Robson Valley Avalanche Tract Mapping Project

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Introduction

The purpose of this project was to identify and map all warm aspect (south-east to south-west facing) avalanche tracts below 2000 meters elevation in the Robson Valley forest district (approximately 1.4 million hectares). We also wanted to classify each warm aspect tract as herb/forb or shrub dominated but could not complete this part of the project due to funding constraints.

The Robson Valley Land and Resource Management Plan (LRMP) and Timber Supply Analysis (TSA) report both recognize the importance of preserving high quality grizzly bear habitat and provided the impetus for initiating this project.

The Robson Valley LRMP's grizzly bear biodiversity emphasis states that (with regards to avalanche tract management), 'Where feasible locate roads to avoid avalanche paths, especially on south facing slopes. Road locations close to avalanche paths should avoid allowing a clear line of sight between road and path. Where important avalanche paths are identified, a total reserve of 100 metres should be left on each side of the path. Selective harvesting will be considered pending further research'.

The May 2000 Robson Valley TSA report excludes all grizzly bear habitat areas from the harvesting land base. Grizzly bear habitat areas are defined as south and west facing avalanche tracts in the ESSF biogeoclimatic ecosystem classification (BEC) zone. To protect this habitat, the current policy has been to retain 50 metre wide buffers on these avalanche tracts. To account for these buffers a 1% reduction was applied to the total current productive forest available for harvest.

To help managers better fulfill the LRMP and TSA requirements we produced a digital layer of all avalanche tracts under 2000 meters elevation. Each avalanche tract was classified based on aspect and buffered.

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 Robson Valley 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 vegetative layers requires high resolution satellite imagery such as IKONOS or SPOT. Both products are again too costly when considering an area as large as the Robson Valley. Cheaper, coarser resolution satellite image products (such as LANSAT TM) lack both the spatial and spectral resolution needed to classify avalanche tracts.

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 2000m beyond which no identification occurred.

The decision to not digitize tracts above 2000m 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 greener 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 Robson Valley 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 herb dominated high quality tract following years of high avalanche activity.

Identifying avalanche tract polygons using existing digital layers

We originally thought we could extract avalanche tract polygons from existing polygon 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 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 some 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.

We thought we could possibly use a combination of satellite classification and GIS analysis to extract avalanche tracts from FC alpine polygons. In this case an image classification would be used to subtract rock, talus and ice from FC alpine polygons. The resulting polygons were assumed to be avalanche tracts. At first this method appeared to hold the most promise. However, upon further investigation it was found that, due to either poor digitizing or the changing spatial and temporal nature of avalanche tracts, FC polygon lines often did not represent the true size and shape of many tracts. At this point we decided to abandon efforts to separate out avalanche tracts from FC polygons.

Why we did not do an image classification on a small portion of the district

In the end, we decided we would manually digitize all avalanche tracts in the district off digital orthophotos, classify each based on aspect, and not classify vegetative layers within tracts. This direction was taken because we thought it would provide the best product and for time and funding budgets. We could have done an IKONOS image classification or digitized stereo air photos, but would only have been able to do a small portion of the district. Managers now have a full (albeit courser scale) inventory of all avalanche tracts in the Robson Valley Forest District.

Methodology

Avalanche tracts were digitized off previously orthorectified and tiled black and white digital air photos (orthophotos). The line defining the outer edge of each tract was defined in the upper reaches by a two thousand meter isoline (figure 1). 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.

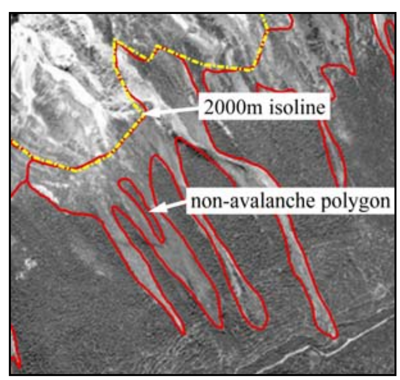

Figure 1: avalanche tract polygons were not digitized above 2000m.

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 2).

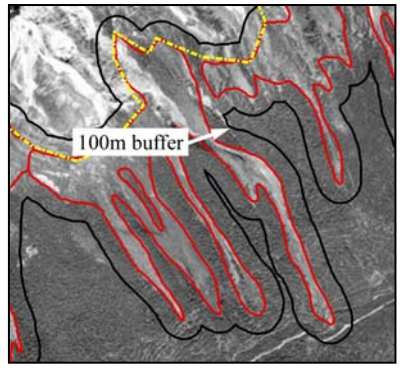

Figure 2: high and medium quality polygons were buffered at 100m, while low quality polygons were buffered at 50m.

Results

A total of 1580 high and medium quality avalanche tracts with a combined area of 88661 hectares were digitized and buffered at 100m. A total of 2404 low quality tracts with a combined area of 114404 hectares were digitized and buffered at 50m (see table 1).

Quality of tract	Number of polygons	Area in hectares	Size of buffer
high	1018	56168	100m
medium	562	32493	100m
low	2404	114404	50m
total	3984	203065	

Table 1: total number of polygons and total area of polygons.

Once buffered and combined there were a total of 1670 buffer polygons with a combined area of 318865 hectares (figure 3a). 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 3b). The total buffered area outside avalanche tracts is 115801 hectares (figure 4).

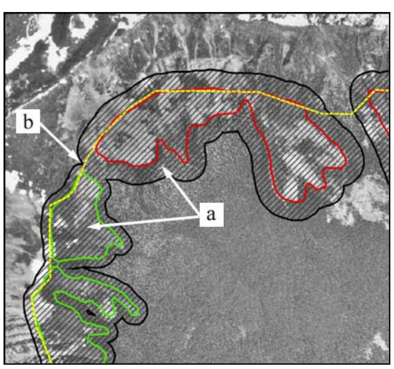

Figure 3: a - total area of all buffered polygons. b - 50 and 100m polygons are combined.

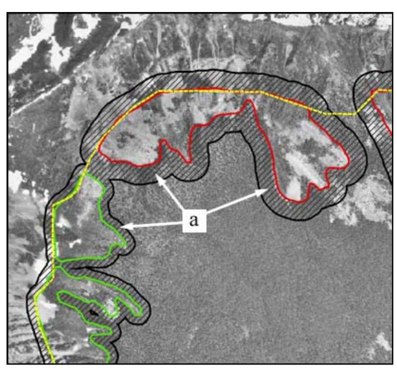

Figure 4: a - total area of buffered polygons minus avalanche tract polygons.

Discussion

Although the results of this work will provide managers with a good inventory of avalanche tracts in the Robson Valley, 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 confirm the quality of the avalanche tract that was buffered, then make some assessment of the potential of that tract as grizzly bear habitat. If it appears the tract does have high grizzly potential, they should establish the opening boundary as per TSA and LRMP requirements.

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.

Third, the quality of tracts was assigned based on the percentage of each 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 Robson Valley and identifying and classifying vegetation within a small number of tracts. For comparison, there has been work done in the Goat River and Cushing Creek watersheds classifying within tract vegetation. Now that there is a good inventory of south facing tracts, more effort could be put into doing a higher resolution classification of vegetation within those tracts throughout the Robson Valley.

It should also be noted that the raw area data does not represent the true impact to the forest resource. Although there is 115801 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 115801 hectares in high elevation valleys where logging is not likely to occur, and in alpine areas above 2000 meters (figure 5).

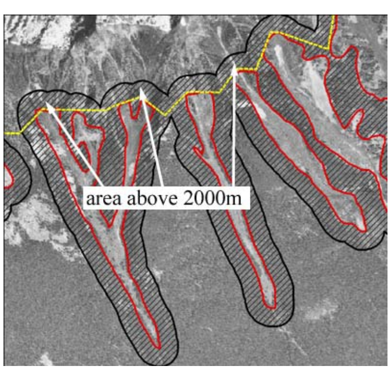

Figure 5: some of the 115801 hectares is located in the alpine.

Literature cited

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