Ungulate Winter Range Delineation
on the Harrop Procter Community Forest

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April 2001
EXECUTIVE SUMMARY

Mapping of ungulate winter range and delineation of habitat attributes of importance to ungulates during periods of high snow accumulation are important components to conserving wildlife values in managed forests in British Columbia (B.C.). Here we summarize the results of a study to delineate ungulate winter range within the 10,800-ha Harrop Procter Community Cooperative Forest in the West Kootenay of southeastern B.C. The Forest lies adjacent to Kootenay Lake and its West Arm, with slopes away from the valley bottom primarily north- and east-facing. White-tailed deer (Odocoileus virginianus) and mule deer (O. hemionus) are the predominant ungulates inhabiting this area. The ungulate winter range study area is located primarily within the Interior Cedar-Hemlock dry, warm (ICHdw) and moist, wet (ICHmw2) biogeoclimatic subzones. Winter 2000–01 was characterized by some of the lowest snowfalls recorded in recent years.

We established 6 track transects systematically placed approximately 3 km apart. Transects were run on bearings directly upslope to 1,100 m, roughly at or just below the 1997 ungulate winter range line as defined in the regional land-use plan. We conducted 1 count during early winter (early January 2001), and 2 counts during mid-winter (February 2001). We counted ungulate tracks within 100-m segments (quadrants) on each transect \( n = 90 \) segments). Surveys were completed over 2–4 days, and took place 2–7 days after snowfall. Track data for each 100-m segment (corrected for days since snowfall) were compared to topographic and forest cover attributes for each segment to gain insight into the habitat use of ungulates during winter.

We used 398 deer tracks to examine relative use of habitats. Deer within the Harrop Procter Community Forest primarily occurred on lower-elevation sites (95% <720 m) within the ICHdw subzone, characterized by lower snow depths, flat to moderate slopes, north aspects, and high components of mature (101–120 yrs; age class 6) Douglas-fir (Pseudotsuga menziesii) – leading stands with high crown closure (80%; crown closure class 8). Open, recently logged stands were also used to a significant extent. There was little difference in habitat use by deer between early and mid-winter season, possibly because of the low snow accumulations.

Ungulate winter range lines within the study area were recently revised downwards to roughly the 900-m level along the slopes above the West Arm between Harrop and Procter, and to about 700 m elevation on the east-facing slopes overlooking Kootenay Lake. Our results from this winter generally support these changes, but suggest further that the vast majority of current deer winter range use is below 720 m elevation. Given the rather unusual snow year experienced and the need to sample additional areas to strengthen modelling results, we suggest that a second year of sampling be conducted during winter 2001–02. This fieldwork will increase the sampling and representation of topographic and forest cover variables within the study area. The results from these track count studies can be used to build a statistical model to identify ungulate winter range within the Community Forest based on habitat suitability. Given the limited range of some variables (i.e., no south aspects), the model resulting from these data will have applications limited to the study area or areas of similar topography.

Results generated from this study will contribute to the current evaluation and refinement of ungulate winter range within the Kootenay Region to be completed by October 2003. The Harrop Procter study area is the only predominantly north-facing study area examined to date. Site series mapping (Predictive Ecosystem Mapping [PEM]), possibly available in the near future, may provide a mapping layer to help differentiate forest stand type polygons not accurately identified by forest cover, but which may be important for ungulate winter range analysis.
INTRODUCTION

Ungulate winter range is an important component in conserving wildlife values in managed forests in British Columbia (B.C.). Within the Kootenay Lake Forest District (KLFD) within the West Kootenay of southeastern B.C., deer (*Odocoileus* spp.) and elk (*Cervus elaphus*) winter habitat has been mapped at the 1:250,000 scale (Kootenay Inter-Agency Management Committee 1997), then refined to the 1:50,000 scale, and recently to the 1:20,000 scale in some areas at the district level (M. Knapik, Forest Ecosystem Specialist, KLFD, Nelson, personal communication). B.C. Ministry of Environment, Lands and Parks (MELP) has identified delineation and refinement of winter range as an important component to forest development planning requirements for the region. In order to meet legislative requirements set in the Forest Practices Code (FPC) by October 2003, current mapped ungulate winter range is being evaluated and refined or confirmed. Objective winter range information gained in this process will aid forest managers in complying with Forest Practices Code (FPC) and current or future Kootenay-Boundary Land Use Plan (KBLUP) ungulate winter range management guidelines (Kootenay Inter-Agency Management Committee 1997). Impacts (both positive and negative) to ungulate winter range in B.C. primarily result from alteration of habitat through human habitation, fire suppression/forest encroachment, roads, and forest harvesting (Armleder et al. 1994). Reduction in canopy cover may be the biggest problem for ungulates in areas of relatively high snowfall.

The Harrop Procter Community Cooperative has been given a 5–year license to manage the forests surrounding its communities as part of a Community Forest Pilot Project. One of few pilot projects of this nature within the province, the Co-op’s tenure covers 10,800 ha in southeastern B.C., including 5 main drainages (Harrop Creek to Irvine Creek) along the south side of the West Arm of Kootenay Lake and around into the west side of the main body of the lake (Fig. 1). This area extends from just above settled lands along the lake to the height of land.

Current ungulate winter range has been delineated throughout the low-elevation forests adjacent to the lake (Fig. 1; Kootenay Inter-Agency Management Committee 1997). The upper boundary of the ungulate winter range lines, originally set at roughly 1,100 to 1,300 m or higher (Kootenay Inter-Agency Management Committee 1997), has recently been revised to roughly the 900 m level along the slopes above the West Arm between Harrop and Procter, and to 700 m elevation on the east-facing slopes overlooking Kootenay Lake (M. Knapik, Forest Ecosystem Specialist, KLFD, Nelson, personal communication).

Snow track surveys have been used to provide information on relative abundance and broad habitat selection for furbearers (Reid et al. 1987, Thompson et al. 1989), snowshoe hares (*Lepus americanus*; Keith and Windberg 1978, Pietz and Tester 1983, Litvaitis et al. 1985), and ungulates (Waterhouse et al. 1990, D’Eon et al. 1998, Poole et al 2000b). Track counts are affected by a number of factors, including weather, population levels, and the period covered by the counting episode, but can provide a reliable method to index ungulate distribution relative to topography and broad habitat classes.

The objective of this study was to identify topographic and forest cover parameters used by ungulates during winter and refine ungulate winter range lines from Harrop Creek to Irvine Creek. This data would provide Harrop Procter Community Cooperative forest planners with ungulate winter range habitat information through identification of the vegetative and topographic attributes of mid-winter deer range within their tenure. This progress report summarizes winter range encounter surveys (track transects) conducted during winter 2000–01.
Figure 1. Location of the Harrop Procter Community Forest. Light brown shading is 1997 ungulate winter range (Kootenay Inter-Agency Management Committee 1997).
STUDY AREA

The community forest is located in the Nelson Range of the south Selkirk Mountains and abuts West Arm Provincial Park to the west and southwest. The area grades through a number of biogeoclimatic (BEC) zones and subzones, from the Interior Cedar Hemlock dry, warm (ICHdw) subzone along the valley bottom from about 540 m to about 900–1,100 m elevation, through the ICHmw2 (moist, warm) subzone/variant to about 1,400–1,600 m, to the Engelmann Spruce – Subalpine Fir wet cool subzone/variant (ESSFwc4) up to 1,900–2,200 m, and then to the Alpine Tundra (AT) zone above (Meidinger and Pojar 1991, Braumandl and Curran 1992). The boundaries between zones and subzones vary with aspect, with a general shift upwards on south and west-facing slopes. The ICH zone includes a wide variety of conifer tree species; Douglas-fir (Pseudotsuga menziesii), western hemlock (Tsuga heterophylla), western redcedar (Thuja plicata), western white pine (Pinus monticola), and western larch (Larix occidentalis) are common, Engelmann spruce (Picea engelmannii) and subalpine fir (Abies lasiocarpa) are found at higher elevations and lodgepole pine (P. contorta) is found on drier sites. Engelmann spruce, subalpine fir, and lodgepole pine are the dominant tree species in the ESSF zone, with excursions of primarily alpine larch (Larix lyallii) and whitebark pine (Pinus albicaulis) into the AT zone. Limited logging has occurred along the lower elevations of portions of the community forest and adjacent private lands over the past century.

July and January mean temperatures for Nelson, 20 km west of the HPC Forest, are 19.3 and –2.8ºC, respectively. Castlegar, 50 km southwest of the study area, receives 732 mm of precipitation annually, 225 cm which falls as snow; the study area would be expected to receive somewhat more precipitation. The West Kootenay experienced exceptionally low precipitation and snow accumulation during winter 2000–01. January monthly precipitation at Castlegar was 31% of normal. Snow pillow data from 930 m elevation near Nelson indicated the snow water equivalent was about 55% of normal (61 years of data; http://www.elp.gov.bc.ca/rib/wat/rfc/river_forecast/spdcolumbia.html).

A number of ungulates occur in varying densities within the study area. White-tailed deer (O. virginianus) are perhaps the most plentiful, followed by lower numbers of mule deer (O. hemionus). Elk, and moose (Alces alces) are found sporadically in low numbers. A remnant herd of perhaps 40 woodland caribou (Rangifer tarandus caribou; mountain ecotype) is found in the south Selkirk Mountains, and have made limited numbers of excursions into the areas adjacent to the West Arm (G. Woods, MELP, Nelson, personal communication). Cougars (Felis concolor) appear to be relatively abundant; at least 25 have been shot in the area in the past 7 years (D. Miller, Harrop, personal communication).

METHODS

We established 6 track transects within the study area. We measured the distance roughly parallel to the shoreline (18 km) and systematically distributed the transects equidistant along Kootenay Lake and the West Arm, resulting in a 3 km spacing. Transects were started above settled areas on the Harrop and Procter side of the study area, and above the railway tracks on the main Kootenay Lake side. Transects were run on bearings directly upslope to roughly 1,100 m elevation, at or below the 1997 ungulate winter range KBLUP line (Fig. 2) and well above the highest elevations deer were observed during mid-winter in adjacent study areas (i.e., Poole et al. 2000b). We measured distance along each transect using a hip-chain, and flagged all transects, identifying 100-m segments or quadrants (contour distance). We obtained GPS locations at 100-m intervals along each transect. For each 100-m segment, we recorded the number of ungulate and carnivore tracks and trails (where individual tracks could not be distinguished) by species (deer species undifferentiated; Stelfox 1993). We standardized each trail as equal to 5 tracks during our analysis. Field workers could usually distinguish up to 3–4 individual tracks in a given crossing. We recorded the approximate number of days since last snowfall for each survey (to the nearest 12 hours), and snow depth every 100 m. For analysis, all track counts were corrected for days since last snowfall.
Among the 6 track transects, we established 90 100-m segments. We surveyed all transects 3 times between 4 January and 21 February 2001, including 1 count during early winter (5 Jan), and 2 counts during mid-winter (6 Feb and 20 Feb). Surveys were completed over 2–4 days, and are presented as the median date of the survey. Surveys took place 2–7 days after snowfall (mean for each run 2.3–5.0 days after snow).

We imported track transect locations into a GIS and obtained digital 1:20,000 scale topographic (Terrain Resource Information Mapping) and forest cover (B.C. Ministry of Forests, Forest Inventory Program) files of the study area. We determined a number of topographic and forest cover attributes for the mid-point of each segment of each transect. We assigned a snow depth to each segment as the mean of the measurements from each end of the segment. We calculated aspect, slope and elevation by averaging these parameters over triangulated irregular networks (tin) developed from digital elevation models; tins were generally 60–100 m on each side of the triangle.

Forest cover maps delineate relatively homogeneous forest stands or forest cover types based on the interpretation of aerial photographs and ground truthing information collected in field surveys. These maps commonly include information on tree species, projected age and crown closure, site index, and tree density (stocking level), and are widely used in B.C. for operational forest development and reforestation planning. Areas not supporting commercial forests are generally described as non-productive, meaning the area is not capable of supporting commercial forests (e.g., alpine, alpine forest, brush, clay banks, or rock), or non-forest, meaning that the area was not currently forested but was capable of supporting commercial forests (e.g., a logged area that was not satisfactorily restocked). From forest cover maps, we determined leading tree species, percent species composition (based on relative gross volume for older stands and number of stems/ha for younger stands), crown closure, stand age, and non-productive descriptors for each segment.

Most recent track count studies conducted in the West Kootenay have identified an early winter and a mid-winter period that reflects distinct periods of habitat use and spatial distribution by deer, with a roughly mid-January division between periods (Pauley et al. 1993; Poole et al. 2000a, 2000b, 2000c). We followed this division during analysis to examine seasonal use of topographic and habitat attributes by ungulates, even though the pattern of snow depth accumulation during winter 2000–01 was not typical. We determined habitat availability by summing forest cover and TRIM attributes at the mid-point of all segments. We displayed relative use of attributes using the mean count (corrected for days since last snowfall) for each segment within each season.

To display habitat use we grouped percent slope into slope classes (slope class 0 = 0–5% slope, class 1 = 6–15% slope, class 2 = 16–25% slope, etc.), and combined classes (classes 1–2, 3–5, 6–9). We grouped aspect into Vegetation Resource Inventory (VRI; Resources Inventory Committee 1999a) classes based on solar incidence (hot [south] = 136–240°; warm [west] = 241–285°; cool [east] = 60–135°; cold [north] = 286–59°), with all land at <10% slope classified as flat with no aspect. We grouped projected stand age classes into classes 0 (open habitats with no tree cover designated or recently [<10 yr] logged stands that were not satisfactorily restocked), and classes 3–4 (41–80 yrs), 5 (81–100 yrs), 6 (101–120 yrs), and 8 (141–250 yrs). There were no stands in classes 1-2 (1-40 yrs) or older than 170 years. We grouped stand crown closure classes to reflective the available classes within the study area: class 0 (<5% crown closure), classes 5–6 (46–65%), class 7 (66–75%) and class 8 (76–85%). There were no stands with 6–45% or >80% crown closure. We classified each stand into 1 of 4 forest types based on overstory species composition (Table 1). No western hemlock or western redcedar occurred on transects.

We performed data summarisation and analyses using SAS software (SAS Institute 1997). Statistical tests were considered significant at \( P < 0.05 \). We present means with associated standard errors (SE).
Figure 2. Location of the ungulate winter range line surveyed within the Harrop Procter Community Forest, winter 2000–01. Transects T1 to T6 are shown, with percentage of total numbers of deer tracks (tracks/km-day) shown with varying sized red dots. Community forest boundary shown with the heavy black border.
Table 1. Forest types along the track transects, derived using tree species information from digital forest cover mapping, winter 2000–01, Harrop Procter Community Forest, B.C.

<table>
<thead>
<tr>
<th>General forest type (short form)</th>
<th>Species (using tree codes(^a)) and range of % composition of stand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Douglas-fir – deciduous (FDDECID)</td>
<td>40–60% Fd, 30% At, with 10% Lw, Bg, Pw, or Ep, age class 6, crown closure 7–8</td>
</tr>
<tr>
<td>Douglas-fir – larch (FDLW)</td>
<td>40–80% Fd, 20–60% Lw, some with &lt;20% Ep and At, or Pw, age class 5–6, crown closure 6–8</td>
</tr>
<tr>
<td>Douglas-fir – pine (FDPL)</td>
<td>30–80% Fd, 20–70% Pl, some with 20% Lw, age class 4–5, crown closure 5–8</td>
</tr>
<tr>
<td>Logged-open (LOGGED/OPEN)</td>
<td>Recently (&lt;10 yrs) logged (NSR) or clearings</td>
</tr>
</tbody>
</table>

\(^a\) Ac = cottonwood; At = trembling aspen; Bg = grand fir; Ep = paper birch; Fd = Douglas-fir; Lw = western larch; Pl = lodgepole pine; Pw = western white pine; NSR = not satisfactorily restocked.

RESULTS

Mean transect length was 1,500 m (±139.0 m; range 1,100–1,900 m), and the mean upper elevation of transects was 1,083 m asl (±6.4 m; range 1,057–1,103 m). We counted 398 deer tracks and no elk tracks, and no trails where the number of tracks could not be counted (<5 tracks). Other tracks noted during surveys were 5 moose, 5 caribou, 11 cougar, 14 bobcat (*Lynx rufus*), 4 coyote (*Canis latrans*), 6 marten (*Martes americana*) and 6 weasel (likely ermine; *Mustela erminea*) tracks. The highest numbers of deer tracks observed were on the 4 transects above the West Arm (89% of total; a third of which were above Sunshine Bay on transect 2), with only 1% of deer tracks counted on transect 5 (west of Irvine Creek) and 10% on transect 6 (near the eastern end of the study area; Fig. 2).

Snow depths along transects varied from 10–83 cm, and both the mean depth and maximum depth increased over the 3 counts (Table 2). During winter, 95% of deer tracks were in snow <46 cm deep, and no deer tracks were recorded in snow depths >53 cm. Logistic regression analysis on track presence/absence data indicated a negative relationship between the number of deer tracks on each segment and snow depth \(\chi^2 = 38.0, 1\ df, P = 0.0001\). Although this relationship was statistically significant, it only explained a small proportion of the variance in the data, suggesting that other variables also influenced the distribution of deer tracks.

Seventy-eight percent of segments were within the ICHdw subzone, and 22% were within the higher-elevation ICHmw2 subzone. All deer tracks counted during winter were within the ICHdw subzone.
Table 2. Mean snow depth (cm) among track transect segments, winter 2000–01, Harrop Procter Community Forest, B.C.

<table>
<thead>
<tr>
<th>Survey date</th>
<th>Mean</th>
<th>SE</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 Jan 01</td>
<td>38.3</td>
<td>1.14</td>
<td>16</td>
<td>66</td>
</tr>
<tr>
<td>6 Feb 01</td>
<td>42.2</td>
<td>1.64</td>
<td>15</td>
<td>76</td>
</tr>
<tr>
<td>20 Feb 01</td>
<td>45.1</td>
<td>1.77</td>
<td>10</td>
<td>83</td>
</tr>
</tbody>
</table>

Elevation – Deer made greater use of low elevations during winter relative to what was available on the transects, with little difference between seasons (Fig. 3). Mean elevation of deer tracks remained similar among counts, but the upper elevation of 95% of deer tracks declined between early winter and mid-winter counts (Table 3). Ninety-five percent of deer tracks observed during combined early and mid-winter counts were located at <720 m elevation, and 45% of deer tracks observed were found at <600 m elevation.

Figure 3. Distribution of deer tracks (n = 398) during early (EW) and mid-winter (MW), relative to elevations surveyed, winter 2000–01, Harrop Procter Community Forest, B.C. Kootenay Lake and its West Arm are about 540 m above sea level.
Table 3. Mean elevation (m) and 95% upper limit of deer tracks observed on track transects, winter 2000–01, Harrop Procter Community Forest, B.C.

<table>
<thead>
<tr>
<th>Season</th>
<th>Date</th>
<th>Mean elevation (SE)</th>
<th>Upper elevation limit of 95% of tracks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early winter</td>
<td>5 Jan 01</td>
<td>664 (14.6)</td>
<td>809</td>
</tr>
<tr>
<td>Mid-winter</td>
<td>6 Feb 01</td>
<td>656 (20.0)</td>
<td>719</td>
</tr>
<tr>
<td></td>
<td>20 Feb 01</td>
<td>624 (13.2)</td>
<td>720</td>
</tr>
</tbody>
</table>

Slope – Slopes of 26–55% comprised 57% of the slopes available on transects (Fig. 4). Use of gentle slopes by deer was about 3 times the available slope, and use of steeper slopes (>56%) was limited. Most of the areas of gentle slope were found at lower elevations near the bottom of transects. From early to mid-winter seasons, there was little change in use of slopes by deer. Ninety-five percent of deer tracks observed during combined early and mid-winter occurred on slopes of 6–64%.

Aspect – North was the predominant aspect available on transects, accounting for over 80% of segments (Fig. 5). Relatively flat land (<10% slope) was used far more than available on transects. Use of the east-facing aspects (primarily above Kootenay Lake) decreased between early and mid-winter surveys. In combined early and mid-winter, 95% of deer tracks were on aspects from 299–62º.

Stand age – Nearly 80% of the segments were within forest stands of age classes 5–6 (81–120 years; Fig. 6), with proportionately more of the age class 5 stands found at higher elevations than the age class 6 stands. During combined early and mid-winter deer used age class 6 (100–120 years) stands extensively, avoided age class 5 stands (81–100 years), and used open stands (primarily not satisfactorily restocked) proportionately more than their availability. About 20% of deer tracks were found in recently logged or disturbed sites. Of the stands with overstory tree cover, 95% of tracks were found in age classes ≥5 (≥81 years).

Crown closure – Eighty percent of the study area was comprised of stands with crown closure between 65–85% (class 7–8; Fig. 7). Deer tracks were found to the greatest extent in crown closure class 8 stands, and appeared to use open (logged) stands greater than their availability. Crown closure class 7 stands were not used to any great extent; most stands with this crown closure were found at higher elevations within transects. Eighty-nine percent of deer tracks in forested stands during combined early and mid-winter were in stands of crown closure classes 7–8, with most (78%) in stands of crown closure class 8.

Forest type – Douglas-fir was the leading species in most stands within the study area (Fig. 8). Douglas-fir–deciduous and Douglas-fir–larch stand types were used in proportion to their availability, Douglas-fir – lodgepole pine stands were avoided, and open, logged stands were used at over twice their availability. Use of Douglas-fir–deciduous and Douglas-fir – larch stands reversed between mid-winter counts (resulting in the wide error bars).
Figure 4. Distribution of deer tracks (n = 398) during early (EW) and mid-winter (MW), relative to slopes surveyed, winter 2000–01, Harrop Procter Community Forest, B.C. There were no slopes >75% on transects. SE bars are from 2 mid-winter surveys.

Figure 5. Distribution of deer tracks (n = 398) among Vegetation Resource Inventory aspect classes during early (EW) and mid-winter (MW), relative to aspects surveyed, winter 2000–01, Harrop Procter Community Forest, B.C. There were no west or south aspects on transects. SE bars are from 2 mid-winter surveys.
Figure 6. Distribution of deer tracks (n = 398) by stand age during early (EW) and mid-winter (MW), relative to stand ages surveyed, winter 2000–01, Harrop Procter Community Forest, B.C. There were no stands >170 years old on transects. SE bars are from 2 mid-winter surveys.

Figure 7. Distribution of deer tracks (n = 398) within crown closure classes during early (EW) and mid-winter (MW), relative to closure classes surveyed, winter 2000–01, Harrop Procter Community Forest, B.C. There were no stands with crown closure 6–45% or >80% on transects. SE bars are from 2 mid-winter surveys.
Figure 8. Distribution of deer tracks \((n = 398)\) within forest types along transects (Table 1) during early (EW) and mid-winter (MW), relative to forest types surveyed, winter 2000–01, Harrop Procter Community Forest, B.C. SE bars are from 2 mid-winter surveys.

Other species – Sample sizes of tracks observed of species other than deer were small. Elevation, predominant forest type, and timing and location of tracks varied among species (Table 4). Caribou tracks were only observed during early January on transects above Procter, and the few moose tracks were observed on transects overlooking Kootenay Lake. Cougar tracks were observed at lower elevations than bobcat tracks.

Table 4. Location of tracks of species other than deer observed during track counts conducted in January and February 2001, Harrop Procter Community Forest, B.C.

<table>
<thead>
<tr>
<th>Species</th>
<th>(n)</th>
<th>Mean</th>
<th>Range</th>
<th>Predominant forest types(^1)</th>
<th>Run</th>
<th>Transects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caribou</td>
<td>5</td>
<td>750</td>
<td>615–1,000</td>
<td>FDLW, FDDECID</td>
<td>1</td>
<td>3 and 4</td>
</tr>
<tr>
<td>Moose</td>
<td>5</td>
<td>680</td>
<td>630–725</td>
<td>FDPL, FDDECID</td>
<td>1 and 2</td>
<td>5 and 6</td>
</tr>
<tr>
<td>Cougar</td>
<td>11</td>
<td>650</td>
<td>590–730</td>
<td>FDLW, LOGGED</td>
<td>1 and 2</td>
<td>1 to 3</td>
</tr>
<tr>
<td>Bobcat</td>
<td>14</td>
<td>750</td>
<td>600–945</td>
<td>FDLW, LOGGED</td>
<td>1, 2 and 3</td>
<td>1 to 4</td>
</tr>
<tr>
<td>Coyote</td>
<td>4</td>
<td>620</td>
<td>590–635</td>
<td>FDLW</td>
<td>2 and 3</td>
<td>1, 3 and 6</td>
</tr>
<tr>
<td>Marten</td>
<td>6</td>
<td>850</td>
<td>770–1,000</td>
<td>FDLW, FDDECID</td>
<td>2 and 3</td>
<td>3, 4 and 6</td>
</tr>
<tr>
<td>Weasel</td>
<td>6</td>
<td>720</td>
<td>670–810</td>
<td>FDPL</td>
<td>3</td>
<td>4 and 6</td>
</tr>
</tbody>
</table>

\(^1\) See Table 1 for descriptions of forest types.
DISCUSSION

Deer in the Harrop Procter Community Forest occurred mainly in lower-elevation sites (<720 m) within the ICHdw subzone, which were characterized by lower snow depths, flat to moderate slopes, north aspects, and high components of mature (101–120 yrs; age class 6) Douglas-fir–deciduous or Douglas-fir–larch stands with high crown closure (80%; crown closure class 8). Open, recently logged stands were also used to a significant extent. Douglas-fir–lodgepole pine stands were generally not used. Use of lower-elevation sites is consistent with other ungulate winter range studies conducted in the ICHdw biogeoclimatic subzone in the West Kootenay (D’Eon et al. 1998; Poole et al. 2000a, 2000b, 2000d). Deer show a significant increase in the net energetic cost of travel in snow depths greater than 25 to 30 cm, and would be expected to modify their habitat selection when snow depths were greater (Parker et al. 1984). Most deer tracks within the Harrop Procter study area were found at <46 cm snow depths and <720 m elevation. In the Woodbury Creek area (ICHdw) on the west side of Kootenay Lake during winter 1999–2000 with roughly 50% higher snow depths, most deer tracks were found in <71 cm of snow and at <855 m elevation (Poole et al. 2000b). Off the west side of Kootenay Lake south of our study area, Mowat (2000) found most ungulate tracks at elevations <900 m in Douglas-fir or lodgepole pine–leading stands. The lower band of elevation use in the Harrop Procter study may be due to the predominantly north and east-facing aspect of the study area, the adjacency of the agricultural and rural lands, and the influences of Kootenay Lake on climatic conditions and snow depths. Along the West Arm, transects 1 through 4 generally started near the upper elevation of private land. Deer in the area also made extensive use of the rural lands between the lower end of our transects and the lake (personal observations), thus much of the land adjacent to the lake should also be considered as contributing to ungulate winter range in the area.

Beyond the West Kootenay in the Priest River drainage in northern Idaho, white-tailed deer selected mature cedar and hemlock old growth stands with dense canopy cover on southeast aspects (Pauley et al. 1993). This area differed from the Harrop Procter area by being generally higher in elevation (>700 m), distant from a major water body, with predominantly lower slopes (77% of area with <25% slope) and comparatively few Douglas-fir leading stands.

Winter 2000–01 exhibited some of the lowest snow depths recorded in recent years. Thus, it is questionable whether the use of habitats observed reflects patterns typical of the middle of a “normal” winter. We divided our surveys into early and mid-winter periods, but neither snow depth nor habitat use differed markedly between seasons. With its predominantly north-facing slope, we expected snow depths in this area to increase dramatically during mid-winter, modifying deer habitat selection patterns. During severe winter conditions, deer generally select stands with heavier canopy cover (Mackie et al. 1998, Boulanger et al. 2000). Hence, we may expect stronger selection for older age stands and higher canopy closure in years of deeper snow.

Population density may also influence habitat use. Boulanger et al. (2000) found that white-tailed deer density and topographic variables (slope, aspect and elevation) had the greatest influence on deer habitat selection, with habitat class (type) or habitat structural attributes selected on a secondary basis. If, as suspected, mule deer numbers within the study area are comparatively low, then with higher numbers of deer we might expect to see broader use of topographic and habitat attributes.

We suspect that the vast majority of deer tracks observed were those of white-tailed deer. This species is typically more closely associated with lower-elevation agricultural lands than mule deer (Mackie et al. 1998), and is the predominant deer observed in the Harrop Procter area (D. Miller and B. Kingsland, personal communication). Mule deer likely exhibit different habitat use patterns than white-tailed deer in this area, showing less use of lower elevation, riparian and agricultural lands, and higher use of steeper and often rocky habitat (Mackie et al. 1998).
Current winter range guidelines for deer within ICHdw call for retention of 35–55% of an area in stands of >100 years old (age class ≥6) and >60% crown closure (Kootenay Inter-Agency Management Committee 1997). Habitat management objectives for these biogeoclimatic subzones are to maintain suitable security cover, snow interception cover and connectivity habitat value; maintain mature forest cover at an optimum distance to forage sites; to maintain high forage to cover differentiation; and particularly to maintain mature Douglas-fir stands (Kootenay Inter-Agency Management Committee 1997). Our track transect data did not allow examination of spatially explicit habitat prescriptions. However, we did see high use of both open stands and older stands with higher crown closure, supporting this partial retention policy. The age class and crown closure components of these guidelines thus appear to be generally supported by our data, although deer tracks were found to a greater extent in higher crown closure (80%) stands than prescribed, which comprised almost two-thirds of the stands with forest cover.

**Critique of methods**

A number of factors can influence measurement of tracks in the snow, including factors influencing the number of tracks deposited (i.e., weather, population levels, behaviour, predators), climatic factors affecting track quality (i.e., days since snow, snow depth, snow consistency), and observer measurement error. To minimize these influences, we standardized tracks counted to account for days after snowfall, attempted to run transects 2–5 days after snowfall, and conducted comparisons among habitat attributes within each run. In addition, field staff involved in the project were highly experienced at track identification.

Statistical variance is inherent in transect data. A replicate of counts over a short period of time has been suggested as the best method to reduce this variance (Harris 1986). Our goal of 3 runs during the mid-winter period was thwarted by unusual winter weather; however, we were able to conduct 3 runs over the course of the winter, and 2 during the normal mid-winter period. As it turned out, there was relatively little difference in results between runs conducted in the mid-winter period (as indicated by low SE), with the exception of forest type use.

We were unable to differentiate tracks between deer species, but suspect that the vast majority of tracks observed were from white-tailed deer. If both species were represented in roughly equal numbers and habitat use at the scale we measured differed significantly between species, then the resulting data summaries and model output may reflect a blend of 2 different selection patterns. Alternatively, it may be the case that in this area differences in habitat use between species are not great relative to the fairly broad habitat classes examined. Regardless, if as we suspect white-tailed deer far outnumber mule deer in this area, then the habitat use we observed should reflect use by the more common of the 2 species.

The results from these track count studies can be used to build a statistical model to identify ungulate winter range based on habitat suitability. Given the limited range of some variables (i.e., no south aspects), the model resulting from these data will have applications limited to the study area or areas of similar topography. The data sources used to build such a model must be broadly available in order to have applicability; currently this is limited primarily to forest cover and TRIM data. Mapping errors and inaccuracies in the description of structural variables in forest cover polygon (i.e., Boulanger et al. 2000) may contribute to a reduction in the accuracy of the habitat database in some areas. In the future, Predictive Ecosystem Mapping (PEM; Resources Inventory Committee 1999b) may be useful as well, but PEM is not currently available for the study area. Variables that are not available across broad scales, such as snow depth, are not useful in model construction. We cannot at this stage build a reliable statistical habitat model for this area because we did not sample enough segments (our effective sample size was 90 autocorrelated segments on 6 independent transects), nor did adequately sample the range of potential values for each variable available on the study area. The only way we can improve the quality of a statistical model is to sample additional transects.
MANAGEMENT RECOMMENDATIONS

Ungulate winter range lines were recently revised to roughly the 900 m level along the slopes above the West Arm between Harrop and Procter, and to 700 m elevation on the east-facing slopes overlooking Kootenay Lake (M. Knapik, personal communication). Our results from this winter generally support these changes, but suggest that the vast majority of current deer winter range use is below the 720 m elevation line. Given the rather unusual snow year experienced and the need to sample additional areas to strengthen modelling results within the Community Forest, we suggest that a second year of sampling be conducted during winter 2001–02. Our results and recent changes to ungulate winter range lines suggest that transects should only be run to the 900 m elevation mark. With shorter transects, the number of lines could be increased (and possibly paired) to increase the efficiency of the fieldwork and the coverage of the area. This fieldwork will increase the sampling and representation of topographic and forest cover variables within the study area. Efforts will be made to conduct 1 survey during early winter, and 2–3 surveys during the mid-winter period. Surveys late in the winter are often of limited value because of snow loss on lower-elevation or exposed sites.

Results generated from this study will contribute to the current evaluation and refinement of ungulate winter range to be completed by October 2003. The Harrop Procter study area is the only predominantly north-facing study area being examined.

ACKNOWLEDGEMENTS

Forest Renewal British Columbia, through the Harrop Procter Community Forest, provided funding for this project. We thank B. Kingsland, Harrop Procter Community Forest, and K. Koerber, Kalesnikoff Lumber Company, for administrative support. C. Stubbe and C. Shurgot provided assistance with track counts. D. Pritchard conducted the GIS analysis. T. Kinley reviewed an earlier draft of this manuscript.

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