Richness (Mammals)

The excellent-quality polygons had a species richness index of 1.983 compared to 2.157 in medium-low-quality polygons. The “excellent” polygons had more species than the “medium-low”, but more than 59% of all the tracks were from squirrels. In medium-low-quality polygons, track abundance was better distributed among species (Figure 2).
4.2.6 Woodpeckers

Only 9 woodpeckers were encountered during the surveys: 7 three-toed woodpeckers (Picoides tridactylus), 1 black-backed woodpecker (Picoides arcticus), and 1 pileated woodpecker (Dryocopus pileatus). All of them were in excellent-quality polygons.

4.2 Evaluation of fisher predictive distribution traps

4.2.1 Frequency of Fisher Tracks per Polygon Type

A total of 12 fisher tracks were encountered during the survey: 10 in excellent- and 2 in high-quality polygons. Because of the small sample size, a significant difference could not be established between polygon types ($P = 0.2$). Fisher tracks were distributed according to relative importance of polygons inventoried.

4.2.2 Attributes of Polygons with Fisher Tracks

All tracks were located in late-successional conifer-dominated stands with good canopy closure and relatively high basal area (Table 5). Some of these stands were younger and had trees with a smaller diameter than those with marten tracks (see sub-section 4.2.2).

Table 4. Stand characteristics at fisher track locations (data missing for 2 fishers from excellent-quality polygons.

<table>
<thead>
<tr>
<th>Track n #</th>
<th>Stand composition (%)</th>
<th>Age (yrs)</th>
<th>Canopy closure (%)</th>
<th>Basal area ($m^2$/ha)</th>
<th>Dhh (cm)</th>
<th>% shrub cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>60Sw20At20Pl</td>
<td>132</td>
<td>60</td>
<td>50</td>
<td>31.7</td>
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<td>132</td>
<td>60</td>
<td>50</td>
<td>31.7</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>60Pl30Sw10Sb</td>
<td>112</td>
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<tr>
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<td>28</td>
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</tbody>
</table>

| High-quality polygons |
|-----------------------|-----------------|-----------------|-----------------------|
| 11                    | 60Sw20Fd20Pl    | 102             | 65                    | 45        | 29.7          | 0            |
| 12                    | 60Sw20Fd20Pl    | 102             | 65                    | 45        | 29.7          | 0            |

4.2.3 Frequency of Fisher Tracks per Habitat Type

From a structural point of view, tracks traversed 3,403 m (22.8%) of open-immature stands, 1,796 m (12%) of young stands, and 9,756 m (65.2%) of mature-old stands. Six fisher tracks were in young stands, and 6 in mature-old stands. Because of the small sample size, a significant difference could not be established between habitat types ($P = 0.2$). Fisher tracks were distributed according to relative importance of habitats inventoried.
4.2 Evaluation of wolverine predictive distribution traps

According to the predictive model, most of the Supply Block F area is unsuitable for wolverine. This is largely due to the scarcity of ESSF stands, and the extensive, active road network. No wolverine tracks were recorded.

5.0 DISCUSSION

This study showed that, after modification of the query to reject pure black spruce and lodgepole pine stands, Proulx et al.’s (2006) model could effectively predict the winter distribution of marten in Supply Block F. Similarly, Proulx’s (2006) model properly predicted the winter distribution of fisher, i.e., it identified areas where fishers should not be found. Unfortunately, not enough tracks were recorded to establish statistical differences. This study also showed that marten was more discriminate than fisher in the selection of sites. Marten used stands that were older, and where trees were larger, than those frequented by fisher. Also, contrary to fisher, marten tracks were absent from pure pine stands. While pure pine stands usually have a poorly developed understorey, their canopy was more open due to the presence of beetle-killed trees. Such conditions are not suitable for marten (Proulx 2001).

Late-successional, mixed coniferous and mixed coniferous-deciduous stands were characterized by horizontal and vertical heterogeneity. Within these stands, the death of pine trees, and the resulting blowdown and shrub openings, create horizontal diversity. Spruce and Douglas-fir provide cover and vertical diversity. The resulting forests meet the needs of forest interior species that require both cover and food. Not surprisingly, marten, fisher, squirrel, and woodpeckers, all species that have been associated with mature and old-growth forests in the past, were found in such stands. On the other hand, snowshoe hares and weasels, which are commonly associated with younger forests and early-successional stands, were mostly found in low-quality polygons. Moose utilized both excellent- and medium-low quality polygons, this depicting their ability to use different cover types and openings according to environmental conditions, although they do not prefer pine-dominated stands (Proulx and Kariz 2006). On the other hand, any coniferous stand with a mature-old overhead cover and a deciduous component may be used by deer.

According to indexes used in this study, medium-low-quality polygons appeared to be as “rich” as excellent-quality polygons from a biodiversity point of view, although the latter had more species. Species richness indices assume that the more abundant a species is, the more important it is to community. But the more abundant species are not necessarily the most important or the most influential. Thus one of the distinctive failures of the indexes is the inability to distinguish between the abundant and “important” species (Smith 1974). The excellent-quality polygons differentiated themselves from other polygons by the exclusive presence of mesocarnivores such as marten and fisher, which are highly discriminate for their thermal and protective cover, and for their prey (Proulx 2001, Weir et al. 2004), and primary excavators such as woodpeckers, which play a significant role to a large array of bird and mammal species by providing cavities (Dailey et al. 1993, Bull et al. 1986). Their foraging activities also create feeding opportunities for other species (Foster and Tate 1966, Miller and Nero 1983) and reduce the abundance of “pest” insects (Thomas et al. 1979).

There is no doubt that forest management plans retaining polygons that are of excellent-quality for marten have a greater chance of maintaining biodiversity across managed landscapes. Because
marten is much more selective than fisher in the selection of its winter habitats, it is suggested that its model be used over that of fisher for the identification of leave areas in managed landscapes. However, the selection of such leave areas should also take into consideration other models, such as the mule deer model validated by Proulx (2006b).

Supply Block F is a very large area with a diversity of habitats. In order to properly survey these habitats, and take into consideration annual variations in environmental conditions and species distributions, I recommend that marten and fisher track inventories be repeated in winter 2007, in other regions of Supply Block F, particularly along 688Road and in the Punchaw Lake area, and on the north side of the study area (e.g., the Gregg Creek FSR). Because wolverine is unlikely to be frequently encountered in Supply Block F because of the large amount of logging and hauling activities, it is unlikely that a habitat model for this species will be useful for foresters. While one should continue to monitor their presence across the landscape, I do not recommend that future inventories in Supply Block F be focused on this species.

6.0 ACKNOWLEDGMENTS

I thank Kerry Deschamps and Ron Beauchesne from Canfor for their interest in this project, and Dan Baxter for field assistance. This project was funded by BC Forest Investment Account.

7.0 LITERATURE CITED


Proulx G. 2006b. Field testing the ability of a query to predict late-winter habitat use by mule deer in Supply Block F, Prince George Forest District. Alpha Wildlife Research & Management Ltd. report submitted to Canfor, Prince George Division, Prince George, BC.


