CANIM NORTH MULE DEER WINTER RANGE

2001/2002 WINTER TRACK TRANSECTS

INTERIM REPORT

Prepared for: Weldwood of Canada Ltd. 100 Mile House Operations

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EXECUTIVE SUMMARY

Mule deer (*Odocoileus hemionus*) are a regionally important species in the Cariboo Forest Region. During winter, deer require habitats that reduce their rate of energy loss. Deep snow increases the cost of travel dramatically for deer. Past research in the Cariboo Forest Region has focused on the Interior Douglas Fir Biogeoclimatic Zone (IDF). Characteristics of good winter range in the IDF include south facing slopes, stands of old-growth forests Douglas-fir, and variable topography. These habitats generally have shallower snow and more available forage. Management plans are required for mule deer winter ranges to ensure that deer populations are sustained while providing for resource extraction. Integrating the needs of mule deer with the forest industry depends on an understanding of the habitats required during winter. Research on the winter diet, habitats and movements of mule deer in the Canim North Mule Deer Winter Range is essential in developing management plans for winter ranges.

This study used winter track transects to measure relative habitat use and found a shift in the use of habitat variables with increasing snow depth. Greater than 75% of all observations were on warm aspects with moderate or moderately steep slopes. Deer showed a preference for warm aspects/moderately steep habitats and this tendency was amplified as snow depth increased. Most deer tracks were found in stands dominated by Douglas-fir. However, this use was concentrated in stands with 60-79% Douglas-fir. Deer use of this habitat was greater than expected and increased with greater snow depth. Stands with greater than 79% Douglas-fir were used less than expected. Greater cover in Douglas-fir is generally associated with increasing snow interception and litterfall. This relationship between the proportion of Douglas-fir and these attributes is also likely to be related to the size and age of the trees present. We found that stands with low numbers of tall Douglas-fir (1-19 trees/ha) were used significantly more than stands with greater densities of tall Douglas-fir. There was no significant relationship between deer use and crown closure at moderate to deep snow depths. The greatest deer use was found in habitats with 36-55% crown closure. This may be due to the greater light penetration and levels of forage in more open stands.

Deer are likely to choose habitats that give them the greatest overall benefit. Warm, steeper aspects have shallower snow, but are also likely to be well drained and contain lower densities of trees. Douglas-fir does well in this type of topography/aspect and older stands will contain larger trees that provide good snow interception and litterfall. The crown closure is also likely to be lower in this habitat which allows for increased light penetration to the forest floor. Greater levels of solar radiation yields shallower snow and can often result in more forage. The benefits of using habitats containing suitable combinations of features will increase with greater snow depth.

These results are based on one years data and must be considered preliminary. Data must be conducted over a period of years before any meaningful trends or conclusions can be made. By collecting information over a number of years, an understanding of the range of snow conditions and habitat use patterns may be determined so that effective management plans can be developed for this winter range.

1.0 INTRODUCTION

Mule deer (*Odocoileus hemionus*) are a regionally important species in the Cariboo Forest Region that often migrate long distances between summer and winter ranges (Schoan and Kirchoff, 1985). During winter, deer require habitats that reduce their rate of energy loss (Rose, 1982; Schoan and Kirchoff, 1985). This is especially critical in areas that receive greater precipitation. Deep snow increases the cost of travel dramatically for deer (Parker et al. 1984). In the central interior of British Columbia, characteristics of good winter range include south facing slopes, stands of old-growth Douglas-fir, and moderate to high crown closure (Armleder et al. 1994). These winter ranges are also valuable to the forest industry. Therefore, developing management plans for mule deer winter ranges is important to ensure that deer populations are sustained while providing for resource extraction (Regional Mule Deer Winter Range Strategy Committee, 1996). An effective process for management planning has been developed and is being implemented for many winter ranges in the Cariboo Forest Region (Mule Deer Winter Range Strategy Committee 1999).

Integrating the needs of mule deer with the forest industry depends on an understanding of the habitat use patterns in the context of local climatic conditions. Research on the winter diet, habitats and movements of mule deer in the Cariboo Forest Region is essential in developing management plans for winter ranges (Armleder et al. 1994). This type of work must be conducted over a period of years before any meaningful trend data or concrete answers can obtained. In order to collect data during a range of snow conditions (– i.e. depths, type of snow, duration of snow/winter etc.), it may take several years, given that some winters may be fairly similar.

Long Term Objectives

1. To determine important habitat attributes of mule deer in wet-belt winter ranges. Extensive information has been collected in the past for drier winter ranges but not for the Interior Cedar Hemlock (ICH) Biogeoclimatic Zone winter ranges. Changes in track density will be examined with respect to elevation, and stand structure map categories. The objective over several years is to statistically compare differences in track density between the various habitat attributes and snow conditions represented in this area.
2. Use of habitats (i.e. track density) will be examined under a range of snow depths and conditions (and over time) to determine how habitat use changes under various snow depths and winter conditions.
3. To determine the winter diet of mule deer wintering in this winter range.

Acknowledgements

Funding for this project has been provided by Forest Renewal British Columbia and administered by Weldwood of Canada, 100 Mile House Operations.

2.0 STUDY AREA

The study is in the Canim Lake North Mule Deer Winter Range. This winter range is located along the north shore of Canim Lake at its east end, approximately 50km east of Lac La Hache, British Columbia (51°53'N 120°40'W). This area is part of the Cariboo Plateau ecosection and is located in the 100 Mile Forest District. Typical elevations range from 700 to1100 m, and south to west aspects are predominate. Most of the winter range is on moderate and moderately-steep terrain above 800 m. Below 800 m, the winter range graduates to flat alluvial fans with the shores of Canim Lake and Canim River forming the southern boundary of the winter range.

The winter range is transitional between the Thomson variant of the moist, warm Interior Douglas-fir biogeoclimatic subzone (IDFmw2) and the dry, cool Interior Cedar Hemlock (ICHdk) subzone (Meidinger and Pojar 1991). It is typical of wet winter ranges in the central interior of British Columbia. Approximately two thirds, the driest part of the range, is dominated by uneven-aged Douglas-fir (*Pseudotsuga menziesii*). The remaining portion has a component of Douglas fir, however it is not the leading species. Other tree species present include lodgepole pine (*Pinus contorta*) and western redcedar (*Thuja plicata*).

The shrub layer is sparse (<10% ground cover) and consists mostly of thimbleberry (*Rubus parviflorus*) and Oregon grape (*Mahonia aquifolium*). The abundant herb layer is dominated by falsebox (*Paxistima myrsinites*), bunchberry (*Cornus canadensis*), queen's cup (*Clintonia uniflora*), and red-stemmed feather moss (*Pleurozium schreberi*).

Current land uses includes forestry, recreation, and some agriculture. The area has a history of logging with clearcuts of various ages in the upper elevations of the winter range. A fringe of recreational properties is found along Canim Lake.

3.0 SUMMARY OF EXISTING INFORMATION

Winter ranges are vital habitats for Mule deer in the Cariboo Forest Region. During winter, deer experience a negative energy balance due to excess energy expenditures for locomotion and decreased nutritional value in forage (Swift et al. 1980; Torbit et al. 1985). Access to good quality winter range may minimize energy loss for deer by providing a variety of desirable features including: lower snow depths, valuable food sources, security from predators, and thermal cover (Jones 1975; Rose 1982; Kirchoff and Schoen 1987). Winter ranges become even more important as environmental conditions become extreme, as in the central interior of British Columbia (Cowan and Guiguet 1978)

In the Cariboo forest region, 250,000 hectares have been identified as mule deer winter range. Most research in this Forest Region has focused on the Interior Douglas-Fir (IDF) biogeoclimatic zone where the majority of the deer winter ranges are located. Some research has been conducted in higher precipitation areas (Sub-Boreal Spruce and Sub-Boreal Pine Spruce biogeoclimatic zones) but little has been conducted in the wettest winter ranges in the region (ICH). These wet winter ranges are located near the northern most limit of the continuous high density distribution of mule deer (BC Wildlife Branch,

1990) and can experience deep snow depths, even at the lowest elevations. Several important winter ranges are located in the ICH and information is required to develop effective management plans for these areas.

Stand structure mapping for mule deer winter range management planning has been completed for this winter range (as defined by the Cariboo Region Mule Deer Committee). The mapping project divided the area into polygons based on the following set of habitat variables: crown closure, number of tall Douglas-fir, percentage Douglas-fir in the overstorey, and slope/aspect. Tall Douglas-fir are trees ≥40cm diameter at breast height. The photo interpreter used appropriate height/diameter curves to obtain a height for tall Douglas-fir and used this parameter to count the number of trees/ha. These descriptors were used to characterize and compare the habitats used by mule deer during winter.

Past studies have found that during winter, under deeper snow conditions, deer move to south facing aspects, exposed ridges and lower elevations where the snow depths are shallower (Gilbert et al. 1970). Snow depth is of critical importance to deer as it has been found to increase energy output dramatically (Parker et al 1984) and is also a major factor limiting ground forage. It is the intent of this study to examine the relationship between snow depth and a host of habitat variables, and their impact on deer usage in an ICH mule deer winter range.

4.0 METHODS

Four transect lines were established on the Canim Mule Deer Winter Range in 1999. The transects cover a range of habitat types and elevations. Each transect was marked on the ground by ribboning, and tagging a tree with two wraps of pink ribbon, and labeled metal tags. Each transect was also divided into 50m segments, using two wraps of pink ribbon and metal tags. The distance from the beginning of the transect was marked on the metal tags at the start of each segment. A total of 9.4 km of transect was established for Weldwood of Canada Ltd, 100 Mile Operations (Figure 1-Map).

Data collection

Track transects were sampled 2-4 days after a significant snowfall (> 6cm in the open) to ensure that only recent tracks were tallied and so that the number of hours of track accumulation was known. During this period, we required atmospheric conditions that maintained snow quality for tracking. Thus, track transects would not be conducted if a snow, rain, or melt occurred during this time since tracks would become obscured under these conditions. With the exception of the first sample period, all transects were surveyed in a single day after a significant snowfall. The first sampling period occurred over two days instead of one (December 4th and 5th, 2001), because of the extra amount of data required to be collected on the first day of sampling. This information included the universal transverse mercator (UTM) coordinates for the start and end point of each segment, microfeatures that may affect the density of tracks (i.e. gullies), segment slope,

Figure 1. Map of North Canim Mule Deer Winter Range track transects.

and segment aspect. This information is only required to be collected once over the term of this project.

Fresh deer tracks crossing the transect were tallied by segment. Tracks crossing the transect had to deviate by more than 1 m perpendicular to the transect before they could be tallied again. Rarely, deer were seen to use the packed snowshoe trail for short distances (i.e. 2m). Forage activities of mule deer and plant species were noted when encountered. The presence of predator tracks (cougar and wolves) was also recorded.

Snow conditions on the transects were recorded during each survey. At the start of each segment, the snow depth was recorded to the nearest centimeter at a point ± 5m from the tag. Snow conditions were documented for each segment. The snowshoe sinking depth was recorded by measuring the depth below surface of an imprint left by a snowshoe. This variable was not collected during the first sampling period due to the shallow depth of the snow. The presence of any surface and/or intermediate crusts was also recorded. Where an intermediate crust was present, the depth below the surface was noted. Crusts were categorized as follows: strong if it was judged able to support the weight of a coyote, moderate if a crust exists but is not strong, or none.

Open area snow conditions were monitored at two locations in the winter range. Two open, flat areas that covered the range of elevations represented in the transect lines were selected. Initially, we searched for areas that were greater than 100m by 75m in dimension. One low elevation site that met these criteria was located on an old air strip near transect 4. However, a high elevation area of these dimensions could not be found due to the topography and age of the stands in the area. Instead, the high elevation site was located on a 50m by 50m landing in a 15 year old clear-cut. At each open area site, a total of 20 measurements (10 per opening) of open snow depths were recorded by measuring depths at 10m intervals for a total of 10 measurments at both selected openings. The snow conditions were measured once in each opening using the same methods as used at 50m tags. This data should be recorded each time a survey is conducted, in the same openings, and in such a way that previous data collection will not affect the current snow measurements (i.e. move transect to avoid previous snowshoe line).

Fecal pellets were collected from the study area over the course of the track surveys and sent to Washington State University for winter diet analysis. During each survey, three pellets were collected from each of three groups along every transect line to comprise a composite sample of 36 pellets. Composite samples were dried and shipped for analysis at the end of the sampling season.

Analysis

Track transects were laid out to cover a range of elevations and polygon types. Thus, each polygon had its own set of descriptors that could be related to the number of tracks found in that polygon. For all transects, the elevation of each 50 m tag was determined and segments were placed into stand structure polygons. Where a segment crossed more than one polygon, it was placed in the category where the majority lay. Snow depths were placed into one of four classes: shallow (0-25 cm), moderate (26-40 cm), deep (40-59 cm) or very deep (>60 cm). The mean snow depth and snow conditions for the transects and the two open sites were summarized by survey date. Mapped slope and aspect categories were compared to information collected on the transects. No large differences were found between mapping and field results.

The number of tracks per segment was standardized to tracks per 50m segment per week (tracks/50m/week) to account for differences between the time of snowfall and when the survey were completed. The mean number of tracks/50m/week were calculated for each of the following attributes: slope, aspect, crown closure, density of tall Douglas-fir, percentage Douglas-fir, percentage other species, elevation, and snow depth and conditions. Since snow depths varied over the sampling season, the mean of each attributes was calculated by sampling date. However, care must be taken when comparing the number of tracks between the different levels of an attribute. The values do not take into account the proportion of each habitat that was sampled. Consequently, a trend of greater use of higher levels of an attribute may be explained by greater sampling effort in those levels rather than selection.

A use-availability analysis was calculated for the four stand structure variables (slope/aspect, crown closure, density of tall Douglas-fir, and percentage of Douglas-fir) based on all surveys completed. Because individual segments on a transect are connected, the mean number of tracks/50m/week for a habitat category on a survey date constitutes one independent observation. Thus, using all survey dates and transects yields a maximum of 16 independent observations for this analysis. All habitat categories that yielded a significant (α=.05) chi-squared result in the use availability analysis had Bonferroni confidence intervals calculated on the proportion of mule deer tracks encountered by habitat type (Byers and Steinhorst, 1984).

Snow depth has been shown to affect mule deer use of habitats (Armleder et al. 1994). Since the snow depth changed over the four survey dates in 2001/2002, mule deer habitat selection would also be expected to change. Therefore, the use-availability analysis was conducted on two subsets of the data. One analysis examined all survey dates grouped together while the second examined use only during the last three survey dates. Whereas the first analysis tests habitat selection over snow conditions that range from shallow to deep, the second analysis tests selection when snow depths were moderate to deep.

5.0 RESULTS

In the winter of 2001/2002 there were four days with snow conditions that were conducive to conducting track transects. The survey dates were December 4-5, 2001, January 23, 2002, February 4, 2002, and March 2, 2002. A total of 631 sets of mule deer tracks (1437 sets when standardized to one week) were counted in the 752 segments sampled. The number of deer tracks per survey decreased with increasing snow depth, and the only predator tracks found were from coyote. Snow depths ranged from shallow (<25cm) to very deep (>60cm) and the snow type was predominantly powder over subsurface crust.

Open snow depths increased over the four sampling days. Over the season, open snow depths at the high elevation site ranged between 18-73cm while open snow depths were between 8-54cm at the low elevation site (Table 1). Snow depths within the forested transects ranged from 6-60 cm over the 4 survey dates and also increased in depth during the season, but much less dramatically than in the open sites (Figure 2). Using the average of the open snow depths, snow conditions were categorized as shallow on December 25, 2001, moderate on January 23, 2002, deep on February 4, 2002, and deep on March 2, 2002. The average open area snow depth on the last survey date was on the threshold of the deep snow category (59.75cm).

Due to the significant changes in snow depth over the season, summary statistics have been calculated on the variables by sampling period. The mean number of tracks/50m/week decreased with increasing snow depth both within individual sample periods and when all sample periods are combined (Figure 3). It is important to note that snow depths are taken at the beginning of each segment and not where the actual tracks are found. The recorded snow depth is an estimate of the average snow depth in the segment; however, the snow depth where the deer crossed the transect is likely to differ from this value. The number of tracks by crust type showed marked differences on only one sample day (Figure 4). On December 4-5, 2001, more than double the number of tracks were found on segments where there was a strong surface crust. Most of the deer tracks on this day were found on transect 3 which largely had a strong crust (Figure 5). The depth of intermediate crust ranged from 2-46cm below the snows surface. Where an intermediate crust layer was present, all tracks were found in snow conditions where the crust was less than 26cm below the surface of the snow (Figure 6). There was no difference in deer use when segments with no subsurface crust were compared to segments containing a subsurface crust. The number of tracks recorded for different snowshoe sinking depth categories also shows no clear trend (Figure 7).

The average number of deer tracks by survey date is variable when compared to the proportion of Douglas-fir in the overstorey (Figure 8). However, the 60-79% class had consistently high use through all survey dates, and the first survey (December 4-5, 2001) had almost double the number of tracks in the 1-19% class as seen in the other classes. The number of tall Douglas-fir trees/ha category had greater use in less dense classes (Figure 9). The 1-19 trees/ha category had the greatest use by deer on three out of the four surveys.

For crown closure, the number of tracks in the lowest category decreased with each sampling period and with increasing snow depth (Figure 10). In sample period one (shallow snow period), the 1-15% crown closure class has the greatest number of tracks. The number of tracks in this class then decreases until none are found in sample period four (deep snow period).

Deer use of slope classes (as determined by habitat mapping) was also variable when examined by survey date (Figure 11). There is also no clear trend when viewed over the winter season. In contrast, deer made greater use of warmer aspects in three out of four

Table 1. Comparison of snow depths between open sites at high (990m) and low (770m) elevations. Shallow snow depth, 0-25 cm; moderate snow depth , 26-40 cm; deep snow depth, 41-59 cm; very deep snow depth, >59 cm.

Date	Low elevation	High elevation	Average
12/5/2001			
average snow depth (cm)	10.9 (shallow)	18.1 (shallow)	14.5 (shallow)
minimum snow depth (cm	8.0 (shallow)	15.0 (shallow)	
maximum snow depth (cm)	14.0 (shallow)	21.0 (shallow)	
1/23/2002			
average snow depth (cm)	35.5 (moderate)	40.8 (deep)	38.15 (moderate)
minimum snow depth (cm	33.0 (moderate)	35.0 (moderate)	
maximum snow depth (cm)	39.0 (moderate)	45.0 (deep)	
2/4/2002			
average snow depth (cm)	37 (moderate)	49.8 (deep)	43.4 (deep)
minimum snow depth (cm	32.0 (moderate)	46.0 (deep)	
maximum snow depth (cm)	42.0 (deep)	52.0 (deep)	
3/2/2002			
average snow depth (cm)	51.3 (deep)	68.2 (very deep)	59.75 (very deep)
minimum snow depth (cm	50.0 (deep)	65.0 (very deep)	
maximum snow depth (cm)	54.0 (deep)	73.0 (very deep)	

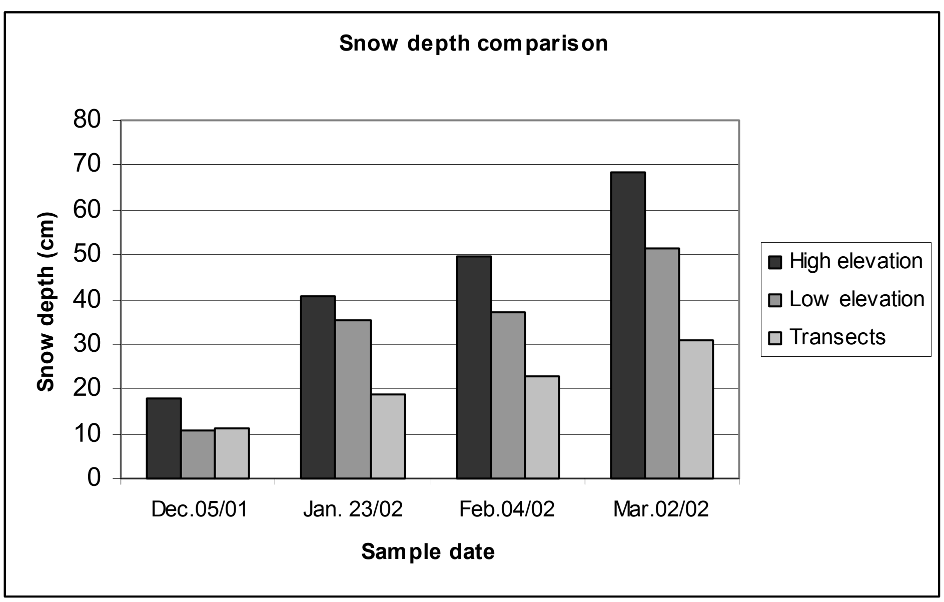


Figure 2. Plot of the average snow depth measurements recorded at open area sites at low elevation (770m) and high elevation (990m), and along the forested transect lines (780-1045m), as a function of the sample dates.

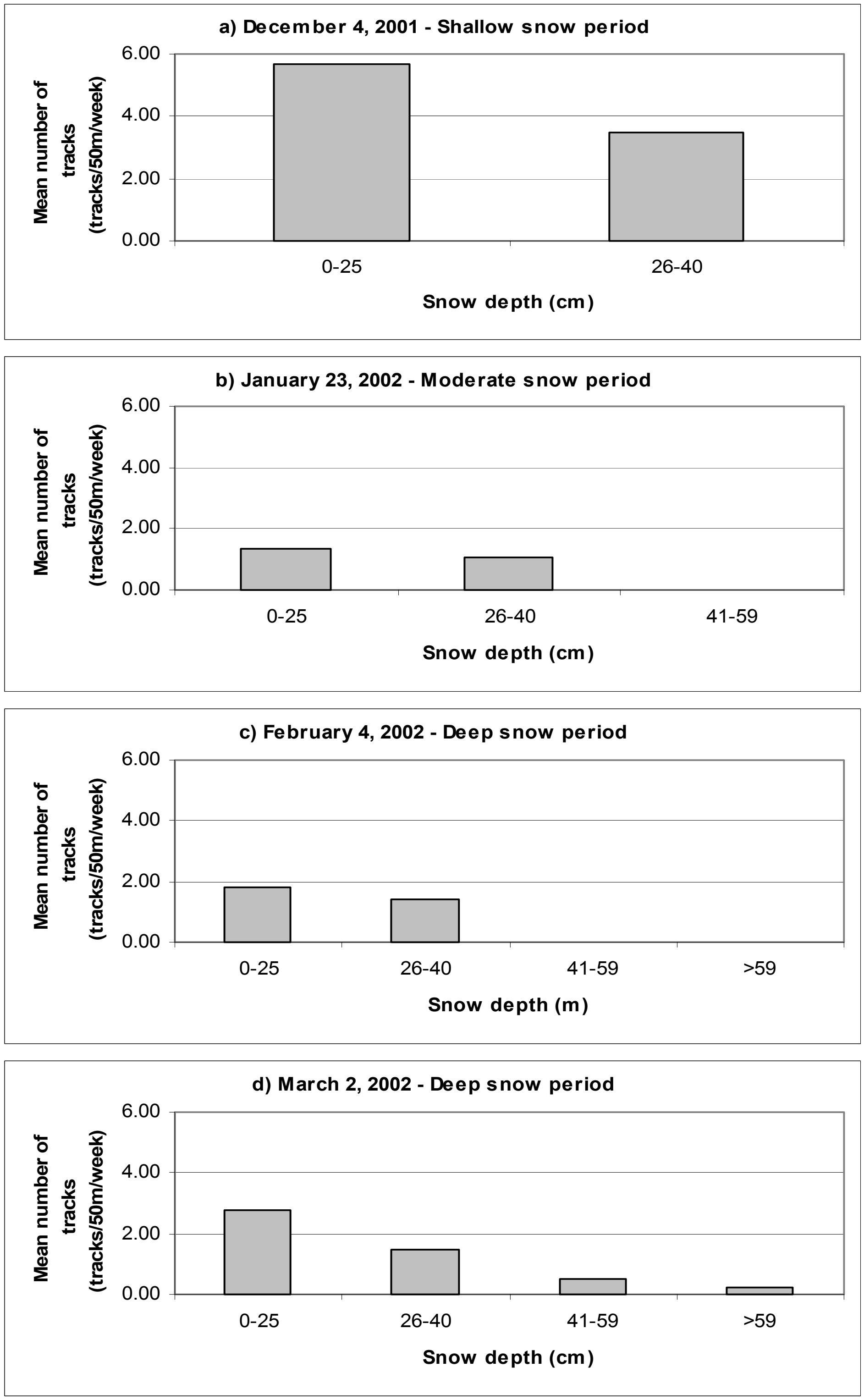


Figure 3. Mean number of mule deer tracks/50m/week by survey date versus snow depth. Snow periods are an average of open area sites at low and high elevations.

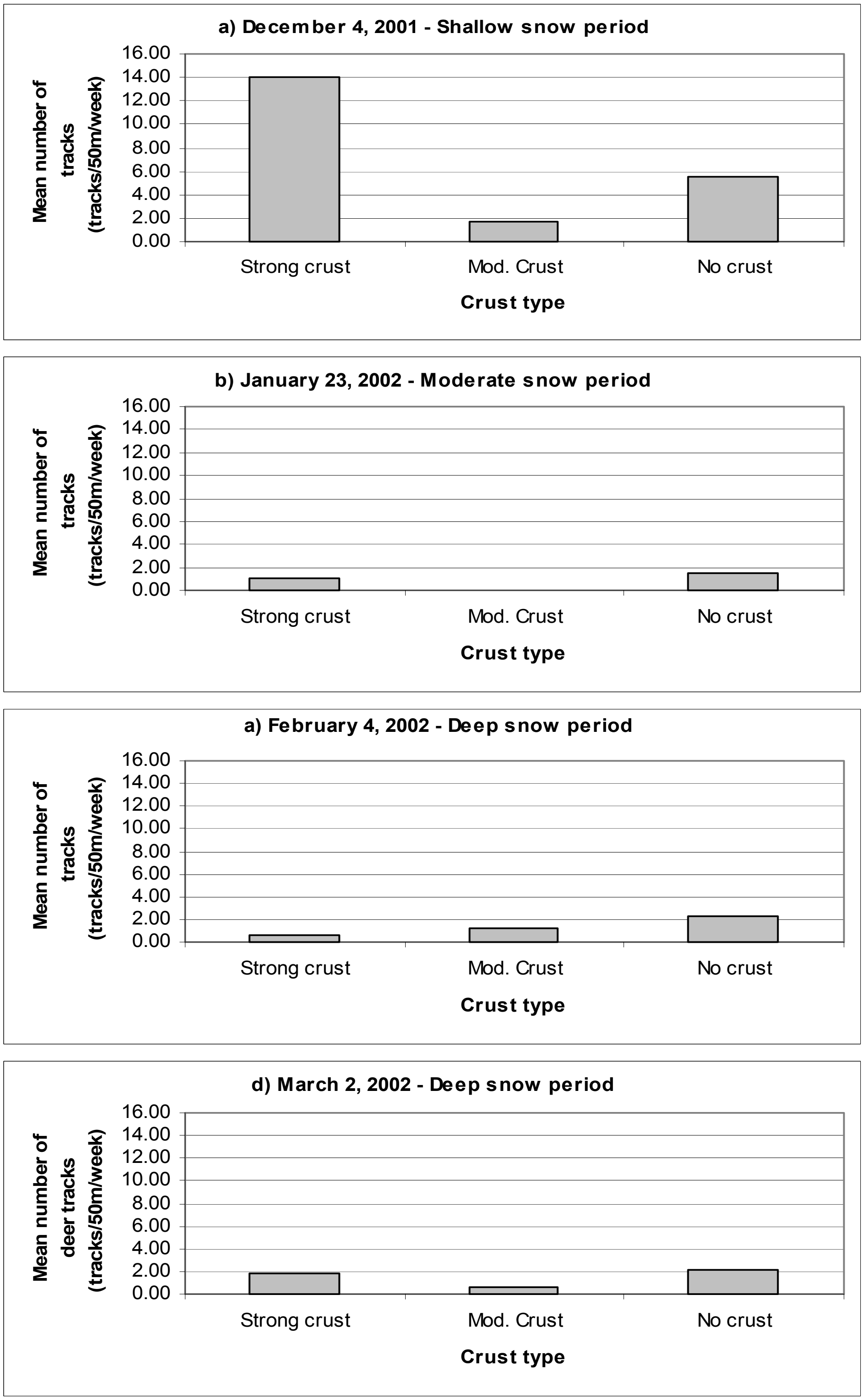


Figure 4. Mean number of mule deer tracks/50m/week by survey date versus crust type. Snow depths are an average of open area sites at low and high elevations.

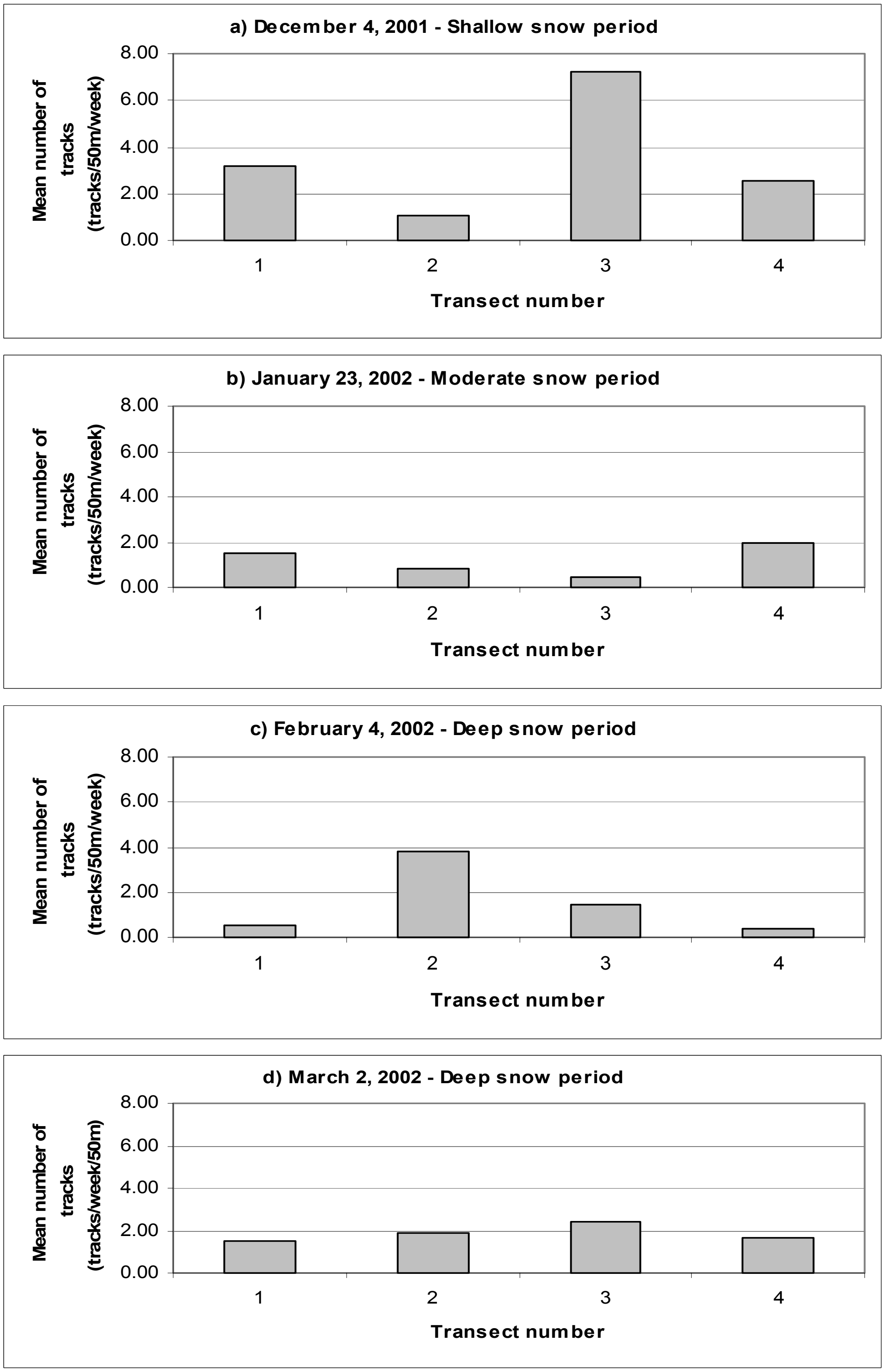


Figure 5. Mean number of mule deer tracks/50m/week by survey date versus transect. Snow depths are an average of open area sites at low and high elevations.

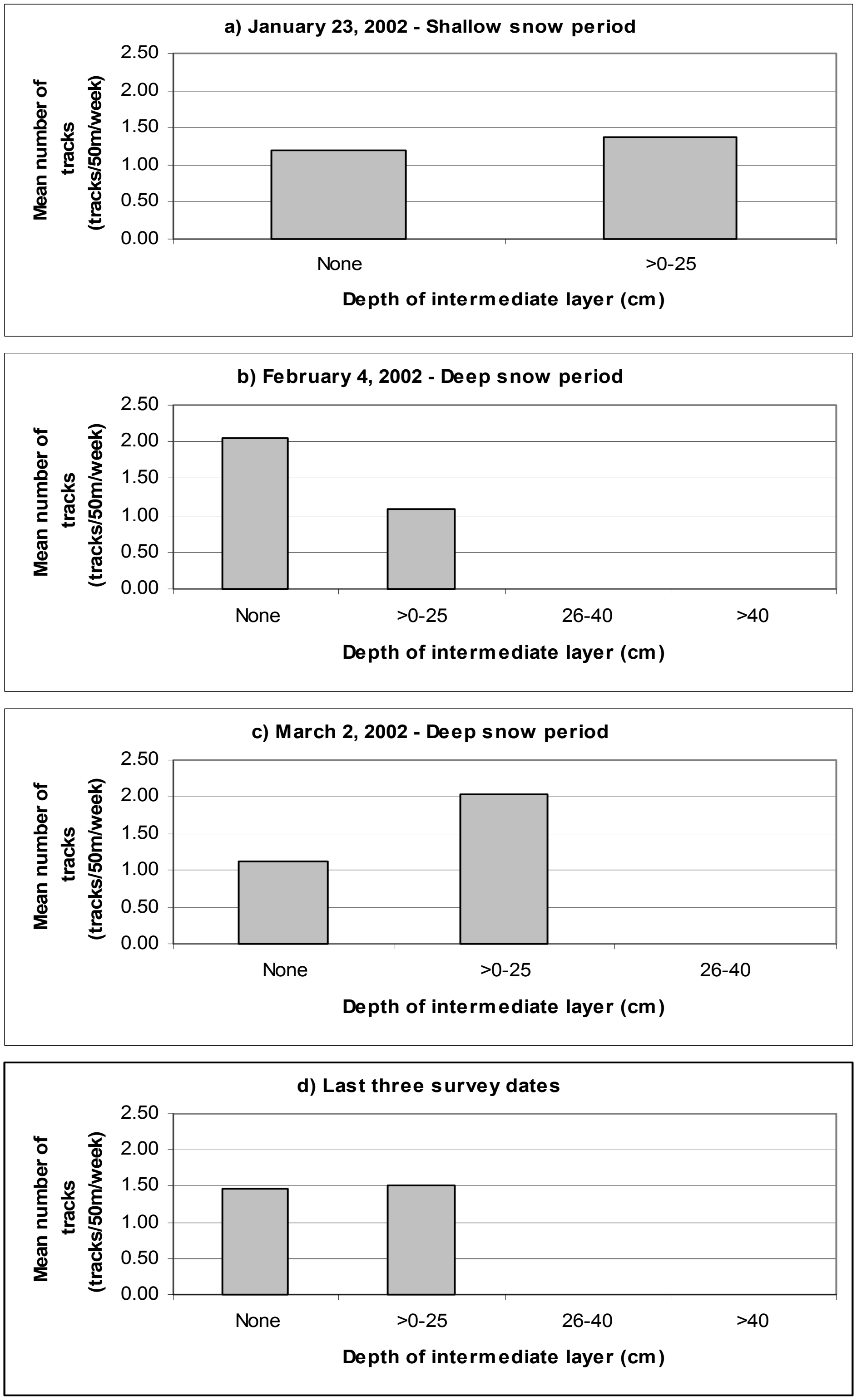


Figure 6. Mean number of mule deer tracks/50m/week by survey date versus the depth to an intermediate layer. No intermediate layers were found on December 4-5, 2001. Snow depths are an average of open area sites at low and high elevations.

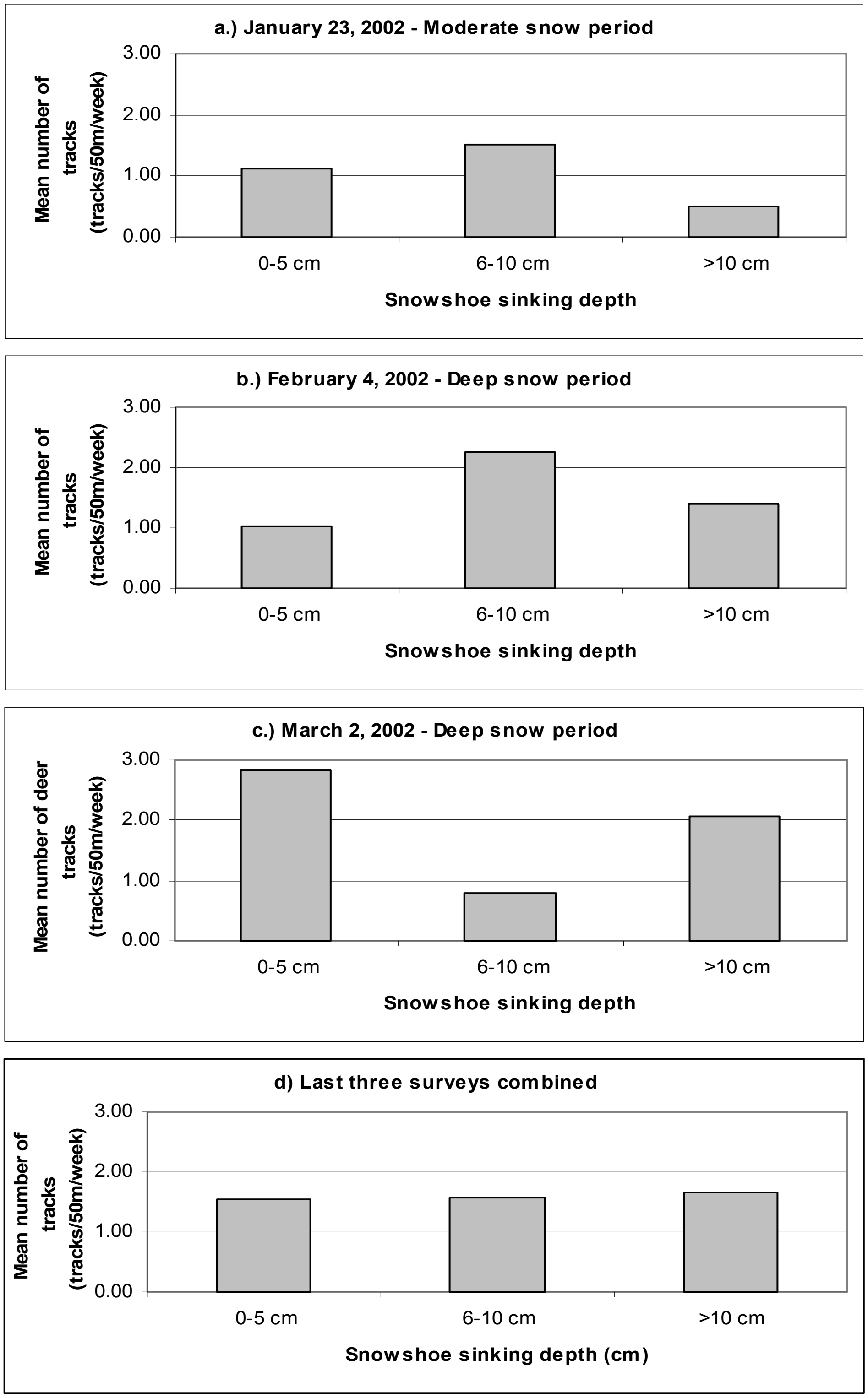


Figure 7. Mean number of mule deer tracks/50m/week by survey date versus snowshoe sinking depth. No snowshoe sinking depth was recorded on December 4, 2001 due to shallow snow conditions. Snow depths are an average of open area sites at low and high elevations.

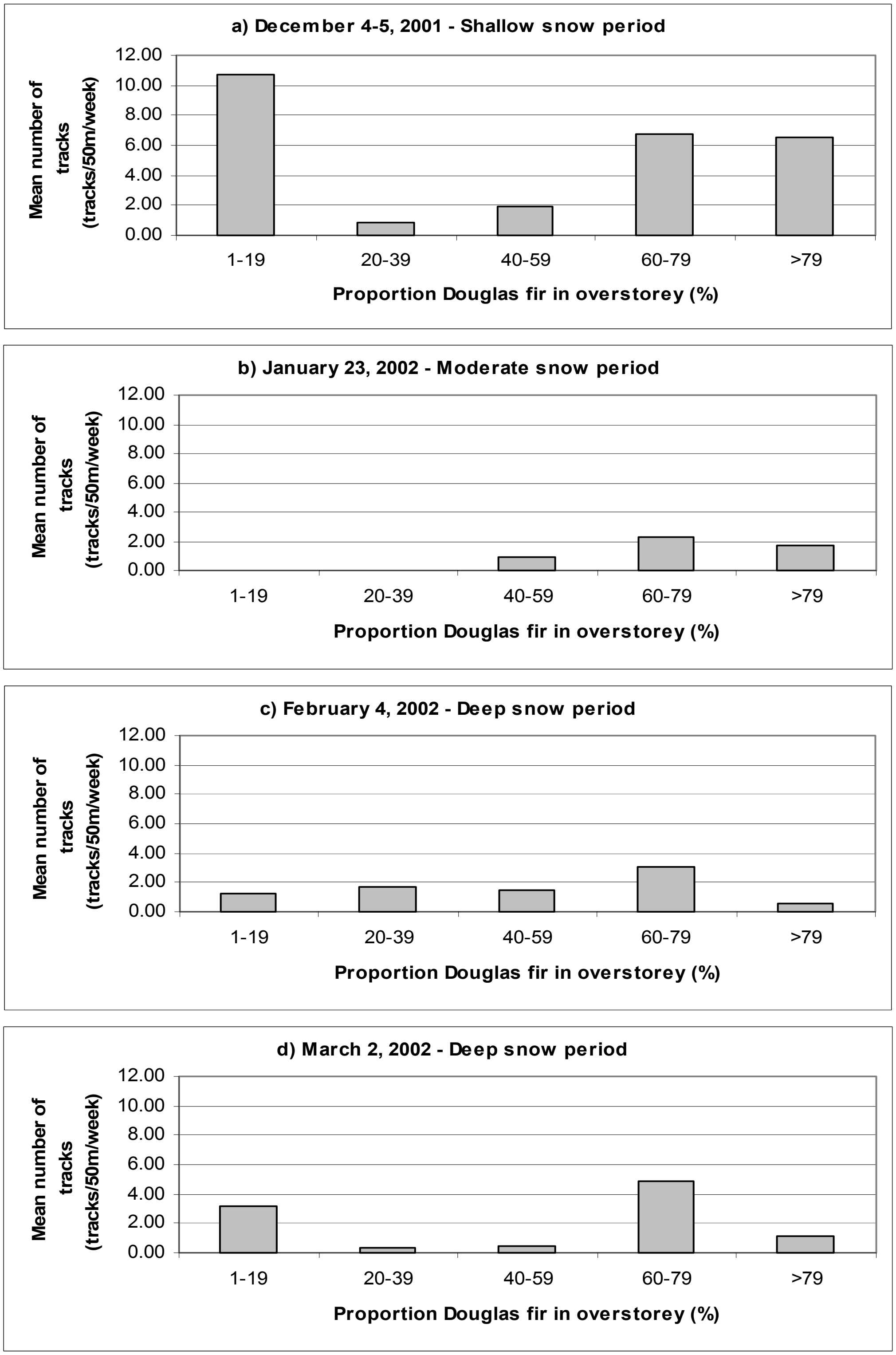


Figure 8. Mean number of mule deer tracks/50m/week by survey date versus the proportion of Douglas fir in the overstorey. The mean snow depth (average snow depths of open area sites at low and high elevations) on March 2, 2002 was 16cm deeper than February 4, 2002 and bordered the very deep snow depth range.

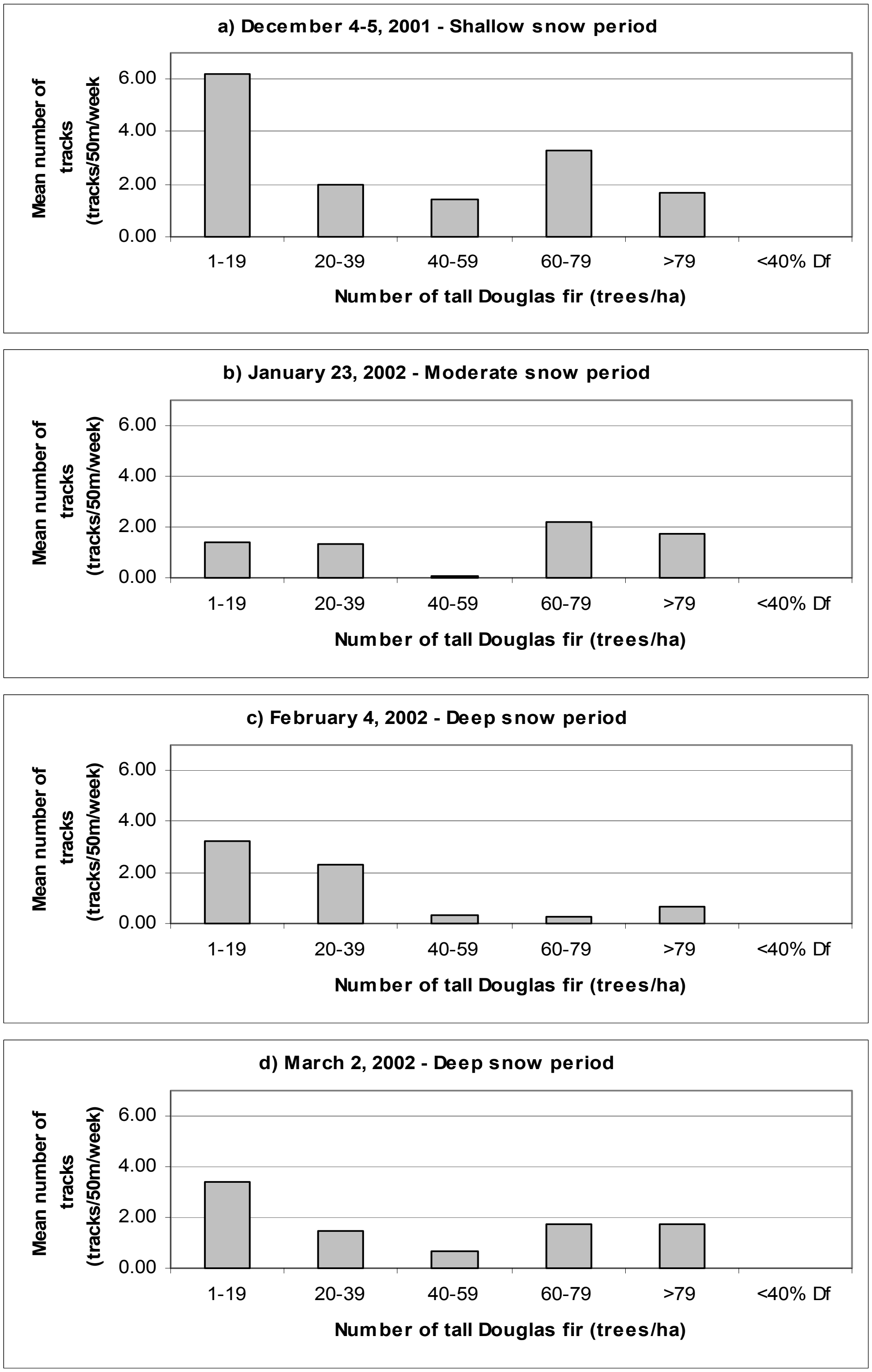


Figure 9. Mean number of mule deer tracks/50m/week by survey date versus the number of tall Douglas fir/ha. The mean snow depth (average snow depths of open area sites at low and high elevations) on March 2, 2002 was 16cm deeper than February 4, 2002 and bordered the very deep snow depth range.

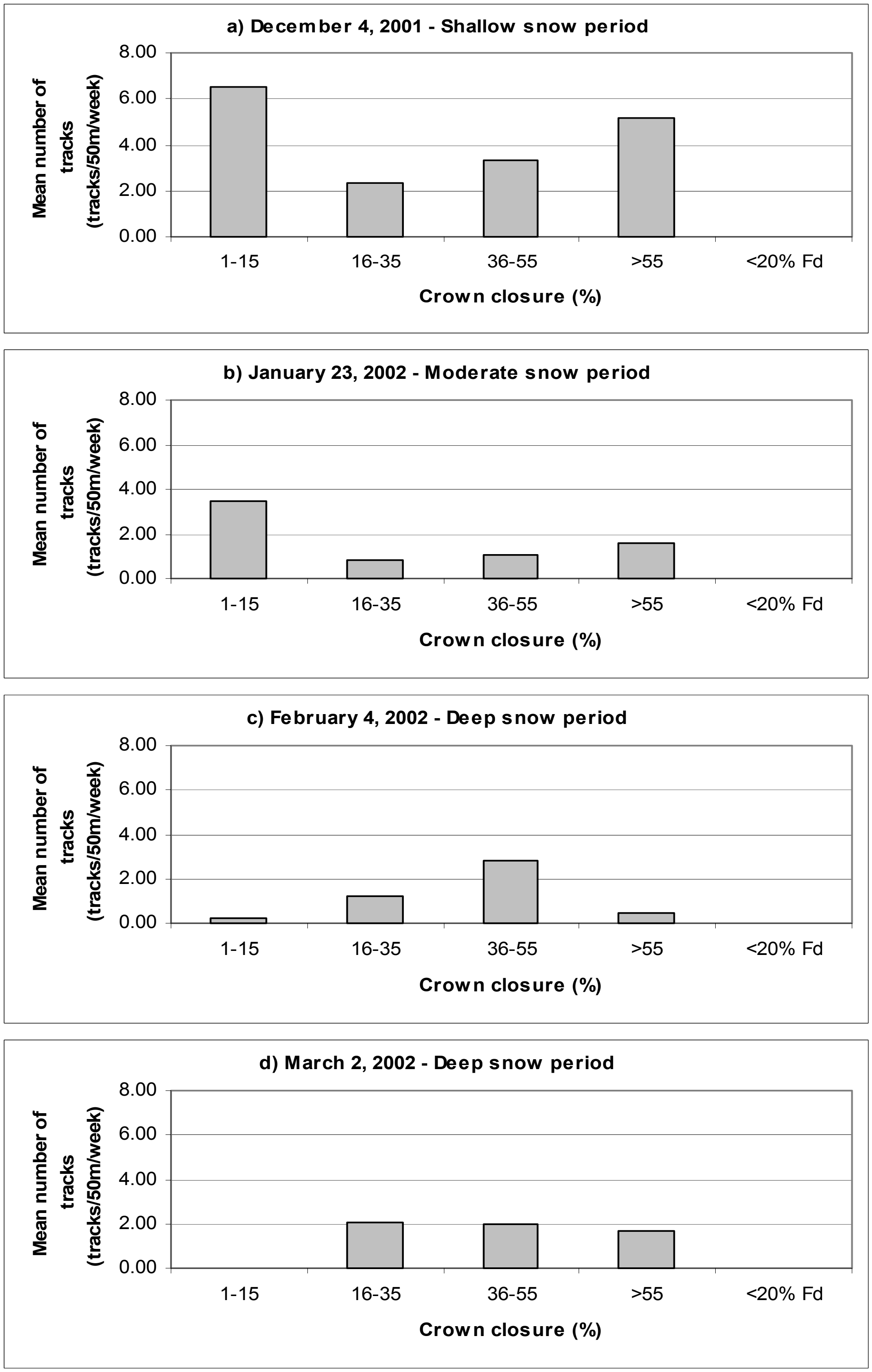


Figure 10. Mean number of mule deer tracks/50m/week by survey date versus crown closure. Snow depths are an average of open area sites at low and high elevations.

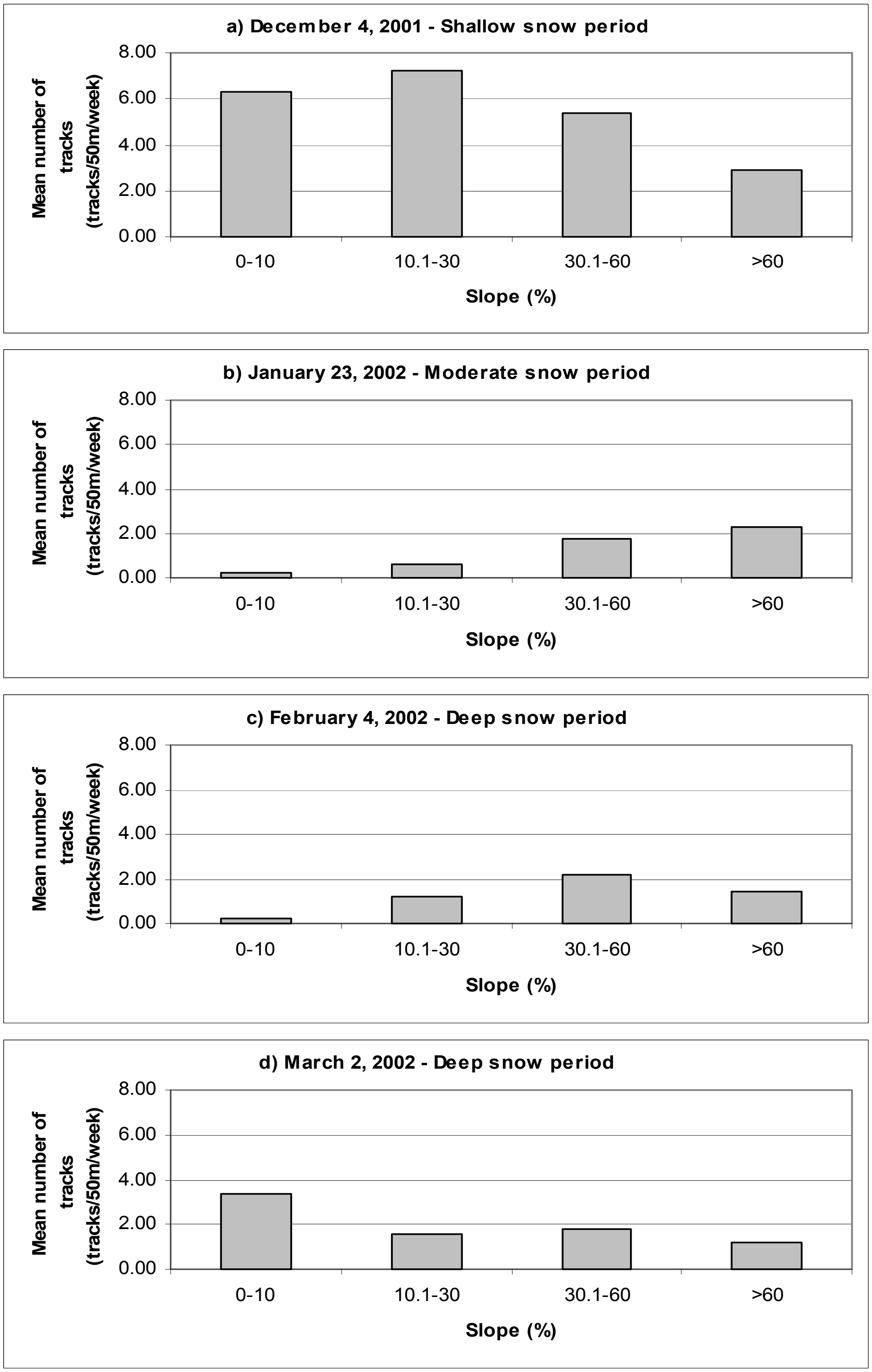


Figure 11. Mean number of mule deer tracks/50m/week by survey date versus slope. Snow depths are an average of open area sites at low and high elevations. Gentle slope, 0-10%; moderate slope, 10.1-30%; moderate-steep slope, 30.1-60%; steep slope, >60%.

surveys (Figure 12). When aspect and slope categories are combined, warmer/steeper areas are used more often than cooler/gentler areas on all survey dates (Figure 13). Elevation did not appear to influence deer use when examined by survey date or over the whole season (Figure 14).

Use-availability analysis of the proportion of Douglas-fir in the overstorey was significant when all surveys are combined and when only the last three surveys are used (Figure 15). When data from all survey dates was averaged, deer use of fir stands was significantly greater than its availability in stands composed of 20-39% fir and 60-79% fir. Stands composed of 40-59% and >79% fir, were used significantly less than their habitat availability. Under deeper snow conditions (last three survey dates), deer use of stands comprised of 60-79% fir was significantly greater than expected, while stands composed of 40-59% and >79% fir were used less than their habitat availability. Close to 48% of all tracks were found in the 60-79% category.

With all survey dates included, deer use of stands comprised of 1-19 tall Douglas-fir trees/ha was significantly greater than expected (Figure 16). All stands with more than 19 tall Douglas-fir/ha were used less than expected; however, the difference was only significant in stands with 60-79 trees/ha. A similar trend was seen during deeper snow conditions with deer use significantly greater in the 1-19 Douglas-fir/hectare class and a trend of less deer use than expected in stands with higher concentrations of tall Douglas-fir trees. However, deer used stands with 40-59 Douglas-fir/ha significantly less than expected instead of the 60-79 trees/ha class.

For crown closure categories, deer use was greater than expected in all stands with <56% crown closure when all survey dates included (Figure 17). However, this was only significant in stands with 1-15% crown closure. Stands with >55% crown closure were used significantly less than expected. Under deeper snow conditions, the same trend was found with use higher than expected in areas of <55% crown closures and almost 45% of deer use observed in stands with 36-55 % crown closure. However, the lower deer use of stands with >55% crown closure was not significant in this analysis.

When all surveys are combined, deer use of aspect/slope categories was significantly greater than expected in warm/moderate-steep habitats (Figure 18). Use was significantly less than expected in both cool aspect/moderate slope and moderate aspect/moderate slope habitats. Deer did not use segments with no aspect. However, there are only four segments in this class. Under deeper snow conditions, deer use of aspect/slope classes followed the same trend as when all the survey dates were analyzed. Deer use of aspect/slope categories was significantly higher than availability in habitats with warm aspect/moderate-steep slopes. Use was significantly lower than expected in habitats with cool aspects/moderate slopes and moderate aspects/moderate slopes. Overall, greater than 75% of deer use was found on warm aspects when analyzed with only deeper snow periods or with all dates combined.

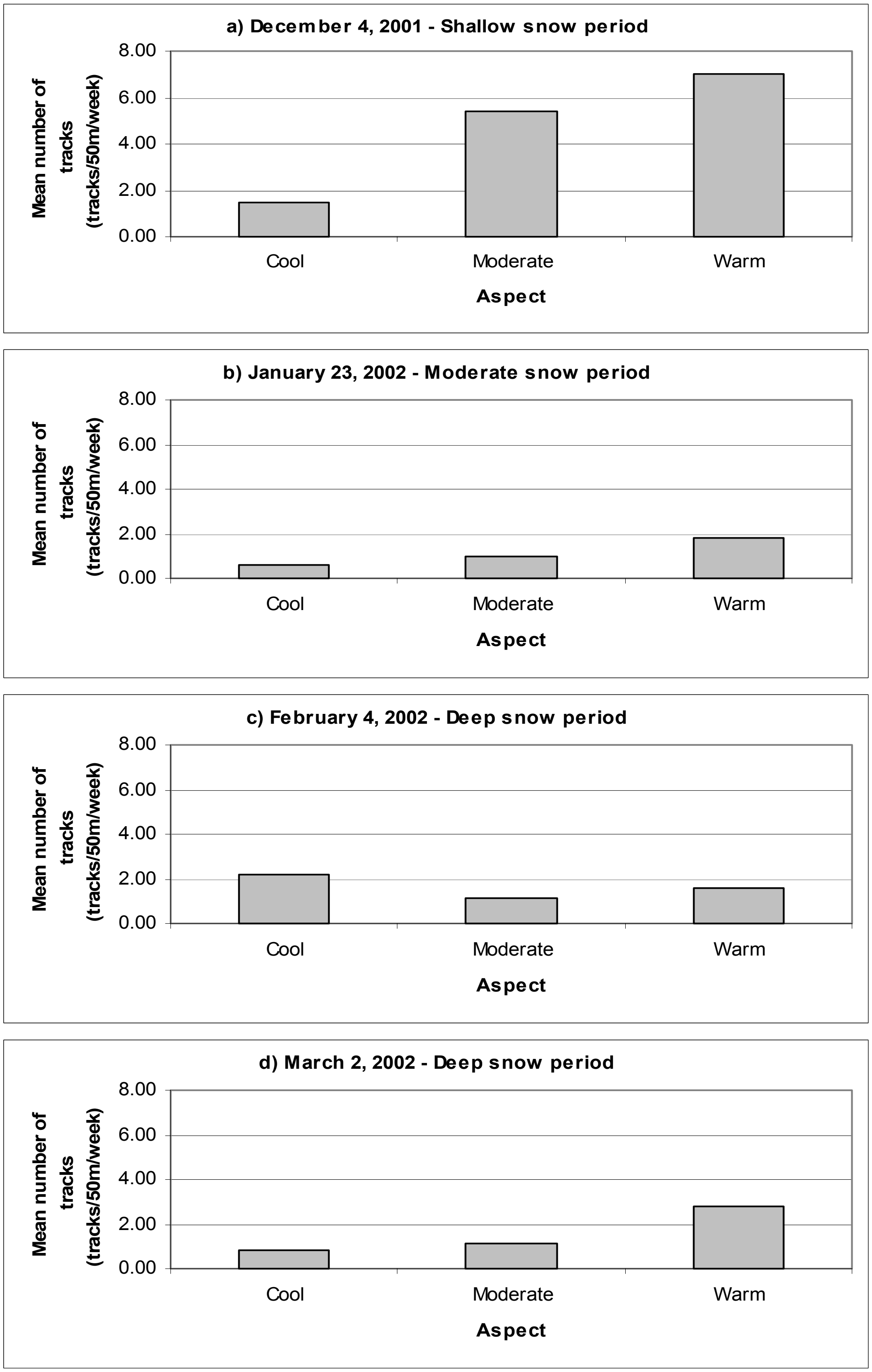


Figure 12. Mean number of mule deer tracks/50m/week by survey date versus aspect category. Snow depths are an average of open area sites at low and high elevations. Cool aspect, 315.1-90˚; moderate aspect, 270.1-315˚ and 90.1-135˚; warm aspect, 135.1-270˚.

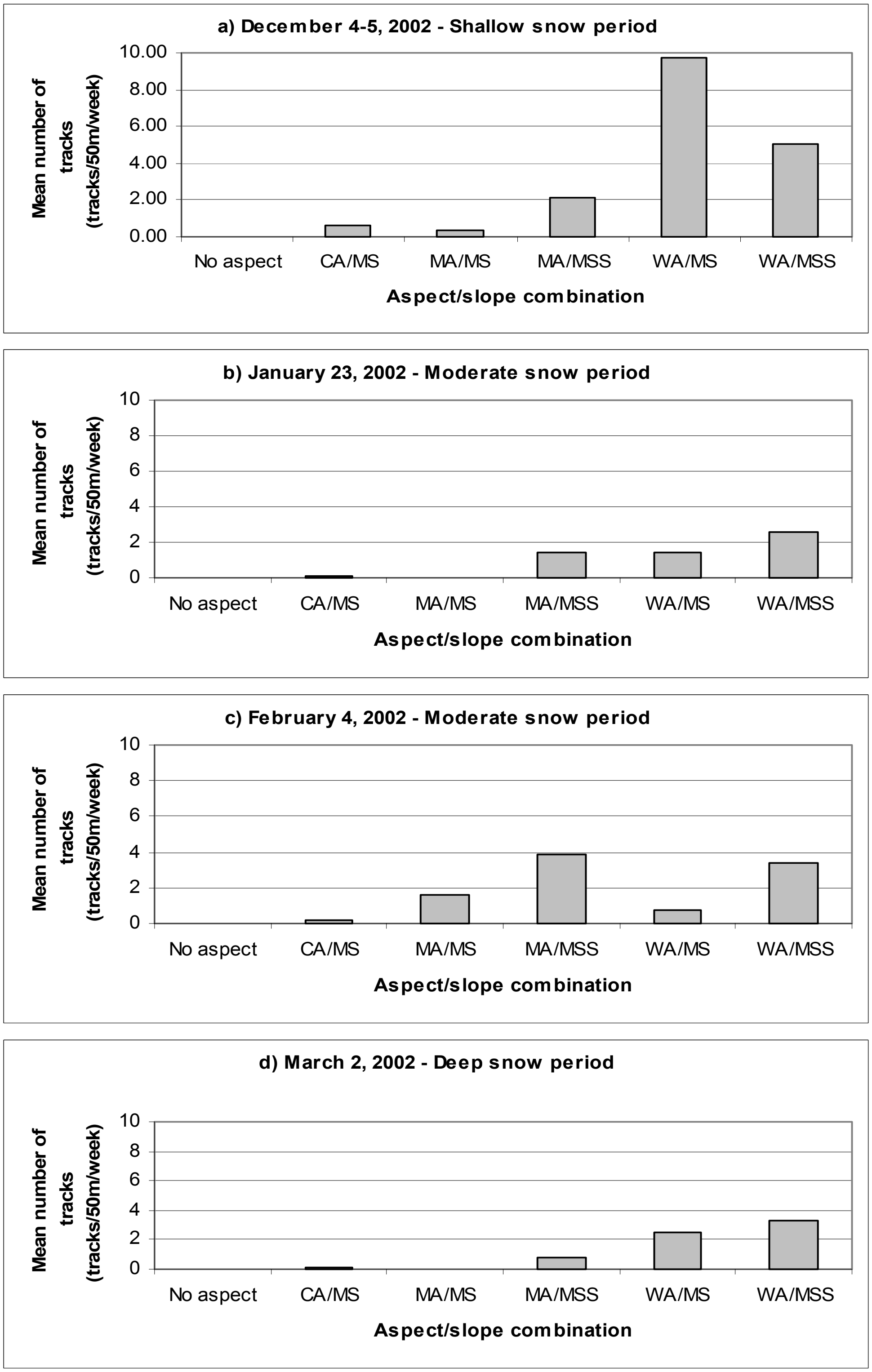


Figure 13. Mean number of mule deer tracks/50m/week by survey date versus areas of slope/aspect combinations. Snow depths are an average of open area sites at low and high elevations. CA, cool aspect (315.1-90˚); MS, moderate slope (10.1-30%); MA, moderate aspect (270.1-315˚ and 90.1-135˚); MSS, moderate-steep slope (30.1-60%); WA, warm aspect (135.1-270˚).

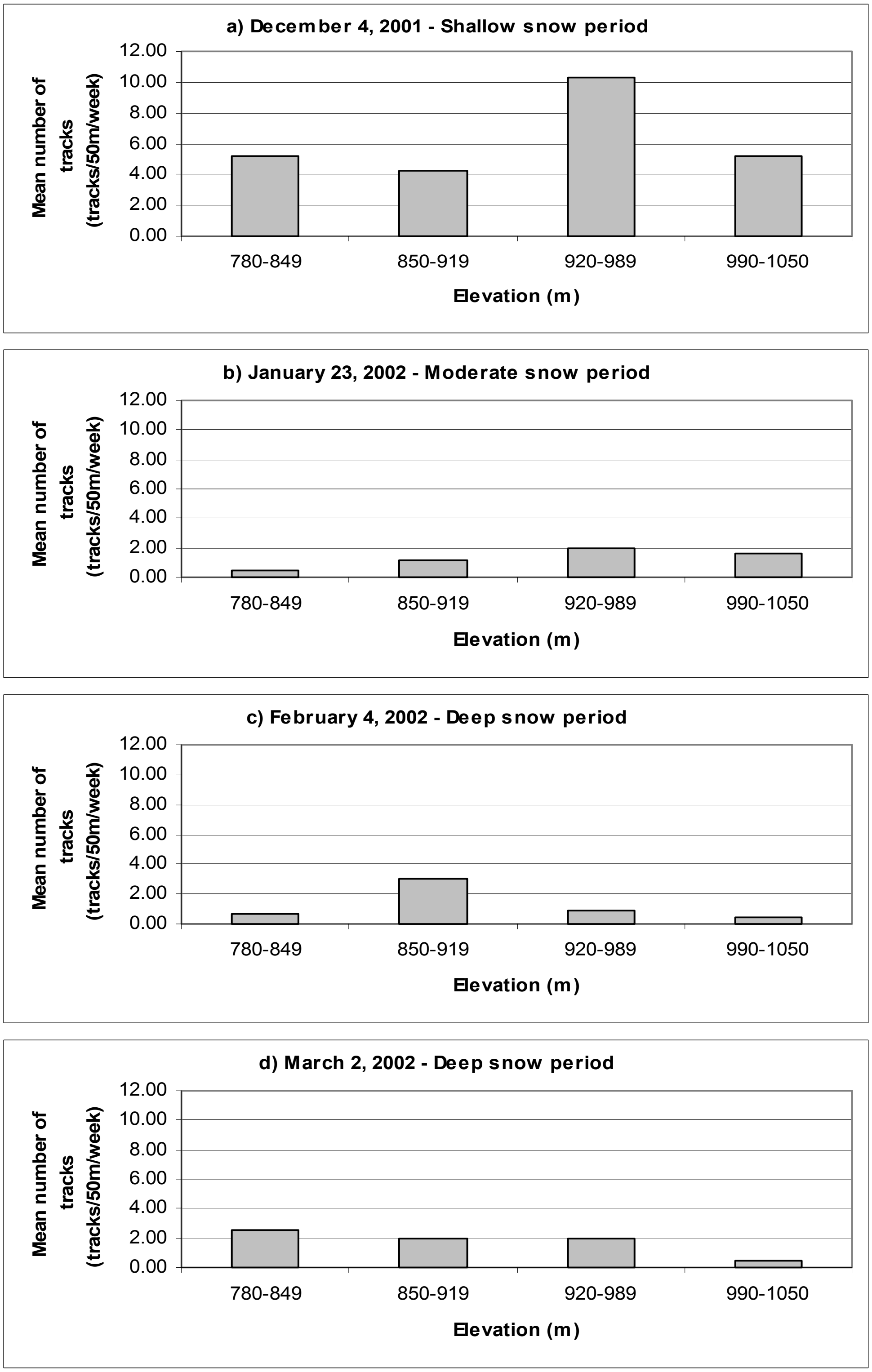
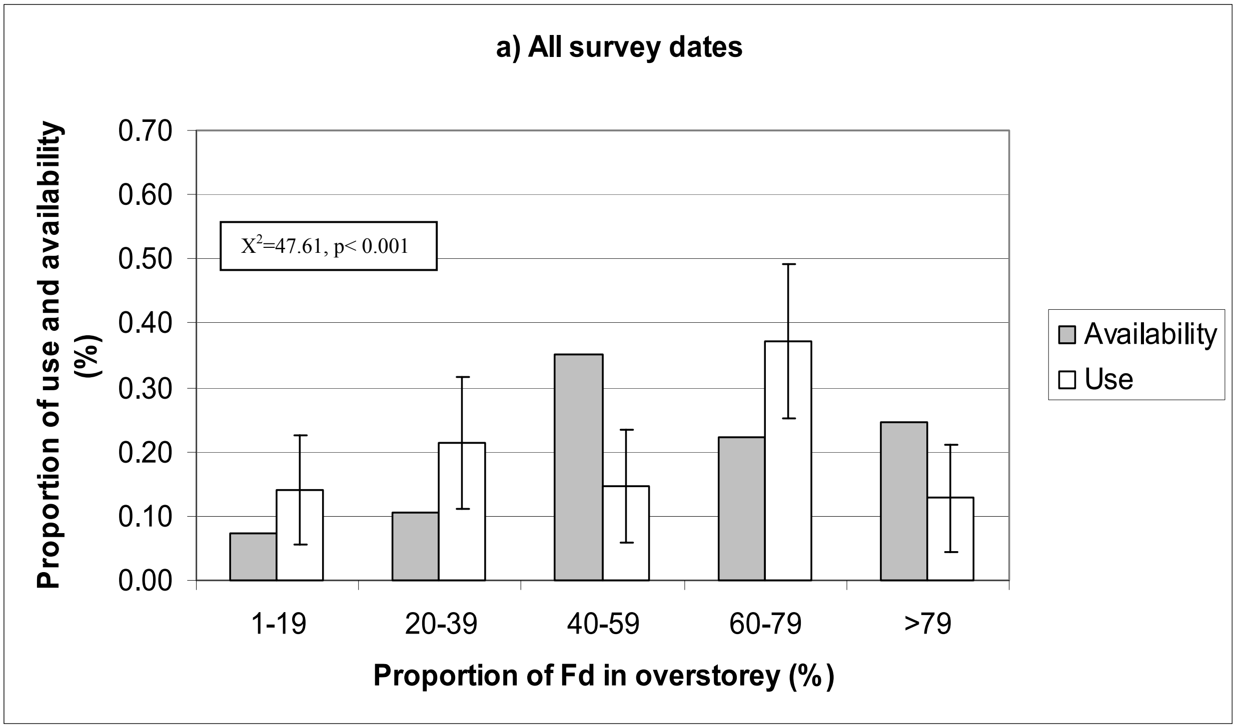


Figure 14. Mean number of mule deer tracks/50m/week by survey date versus elevation. Snow depths are an average of open area sites at low and high elevations.



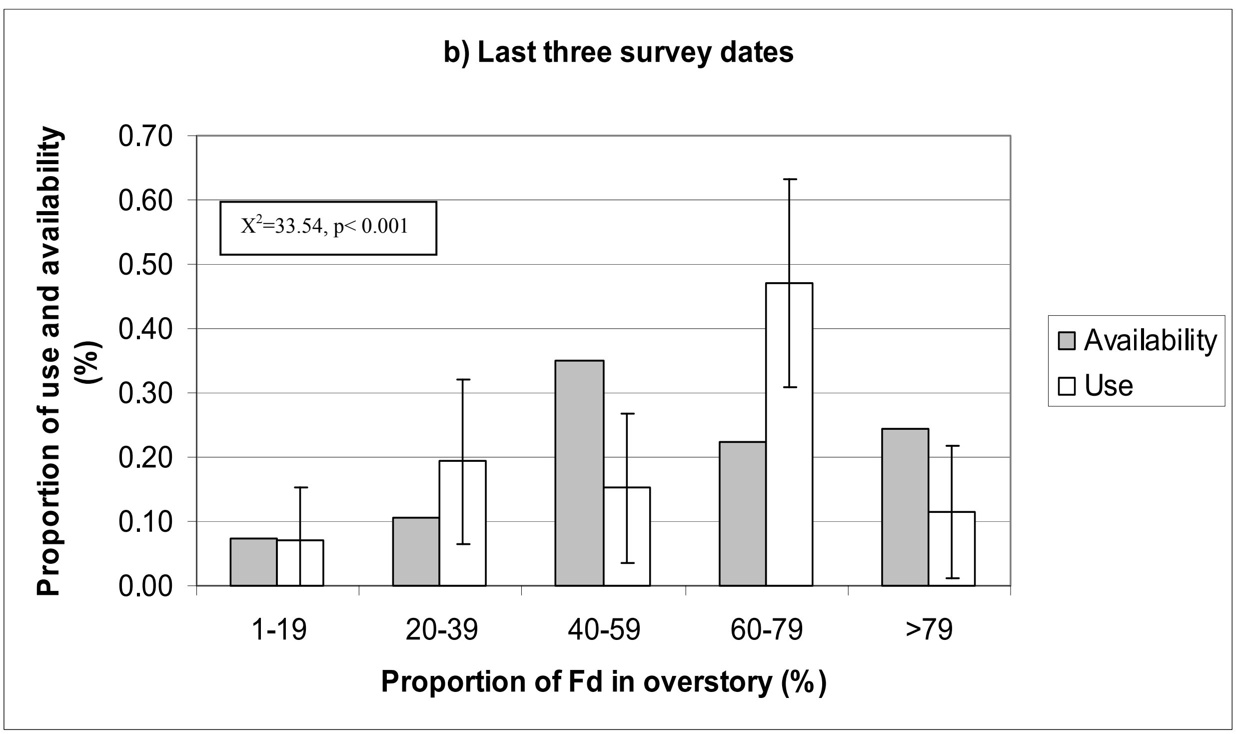


Figure 15. Expected use versus observed mule deer use of Douglas-fir proportion in the overstorey classes.

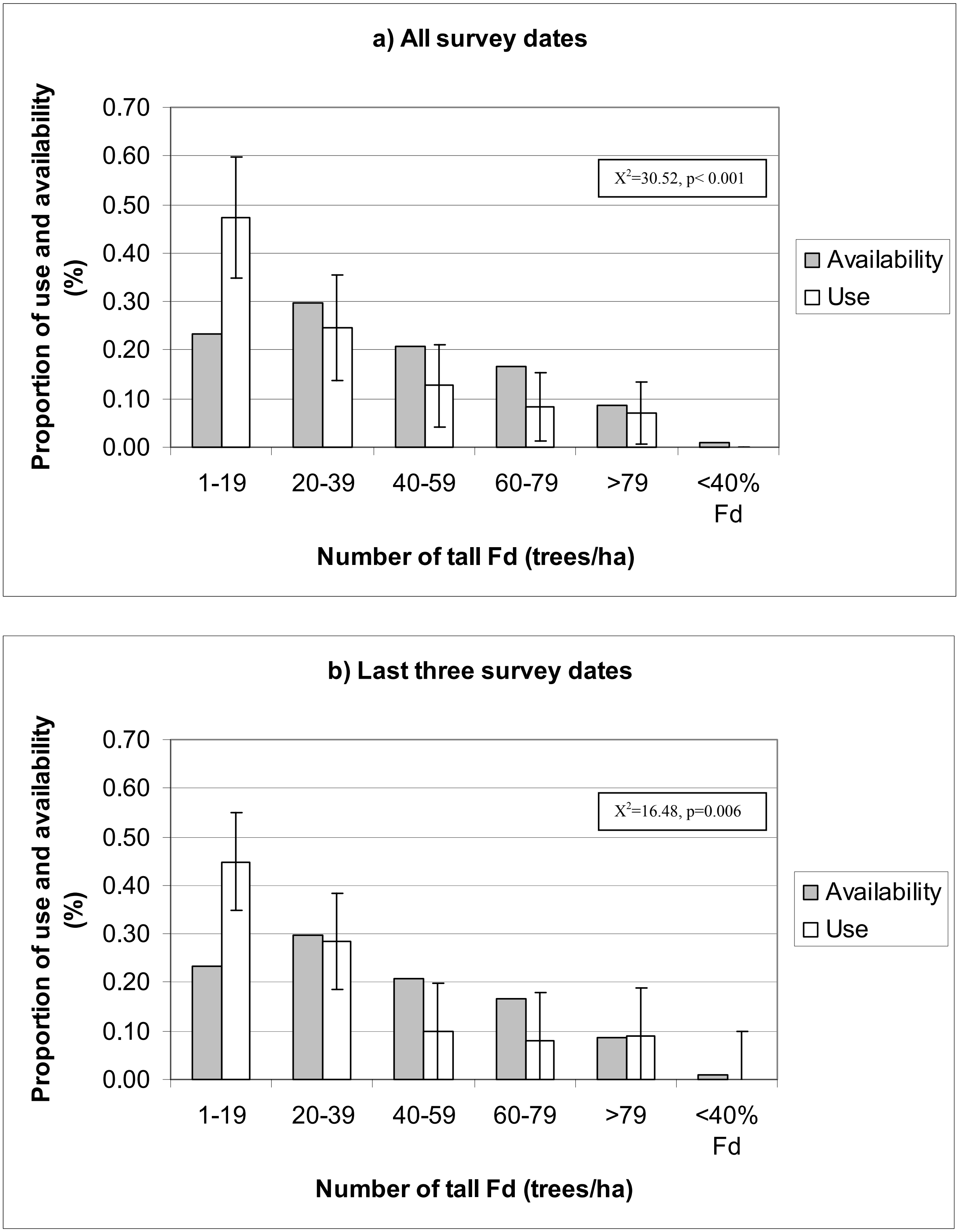
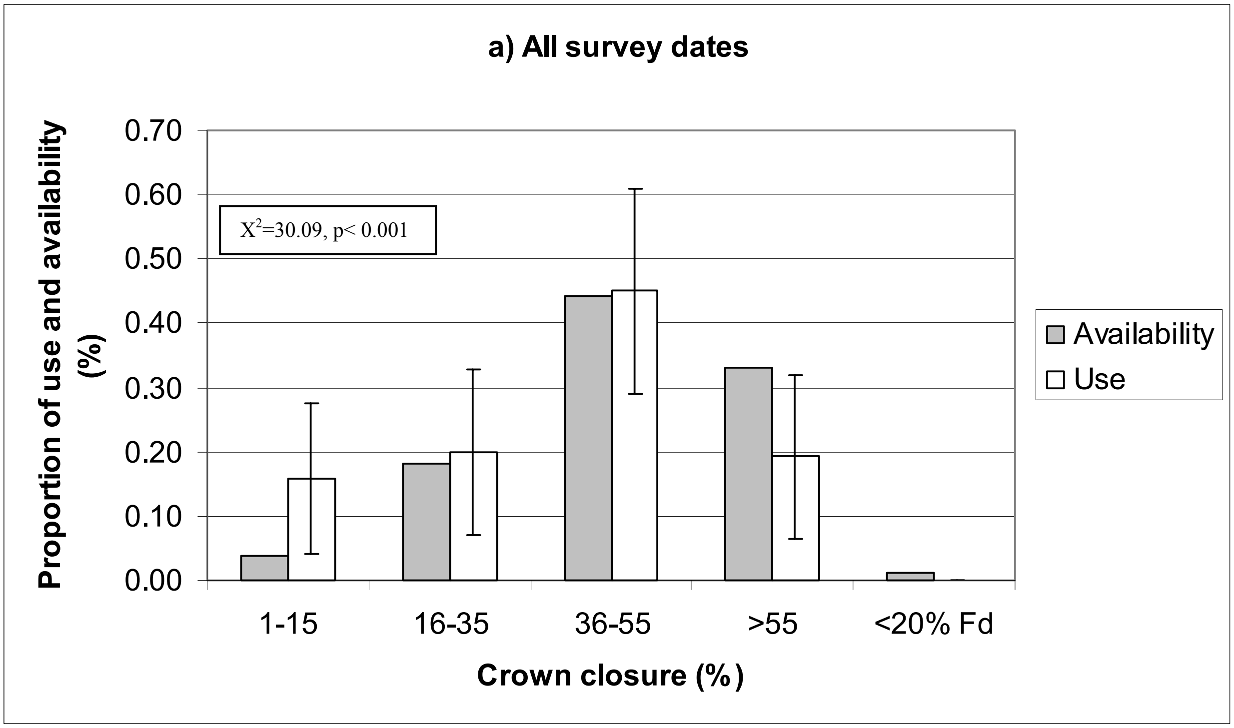


Figure 16. Expected mule deer use versus observed use of tall Douglas-fir density classes.



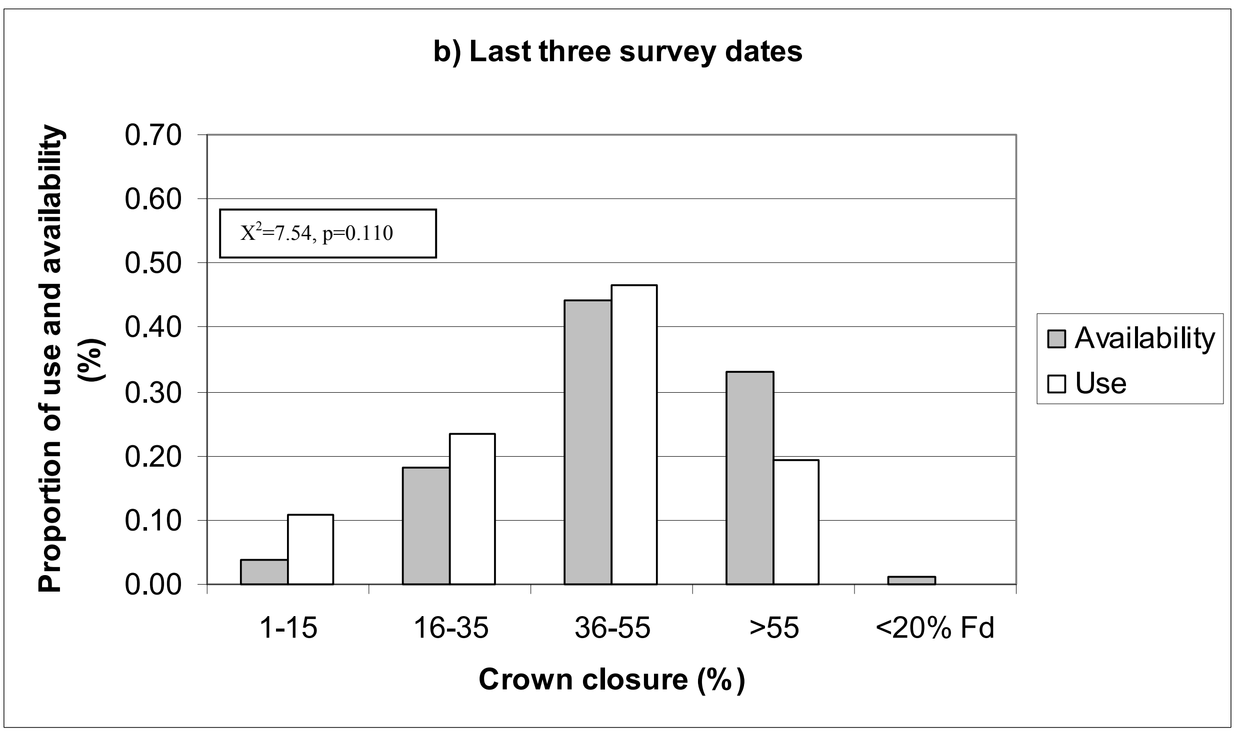
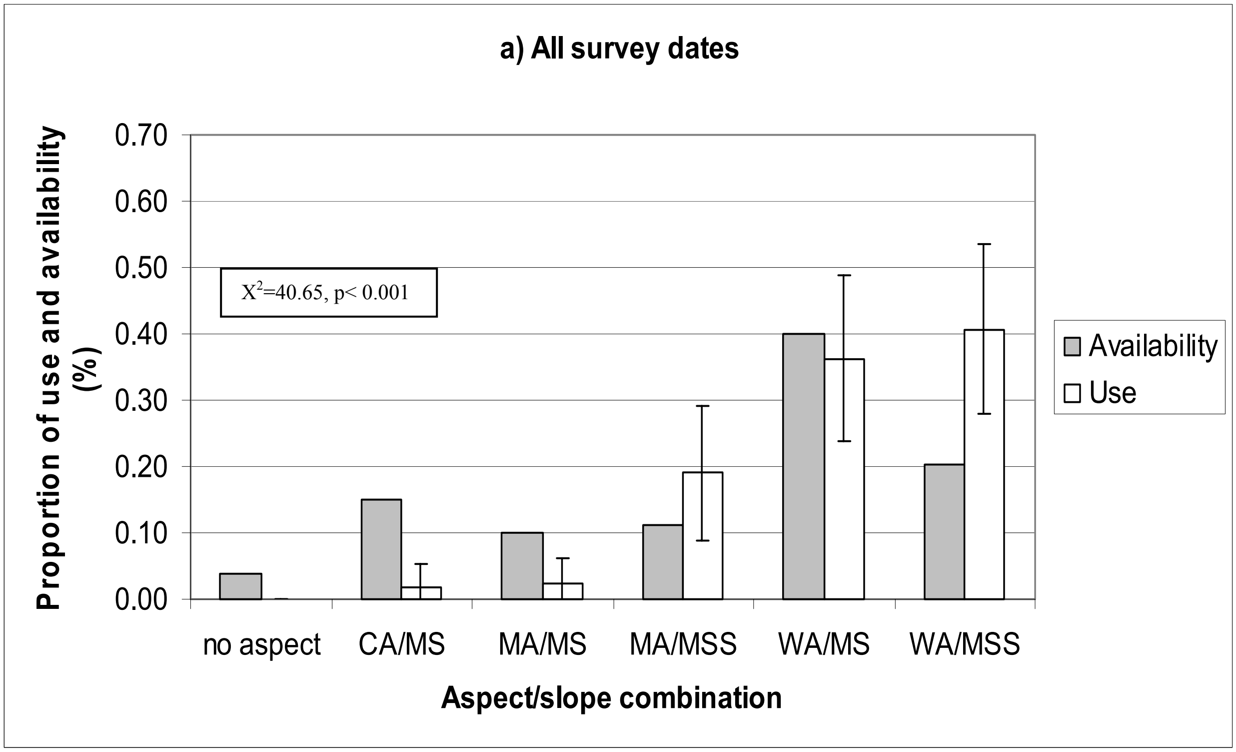


Figure 17. Expected mule deer use versus observed use of crown closure classes. Chi squared analysis found there to be no significant difference in the last three survey dates.



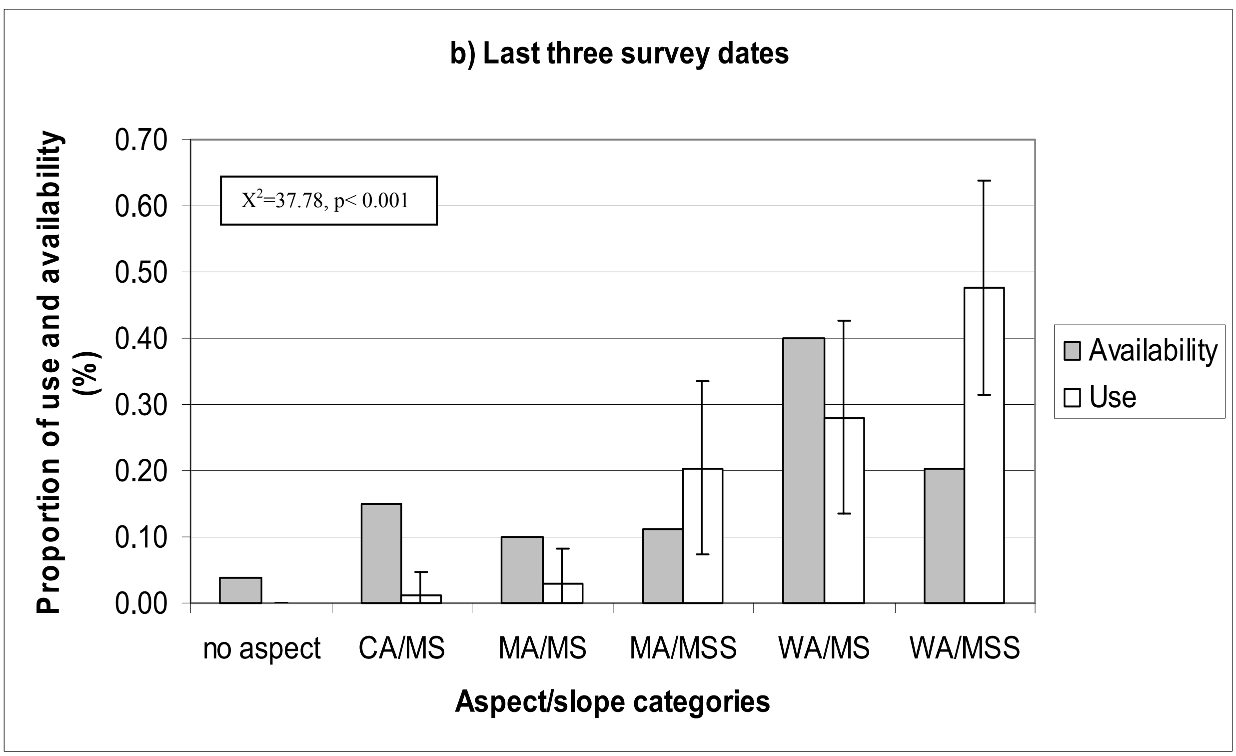


Figure 18. Expected use versus observed use of slope-aspect classes. CA, cool aspect (315.1-90˚); MS, moderate slope (10.1-30%); MA, moderate aspect (270.1-315˚ and 90.1-135˚); MSS, moderate-steep slope (?%); WA, warm aspect (135.1-270˚).

6.0 DISCUSSION

In the winter of 2001/2002, there was a general trend of decreasing deer use with increasing snow depth over time. However, when the data is divided by survey date or snow depth period there is often little or no trend when habitat variables are examined. This is due to the low number of samples and great amount of variability within the data. The number of tracks was highly variable ranging between 0-68 tracks/50m/week within transects. Determining relationships between deer use and habitat attribute is further complicated by variables interacting with one another (Armleder et al. 1994). This work must be conducted over a period of years before any conclusions can be made. Sampling over multiple years will allow surveys in similar snow depth periods to be grouped. This is likely to decrease the variability in deer use and clarify relationships with and between habitat variables.

Previous studies have found that deer use habitats where the snow depths are shallow, such as on southerly aspects and at lower elevations (Gilbert et al. 1970; Willms et al. 1976; Telfer 1978, Armleder et al. 1994). This study also found that warmer aspects generally had greater use. Land Management Handbook 13 (Armleder et al. 1986) also identifies slope as an important factor in winter range selection. Habitat on steeper slopes provides shallower snow, and locomotion in this habitat should have lower energetic costs. However, like Armleder et al. (1994) we found no clear relationship between deer use and slope. When slope and aspect are combined as a variable, deer preferred warm aspect/moderately steep habitats. The use of moderate aspect/moderately steep habitats was also greater than availability. In contrast, cool or moderate aspects on moderate slopes were avoided. The slope and aspect combinations used here appear to interact and influence habitat suitability.

Armleder et al. (1994) found that areas dominated by Douglas-fir were used more often than areas dominated by other species. Deer in the Canim winter range also made greater use of stands dominated by Douglas-fir, but this use was concentrated on stands with 60-79% Douglas-fir in the overstorey while habitats with higher and lower Douglas-fir composition were avoided. Interestingly, the number of tall Douglas-fir has a trend of decreasing use with increasing density of trees. Tall Douglas-fir trees tend to have wider canopies, heavier foliage, and be greater in age. Older, taller Douglas fir trees tend to intercept more snow and produce more litterfall than younger trees (Waterhouse et al. 1991). This habitat also provides thermal protection (Kirchoff and Schoen 1987). Because of these features, less energy is required to move in such habitat and more forage may be available (Harestad 1979; Parker et al. 1984). However, the only habitat where use was greater than availability was in areas with the lowest density of Douglas-fir (1-19 trees/ha). From this data, there appears to be a relationship between the proportion of Douglas-fir in the overstorey, the number of tall Douglas-fir trees/ha, and mule deer use. It may be that these lower density stands are made up of a higher proportion of Douglas-fir. This combination of attributes may provide a balance of cover and other features that are attractive to mule deer.

The greater use of stands containing large Douglas-fir may also be related to the mule deer's winter diet. In the IDF, 62-89% of the winter diets of mule deer were found to be composed of Douglas fir foliage (Waterhouse et al. 1993). The foliage of older Douglas-fir was found to be preferred over that of younger trees (Dawson, et al. 1990). However, no instances of browsing on Douglas-fir were noted in this study. Many observations of feeding were found on falsebox (*Paxistima myrsinites*). This plant was well distributed on the Canim winter range and deer appeared to exploit it where evidence of browsing was found. Most other feeding sign was seen on Oregon grape (*Mahonia aquifolium*) (several instances) with one occurrence of browsing on lodgepole pine blowdown also found. It is likely that the browsing at the pine blowdown was actually on arboreal lichen that was on its branches. In contrast, feeding on Douglas-fir foliage may be opportunistic and only occur when windfalls are available. Fecal pellet analysis is being conducted on samples from the 2001/2002 season and more information on the deer's winter diet will become available.

Crown closure has a direct relationship with the ability of the canopy to intercept snow. Snow depth affects both deer mobility and the availability of food sources. When all surveys were combined, deer used stands of the lowest crown closure class significantly more than expected while the highest crown closure class was used significantly less than expected. In contrast, Armleder et al. (1994) found that deer avoided low crown closure stands and selected for stands with moderate crown closure. Although use of moderate crown closure habitat was not significant in this study, we also found that these stands had the greatest use. This illustrates a problem with use-availability indices that relates to the scale of the analysis (Johnson, 1980). An animal may choose its winter range based on the great abundance of a particular habitat. If this habitat covers the majority of the winter range, the magnitude of its availability will be likely to prevent selection from being indicated even when use is high. Consider deer use of moderate crown closure stands in this study. This habitat covers 43% of the winter range and deer use was three times that found in the lowest crown closure class classes (where selection was indicated). Clearly, moderate crown closure habitat is an important habitat component of mule deer. This may be due to moderate crown closure stands providing a balance of browse and snow interception cover.

7.0 CRITIQUE OF EXISTING PROTOCOLS

Several variables failed to produce meaningful trends or insights on mule deer habitat use. This may be because the variables do not reflect habitat components that influence deer movement or there is too much variability in the data to produce clear trends. More data is required to determine if or how these variables influence habitat use by deer.

Part of the contract requirements was a summary of habitat variables using mean number of tracks per 50m per week. However, this variable is of limited utility without comparing it to the sampling effort within each habitat category and may be misleading. If this information is required in future reports, it should be added as an appendixes. More useful information would be garnered by increasing the number of variables examined using use-availability analysis and including this in the body of the report. Also, an examination of snow depth by habitat type may help explain some of the habitat selection.

Track transects provide a relatively inexpensive form of data collection for use-availability studies. However, when individual transects cross more than one level of a habitat category, autocorrelation of observations may be a problem. Data collection procedures must ensure that the study animals have access to and opportunity to be observed in all available habitats (Byers and Steinhorst, 1984). Our data window covers two-three days in which individual deer may make tracks in a number of habitats. The distribution of those habitats may be such that there is no opportunity to access all habitats. However, when the number of observations are averaged for each survey date and considered an index of use, autocorrelation may not be occurring. In this case, deer have access to all habitat types over the time period between survey dates.

8.0 CONCLUSIONS

This study found a shift in deer use of habitat variables with increasing snow depth. Greater than 75% of all observations were on warm aspects with moderate or moderately steep slopes. Deer showed a preference for warm aspects/moderately steep habitats and this tendency was amplified as snow depth increased. Deer are likely to be seeking out these habitats because of lower snow depths due to increasing slope and solar radiation.

Most deer tracks were found in stands dominated by Douglas-fir. However, this use was concentrated in stands with 60-79% Douglas-fir in the overstory. Deer use of this habitat was greater than expected and increased with greater snow depth. Stands with greater than 79% Douglas-fir were used less than expected. Greater cover in Douglas-fir is generally associated with increasing snow interception and litterfall. This relationship between the proportion of Douglas-fir and these attributes is also likely to be related to the size and age of the trees present. In contrast, we found that stands with low numbers of tall Douglas-fir (1-19 trees/ha) were used significantly more than stands with greater densities of trees. The wide, deep crowns of Douglas-fir in this habitat would provide both good litterfall and snow interception. The use of proportion of Douglas-fir in the overstorey and the number of tall Douglas-fir categories appears to be contradictory. However, it may be that the low Douglas-fir density stands are made up of 60-79% Douglas-fir. These stands are likely to be somewhat open and may provide both forage and snow interception cover. There was no significant relationship between deer use and crown closure at moderate to deep snow depths. The greatest deer use was found in habitats with 36-55% crown closure. This may be due to the greater light penetration and levels of forage in more open stands.

Deer are likely to choose habitats that give them the greatest overall benefit. Warm, steeper aspects have shallower snow, but are also likely to be well drained and contain lower densities of trees. Douglas-fir does well in this type of topography/aspect and older stands will contain larger trees that provide good snow interception and litterfall.

The crown closure is also likely to be lower in this habitat which allows for increased light penetration to the forest floor. Greater levels of solar radiation yields shallower snow and can often result in more forage. The benefits of using habitats containing suitable combinations of features will increase with greater snow depth.

9.0 RECOMMENDATIONS

The findings in this paper are based on one year of data and should be considered preliminary. This type of data must be collected over a number of years before any conclusions can be drawn. It is hoped that completing these surveys over several years will provide a more complete picture of winter conditions and mule deer responses. The results of this year's data should be used to focus future data analysis. While there are many possible combinations of variables, some may be more meaningful than others. Determining which of these variables influence habitat selection will allow research managers to develop plans for mule deer winter ranges that ensure that deer populations are sustained while providing for resource extraction

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Appendix 1. Summary of the mean number of mule deer tracks per 50m per week and total observations over the 2001/2002 sampling season.

Habitat variable	***4/12/01***		***5/12/01***		***23/01/02***		***4/2/02***		***2/3/01***	
	mean	N	mean	N	mean	N	mean	N	mean	N
Snow depth (cm):										
0-25	3.14	137	2.52	50	1.35	145	1.83	125	2.78	78
26-40	3.50	1			1.09	37	1.44	51	1.46	72
41-59					0.00	6	0.00	10	0.50	28
>59							0.00	2	0.23	10
Crust type:										
strong			14.00	1	1.00	79	0.64	38	1.80	105
moderate			1.75	4	0.00	1	1.18	55	0.65	18
none	3.14	138	2.33	45	1.46	108	2.27	94	2.19	63
Transect number:										
1	3.18	54			1.49	54	0.52	54	1.51	54
2	1.06	56			0.84	56	3.84	56	1.92	56
3	7.25	28			0.44	28	1.44	28	2.42	28
4			2.52	50	1.93	50	0.39	50	1.63	50
Depth of intermediate layer (cm):										
none	3.14	138	2.52	50	1.19	118	2.05	112	1.13	29
>0-25					1.38	70	1.08	68	2.04	150
26-40							0.00	7	0.00	9
>40							0.00	1		
Snowshoe sinking depth (cm):										
0-5					1.11	79	1.04	81	2.82	57
6-10					1.52	92	2.27	81	0.81	72
>10					0.51	17	1.39	24	2.09	57
Proportion Douglas fir in overstorey (%):										
1-19	10.75	14			0.00	14	1.25	14	3.17	14
20-39	0.88	20			0.00	20	1.66	20	0.35	20
40-59	1.89	61	0.00	5	0.88	66	1.48	66	0.46	66
60-79	2.96	26	3.79	16	2.33	42	3.08	42	4.83	42
>79	4.32	17	2.25	29	1.75	46	0.53	46	1.17	46

Appendix 1. Continued.

Habitat variable	*4/12/01*		*5/12/01*		*23/01/02*		*4/2/02*		*2/3/01*	
	mean	N	mean	N	mean	N	mean	N	mean	N
Number of tall Douglas fir (trees/ha):										
1-19	6.20	44			1.43	44	3.22	44	3.39	44
20-39	2.00	56			1.34	56	2.31	56	1.46	56
40-59	1.44	34	0.00	5	0.04	39	0.31	39	0.66	39
60-79			3.31	31	2.20	31	0.28	31	1.73	31
>79	0.00	2	1.67	14	1.75	16	0.66	16	1.75	16
Crown closure (%):										
1-15	6.50	7			3.50	7	0.25	7	0.00	7
16-35	2.37	34			0.82	34	1.18	34	2.06	34
36-55	3.33	83			1.05	83	2.83	83	2.00	83
>55	2.63	12	2.52	50	1.55	62	0.42	62	1.66	62
Slope (%):										
gentle (0-10)	6.30	10	0.00	4	0.25	14	0.25	14	3.33	14
moderate (10.1-30)	3.34	66	3.89	6	0.63	72	1.19	72	1.56	72
moderate-steep (30.1-60)	2.45	60	2.92	32	1.79	92	2.17	92	1.83	92
steep (>60)	1.75	2	1.17	8	2.28	10	1.40	10	1.17	10
Aspect (°):										
cool (315.1-90)	1.49	47	0.00	5	0.64	52	2.19	52	0.81	52
moderate (270.1-315 and 90.1-135)	4.25	42	1.17	10	1.01	52	1.11	52	1.17	52
warm (135.1-270)	3.79	49	3.27	35	1.79	84	1.56	84	2.81	84
Aspect/slope combination (°/%):										
CA/MS (315.1-90°/10.1-30%)	0.63	28			0.06	28	0.19	28	0.17	28
MA/MS (270.1-315° and 90.1-135°/10.1-30%	0.37	19			0.00	19	1.57	19	0.00	19
MA/MSS (270.1-315° and 90.1-135°/30.1-60%)	2.17	21			1.42	21	3.83	21	0.78	21
WA/MS (135.1-270°/10.1-30%)	6.44	44	3.31	31	1.45	75	0.77	75	2.55	75
WA/MSS (135.1-270°/10.1-30%)	3.35	24	1.67	14	2.53	38	3.41	38	3.32	38
Elevation (m):										
780-849	3.68	19	1.47	19	0.46	38	0.69	38	2.58	38
850-919	2.14	67	2.07	9	1.13	76	2.99	76	1.96	76
920-989	5.95	30	4.33	7	1.94	37	0.90	37	1.95	37
990-1050	1.91	22	3.27	15	1.66	37	0.43	37	0.50	37