Snow Conditions on the Winter Range of the Itcha-Ilgachuz and Rainbow Caribou Herds from 1997-1999

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INTRODUCTION

Snow depths and snow density may play a role in the availability of caribou winter forage. The Itcha-Ilgachuz caribou consume both terrestrial and arboreal lichens in roughly equal proportions (Cichowski 1993). Deep snow may prevent cratering for terrestrial lichens, while crusted snow may provide a platform on which to reach arboreal lichens. Therefore, annual variation in use of the caribou winter range may be associated with annual variations in snow depth and density.

In order to obtain more information on snow conditions throughout the winter range of the Itcha-Ilgachuz and Rainbow caribou herds, snow stations were established and monitored during the winters of 1997-1998 and 1998-1999. First year results were summarized by Shaw (1998). Twenty stations were selected in 4 general areas: around Anahim Lake, along the Chezacut Road, near Satah Mountain, and near the Baezaeko Road west of Nazko. All of these locations extend into the range where caribou have been observed in previous winters (Cichowski 1993 and Young and Shaw 1998), although caribou use varies by year.

OBJECTIVES

This report documents the results of the first and second years of monitoring snow depths and sinking depths throughout the winter range of the Itcha-Ilgachuz and Rainbow caribou herds. Specific objectives of this project are:

1. To measure snow depths and human sinking depths in the Itcha-Ilgachuz and Rainbow caribou winter range;
2. To integrate this information with other caribou habitat data in order to understand the factors which influence winter habitat selection (to be addressed in a separate report); and
3. To determine if there is any correlation between snow conditions on the winter range and adjacent long-term snow stations established by the Water Management section of the Ministry of Environment, Lands and Parks (MELP).

STUDY AREA

For more information on the range of the Itcha-Ilgachuz and Rainbow caribou herds, refer to "Towards Integrated Management Solutions: The Itcha-Ilgachuz Caribou Project Radio-Telemetry Year Three Progress Report 1995-1998" (Young and Shaw

1998). The specific locations of the snow stations for both the 1997-1998 and 1998-1999 winters are shown in Table 1 and Figure 1. An attempt was made to place all stations at approximately the same elevation, however the Anahim Lake stations were on average at least 136m lower than the stations in the other three general areas (Table 1).

Table 1. Snow station locations for the 1997-98 and 1998-99 winters. Stations highlighted in grey were stations moved to a new location for the winter of 1998-99. Average elevation and standard deviation are only shown for the winter of 1998-99 when there was a change in these figures due to a change in the location of a station.

Station ID*	UTM X	UTM Y	Elevation (m)	Site Type	Forest Descriptor	Winter(s) monitored	Average Elevation		Standard Deviation	
							97/98	98/99	97/98	98/99
Anahim Lake										
CSS #1C	346899	5832111	1293	Open		97/98, 98/99				
CSS #2C	331413	5841840	1056	Open		97/98, 98/99				
CSS #3C	331773	5820278	1180	Open		97/98, 98/99	1176		119	
CSS #1F	346110	5827231	1177	Forested	239 Pl 420P4	97/98, 98/99				
CSS #2F	331413	5841840	1056	Forested	727 Pl 723P5	97/98, 98/99				
CSS #3F	331773	5820278	1180	Forested	144 Pl 722P	97/98, 98/99	1138		71	
Chezacut										
CSS #1C	402836	5840939	1440	Open		97/98				
CSS #1C	396867	5844155	1590	Open		98/99				
CSS #2C	408492	5834156	1417	Open		97/98, 98/99				
CSS #3C	416909	5829989	1286	Open		97/98, 98/99	1381	1431	83	152
CSS #1F	402457	5840463	1428	Forested	356 Pl 831M4	97/98				
CSS #1F	396417	5843705	1585	Forested	623 Pl 8215-9	98/99				
CSS #2F	408492	5834156	1417	Forested	247 Pl 622P	97/98, 98/99	1423	1501	8	119
Baezaeko										
CSS #1C	427565	5861543	1357	Open		97/98, 98/99				
CSS #2C	419801	5852955	1192	Open		97/98				
CSS #2C	404418	5862754	1502	Open		98/99				
CSS #3C	412122	5867343	1310	Open		97/98, 98/99				
CSS #4C	395732	5865407	1389	Open		97/98, 98/99	1312	1390	86	82
CSS #3F	412122	5867343	1310	Forested	136 Pl 831M4	97/98, 98/99	1310			
Satah Mountain										
CSS #1C	390133	5816419	1380	Open		97/98, 98/99				
CSS #2C	396074	5812232	1288	Open		97/98, 98/99				
CSS #3C	397867	5813736	1280	Open		97/98, 98/99	1316		56	
CSS #1F	390133	5816419	1380	Forested	70 Pl 823P5	97/98, 98/99	1380			

* "CSS" represents Caribou Snow Station

Figure 1. Snow station locations.

METHODS

Snow Stations

Employees from the Ministry of Environment, Lands and Parks, the Ministry of Forests, and B.C. Conservation Foundation measured snow depths and human sinking depths at specific locations once a month during the winters of 1997-98 and 1998-99. Measurements were taken each year from the beginning of November until there was no snow on the ground (which turned out to be early May in both years). Measurements were to be taken on the first of every month, or within a 3 day window on either side of the first, although some measurements did not fall within this window (see Appendices A and B). A combination of forested and open sites were chosen to monitor. All sites were mapped and marked for easy relocation.

Snow station sites were chosen to cover as much of the caribou winter range as possible, utilizing mostly road access (in 1998-99 two were accessed by ATV). Forested sites were chosen taking into consideration proximity to cleared areas so they could be paired with an open site, thus allowing easy comparison between the two sources of data. The pine stands chosen were mostly 100 years or older (with one exception that was 61-80 years old) and crown closure ranged from 36-55%. Forested sites contained ten 8 foot long wooden stakes marked off by centimeters and driven into the ground, approximately 15-40 paces from each other. The stakes were randomly placed in the middle of small openings in the forest at least one meter away from any tree in order to minimize any direct canopy effect. The stakes were also placed in areas with as close to zero slope and aspect as possible.

Open sites were usually located in clearcuts or meadows, and contained only one 8 foot long wooden stake. They were chosen to be near a forested site and a road, and to be at least 50 m away from trees to prevent their influence, and also to have as close to zero slope and aspect as possible.

Only one stake was placed in the open sites instead of ten stakes as at the forested sites because it was thought that they might not be as protected in the open and be blown down more easily. Also, at the open sites there was no need to consider the effects that the canopy would have on snow measurements, thus measurements could be taken in a straight line instead of a pattern.

Both types of sites also had 2 foot lengths of half inch rebar pounded into the ground beside the stakes so the stake location could still be found in the event that the wooden stake was knocked over.

At forested sites, recorders were required to take ten snow depth measurements, one at each of the ten staked locations. Human sinking depth was also measured at the same spot that snow depth was measured, by measuring how far a person sank into the snow while standing on one leg. Human sinking depth was measured because it has been shown to be linearly related to caribou sinking depth (Cichowski 1993).

At open sites, the recorder started at the stake and sampled in a pre-determined direction, taking snow depth and human sinking depth measurements every 2 or 3 paces until 10-30 pairs of measurements had been taken.

To compare human sinking depth measurements at different times of year and at various sites, relative sinking depth (RSD) was calculated for each monitoring of a site, using the formula:

$$RSD = \frac{\text{Mean human sinking depth}}{\text{Mean snow depth}} \times 100$$

Thus a low RSD indicates that the observer did not sink very far into the snow, and a high RSD indicates the observer sank through most of the snow that was there.

For the winter of 1998-1999, some of the snow station sites were changed to a new location due to difficulties in monitoring those sites the previous year. At Chezacut, CSS#1C (open) and CSS#1F (forested) were moved further up the Chezacut road as the side road they had been on was deactivated, making the sites inaccessible. Because the sites were moved unexpectedly, there were no stakes at the forest site, thus the observer usually took 30 sets of measurements instead of the usual 10. At Baezaeko, CSS#2C (open) was moved as the previous location required the snowmobiles to be loaded and unloaded twice in order to access all the sites, which meant that it took several hours to monitor all the sites.

In addition to the above data, historical data exists from open site CSS#1C at Satah Mountain from February 1996 to April 1997. This older data was combined with the 1997 to 1999 data to investigate long-term trends in snow depth and human sinking depth at this site. The entire data set was also used to determine whether a relationship existed between the CSS#1 data and data collected at a long-term snow station established at Puntzi Mountain by the Water Management section of the Ministry of Environment, Lands and Parks.

Snow Landscape Grid Survey

In the winter of 1998-1999, in addition to the regular monitoring of the snow stations, a snow transect survey was conducted by the Ministry of Forests across the winter range of the Itcha-Ilgachuz and Rainbow caribou herds. A grid of UTM coordinates spaced 10 km apart was defined across the winter range area. On February 24th and 25th, 1999, a helicopter was used to land in openings nearest to each of the pre-determined UTM coordinates. Openings typically had a minimum width of five tree lengths, and the helicopter always landed two tree lengths from the southern edge of any given opening. Ten snow depth measurements were taken (approximately one meter apart) in a transect usually toward the center of the opening from the point at which the helicopter landed. One human sinking depth measurement was also taken at each opening. In order to minimize time on the ground, the data was transmitted from the observer on the ground to the recorder in the helicopter via radio. The UTM coordinates of the actual location were recorded using the helicopter's onboard GPS unit. Using this methodology, 60 locations were measured in a two day period.

RESULTS AND DISCUSSION

Snow Stations

Data were collected from the four areas from early November 1997 until early May 1998 and from early December 1998 until early May 1999. Logistical problems including poor weather conditions, equipment failure and staff lacking the time to monitor, resulted in locations with missing or partial data collected in both years. For the winter of 1998-99, the Anahim Lake area has data from January to May, the Chezacut area from November to April, the Satah Mountain area from December to May, and the Baezaeko area from February to May. Data obtained from all the stations during both winters is summarized in Appendices A and B.

Snow depths increased from early winter (November-December) to mid-winter, and then began to decrease through March and April, until there was little or no snow observed on May 1 (Figures 2, 3, 6, 7). Human sinking depths followed a similar trend (Figures 4, 5, 8, 9). In the winter of 1998-99, mean snow depths at open sites in all four areas remained high until April 1, and then snow depths showed a large decline over the next month until May 1 (Figure 3). In the winter of 1997-98, however, snow depths more gradually declined from March 1 through April and May (Figure 2). A similar trend occurred in the forested sites in 1998-99 as compared to 1997-98.

The month of peak snow depth and human sinking depth varied with location and year, but was most often February 1 or March 1.

In the winter of 1998-99, mid-winter snow depths and human sinking depths were significantly greater at all open and forested sites than they had been at the same sites in the previous winter (Figures 3 and 7 versus Figures 2 and 6; Figures 5 and 9 versus Figures 4 and 8). In fact, in 1998-99, peak snow depths and human sinking depths at forested sites were greater than the peak measurements at the open sites in the previous winter.

An unusual decline in the snow depths occurred at Chezacut from February to March of 1998, when the snow depths were only 3.8 cm for open sites and 2.5 cm for forest sites (Figures 2 and 6). These low snow depths were only observed at Chezacut in 1998 (other sites on March 1, 1998 all had over 20 cm of snow), and only in that year (on March 1, 1999, all sites including Chezacut had over 50 cm of snow).

In comparing mean snow depths at different sites within a given year and type of station, there does not appear to be a trend that any one site has consistently lower or higher snow depths. For example, at open sites in 1997-98, it appeared that Anahim Lake and Satah Mountain had greater mean snow depths than Baezaeko over much of the winter (Figure 2). However, this trend did not continue in 1998-99 at the open sites, when it appears that Satah Mountain had lower snow depths than Anahim Lake and similar snow depths to the Baezaeko sites (Figure 3).

In comparing mean human sinking depths at different sites within a given year and type of station, trends are equally difficult to distinguish. In the forested sites, however, in both 1997-98 and at least February and April of 1998/99, mean human sinking depth at the Satah Mountain site was higher than that at the other sites (Figures 8 and 9).

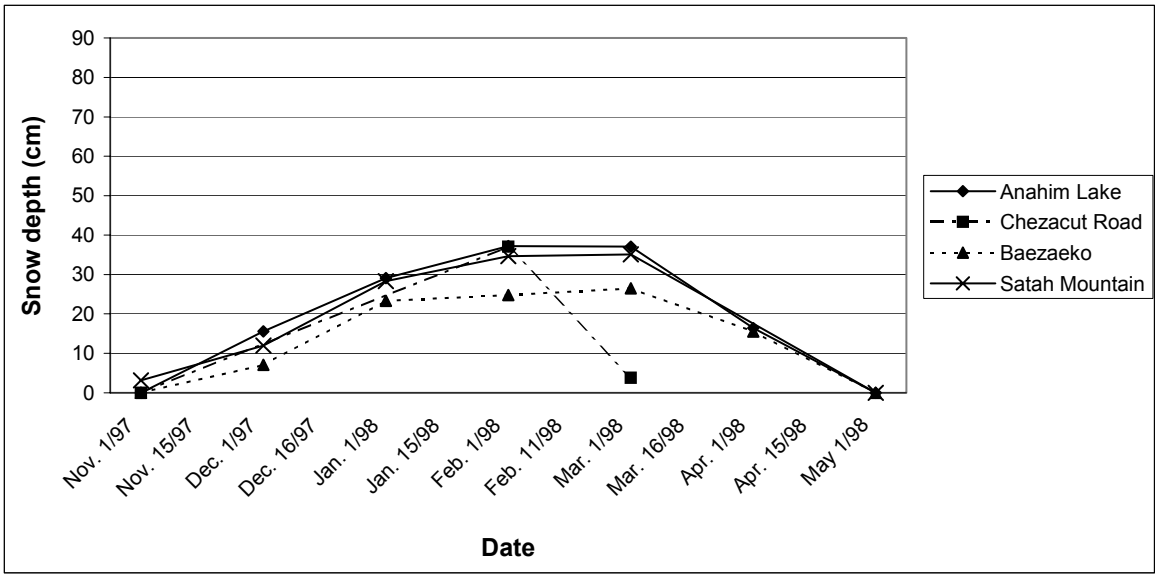

Figure 2. Mean snow depth from all open stations from November 1997 - May 1998.

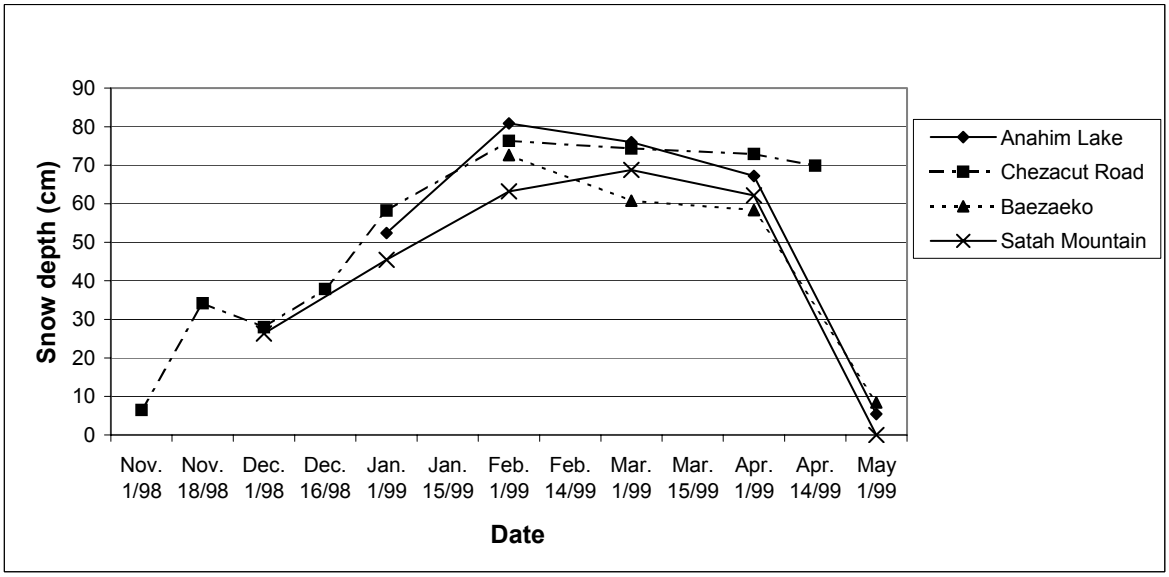

Figure 3. Mean snow depth from all open stations from November 1998 - May 1999. Note: on Nov. 4th/98, the snow depth at all sites at Satah Mountain was estimated to be approximately 10 cm, but this point is not shown on the above figure as the snow was not actually measured.

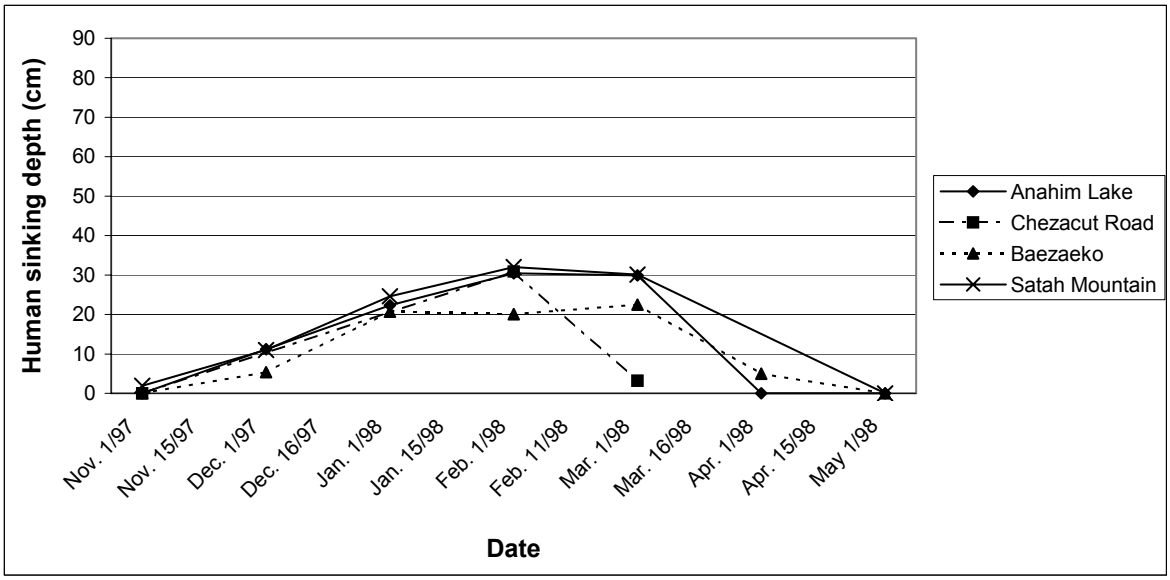

Figure 4. Mean human sinking depth from all open stations from November 1997 - May 1998.

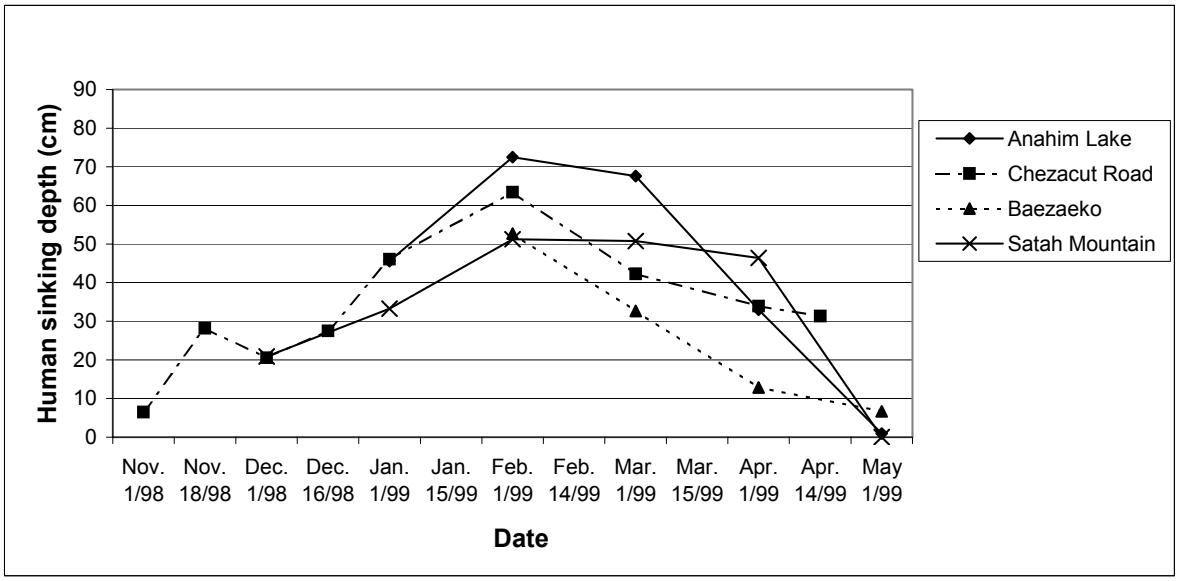

Figure 5. Mean human sinking depth from all open stations from November 1998 - May 1999.

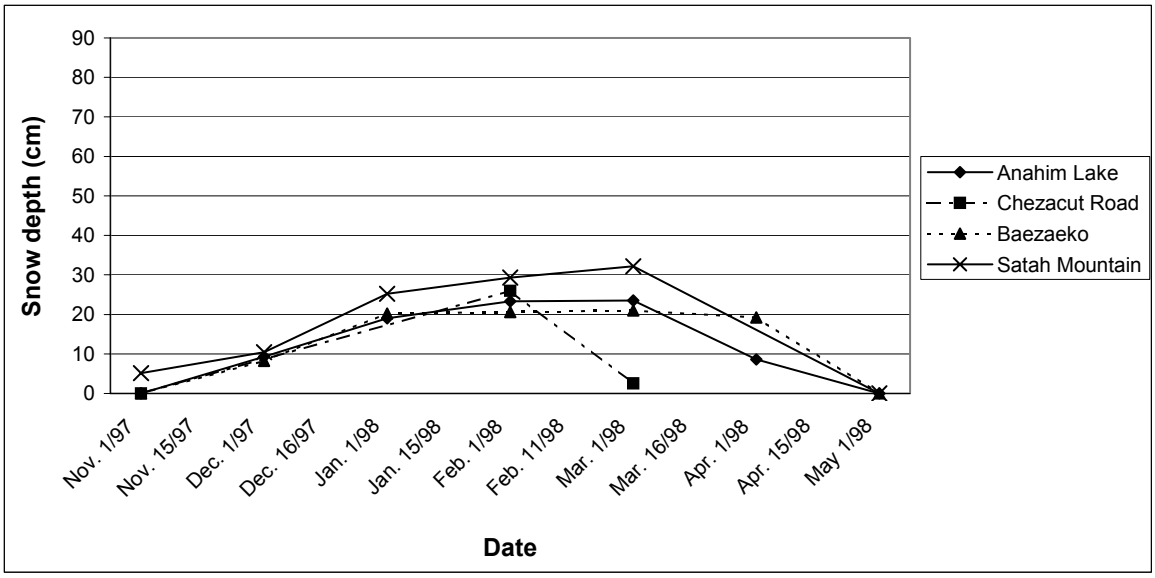

Figure 6. Mean snow depth from all forested sites from November 1997 - May 1998.

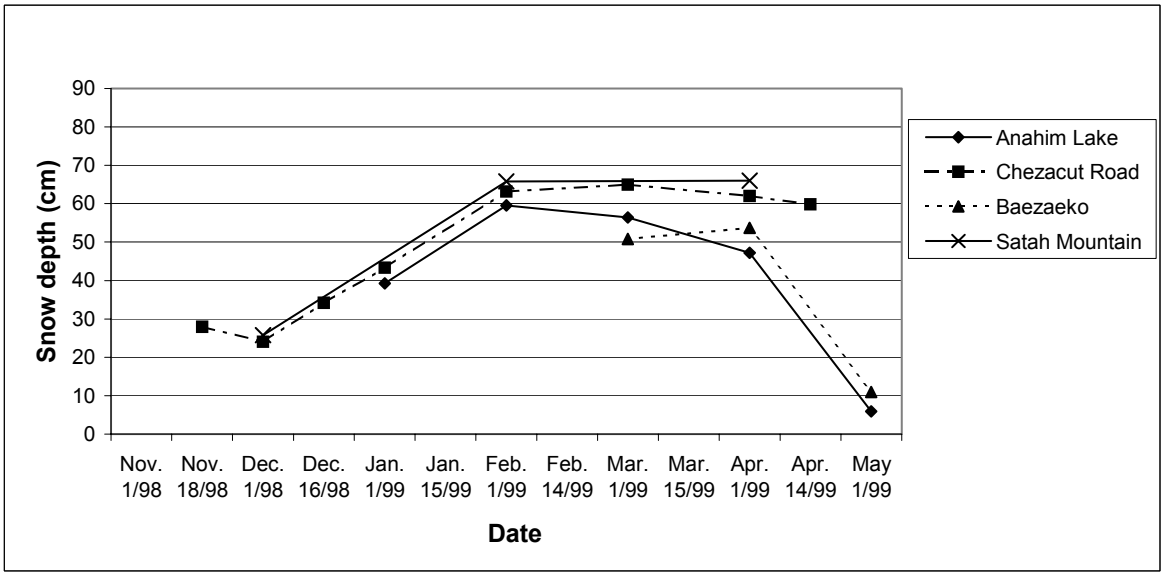

Figure 7. Mean snow depth from all forested sites from December 1998 - May 1999.

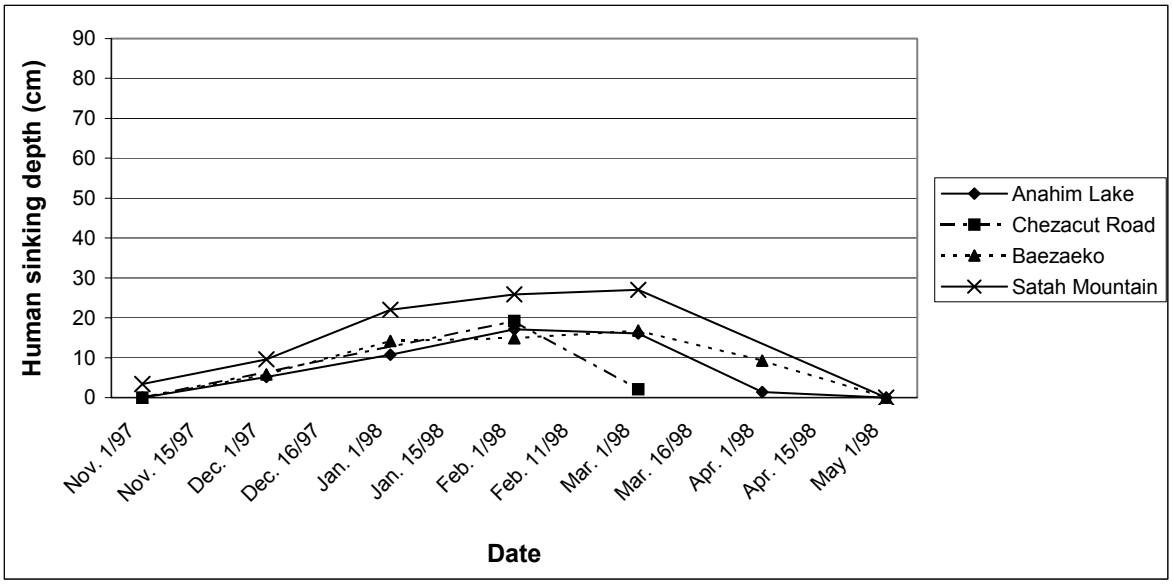

Figure 8. Mean human sinking depth from all forested sites from November 1997 - May 1998.

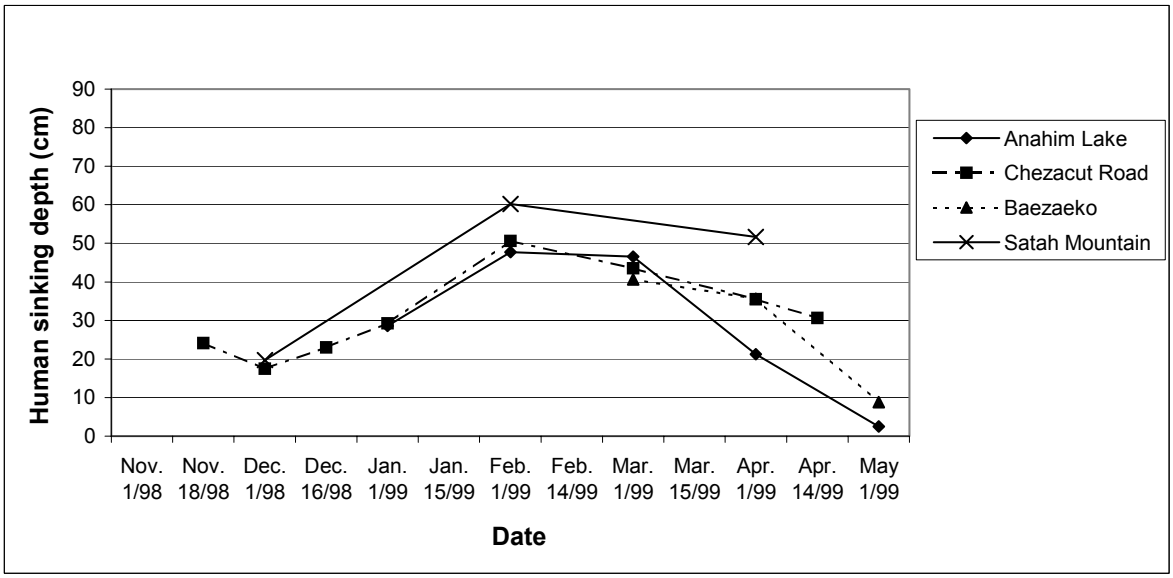

Figure 9. Mean human sinking depth from all forested sites from December 1998 - May 1999.

When mean snow depth was compared between forested and open sites that were at the same location, it was found that forested snow depth was linearly related to open snow depth ($y = 0.796x - 1.2168$, $R^2 = 0.9735$, Figure 10).

Low to moderate RSD (i.e. 50% RSD or less), indicating that the observer sank less through the snow, were observed in April 1998 at Anahim and Baezaeko open and forested sites (Figures 11 and 13). Low to moderate RSD were observed in April 1999 at Anahim open and forested sites, and Chezacut and Baezaeko open sites; and in May 1999 at Anahim open and forested sites (Figures 12 and 14).

To determine whether there was a difference in the degree of sinking in open versus forested sites, RSD was compared between pairs of open and forested sites at the same location. In the winter of 1997-98, where pairs of percentages differed by 10% or more, it was almost always the forested site that had a lower RSD than the open site, indicating that the observer sank less in the forest as compared to the open. However, at Baezaeko on April 1, 1998 the observer sank less in the open site than in the forested site. In the winter of 1998-99, pairs of percentages differing by 10% or more in January showed that the observer sank less in the forested site, but by February at some open sites then observer sank less than at the forested sites. From March 1, 1999 through the rest of that winter, usually open sites supported human weight to a greater degree than the forested sites, except for one pair of measurements at Anahim Lake on April 1,1999.

Historical data from CSS#1 at Satah Mountain illustrates that snow depths in the winter of 1997-98 were much lower than depths recorded in the winters of 1995-96, 1996-97, and 1998-99 (Figure 15). The historical data also shows that snow crusting patterns had varying effects on human sinking depth (Figure 16). For example, in the low

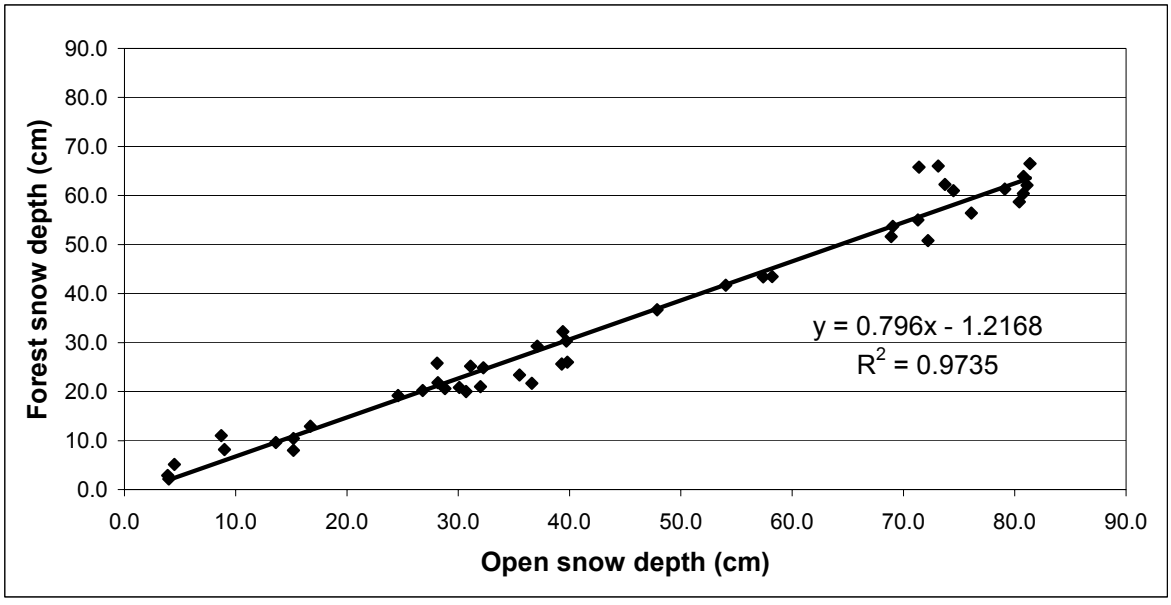

Figure 10. Relationship of forested to open site snow depths for paired stations at the same site – 1997/98 and 1998/99 combined.

snowfall winter of 1997-98, human sinking depths closely matched snow depths. However, in higher snowfall years, particularly from February to April 1996, human sinking depths showed remarkably different trends than snow depth.

Snow depth data from the Moore Creek area of Chezacut Road from the winters of 1986-87 and 1987-88 (Cichowski 1993) is comparable to snow depth data from Chezacut Road from this study. In the winter of 1986-87, snow depths from approximately mid-December to early April ranged from 50 to 80 cm in wetland sites and from 40 to 60 cm in mature forest sites. In the winter of 1987-88, snow depths were lower, ranging from 30 to 50 cm in wetland sites and from 20 to 40 cm in mature forest sites. Mean snow depths at open sites on Chezacut Road between mid-December 1997 and early April 1998 were lower than the snow depths at wetland sites in either 1986-87 or 1987-88, while mean snow depths from open sites on Chezacut Road between mid-December 1998 and early April 1999 were similar to the snow depths at wetland sites in the winter of 1986-87. Mean snow depths at forested sites on Chezacut Road between mid-December 1997 and early April 1998 were lower than the snow depths at mature forest sites in either 1986-87 or 1987-88, while mean snow depths from forested sites on Chezacut Road between mid-December 1998 and early April 1999 were similar to the snow depths at mature forest sites in the winter of 1986-87.

Data from CSS#1 at Satah Mountain was also used to determine whether a relationship existed between this site and the long-term Puntzi Mountain snow station established by the Water Management section. In Figure 17, Satah Mountain snow depths are compared to Puntzi Mountain snow depths. Satah Mountain depths are consistently greater than Puntzi Mountain depths, by about 38 cm, but the linear correlation is weak ($y = 0.9354x + 38.282$; $R^2=0.6159$). Satah Mountain snow depths are expected to be greater than those at Puntzi Mountain, as Puntzi Mountain is at 970 m above sea level while Satah Mountain is at 1380 m.

Snow Landscape Grid Survey

The results of the snow transect survey indicate that the greatest snow depth (greater than 85 cm deep) in the caribou winter range in late winter occurs throughout an area that starts west of Mt. Downton and Itcha Mtn. and proceeds south around these peaks, and then heads north-east over Downton Creek and Baldface Mtn. to Baezaeko Creek (Figure 18). A second area of peak snow depths occurs around Thunder Mtn. Adjacent to the bands of peak snow depth is a band of slightly lower snowfall (75 to 85 cm deep), which has a finger-like projection to the south to cover areas south of Satah Mtn. The Montane Spruce (MSxv) biogeoclimatic subzone has a deeper snowpack than the lower elevation Sub-Boreal Pine Spruce (SBPSxc) subzone.

Areas of lowest snow depth in late winter include the southern edge of the surveyed area, including Aktaklin Lake, Puntzi Creek, Chanstlar Lake and Luck Mtn.. These areas tend to be at lower elevations than the higher snowpack parts of the range. The area to the north-west of Itcha Mtn., including Itcha Lake, Tsetzi Creek and Shag Creek have dramatically lower snowpack. This is possibly the result of a double snow shadow effect caused by the coast range and the Itchas-Ilgachuz mountains.

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Figure 11. Mean relative sinking depth from all open stations from November 1997 – May 1998.

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Figure 12. Mean relative sinking depth from all open stations from November 1998 – May 1999.

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Figure 13. Mean relative sinking depth from all forested stations from November 1997 – May 1998.

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Figure 14. Mean relative sinking depth from all forested stations from November 1998 – May 1999.

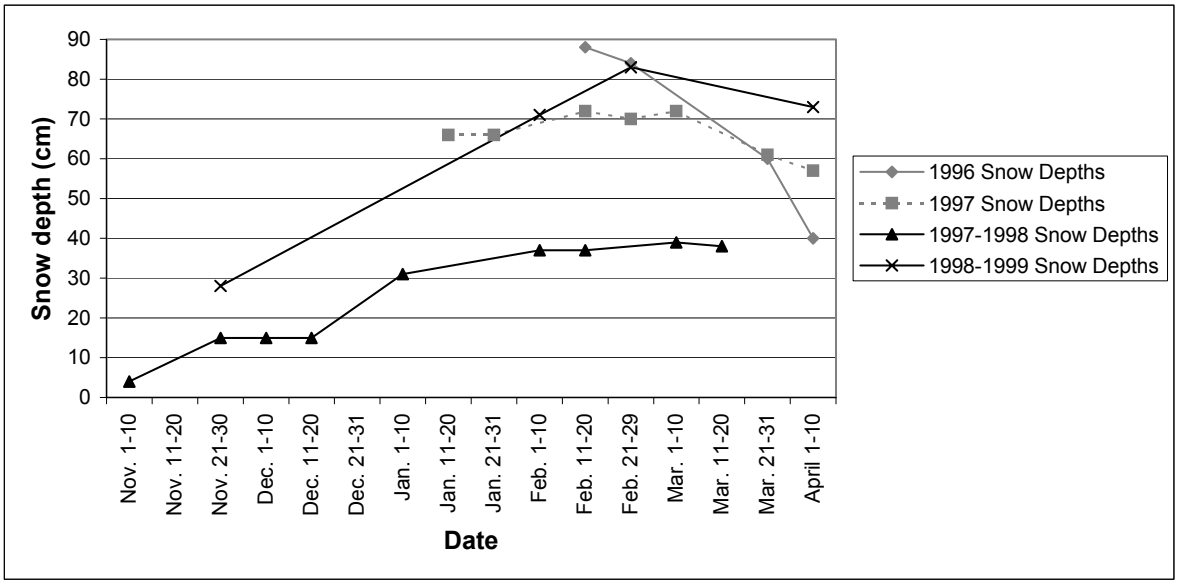

Figure 15. Snow depth results for open site CSS#1C at Satah Mountain.

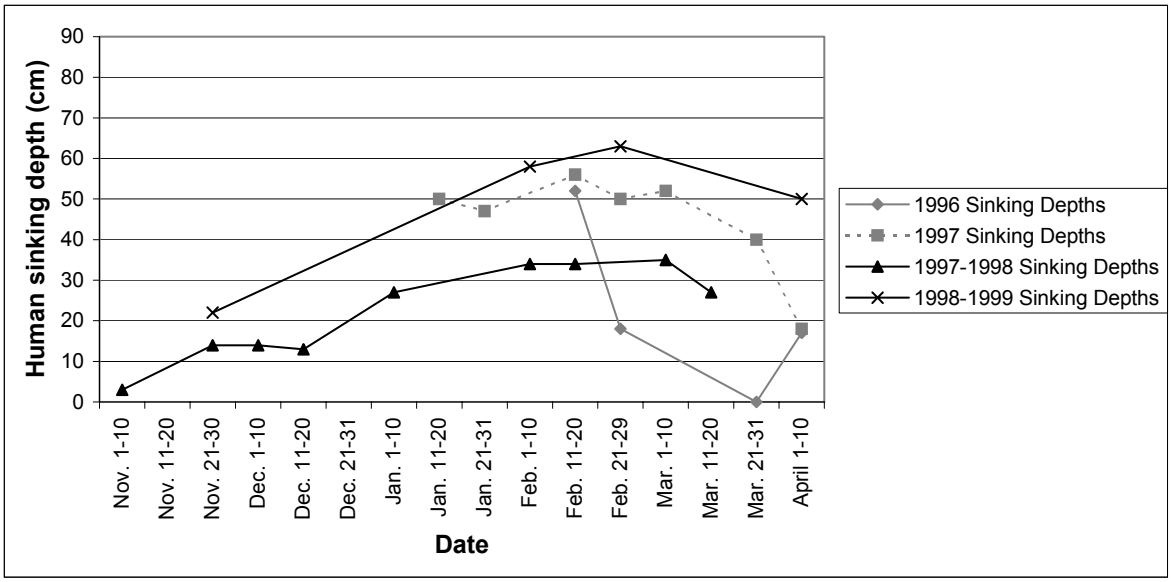

Figure 16. Human sinking depth results for open site CSS#1C at Satah Mountain.

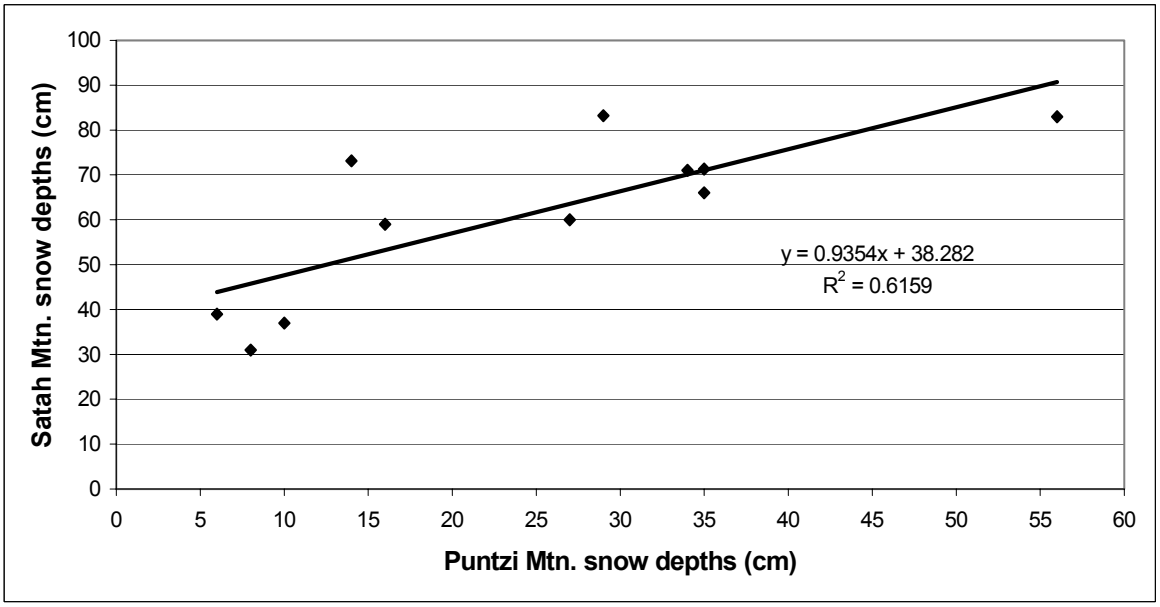

Figure 17. Relationship between Puntzi Mountain and Satah Mountain CSS#1C snow stations.

Data from the March 1 1999 measurements at open snow stations were compared to the snow landscape grid survey, to determine how well the data from specific snow

stations compared to the data represented in the snow landscape grid survey. Seven open stations occurred within the snow landscape grid survey area, and all 7 stations had data from March 1. Of these 7 stations, 5 stations had measurements that were within the 10 cm wide isocline shown on the landscape grid survey. One station had a mean snow depth measurement 1 cm greater than the isocline the station was in. One station, CSS#4C at Baezaeko, differed from the snow landscape grid isocline by over 27 cm with a snow depth measurement of 37.5 cm compared to the 65 to 75 cm isocline. This station may be in a very windswept area, and it is possible that snow depth data from this station is not representative of snow depths in other nearby openings.

Figure 18. Results of snow landscape grid survey Feb. 24-25th, 1999.

CONCLUSION

There is the potential for great variability in snow conditions across the caribou winter range, not only from year to year, but also from month to month and site to site. Snow crusting, gauged by human sinking depth and relative sinking depth, was not found to follow a consistent trend throughout a given year, likely due to site-specific weather patterns and canopy effects. Perhaps the variable which applied itself most consistently to all sites was the amount of snowfall. The second year of monitoring was a year in which significantly greater snowfall occurred, and this was evident at all sites in 1998-99.

These results highlight the need for long-term monitoring of these sites, so that enough data can be obtained to strengthen the conclusions of this report and to more positively identify trends that are occurring in both low and high snowfall years. The snow landscape grid survey, in particular, is worth repeating in future years as it gives a broader picture of snow depths across a greater area of the winter range.

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