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THINHORN SHEEP (OVIS DALLI STONEI) WINTER RANGE DISTRIBUTION IN THE CASSIAR MOUNTAINS, YUKON. Jean Carey, Dept. of Renewable Resources, Fish and Wildlife Branch, Box 2703, Whitehorse, Yukon Y1A 2C6.

INTRODUCTION

Thinhorn sheep (*Ovis dalli* sp.) are very traditional in the use of their range. They are a climax species, adapted to life in a relatively predictable, stable environment. Several habitat parameters, including lambing cliffs, rugged escape terrain, mineral licks and winter range are critical to their well-being. For example, the extent of snow-free areas in March and April, after maximum snow accumulation and before melting has occurred is thought to be a factor limiting sheep population size and distribution. It is thus very important that the locations of these critical parameters be delineated and subsequently protected from activities which may prevent sheep from using them.

Summer surveys in the Cassiar Mountains have always found far fewer sheep than what the available range intuitively seemed able to support: summer range is extensive and there appears to be adequate escape terrain. A winter survey, however, found sheep in scattered patches, in what appeared to be relatively discrete snow-free areas. Winter range, then, is apparently the factor limiting this sheep population. The winter ranges seemed very obvious during the flight, but unfortunately the entire mountain range could not be covered. The ground truthing therefore precipitated the remote sensing project: could what seemed so obvious to our eyes during a low-level survey flight be detected over a much broader area using satellite imagery?

Remote sensing has been used for snow cover mapping to predict run-off (NORDCO 1988), while Dozier (1989) discussed techniques to separate snow from other targets. The techniques used by Dozier were more elaborate than that proposed here, but suggested that it may be possible to separate snow-free areas from other targets.

STUDY AREA

The Yukon portion of the Cassiar Mountains extends north from the B.C./Yukon border (60°N) to 61°N and from 130° to 131°30'W (Figure 1). The terrain is of moderately high relief, generally over 1500 m, with treeline occurring at 1350 to 1500 m a.s.l. (Oswald and Senyk 1977). Bedrock is composed mainly of intrusive rock. Annual precipitation may reach 625 mm or more at higher elevations.

MATERIALS AND METHODS

An aerial sheep survey was carried out on 27 February 1991. Each mountain block was contoured in a counterclockwise direction at 120 kph approximately 150 m above ground level. All sheep observed were counted and classified by sex and horn class and snow-free areas were delineated on a 1:250,000 NTS map (YTG file rep.).

A georeferenced Landsat TM Quarter Scene image (7 bands) was obtained 23 March 1991. This data set was chosen after searching available archived data. The image with the least cloud cover obtained closest to the ground collection date was selected.

The processing carried out on this imagery included:

- a geometric correction to UTM co-ordinates

- several enhancements, including contrast stretching, principal components and ratios, were applied to the data in an attempt to increase the apparent contrast between the snow-free areas and other targets in the imagery.

- feature space exploration was used to assist in band selection for the classifications. Numerous combinations were assessed for their ability to identify snow-free areas.

- unsupervised classifications were derived from the following combination of bands or band enhancements:
    - TM Bands 1,2,5
    - TM Bands 1,3,4
    - TM Bands 2,4,5
    - TM Bands 1,2,4,5
    - TM Bands 2,4,5 and Eigen channel 1
    - Eigen channels 1,2,3

- supervised classification using 1/3 of the ground or reference data were derived for these combinations:
    - TM Bands 2,4,5
    - Eigen channels 1,2,3,4,5,6,7,8

- post-classification filtering was applied.

RESULTS AND DISCUSSION

SATELLITE IMAGERY

Several problems were encountered in the image registration. The study area map spanned two UTM zones, therefore a direct linear relationship between the grid designations and the ground control points did not exist. Since the software currently available is unable to handle this problem, an artificial UTM grid with an origin of 0 was created. The relative position of each of the ground control points was then consistent and we were thus able to "trick" the system into successfully registering the image to the map.

Working with a winter image also posed some problems during the image registration. Many features, such as small lakes or creeks, which would have been useful as ground control points were obscured by snow. There were not enough identifiable features on each 1:50,000 mapsheet to register the image at that scale. Even at 1:250,000 there was some distortion in one area with few ground control points.

IMAGE ANALYSIS

It was fortunate that the available image acquired closest to the aerial helicopter survey was virtually cloud free and therefore no ratioing was necessary to spectrally separate the cloud from snow (Dozier 1989).

The unsupervised classifications were carried out using a K-means clustering method. Eight and 16 classes were generated. These classifications were not accurate in delineating the winter ranges as identified during the aerial survey. The best classification was obtained when 3 eigen channels were used. Known sheep areas were represented by 2 theme classes 74% of the time and incorrectly classified as other ground types 24.3%.

The image was confused and confounded by similar signatures at low-lying elevations. It would have been useful to have a digital topographic map (DTM) for the classification process. The creation of a digital elevation model would have allowed masking out all areas that were not potential sheep range and thus limit the areas to be classified. Other factors, such as slope and aspect, could also have been incorporated into the classification.

The supervised method provided even poorer results. The areas outlined as winter ranges were spectrally identical to the background areas. Only 2.58% of the reference data were correctly classified. Much of the error introduced here may have resulted in the difficulty found transferring the ground reference data into the computer.

CONCLUSIONS

The results of this study provided no evidence that sheep winter ranges could be identified with Landsat TM imagery.

Numerous processing problems were encountered correcting the imagery and identifying known sheep winter ranges. Software capable of incorporating a DTM into the geometric correction would have been useful. Although the spectral signatures of the winter range or snow-free areas may not be sufficient to allow identification through the methods used, a number of other techniques could still provide the accuracy required by this project.

1. A DTM incorporated into the geometric registration process, creating more accurate results.

2. Integration of the remote sensing data and geographic information system (GIS). The ground or reference data could have been more accurately located on the satellite image, reducing a source of error.

3. Use of DTM data to eliminate those elevations, slopes and

aspects unlikely to have winter range, reducing confusion with unrelated spectrally similar ground types.

4. Collection of sheep winter range ground information using the satellite imagery. The size, shape and location might then have been more easily and more accurately identified at later stages of the analysis.

As little work has been previously done to identify winter range or snow-free areas and the techniques that may be employed, this project should be considered as an initial step. The results may have been discouraging but other efforts may still be warranted. An integrated study using GIS technology seems to be appropriate.

REFERENCES

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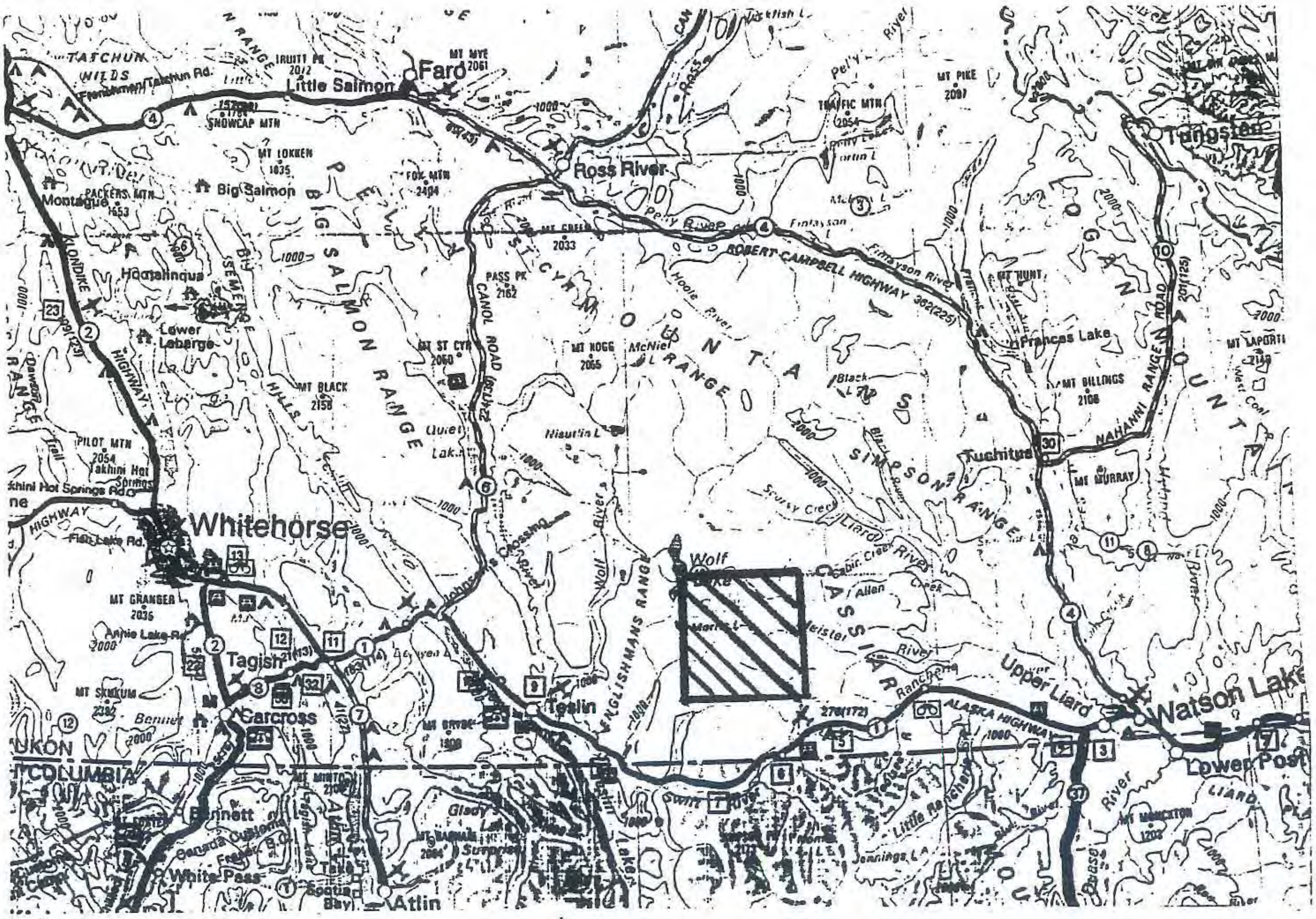

Figure 1. Study area.