Prince George Forest District Avalanche Tract Mapping Project

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Introduction

This report presents the results of avalanche tract mapping and a test of grizzly bear habitat selection in mountainous portions of the Prince George forest district. The purpose of this project was to identify and map all avalanche tracts below 1700 metres elevation. Once tracts were identified and classified, a buffer of 100 metres maximum distance was built around the resulting avalanche tract layer. The area within buffered polygons is considered high quality grizzly bear habitat and is given special consideration in the Prince George Land and Resource Management Plan (LRMP). The final polygon layer will help natural resource and wildlife managers make decisions regarding land/habitat access management in areas with high suitability grizzly bear habitat. Prior to this project there was no layer of avalanche tract polygons that could be used by forest and wildlife managers.

The management impetus for this project comes from the Prince George LRMPs grizzly bear objective and strategies. In high suitability grizzly bear habitat, one of the stated strategies is to, “undertake access management planning with the intent of deactivating non-essential roads and minimizing the amount and duration of new roaded access. Particular attention to access management will be applied to critical habitat for grizzly bear (e.g., avalanche paths, riparian areas, seeps or springs, high elevation burns and sub-alpine forest).” The layer will provide information for consideration when defining wildlife habitat objectives for the Forest Stewardship Plan.

To test whether bears are selecting avalanche tracts over other habitat types we generated use/availability ratios using existing grizzly bear telemetry data.

Avalanche tracts are only present in Rocky Mountains and North Caribou Mountains portion of the district. These areas make up approximately 1.13 million hectares or 33% of the total 3.40 million hectare Prince George forest district land base.

With the completion of this project, all avalanche tracts in the Prince George forest district and Robson Valley TSA (now part of the Headwaters forest district) have been digitized, classified, and buffered (figure 1).

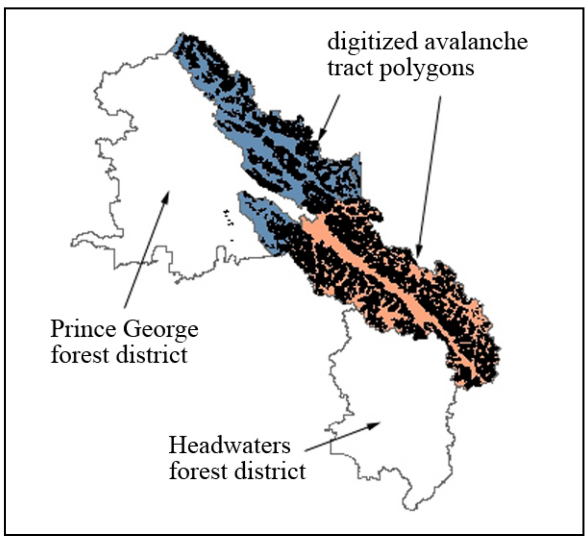


Figure 1: Digitized portions of the Prince George forest district and Robson Valley TSA.

Background

Identification and classification techniques

The job of delineating avalanche tracts from surrounding vegetative cover and classifying vegetation within avalanche tracts has, for the most part, been done using either remotely sensed satellite images or manually digitized stereo air photos. Most of the work done in BC has utilized the hard copy air photo method.

Mowet (2000) provides a good description of the techniques used to identify and classify avalanche tracts using air photos. The photo classification technique involves manually drawing polygons on hard copy stereo air photos, then digitizing and orthorectifying the polygons into a digital layer. This method produces good results but is time consuming and ultimately too costly for an area as large as the Prince George forest district.

Work has also been done to classify avalanche tracts using satellite images. Misurak and Smith (2000) provide a good review of avalanche tract image classification techniques. An accurate classification of avalanche tracts and avalanche tract vegetation requires high resolution satellite imagery such as IKONOS or SPOT. Both products are again too costly when considering an area as large as the Prince George and Robson Valley. Cheaper, coarser resolution satellite image products (such as LANSAT TM) lack both the spatial and spectral resolution needed to classify avalanche tracts.

Work is also being done on classifying avalanche tracts using pan-sharpened Landsat 7 (L7) ETM+ satellite images. Pan-sharpening is the relatively new technique of 'fusing' low resolution multispectral (colour) images with higher resolution panchromatic (black and white) images. The L7 ETM+ sensor now takes 15 metre panchromatic and 30 metre multispectral images at the same time. Pan-fusing L7 ETM+ data results in a 15 metre multispectral image with similar spectral characteristics to the original 30 metre image. If avalanche tracts can be identified from surrounding forested habitat types using pan-sharpened L7 data, it would be a preferable alternative to more costly products like SPOT and IKONOS.

Problems with identification and classification

In some cases the identification of avalanche tracts from surrounding forests is relatively easy. They often occur on steep slopes, have obvious long linear down hill shapes and have well defined run out zones. Many times, however, it is impossible to distinguish between upper portions of avalanche tracts and alpine meadows or alpine tundra. Avalanche tract start zones and alpine tundra or alpine meadows often occur in the same place and have similar floral structural and compositional characteristics. Avalanches are often the main disturbance agent that forms alpine meadows and tundra. To get around the problem of separating upper start zones from alpine meadows and alpine tundra, we selected an upper elevation limit of 1700 metres beyond which no identification occurred. This is 300 metres lower than the upper limit used in the Robson Valley TSA classification project (Wolowicz 2003). This lower elevation isoline was used because the Prince George forest district is further north and has higher average snowfall than the Robson Valley forest district. Higher latitude and greater snowfall results in a lower transition zone between alpine and mature forest.

The decision to not digitize tracts above 1700 metres was supported by the fact that alpine areas are not important from a forest management or early spring grizzly bear habitat management perspective. There is very little harvestable timber in alpine areas, and bears tend to use lower portions of avalanche tracts in early spring.

It is also difficult to identify lower extents of avalanche tract run out zones when they do not run out into forested areas. Often avalanches run out into wetland areas, thinly spaced forest matrixes, and even clear cuts or burns. Defining the lower limits of avalanche run out zones that occur in open areas was left to the discretion of the digitizer.

Cost was the main consideration when deciding not to classify different vegetative communities within avalanche tracts. As stated above, classifying vegetation layers over an area as large as the Prince George district is cost prohibitive. It was also thought that classifying vegetative layers within chutes was less important than simply identifying warm aspect chutes because of the dynamic nature of avalanche tracts. A shrub dominated poor quality tract may become a herb dominated high quality tract following years of high avalanche activity.

Identifying avalanche tract polygons using existing digital layers

There are currently no digital layers available at a large enough scale (cartographic definition of scale – large scale = 1:20,000) which accurately map avalanche tracts. The only large scale, district wide, digital layer that identifies avalanche tracts is the Ministry of Forests forest cover (FC) polygon layer. The FC polygon layer sometimes groups avalanche tracts with alpine areas to form large, non-treed, contiguous mountaintop polygons. These combination alpine/avalanche tract polygons are identified with the record ‘A’ (alpine) under the non-productive data field.

In other cases FC avalanche tract polygons are mapped individually but identified with the record ‘NPBR’ (non-productive brush). In this case it is impossible to separate avalanche tract NPBR polygons from other NPBR polygons without visually inspecting each polygon. Also, due to either poor digitizing or the changing spatial and temporal nature of avalanche tracts, FC polygon lines often do not represent the true size and shape of many tracts.

Methodology

Identifying and classifying avalanche tract polygons

Avalanche tracts were digitized off previously orthorectified and tiled black and white digital air photos (orthophotos). The outer edge of each tract was defined in the upper reaches by a 1700 metre isoline (figure 2). Each tract was classified as high, medium, or low based on the percentage of the tract falling on warm aspects. Warm aspects were defined as slopes facing 135^o to 225^o degrees (45^o either side of south). Tracts with < 25% area falling on warm aspects were given a low, 25 to 75% a medium, and > 75% a high classification. Adjoining tracts that occurred across the face of a mountain were usually grouped into one polygon. If, however, a set of adjoining tracts changed aspects enough to change the warmth classification between low, medium, or high, a new polygon was started. Forested areas or islands contained by avalanche tract polygons were digitized and classified as non-avalanche tract.

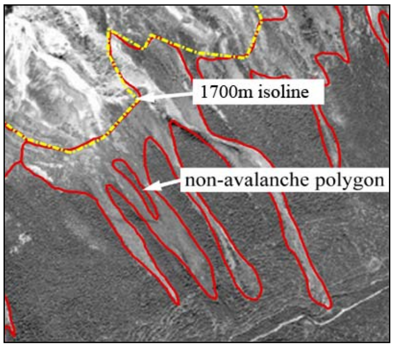


Figure 2: avalanche tract polygons were not digitized above 1700m.

Each polygon was then buffered to 50 or 100 meters depending on its warmth rating. High and medium polygons were buffered at 100 meters. Low polygons were buffered at 50 meters (figure 3).

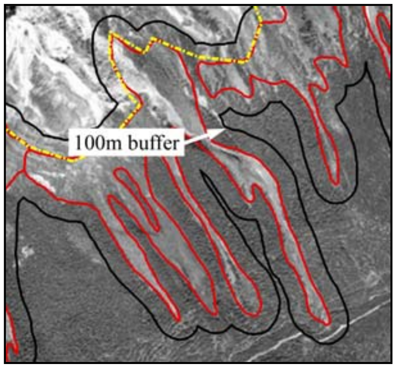


Figure 3: high and medium quality polygons were buffered at 100m, while low quality polygons were buffered at 50m.

Creation of habitat use and availability ratios and distance to nearest tract

One of the main objectives of this project was to analyze existing grizzly bear telemetry data to see if bears are selecting avalanche tracts over other habitat types. We obtained 1679 grizzly bear telemetry points from bears collared as part of the Parsnip Grizzly Bear Project. A 134,000 hectare 95% minimum convex polygon (MCP) was created using the ArcView Animal Movements extension. Approximately 40% of the telemetry locations used to create the MCP polygon fell within the Peace forest district (figure 4). This was a problem in that we only had a digitized avalanche tract layer for the Prince George forest district. To ensure all avalanche tracts were used in the use/availability analysis, the MCP was clipped using the Prince George forest district boundary (figure 5). Only telemetry locations and avalanche tract polygons falling within the resulting 64,000 hectare clipped MCP polygon were used in the analysis. Of the original 1697 telemetry locations, 996 fell within the clipped MCP polygon.

The clipped MCP polygon was overlaid on the avalanche tract layer to generate proportions of 'available' habitat. The 996 telemetry locations were also overlaid on the avalanche tract layer to generate proportions of 'used' habitat.

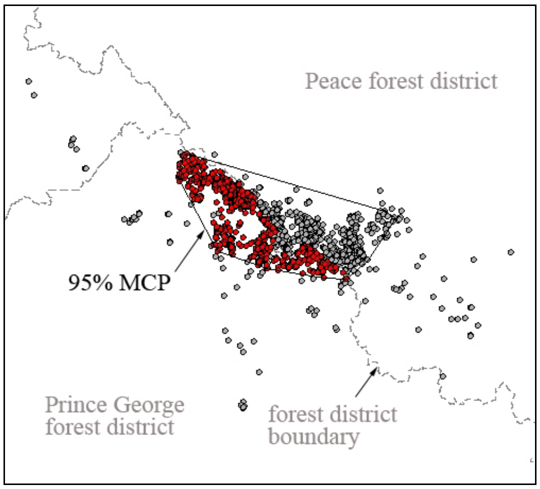


figure 4: 40% of telemetry locations fell within the Peace forest district. Points falling within the 95% MCP and PG district are in red.

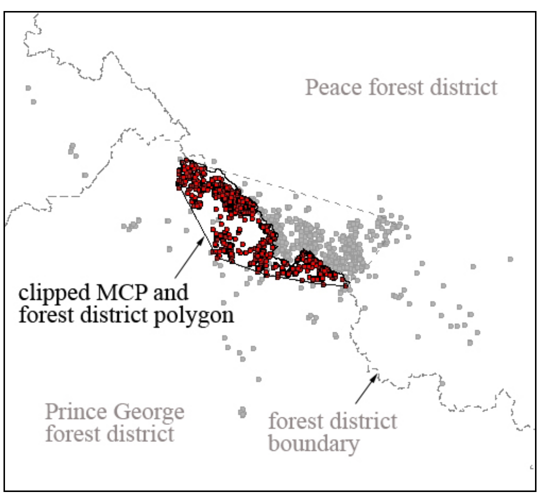


figure 5: 996 points (in red) fell within the 64,000 hectare clipped MCP polygon.

The use and availability analysis was performed using four different habitat classes;

1 – warm tract: warm aspect avalanche tract polygons.
2 – medium tract: medium aspect avalanche tract polygons.
3 – cool tract: cool aspect avalanche tract polygons.
4 – buffer polygon: buffered avalanche tract polygons.
5 – other: anything that is not an avalanche tract polygon or a buffer polygon.

Points were separated into three classes based on the date they were collected. There were 464 spring points between den emergence and July 15th, 338 summer points between July 15th and September 15th, and 134 fall points between December 15th and den entry. Class break dates were obtained from the Parsnip Grizzly Bear Population and Habitat Project (2003).

We also measured the average distance from points falling outside avalanche tract polygons to the nearest tract polygon. Distance to nearest tract, and the warmth class of the nearest tract were recorded (table 2 and figures 10, 11, and 12).

All GIS analysis was performed using ArcInfo workstation and ArcGIS.

Results

Avalanche tract classification

A total of 897 high and medium quality avalanche tracts with a combined area of 46700 hectares were digitized and buffered at 100m. A total of 1424 low quality tracts with a combined area of 63900 hectares were digitized and buffered at 50m (see table 1).

Quality of tract	Number of polygons	Area in hectares	Size of buffer
high	529	22400	100m
medium	368	24300	100m
low	1424	64000	50m
total	2384	110700	

Table 1: total number and area of avalanche tract polygons (avalanche tract polygons only).

All avalanche tract polygons and buffer polygons have a combined area of 176909 hectares (figure 6a). Because the buffering process combines adjacent 50 and 100 meter buffers into one contiguous polygon, it is impossible to report the total area buffered at each distance (figure 6b). The total buffered area outside avalanche tracts is 66245 hectares (figure 7).

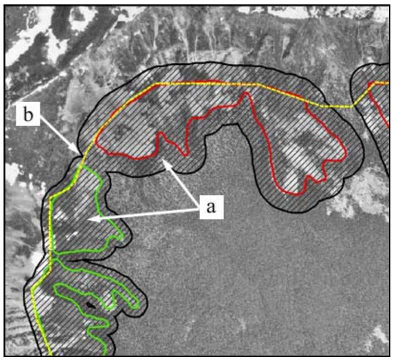


Figure 6: a - total area of all buffered polygons. b - 50 and 100m polygons are combined.

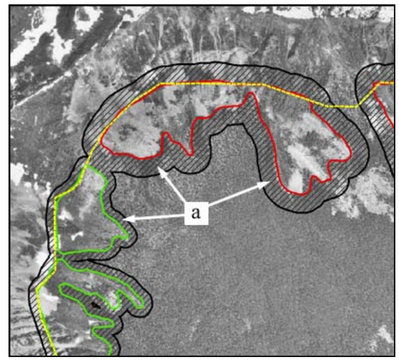
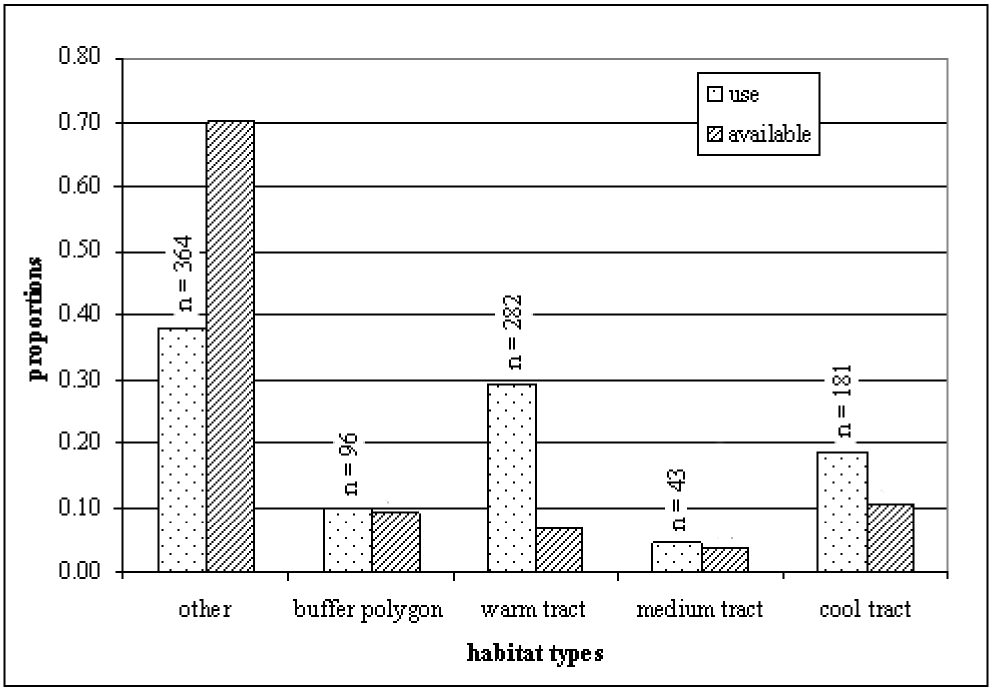


Figure 7: a - total area of buffered polygons minus avalanche tract polygons.

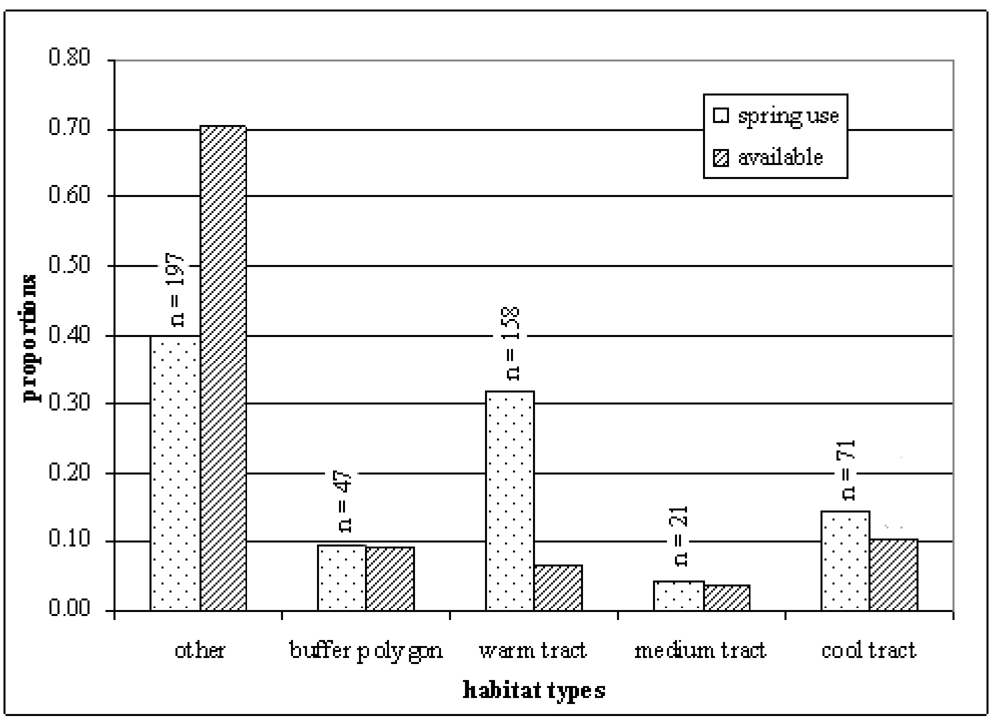
Use and availability ratios

Five hundred and ninety nine (62%) of all telemetry points fell within avalanche tract and buffer polygons, while avalanche tract and buffer polygons made up 30% of the total available area. The remaining 367 points fell in the 'other' class or outside of avalanche tract polygons and buffers. Approximately 10% of points fell within the 50/100 metre buffer, while that buffer made up roughly 10% of the total area. Twenty nine percent of all points fell within warm aspect polygons, while warm aspect polygons made up approximately 7% of the total area. Figure 8 is the use and availability ratios for all 966 points combined. Figure 9, 10, and 11 are the use and availability ratios separated by spring, summer, and fall.



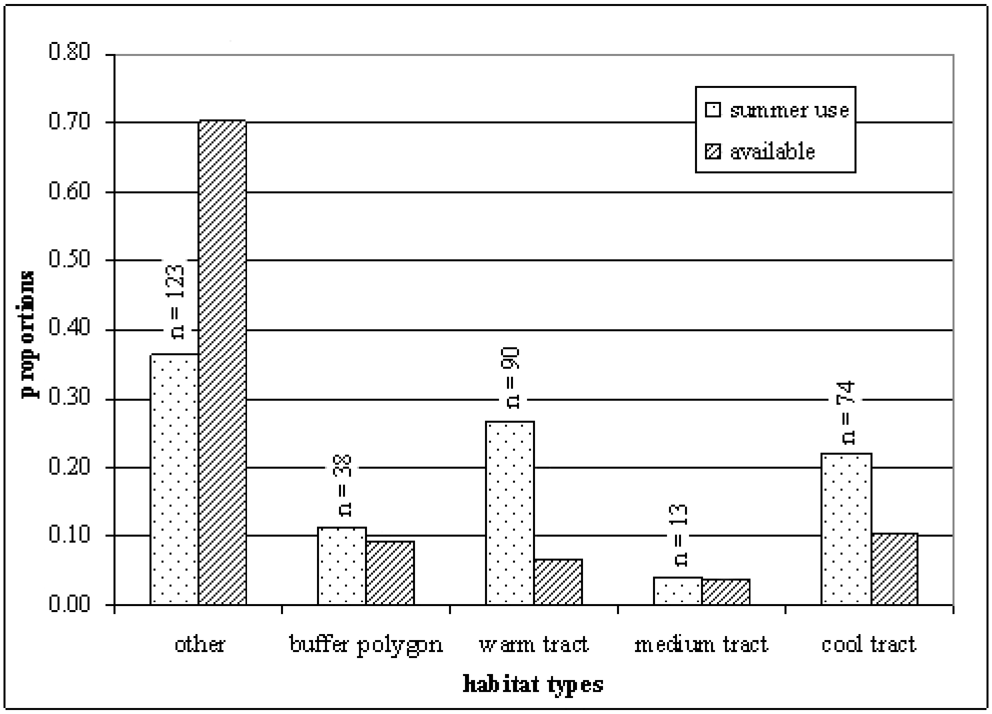
habitat type	other	buffer polygon	warm tract	medium tract	cool tract
use	37.68%	9.94%	29.19%	4.45%	18.74%
available	70.11%	9.16%	6.75%	3.54%	10.45%
u/a ratio	0.54	1.09	4.33	1.26	1.79

Figure 8: overall use and availability – all 966 points.



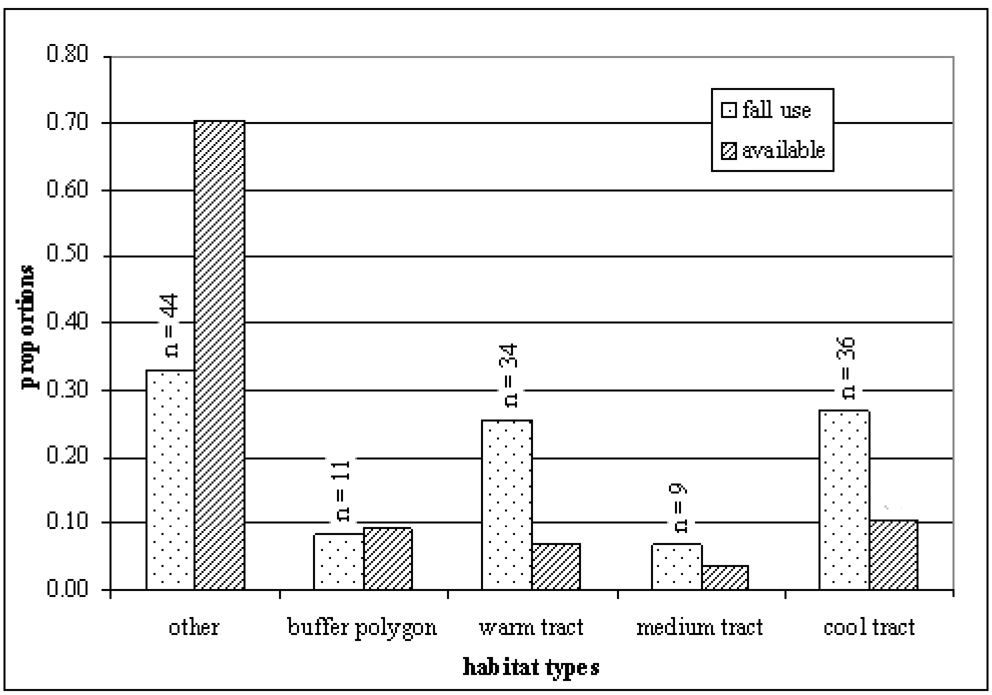
habitat type	other	buffer polygon	warm tract	medium tract	cool tract
use	39.88%	9.51%	31.98%	4.25%	14.37%
available	70.11%	9.16%	6.75%	3.54%	10.45%
u/a ratio	0.57	1.04	4.74	1.20	1.38

Figure 9: spring use and availability – 464 points.



habitat type	other	buffer polygon	warm tract	medium tract	cool tract
use	36.39%	11.24%	26.63%	3.85%	21.89%
available	70.11%	9.16%	6.75%	3.54%	10.45%
u/a ratio	0.52	1.23	3.95	1.09	2.09

Figure 10: summer use and availability – 338 points.



habitat type	other	buffer polygon	warm tract	medium tract	cool tract
use	32.84%	8.21%	25.37%	6.72%	26.87%
available	70.11%	9.16%	6.75%	3.54%	10.45%
u/a ratio	0.47	0.90	3.76	1.90	2.57

Figure 11: fall use and availability – 134 points.

Distance to nearest tract

Of the 454 points that did not fall within an avalanche tract polygon, 249 were closest to warm aspect tracts, 38 were closest to medium aspect tracts, and 167 were closest to cool aspect tracts. Table 2 presents the mean, and standard deviation of the distance to tracts for each warmth class. Figures 12, 13, and 14 present frequency distributions for each warmth class.

Warm aspect tracts	Average of Distance	723m
	StdDev of Distance	949m
Medium aspect tracts	Average of Distance	387m
	StdDev of Distance	37m
Cool aspect tracts	Average of Distance	326m
	StdDev of Distance	321m

Table 2: average and standard deviation of distances to closest polygons.

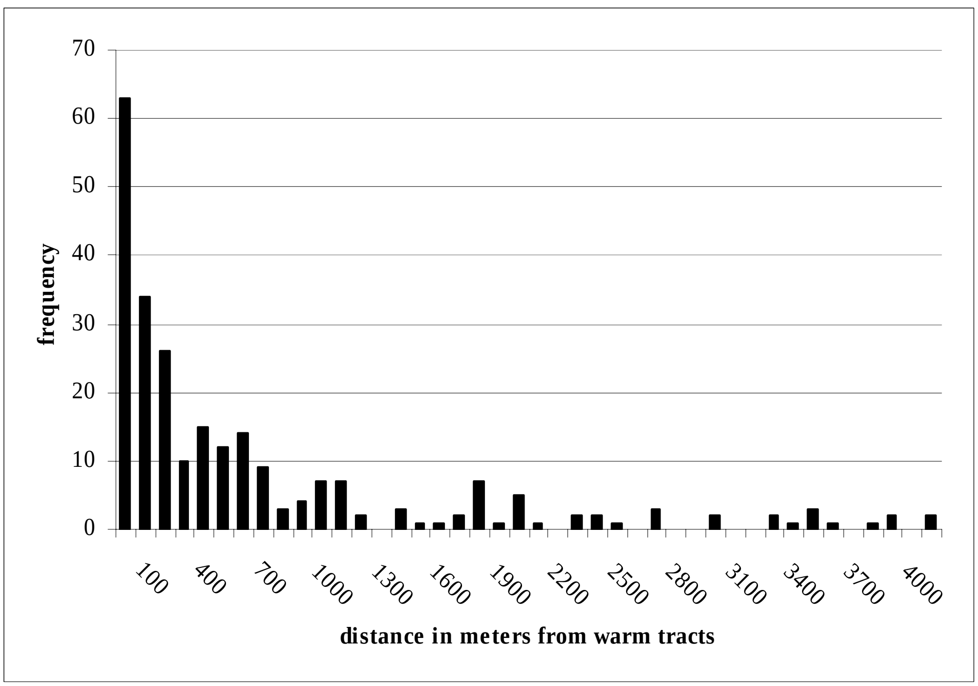


Figure 12: Frequency distribution of 249 distances to warm tracts.

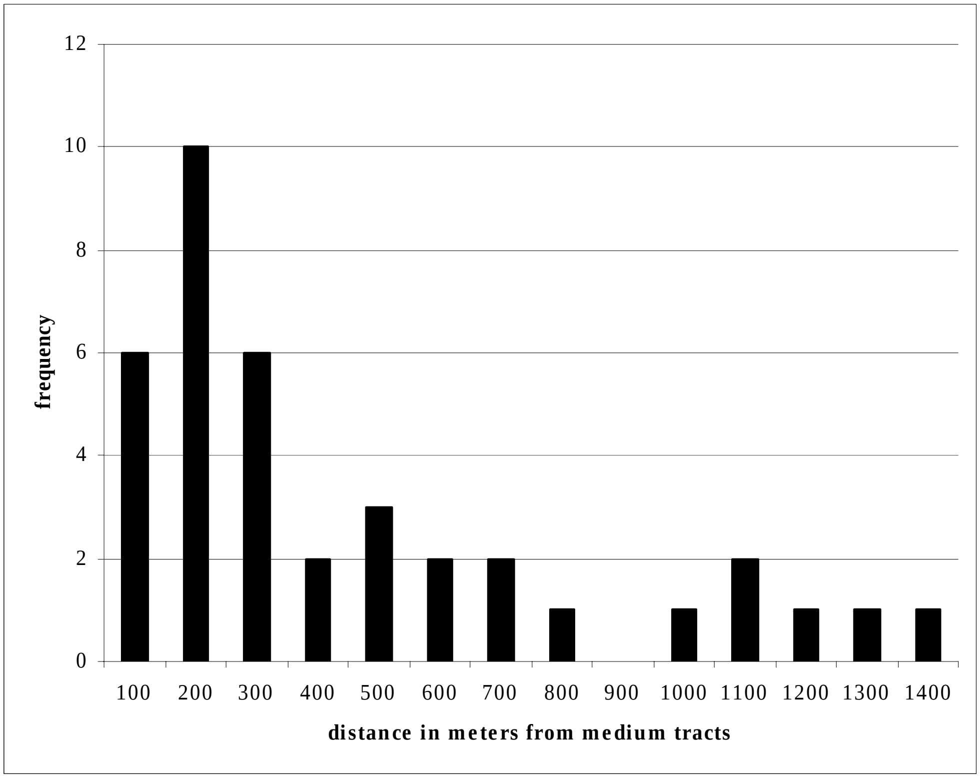


Figure 13: Frequency distribution of 38 distances to medium tracts.

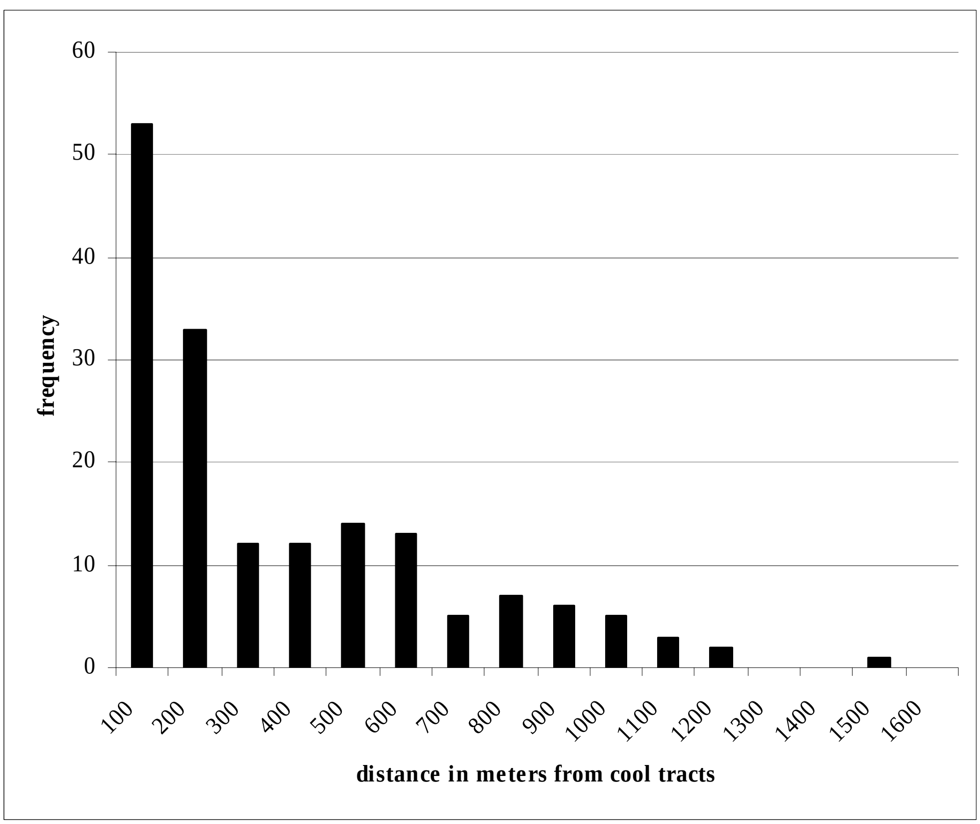


Figure 14: Frequency distribution of 167 distances to cool tracts.

Discussion

Data limitations

Although the results of this work will provide managers with a good inventory of avalanche tracts in the Prince George forest district, there are some data limitations. First, digitized polygon lines will not match avalanche tracts at large scales. This data is meant to act as a reasonable filter to identify areas where forest managers should exercise caution. It is not meant to be used to draw cutblock or road boundaries. If, for instance, a licensee wishes to create an opening that will intersect the buffered polygon edge, they should first check the quality of the avalanche tract that was buffered, then make some assessment of the potential of that tract as grizzly bear habitat.

Second, several high and medium quality tracts run through burns or existing clear cuts. Depending on the age of the opening, it was very difficult to pick out the boundary between avalanche tracts and forested areas. In this case we tried to follow avalanche tracts from start zones down draws or gullies to the valley bottom. In recently created openings, polygon boundaries are gross approximations of real avalanche tract boundaries.

Use availability ratios and distance to tracts

The quality of each tract was assigned based on the percentage of tract falling on southerly aspects, not an assessment of grizzly bear habitat potential. There is strong evidence suggesting south facing avalanche tracts are important spring grizzly bear habitat. But those tracts also have to have well developed grass and forb layers, and low visual cover (Ramcharita 1999). We did no assessment of vegetation development or visual cover. This means that there could be low quality, shrub dominated, avalanche tracts classified as high quality tracts or visa versa. The lack of within tract vegetation classification is a result of the trade off between trying to identify all tracts in the Prince George forest district, and identifying and classifying vegetation within a small number of tracts.

The results of the use availability analysis indicate that bears are selecting avalanche tract habitats over non-tract habitat types. Warm tracts appear to be selected over medium and cool tracts, and cool tracts appear to be selected over medium tracts. The higher proportion of points in cool over medium tracts could be because cool tracts are much more abundant than medium tracts. It is also interesting to note that the bears appear to move out of warm and into cool aspect tracts as the season progresses. This could be because warm tracts melt before cool tracts providing better early spring habitat. This time lag also provides higher habitat values in cooler tracts later in the season

The frequency of distribution of distances to each warmth class would seem to indicate that a 200 to 300 metre buffer would capture the majority of point locations. The number of points close to warm and medium tracts drops significantly beyond 300 metres. The number of points close to cool aspect tracts drops significantly beyond 200 metres.

True impact on forest resources

It should also be noted that the raw area data does not represent the true impact to the forest resource. Although there is 66245 hectares of buffered polygon outside of avalanche tracts, and much of that area is forested, the majority of that area is surrounding low and medium quality tracts. There is also a significant portion of the 66245 hectares in high elevation valleys where logging is not likely to occur, and in alpine areas above 1700 meters (figure 15).

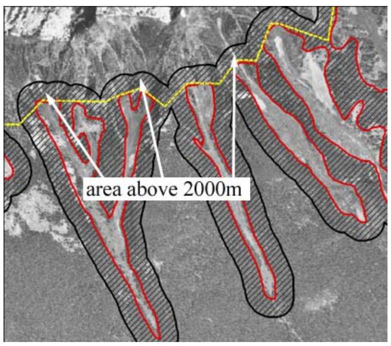


Figure 15: some of the 11577 hectares is located in the alpine.

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