# Abundance & Distribution of Moose in the Suncor Study Area

May, 1996

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**This report is one of a series of reports prepared for Suncor Inc. Oil Sands Group for the Environmental Impact Assessment for the development and operation of the Steepbank Mine, north of Fort McMurray, Alberta. These reports provided information and analysis in support of Suncor's application to the Alberta Energy Utilities Board and Alberta Environmental Protection to develop and operate the Steepbank Mine, and associated reclamation of the current mine (Lease 86/17) with Consolidated Tailings technology.**

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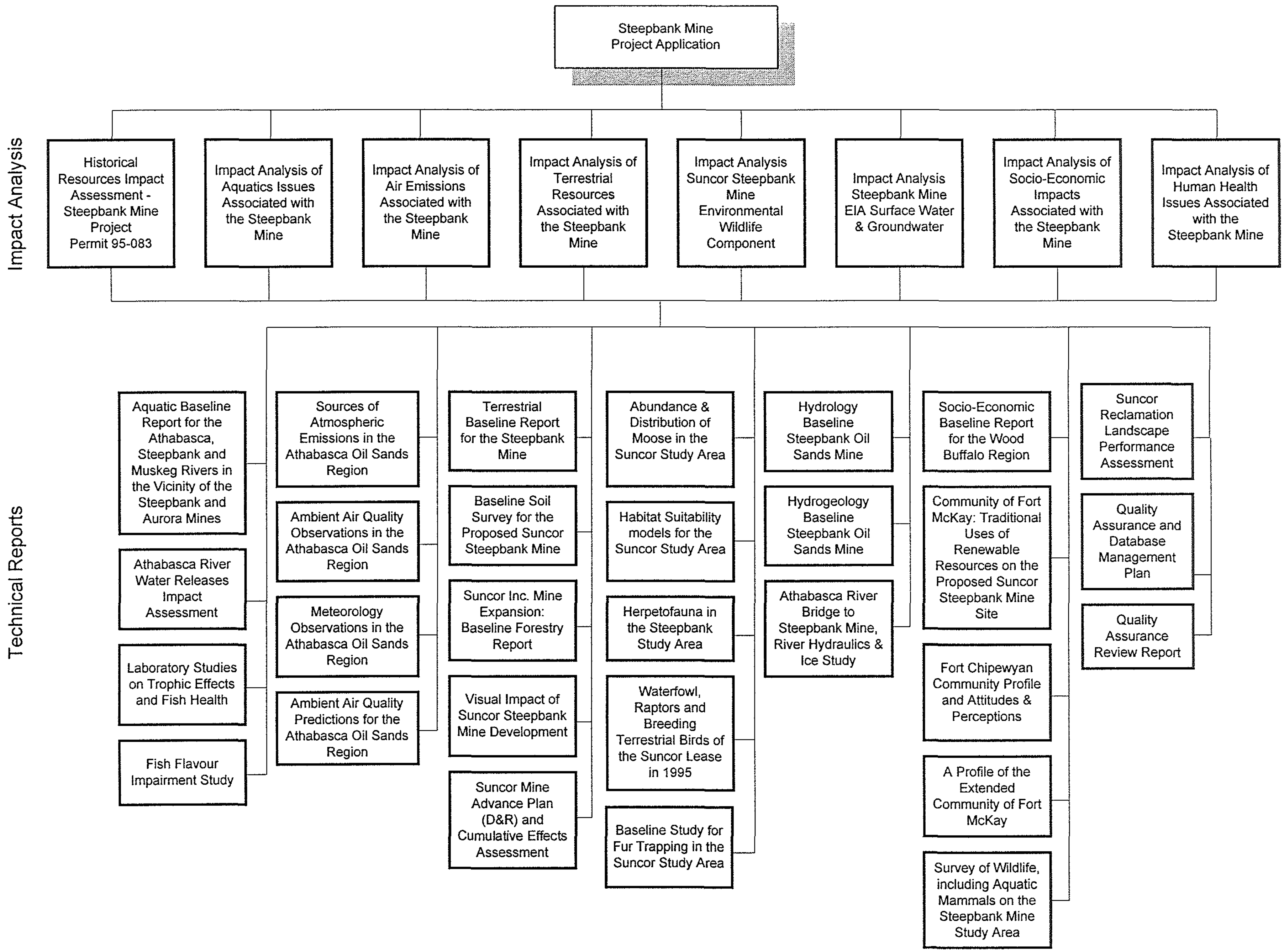


**Reports Prepared for the Steepbank Mine Environmental Assessment**

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# ABUNDANCE AND DISTRIBUTION OF MOOSE AND OTHER MAMMALS IN THE SUNCOR STUDY AREA

**May 1996**

**Prepared for:**

**Suncor Inc., Oil Sands Group**
**Fort McMurray, Alberta**

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## EXECUTIVE SUMMARY


Wildlife studies were conducted in the Suncor study area (56°53' north, 111°33' west) during winter and spring 1995 to determine the abundance and distribution of mammals in the area that would be affected by the development of Suncor's Steepbank Mine. These studies involved aerial surveys, browse and pellet-group counts, and winter track surveys.

In 1995, the population density of moose in the Suncor study area ranged from 0.22 to 0.27 moose/km$^2$, although moose were slightly more abundant in the area east of the Athabasca River than west of the river in February (0.24 vs. 0.20 moose/km$^2$). Population composition also differed between the east and west sides of the Athabasca River. The west side had a lower proportion of bulls and a higher proportion of calves. This was attributed to higher quality habitat, less predation by wolves, and greater hunting pressure in the western part of the study area.

Aerial surveys and pellet-group counts indicated that deciduous forests on the Athabasca River escarpment were the most important habitat feature in the Suncor study area for moose; however, track count surveys indicated that open tamarack ens in upland landscapes also provided important habitat. In contrast, browse production was greatest in wetland shrub complexes located in upland landscapes (6226 kg/ha), where 22% of the annual production was consumed by ungulates, followed by wetland shrub complexes located in riparian landscapes (1637 kg/ha), in which no browse consumption was recorded. Browse production and consumption was also relatively high in closed deciduous forest. On the Athabasca River escarpment, ungulate browse consumption in deciduous forest exceeded production by 18%.

Other ungulate species were much less abundant than moose in the Suncor study area. Only seven white-tailed deer were recorded during aerial surveys as compared to 133 moose; however, track surveys indicated that, like moose, deer were associated primarily with deciduous forest habitat and escarpment landscape features. In contrast, no woodland caribou or caribou sign was recorded in the Suncor study area, although caribou are known to reside in the Fort McMurray region. The absence of caribou in the study area probably reflects the marginal quality of habitat available for this species. Other studies conducted in the region suggest that little of the Suncor study area provides suitable habitat for caribou.

Compared to the results of tracking studies conducted in the region in the past, the results of this study suggest that wolves, coyotes, and marten are relatively abundant in the Suncor study area, whereas mink, otter, red fox, snowshoe hare and lynx are uncommon. The abundance of marten reflects a regional increase in marten populations since the 1970s, whereas low densities of snowshoe hares and lynx reflect a low in the "10-year" population cycle of these species. The relative abundance of most other mammals as indicated by this study appears to be consistent with those reported by other workers in the region.

Most of the mammalian wildlife recorded during this study exhibited a significant preference for riparian or escarpment landscape features. Deer, red squirrels, and wolves were associated primarily with escarpments, whereas coyotes and fishers were associated with riparian features. Two species, marten and moose, were associated with two features. Marten were associated with riparian and escarpment features, whereas moose were associated with escarpment and upland landscapes. The snowshoe hare and weasel were the only species that were associated primarily with upland landscapes.

Although closed deciduous and mixed coniferous forests were preferred by the greatest number of species, most of the habitat types identified in the Suncor study area were preferred by at least one species of mammal. Closed deciduous forest was preferred by moose, deer, and coyotes. Mixed coniferous forest was also preferred by three species, the snowshoe hare, red squirrel, and marten. Closed mixedwood, closed jack pine, black spruce-tamarack, closed black spruce and open tamarack fens were preferred by two species of mammals. Moose and snowshoe hares were associated with mixedwood forest, snowshoe hares and red squirrels with jack pine, fishers and weasels with black spruce-tamarack, snowshoe hares and weasels with closed black spruce, and moose and weasels with open tamarack fen. In contrast, two habitat types were preferred by one species of mammal; closed white spruce forest was preferred by the marten, whereas fen was preferred by the weasel.

Some differences in wildlife abundance and habitat use were noted between the parts of the study area east and west of the Athabasca River. It is believed that some of these differences are related to the greater degree of human activity and hunting pressure on the west side of the Athabasca River.

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The component leader for the wildlife resources impact assessment was Mr. Lawrence Brusnyk. Mr. Doug Skinner and Mr. Lawrence Brusnyk served as the principal authors of this baseline report. The field work was conducted by Mr. Doug Skinner and the crew included Mr. Greg McCormick, Mr. Don Albright, Ms. Sharilyn Johnston and Mr. John Orr. Ms. Kari Donnelly and Ms. Carol Brittain were responsible for word processing and report formatting.

Mr. John Gulley (Suncor) and Ms. Bette Beswick reviewed the draft of the report.

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# 1.0 INTRODUCTION

## 1.1 Background

Because of declining oil sands reserves at the site of their present mine, Suncor Inc., Oil Sands Group (Suncor) has proposed expanding their operation to include oil sands reserves in the vicinity of the Steepbank River on the east side of the Athabasca River. As part of their environmental impact assessment for the proposed project, Suncor has undertaken to conduct wildlife studies in areas that could be affected by the proposed development.

There is little information available about wildlife in the Suncor study area, although a number of wildlife studies have been conducted in the region in the past. Aerial surveys for ungulates have been flown as part of the Alberta Oil Sands Environmental Research Program (AOSERP) in the 1970s (Nowlin 1977, Cook and Jacobson 1978) and Syncrude Canada Ltd. has monitored moose (*Alces alces*) on their leases since the mid-1970s (Penner 1976; Hauge and Keith 1978; Westworth 1979, 1980; Pauls 1982, 1984, 1985, 1987, 1991). A number of tracking studies have also been conducted in the Fort McMurray region. Penner (1976) conducted track surveys near the present Syncrude Canada Ltd. site in the mid-1970s and Skinner and Westworth conducted track counts near the Fort Hills in 1981 (Skinner and Westworth 1981). A comprehensive wildlife study, which included summer and winter track and sign surveys, was conducted in the vicinity of Calumet Lake during the winter of 1981-82 (Brusnyk and Westworth 1982; Westworth and Brusnyk 1982a,b). However, the information from most of these surveys is either outdated or does not provide information specific to the area that could be affected by Suncor's proposed mine expansion. As a result, Suncor retained D.A. Westworth & Associates Ltd. to conduct wildlife surveys in areas that could be affected by mine expansion.

## 1.2 Objectives

The objectives of the wildlife surveys were to determine:

- the relative abundance of wildlife species residing in the Suncor study area, and
- the distribution of wildlife with respect to habitat types and terrain features.

## 2.0 METHODS

A combination of techniques was used to assess the abundance and distribution of mammalian wildlife in the Suncor study area. Aerial surveys were conducted during both February and December 1995 to determine the abundance and composition of ungulate populations, whereas browse and pellet group counts were conducted in May to assess the carrying capacity of various habitat types for ungulates. In addition, track count surveys were conducted during February and December to assess the relative abundance and distribution of a variety of wildlife species. Several workers have indicated that track counts provide accurate information about the abundance and population trend of most wildlife species (Keith and Windberg 1978, Van Dyke et al. 1986, Reid et al. 1987, Thompson et al. 1989).

### 2.1 Aerial Surveys

Complete aerial surveys for ungulates were flown in the Suncor study area from 26-27 February (late winter) and 19-20 December (early winter) 1995. The February survey covered an area of 365 $km^2$, which included almost all of Suncor's regional study area with the exception of large industrial sites. In contrast, the December survey, which covered an area of 238 $km^2$, concentrated primarily on the area that would be directly affected by the proposed Steepbank mine development, although a portion of the study area in the vicinity of Poplar Creek was also included for comparative purposes. Both surveys were flown in a Bell 206 helicopter containing an observer on each side of the rear seat and a navigator/observer in the front seat. Surveys were flown at an airspeed of approximately 125 km/h and an altitude of 150 m above ground level along overlapping parallel flight lines spaced 0.4 km apart.

The locations of all ungulates observed were plotted on airphoto mosaics of the study area. Other information, such as the time of observation, flight line, species, sex, habitat type, and the behaviour of animals when first observed, was recorded on a micro-cassette recorder. The sex of moose was determined by the presence or absence of antlers, or vulval patch and snout colour characteristics (Mitchell 1970).

The number of moose residing in the Suncor study area was estimated by means of a Sightability Correction Factor (SCF), which was calculated from the results of standard and intensive searches as described by Gasaway et al. (1986). The method involves conducting a standard search at an effort of

1.5 to 2.3 min per $km^2$ and then using intensive searches to calculate a correction factor, which compensates for animals that were missed during the standard search.

Standard searches of the survey area were conducted at an average effort of 1.62 min per $km^2$, which is within the recommended range of effort (Gasaway et al. 1986). In addition, during the February survey, three intensive survey blocks were searched at 2.5 times the standard search effort immediately after the standard search of each block. These intensive search blocks were randomly selected from areas that contained medium or high moose densities; areas with low moose densities were not intensively searched because they provide little information about ungulate sightability (Gasaway et al. 1986).

## 2.2 Browse and Pellet Group Counts

### 2.2.1 Browse Production and Use

Browse and pellet group surveys in the Suncor study area were conducted from 9 to 18 May, prior to leaf flush. The surveys were conducted in 1106 study plots located at 25 m intervals on 56 transects each 500 m long. These transects were located in a variety of habitat types and terrain features (Table 1).

Densities (stems/ha) of 12 browse species, which included saskatoon (*Amelanchier alnifolia*), bog birch (*Betula glandulosa*), paper birch (*B. papyrifera*), beaked hazel (*Corylus cornuta*), red-osier dogwood (*Cornus stolonifera*), balsam poplar (*Populus balsamifera*), trembling aspen (*P. tremuloides*), chokecherry (*Prunus virginiana*), pincherry (*P. pensylvanica*), willow (*Salix* spp.), low-bush cranberry (*Viburnum edule*) and high-bush cranberry (*V. opulus*), were determined by using plot sampling techniques. At each sampling point, the number of stems of each species within a 10 $m^2$ circular plot (1.78 m radius) was tallied. Available browse was considered to be any stem between 0.4 and 2.5 m tall and less than 3.0 cm in diameter at breast height (dbh). The lower limit is based on mean snow depth for the Fort McMurray area, whereas the upper limit is based on the maximum height reported to be available to moose through stem breakage (Telfer and Cairns 1978). The amount of browse provided by each browse species on each plot was determined by selecting the stem of each species nearest the centre of the plot and counting the number of browsed (ungulate vs. hare) and unbrowsed twigs (>2.5 cm long).

Annual browse production (kg/ha) was determined by clipping, drying and weighing the current annual growth (CAG) from sample stems of each species. Where possible, six twigs representing the CAG of a species were clipped from the top, middle and lower portions of at least ten randomly selected stems of each species. Twigs were dried in a convection oven for 48 h at 70°C in the laboratory and then weighed to the nearest 0.01 g on an electronic balance. The biomass of browse produced within each habitat type and landscape feature was calculated as the product of stem density (stems/ha) for each species, mean number of twigs per stem and mean dry weight (g) per twig. This estimate of net annual yield in perhaps the most useful measure of habitat carrying capacity for moose (Telfer 1978).

The amount of browse removed by ungulates was determined by counting the number of browsed twigs and recording the diameter (mm) at the point of browsing (DPB) for each species. The biomass of browse used by ungulates was determined by inserting the mean DPB into weight-diameter regression equations developed for each species and multiplying this weight by the mean number of browsed twigs per stem and stem density. Because browse utilization sometimes exceeds current annual growth, diameter-weight measurements were extended to include older growth. Studies conducted elsewhere in Alberta indicate that ungulates frequently remove more that the current annual growth of browse species (Westworth et al. 1984; Brusnyk and Westworth 1984, 1985).

### 2.2.2 Pellet-Group Counts

Pellet group counts to obtain estimates of relative winter habitat use were conducted in conjunction with browse surveys. This technique has been reviewed in detail by Van Etten and Bennett (1965), Neff (1968), Stelfox and McGillis (1977), Collins and Urness (1981) and Rowland et al. (1984). The standard method involves counting the number of pellet groups deposited within sampling areas between leaf fall and snow melt. It provides a relatively unbiased estimate of cumulative winter use by various species of ungulates within different habitat types.

Numbers of pellet groups for each ungulate species were counted within 50 $m^2$ circular plots (3.99 m radii) centred on the same sample points as browse plots. Pellet groups were tallied if at least one-half of the pellets fell within the sample plot.

## 2.3 Winter Track Counts

Winter track count studies, which were conducted from 4 February to 2 March (late winter) and 3 to 22 December (early winter) 1995, were used to determine the relative abundance and habitat relationships of wildlife in the Suncor study area during winter. Between one and 15 transects, each 500 m long, were established in each of 14 habitat types identified in the study area (Table 2). Overall, 71 track transects were established. Sixty-seven transects, 22 of which were located on the west side of the Athabasca River and 45 of which were located east of the river, were established in February; however, only the area east of the Athabasca River was included in December track surveys. Transects surveyed in December included 27 that had been established in February and four that were established in December.

Track surveys were conducted by workers on foot or snowmobile who counted the number of times the tracks of each animal species crossed each transect; however, tracks that obviously recrossed a transect within 25 m of an initial observation were counted only once. All tracks were obliterated immediately after being counted to prevent them from being recounted on subsequent surveys.

Between one and four track counts were conducted along each transect. In February, 22% of the transects were surveyed four times, 30% were surveyed three times, 42% were surveyed two times, and 6% were surveyed once. During December, 7% of the transects were surveyed three times, 90% were surveyed twice, and 3% were surveyed once. A total of 369.0 and 107.5 km track-days of effort were expended during the February and December track surveys, respectively (Table 2).

During this study, tracks of some species could not be identified to the species level because of similarities in track patterns. As a result, white-tailed deer (*Odocoileus virginianus*) and mule deer (*O. hemionus*) tracks were combined, as were the tracks of the least weasel (*Mustela nivalis*) and short-tailed weasel (*M. erminea*). In contrast, marten (*Martes americana*) and fisher *(M. pennanti*) tracks were identified to the species level. Tracks of these two species were combined in previous tracking studies in the Fort McMurray area because there is considerable overlap in the track sizes of female fisher and male marten (Penner 1976, Skinner and Westworth 1981, Westworth and Brusnyk 1982b); however, Zielinski and Truex (1995) recently reported that these two species could be separated with over 70% accuracy based on track size alone. The accuracy in snow tracking studies is likely even greater because of the greater body size and weight of the fisher (see Douglas and Strickland 1987, Strickland and Douglas 1987), which allows sinking depth and stride to be used in addition to track size to assist in differentiating between tracks of the two species.

## 2.4 Data Analysis

To obtain an estimate of the total number of moose residing in the study area, information from intensive aerial searches was used in conjunction with that from the standard survey. The method involved calculating an expanded population estimate based on the sightability correction factor ($SCF_o$) obtained from the number of animals observed during the standard and intensive searches of the intensive search areas:

$$SCF_o = \text{(No. seen during intensive search)/(No. seen in standard search).}$$

A total population estimate for the study area was then calculated by applying a correction factor constant ($SCF_c$) of 1.02 to the expanded population estimate. This is an experimentally-derived constant based on studies that indicated that 98% of radio-collared moose were observed during intensive searches in Alaska (Gasaway et al. 1986).

In addition to examining moose populations in the entire Suncor area, the portions of the Suncor survey area east and west of the Athabasca River were examined independently. This was done because forest cover characteristics and land use factors affecting these two areas are different. Black spruce (*Picea mariana*) and tamarack (*Larix laricina*) forests cover 44% of the study area east of the Athabasca River as compared to 26% in the area west of the river. Moreover, much of the area west of the river has been intensively modified as a result of the construction of the Poplar Creek Reservoir and spillway, gravel extraction, timber harvesting, and road construction. In contrast, the area east of the Athabasca River is comparatively undisturbed, although numerous seismic lines are present.

Chi-square tests were performed to determine if habitat utilization by various wildlife species differed between the portions of the study area east and west of the Athabasca River, and between February and December. If no significant differences were detected ($P>0.05$) or if sample sizes were insufficient for this procedure, data were combined among areas and seasons.

Chi-square tests were also used to determine if the abundance of each species differed significantly (P<0.05) among habitat types and landscape features. Habitat types with similar characteristics were combined where sample sizes were small; however, because expected values sometimes remained low (<5) after this procedure, Yate's Correction was used to increase the fit to the Chi-square distribution. Where Chi-square tests were significant, the relationship between an animal species and individual habitat types was determined by means of a Bonferroni Z-test (Byers et. al. 1984). Chi-square tests were also used to determine if there were differences in wildlife abundance among upland areas, the Athabasca River escarpment, and floodplains and terraces along the Athabasca River.

To facilitate comparisons among habitat types and landscape features, the tracking data were standardized by calculating the frequency of tracks within each habitat type in terms of the number of tracks per km track-day.

# 3.0 RESULTS

## 3.1 Ungulates

### 3.1.1 Moose

*Abundance*

Seventy-five moose were recorded during the February 1995 aerial survey of the Suncor study area (Figure 1). Application of the SCF resulted in an expanded population estimate of 79 moose and a total population estimate of 81 moose (0.22 moose/km$^2$). These estimates are based on an $SCF_o$ of 1.053, which was derived from observations of 20 moose during intensive searches and 19 during the standard searches of the same survey blocks (Table 3).

During February, the population density of moose in the eastern portion of the Suncor study area was slightly higher than that recorded in the western portion of the study area. Fifty moose were observed on the east side of the Athabasca River compared to 25 on the west side (Table 3). Based on the SCF calculated from the results of standard and intensive surveys, an estimated 0.24 moose/km$^2$ (n=54) resided in the eastern portion of the study area during February 1995 as compared with 0.20 moose/km$^2$ (n=27) in the western portion of the study area.

Track count surveys also indicated that moose were more abundant in the eastern portion of the study area during February ($P<0.001$). A total of 81 moose tracks were recorded during this period for an overall frequency of 0.22 moose tracks/km track-day; however, 0.27 moose tracks/km track-day (n=78) were recorded east of the river, whereas only 0.04 tracks/km track-day (n=3) were recorded west of the river.

Fifty-eight moose were recorded during the December 1995 aerial survey (Figure 1). Because no intensive survey blocks were flown during this survey, the SCF derived from the February survey was used to estimate the population density of moose in December. The February SCF was considered appropriate for the December survey because both surveys were flown over the same area under similar survey conditions, and two of the three personnel involved in the December survey had also conducted the February survey.

Application of the SCF to the December survey data resulted in an overall population estimate of 63 moose or 0.27 moose/km$^2$. However, in contrast to February 1995, the moose density of 0.32/km$^2$ (n=24) calculated for study area on the west side of the Athabasca River was substantially higher than the density of 0.24 moose/km$^2$ (n=39) calculated for the eastern portion of the study area.

Although these results suggest that moose population density in the western portion of the study area was much higher in December than in February, other evidence indicates that moose population density probably did not change over this period. The apparent difference between February and December is related to the characteristics of the reduced area surveyed during December 1995. The area surveyed west of the Athabasca River in December contains most of the deciduous forest in that part of the study area and is therefore capable of supporting a relatively high density of moose. If only the reduced survey area is considered, the density of moose in western part of the study area was identical during February and December (0.32 moose/km$^2$).

Moose track frequencies recorded during December were similarly higher than those in February. During December, 70 moose tracks were recorded in the study area for a frequency of 0.65 tracks/km track-day, which is almost three times that recorded during February.

### *Population Composition*

The sex and age composition of moose in the Suncor study area was similar during both the February and December surveys (Table 4). During February, 20 of the 75 moose observed in the study area were bulls, 35 were cows, and 20 were calves for a bull:cow:calf ratio of 57:100:57. Overall, 19 of the cows observed in this survey had no calves, 13 had one calf, and three had two calves. The twinning rate, calculated as the proportion of cows with calves having twins (Hauge and Keith 1981), was 0.19.

During the December survey, 17 of the 58 moose observed were bulls, 28 were cows, and 13 were calves for a bull:cow:calf ratio of 61:100:46. Fifteen of the cows observed during this survey had no calves and 13 had one calf. No twin calves were recorded during the December aerial survey.

The sex and age composition of moose differed substantially between the eastern and western portions of the study area in both February and December. The population east of the Athabasca River had a higher proportion of bulls and a lower proportion of calves than that west of the river. In February, 17 of the 50 moose observed in the eastern part of the survey area were bulls, 23 were cows, and ten were calves, whereas during December, 13 bulls, 17 cows, and six calves were recorded in this area. Bull:cow:calf ratios for this portion of the study area were 74:100:43 and 76:100:35 for February and December, respectively (Table 4).

In contrast, only three of the 25 moose observed in the western part of the Suncor survey area during February were bulls, 12 were cows, and ten were calves for a bull:cow:calf ratio of 25:100:83. In December, four bulls, 11 cows, and seven calves were recorded for a bull:cow:calf ratio of 36:100:64.

Seventeen of the 24 cows observed in the eastern portion of the study area during February had no calves, five had one calf, and two had two calves. A lone calf was also recorded. The twinning rate for moose east of the Athabasca River was 0.29. In contrast, three of the 12 cows observed in the western part of the survey area had no calves, eight had one calf, and one had two calves. The twinning rate in this area was 0.11.

During December, 11 cows in the eastern portion of the study area had no calves and six cows had one calf. In comparison, four cows in the western portion of the study area had no calves and seven had one calf.

***Distribution and Habitat Use***

During the February 1995 aerial survey, a disproportionate number of moose in the eastern portion of the Suncor study area were recorded on the terraces and floodplains of the Athabasca River. Twenty-two percent (n=11) of the moose were associated with these landscape features, which comprise only about 11% of eastern portion of the survey area (P=0.014). Other small concentrations of moose observed in the eastern part of the study area included a group of three bulls, which was recorded in tamarack forest near the southern boundary of the survey area, and a group of four cows, which was recorded in aspen (*Populus tremuloides*)-dominated mixedwood forest near the eastern boundary of the survey area.

Track count studies similarly indicated that moose distribution in the Suncor study area in February differed significantly among landscape features ($P<0.001$), although they indicated that moose were associated primarily with upland landscapes during this period (Figure 2). The track frequency of 0.36 tracks/km track-day recorded in upland landscapes was almost 50% greater than that on the Athabasca

River escarpment, and ten times greater than that in riparian floodplains/terraces, where frequencies were 0.25 and 0.04 tracks/km track-day, respectively.

Almost all of the moose observed in the western portion of the Suncor survey area during February were concentrated in small areas of good habitat. Thirteen moose, which included two bulls, seven cows, and four calves were concentrated within an area of approximately 6 $km^2$ in the southwestern part of this area (Figure 1). All of these animals were recorded in either trembling aspen or riparian balsam poplar (*Populus balsamifera*) stands. All remaining moose in western portion of the survey area were observed within 1.5 km of the Athabasca River or Poplar Creek. A single cow with a calf was recorded near the Athabasca River in the northeastern part of this portion of the Suncor survey area and a lone bull was recorded in aspen forest adjacent to the Athabasca River in the southern part of the survey area. Four cows and five calves were recorded in the vicinity of Poplar Creek.

Aerial survey results indicated that moose were not disproportionately associated with the riparian floodplains and terraces of the Athabasca River during December (P=0.65); however, a few small concentrations of moose were recorded in the eastern portion of the study area. Three bulls were observed in a recent clearcut approximately 800 meters east of the Athabasca River and four moose, which included three bulls and a cow, were recorded at the top of the Athabasca River escarpment near Wood Creek. An additional three moose, which included a bull, a cow, and a calf, were recorded in black spruce-tamarack fen near Leggett Creek.

In contrast, track count studies indicated that, in December 1995, moose in the Suncor study area were associated primarily with the Athabasca escarpment (P=0.002, Figure 2). The track frequency of 0.99 tracks/km track-day recorded on this landscape feature was over twice those of 0.48 and 0.46 tracks/km track-day recorded in upland area and riparian floodplains/terraces, respectively.

In the western portion of the study area, three bulls were recorded in closed mixedwood forest near the mouth of Poplar Creek, and two cows and a calf were observed in aspen forest near Highway 63 in December. Six moose, which included four cows and two calves, were recorded in aspen forest near Poplar Creek upstream of the Poplar Creek Reservoir.

The results of the various census techniques employed in this study generally agree that deciduous forest in escarpment landscapes provides important habitat for moose in the Suncor study area. Aerial surveys indicated that the use of various habitat types by moose differed significantly in February 1995 ($P<0.001$). During that month, moose in the Suncor study area preferred closed deciduous and mixedwood forests (Table 5), which contained densities of 0.70 and 0.74 moose/$km^2$, respectively (Figure 3). Overall, 77% of the moose recorded during the February aerial survey were observed in these two habitat types, which together comprise only 23% of the study area. In contrast, moose neither preferred nor avoided open tamarack/fen and black spruce-tamarack, which contained 0.35 and 0.22 moose/$km^2$, respectively. All remaining habitat types contained less than 0.04 moose/$km^2$ and were avoided by moose.

Moose were more evenly distributed among habitat types during the December aerial survey than they were in February (Figure 3). A statistical analysis indicated that no habitat types were preferred by moose during this period and that most habitat types, including closed deciduous and mixedwood forest, were used in proportion to their availability ($P=0.014$). However, moose densities of 0.48 and 0.46 moose/$km^2$ recorded in closed deciduous and mixedwood forests, respectively, were the highest recorded in any habitat type. Three habitat types, closed jack pine (*Pinus banksiana*), closed white spruce (*Picea glauca*), and mixed coniferous forest, contained no moose and were avoided during December (Table 6).

Pellet-group surveys also indicated that closed deciduous forest on escarpment landscapes received the highest use by moose of any ecotype in the Suncor study area during winter 1995 (Figure 4). A total of 50 pellet-groups/ha were recorded in this ecotype, compared to 34/ha for closed deciduous forest in riparian landscapes and 16/ha in closed deciduous forest in upland landscapes, the second and third ranked ecotypes, respectively. Pellet group densities in the remaining ecotypes did not exceed 13/ha.

In contrast, tracking studies indicated that the habitat preferences of moose differed between February and December 1995 ($P<0.001$), although these differences were slight. During February, open tamarack/fen contained the highest frequency of moose tracks in the Suncor study area (Figure 5); 0.65 tracks/km track-day were recorded in this habitat type compared with 0.38 tracks/km track-day in black spruce-tamarack, which had the second highest track frequency. Track frequencies of 0.10 to 0.30 tracks/km track-day were recorded in closed jack pine forest, closed deciduous forest, closed black spruce, and wetland shrub complex. In contrast, moose track frequencies in the remaining seven habitat types did not exceed 0.10 tracks/km track-day.

During December, closed jack pine forest, which contained 2.40 moose tracks/km track-day, had the highest track frequency for moose; however, this high frequency is likely the result of low sampling effort in this habitat type; six moose tracks were recorded in only 2.5 km track-days in jack pine forest during the December tracking study. In contrast, track frequencies of 1.33 and 1.14 tracks/km track-day were recorded in disturbed habitats (primarily clearcuts) and fen, the second and third ranked habitat types, respectively.

Although there were significant differences in moose track frequencies among habitat types, tracking studies indicated that none of the habitat types identified in the Suncor study area were preferred by moose, during either February or December (Table 7). During February, all upland coniferous forest types (jack pine, white spruce, mixed coniferous) except closed jack pine forest were avoided and moose also avoided mixedwood forest, shorelines, and fen ($P<0.001$). The remaining habitat types were used in proportion to their availability.

Track surveys indicated that habitat use during December did not differ substantially from that in February, although upland coniferous forest was used in proportion to its availability during December and (closed black spruce and open tamarack fen) were avoided ($P=0.042$).

In contrast to the present study, most other studies in the Fort McMurray region have indicated that riparian habitat types are preferred by moose during winter. Thompson et al. (1980) reported that moose in the Fort McMurray region preferred riparian areas because of their comparatively high production of browse, which was maintained by seasonal flooding and ice scouring, and Penner (1976) similarly reported that, during late winter, moose preferred riparian and tall shrub communities. Moose near Calumet Lake preferred riparian aspen stands and willow-dominated habitats over other habitat types (Westworth and Brusnyk 1982a), whereas moose near the Fort Hills preferred riparian shrub (Skinner and Westworth 1981). However, Nowlin (1977) reported that moose in the Fort McMurray region preferred aspen and mixedwood forest, and used tall shrub habitats in proportion to their availability.

*Browse Production and Use*

In determining the amount of browse produced and consumed by ungulates in the Suncor study area, it was assumed that most of the browse consumed in 1995 was eaten by moose. This assumption was based on the fact that 133 moose were recorded during aerial surveys in the Suncor study areaas as compared with only seven white-tailed deer. Moreover, Telfer (1978) reported that moose rely more heavily on browse for forage than other ungulate species.

Regression equations developed to determine the relationship between twig diameter and twig weight indicated that the two variables were strongly related for all browse species (Table 8). The coefficient of determination ($r^2$), which indicates the proportion of the variance in twig weight explained by twig diameter, ranged from 0.73 to 0.95.

Browse production and utilization in the Suncor study area varied widely among both habitat types and landscape features (Figure 6). Wetland shrub complex in both riparian and upland landscape features produced the greatest browse biomass. In upland landscapes, this habitat type produced 6226 kg/ha of browse as compared with 1637 kg/ha in riparian landscapes. Browse utilization in shrub complex also differed among landscape features; no browse was consumed in riparian landscapes, whereas 22% of the browse produced in upland landscapes was consumed. Browse production was also comparatively high in closed deciduous forest. In riparian, escarpment, and upland landscape features this forest type produced 1215, 548, and 1019 kg/ha of browse, respectively. Browse utilization was also high in this habitat type, particularly in escarpment landscapes where utilization exceeded production by 18% (Figure 6). In contrast, ungulates consumed 57% and 23% of the browse produced in deciduous forests in riparian and upland landscape features, respectively. Browse production was also high (542 kg/ha) in open black spruce-labrador tea forest in upland landscapes, although no ungulate browse was recorded in this habitat type. In contrast, browse production and utilization in other ecotypes did not exceed 300 kg/ha and 95 kg/ha, respectively.

### 3.1.2 Deer

*Relative Abundance*

Only seven deer were recorded during the two aerial surveys conducted in the Suncor study area (Figure 1). Two white-tailed deer, a doe and a fawn, were recorded in deciduous forest near the Steepbank River during the February survey and five white-tailed deer were recorded during the December survey. Two of the five deer observed in February were recorded in mixedwood forest near the Steepbank River, whereas the other three were recorded in deciduous forest near Highway 63.

Tracking studies also indicated that deer were less abundant than moose in the Suncor study area. During February, 32 deer tracks were recorded for an overall track frequency of only 0.09 tracks/km track-day and track frequencies were similar on the east and west sides of the Athabasca River (0.09 vs. 0.08 tracks/km track-day). However, the track frequency in December was higher than that in February; 15 deer tracks were observed during December for a track frequency of 0.14 tracks/km track-day for that period.

Deer track frequencies recorded in this study are much higher than those recorded during other tracking studies in the Fort McMurray region. Near Calumet Lake, Westworth and Brusnyk (1982a) recorded deer tracks on only a single transect and believed that a lone deer was represented. Similarly, only a single deer track was recorded near the Fort Hills in the winter of 1980-81 (Skinner and Westworth 1981).

***Habitat Associations***

Because tracking studies indicated that the habitat associations of deer did not differ between February and December 1995 ($P>0.90$), the data from both periods were combined to assess habitat utilization. The highest track frequencies for deer were recorded in closed deciduous forest and disturbed habitats, which contained 0.20 and 0.15 tracks/km track-day, respectively (Figure 7). However, although a variety of disturbed habitats occur within the study area, deer tracks were usually associated with clearcuts, in which regenerating shrubs provide winter forage. Track frequencies for deer in other habitat types were lower. A total of 0.12 deer tracks/km track-day was recorded in both closed jack pine and mixed coniferous forest. Track frequencies in the remaining habitat types did not exceed 0.07 tracks/km track-day.

A statistical analysis of the tracking data indicated that deer were disproportionately associated with specific habitat types ($P=0.002$). Deer in the Suncor study area preferred closed deciduous forest over all other habitat types and neither preferred nor avoided upland coniferous forest (white spruce, jack pine, mixed coniferous), mixedwood forest, black spruce-tamarack, closed black spruce, open taramarck fen, and disturbed habitat types. All remaining habitat types were avoided (Table 9).

A disproportionate number of deer tracks within the Suncor study area were recorded in landscape features associated with the Athabasca River (P=0.035) in February, although this was not the case in December (P=0.58). In February, riparian floodplains/terraces, and escarpments contained 0.13 and 0.15 tracks/km track-day, respectively, as compared with a frequency of 0.05 tracks/km track-day, recorded on transects in upland sites (Figure 8). The relationship between deer and landscape features associated with the Athabasca River likely reflects the preference of deer for closed deciduous forest, which, on the east side of the Athabasca, occurs predominantly near the river.

The results of pellet-group counts were generally similar to those of the tracking study. Deer pellet group density in closed deciduous forest differed among landscape features. Twenty pellet groups/ha were recorded in this habitat type in escarpment features, which is over twice the density of nine and six groups/ha recorded in upland and riparian landscape features, respectively. The highest deer pellet group density was recorded in reclaimed conifer habitat, in which 35 pellet groups/ha were recorded, whereas mixedwood forest in upland landscapes ranked second with 26 groups/ha (Figure 9). In comparison, deer pellet group density did not exceed five groups/ha in any of the remaining ecotypes.

### 3.1.3 Woodland Caribou

No woodland caribou or caribou sign was observed in the Suncor study area during either aerial surveys or tracking studies conducted in 1995. This species was also not recorded in the present Suncor study area during caribou studies conducted in the 1970s, although they were frequently observed in an area extending from the Birch Mountains to the McKay River (Fuller and Keith 1980a). However, several caribou herds are known to occur in the study region, near Muskeg Mountain, the Birch Mountains and Thickwood Hills (B. Rippen, Alberta Environmental Protection, pers. comm.).

The lack of caribou sign in the Suncor study area likely reflects a long-term, province-wide decline in caribou numbers (Edmonds 1986) and the marginal quality of habitat present within the study area. Bradshaw et al. (1995) recently examined habitat selection by caribou in the Fort McMurray region in relation to peatland classes developed by Vitt et al. (1992). These authors found that peatland complexes preferred by caribou had the following characteristics:

- at least 25% forest cover and 25% open area, or forested fen with any combination of tamarack, black spruce, willow, and birch,
- largely minerotrophic but may have ombrotrophic or oligotrophic areas dominated by black spruce, and
- more than 50% peatland within a habitat polygon.

Peatlands with these characteristics, which are found primarily adjacent to McLean Creek, occupy less than 3% of the Suncor study area. Moreover, because none of these peatlands occupies an area of greater than 4 $km^2$, they are probably too small to provide habitat for caribou.

The largest mapped peatland in the study area (Vitt et al. 1992), which covers an area of approximately 100 $km^2$ north of the Steepbank River and east of Saline Lake, occupies less than 15 $km^2$ of Suncor's local study area. However, this polygon contains less than 15% peatland cover. Data presented by Bradshaw et al. (1995) indicate that peatlands with these characteristics receive a moderate amount of use by caribou.

## 3.2 Small Herbivores

### 3.2.1 Snowshoe Hare

***Relative Abundance***

The frequency of snowshoe hare (*Lepus americanus*) tracks was low in the Suncor study area during both February and December 1995. In February, 181 snowshoe hare tracks were recorded for an overall track frequency of only 0.49 tracks/km track-day. However, the frequency of snowshoe hare tracks recorded during this period differed significantly between the western and eastern portions of the Suncor study area ($P<0.001$). Only 0.19 tracks/km track-day were recorded east of the Athabasca River, whereas 1.63 tracks/km track-day were recorded west of the river.

Although the track frequency of 4.14 tracks/km track-day recorded in December was over eight times that recorded in February, it was also extremely low compared to those reported in other tracking studies conducted in the Fort McMurray region. Skinner and Westworth (1981) recorded 21.15 tracks/km track-day in the vicinity of the Fort Hills during the winter of 1980-81, whereas Westworth and Brusnyk

(1982b) reported a frequency of 76.2 tracks/km track-day near Calumet Lake in 1981-82.

Snowshoe hare populations undergo cyclic fluctuations approximately every 10 years, during which abundance may change over 20-fold (Keith and Windberg 1978, Keith et al. 1984). Although snowshoe hare populations in the Fort McMurray area have been low for several years (C. Graves, K. Schmidt, pers. comm.), data obtained by the Alberta Fish and Wildlife Division show that numbers are beginning to increase throughout most of the province (F. Kunnas, pers. comm.). Most cyclic events for snowshoe hares in Alberta occur initially in the northeastern part of the province and then spread across Alberta (Smith 1983). Consequently, snowshoe hare populations in the Suncor study area could increase to high levels over the next few years.

***Habitat Associations***

Habitat utilization by snowshoe hares in the Suncor study area differed significantly between February and December 1995 ($P<0.001$); however, the data from both periods were combined because the differences between February and December were slight and appeared to be related primarily to differences in the sampling regime and track frequencies. Overall, snowshoe hare track frequencies were greatest in mixed coniferous and closed jack pine forest, which contained 4.88 and 4.58 tracks/km track-day, respectively; however, track frequencies in mixedwood forest and closed black spruce, which exceeded 2.60 tracks/km track-day, were also high (Figure 10). A statistical analysis indicated that these four habitat types were preferred by snowshoe hares, whereas the remaining habitat types, all of which contained less than 0.60 tracks/km track-day, were avoided ($P<0.001$, Table 10).

During February, the habitat preferences of snowshoe hares differed significantly between the eastern and western portions of the Suncor study ($P<0.001$), although these differences were slight. Snowshoe hares in both areas preferred closed jack pine to all other habitat types and neither preferred nor avoided closed black spruce-tamarack ($P<0.001$). However, hares in the western portion of the study area avoided other upland coniferous forest types, mixedwood forests, and closed black spruce, all of which were used in proportion to their availability in the eastern part of the study area during February.

The habitat preferences indicated by this study differ slightly from those reported in other studies conducted in the Fort McMurray region. Westworth and Brusnyk (1982b) also reported that snowshoe hares near Calumet Lake preferred jack pine forest in addition to deciduous and white spruce forests.

In contrast, snowshoe hares near the Fort Hills avoided jack pine and preferred mixedwood, black spruce, and riparian white spruce forest (Skinner and Westworth 1981).

Although Keith (1966) reported that snowshoe hares near Rochester, Alberta preferred shrubby habitats, this study indicated that snowshoe hares were most abundant in habitats with a strong coniferous component. Other studies have also indicated that coniferous cover is important to this species. Skinner and Westworth (1981) suggested that, near the Fort Hills, hares were most common where both coniferous cover and a well-developed shrub layer were present. Studies conducted in New York similarly indicated that this species preferred habitats with a well-developed coniferous overstory, although shrub-dominated habitats provided most of the winter forage (Rogowitz 1988).

***Distribution Among Landscape Features***

Snowshoe hare track frequencies differed significantly among landscape features in both February and December ($P<0.01$ in both cases). During both periods, the track frequency in upland landscapes was over twice that in riparian floodplains/terraces and on the Athabasca River escarpment (Figure 11). The distribution of hares among landscape features appeared to be related to the distribution of mixedwood and coniferous forests, which are preferred by hares and occur primarily in upland landscapes.

### 3.2.2 Red Squirrel

***Relative Abundance***

Few red squirrel (*Tamiasciurus hudsonicus*) tracks were recorded in the Suncor study area in February 1995, whereas tracks of this species were frequently observed in December. During February, only 154 squirrel tracks were observed for a track frequency of 0.42 tracks/km track-day. Track frequencies during this period were similar in both the eastern and western portions of the study area (0.41 vs. 0.45 tracks/km track-day, $P=0.70$). In contrast, red squirrel track frequencies were much higher in December when 2.78 tracks/km track-day were recorded.

The February track frequency recorded in this study is much lower than those reported from other studies in the Fort McMurray region, whereas the December track frequency is higher. Westworth and Brusnyk (1982b) recorded an overall frequency of 1.59 tracks/km track-day near Calumet Lake during winter 1981-82, whereas Skinner and Westworth (1981) recorded 2.08 tracks/km track-day in the vicinity of the Fort Hills in winter 1980-81.

*Habitat Associations*

Although habitat use by red squirrels differed significantly (P<0.001) between February and December, both seasons were combined to determine the habitat preferences of this species. This was done because differences in habitat use between the two study periods were slight. Moreover, because red squirrels in Alberta have small home ranges, they are unlikely to move seasonally between habitats. Rusch and Reeder (1978) reported that average territory size for red squirrels in central Alberta is only about 0.30 ha.

The highest track frequency for red squirrels in the Suncor study area was recorded in closed jack pine forest followed by mixed coniferous forest. These two habitat types contained 3.50 and 3.20 tracks/km track-day, respectively (Figure 12) and a Bonferroni Z-test indicated that they were preferred by squirrels (Table 11, P<0.001). Squirrels neither preferred nor avoided closed white spruce, closed deciduous, and closed mixedwood forests. Track frequencies in these three habitat types ranged from 0.89 to 2.60 tracks/km track-day. All remaining habitat types contained track frequencies of less than 0.40 tracks/km track-day and were avoided by squirrels.

The habitat associations of the red squirrel differed significantly between the eastern and western portions of the study area in February (P<0.001). Squirrels in the eastern portion of the study area neither preferred nor avoided closed jack pine, although this habitat type was preferred in the western portion of the study area (P<0.001 in both cases). In contrast, squirrels in the eastern portion of the study area preferred disturbed habitats, which were avoided in the western portion of the study area.

The habitat relationships as indicated by this study are generally similar to those reported in other tracking studies in the Fort McMurray region. Near the Fort Hills, red squirrels preferred jack pine and white spruce forest, although deciduous and mixedwood forests were also preferred (Skinner and Westworth 1981). Squirrels near Calumet Lake preferred white spruce forest, as well as mixedwood and black spruce forests (Westworth and Brusnyk 1982b).

Although this study indicated that red squirrels in the Suncor study area neither preferred nor avoided white spruce forest, this is probably the result of low sampling effort in this habitat type (Table 2). Most other studies have shown that white spruce forest provides excellent habitat for this species. In Alberta, red squirrel populations are correlated with the production of white spruce cones (Kemp and Keith 1970); consequently, white spruce forest usually supports a much higher density of red squirrels than other habitat types. Todd (1978) reported that red squirrel densities in white spruce forest were usually greater than 1.8 animals/ha as compared to 0.4 to 0.8/ha in black spruce forest. Brink and Dean (1966) also reported that white spruce forest was preferred by red squirrels but that black spruce forest supported subordinate individuals and was important because it continued to produce forage when the white spruce cone crop failed.

***Distribution Among Landscape Features***

Red squirrel abundance differed significantly among landscape features in both February and December ($P<0.001$ in both cases). In February, the track frequency on the escarpment was 1.88 tracks/km track-day, which is over twice the frequencies of 0.96 and 0.56 tracks/km track-day recorded in riparian floodplains/terraces and upland landscapes, respectively. Although track frequencies were much higher in December, the pattern of use among landscape features was similar (Figure 13). The distribution of red squirrels in relation to landscape features appears to be related to the prevalence of lowland coniferous forests (black spruce and tamarack), which were avoided by red squirrels, in upland landscapes.

## 3.3 Terrestrial Carnivores

### 3.3.1 Lynx

Lynx (*Lynx lynx*) tracks were uncommon in the Suncor study area. No lynx tracks were recorded during December and only four lynx tracks, all of which were observed in the eastern portion of the study area, were recorded in February for a track frequency of 0.01 tracks/km tracks-day for that period. During February, a single lynx track was observed in each of four different habitat types: closed deciduous forest, mixed coniferous forest, black spruce-tamarack, and disturbed habitat.

The lynx track frequency recorded in this study was much lower than those recorded in other studies in the Fort McMurray region. Westworth and Skinner (1981) reported a frequency of 0.06 tracks/km-track day near the Fort Hills, whereas Westworth and Brusnyk (1982b) recorded 0.13 tracks/km-track day near

Calumet Lake and indicated that the lynx was one of the most abundant carnivores in that area. Lynx near Calumet Lake preferred aspen forests and avoided most coniferous forest types.

Low lynx populations in the Suncor area are likely related to the scarcity of snowshoe hares, their principal prey species. During periods of abundance, snowshoe hares comprise 75 to 95% of the diet of lynx (van Zyll de Jong 1966, Nellis et al. 1972, Brand et al. 1976, Koonz 1976, Parker 1981). Because lynx rely so heavily on snowshoe hares for food, lynx populations may change over 4-fold in response to fluctuations in snowshoe hare abundance. Lynx population cycles usually lag those of the snowshoe hare by one to two years (Brand et al. 1976, Brand and Keith 1979).

### 3.3.2 Wolf

***Relative Abundance***

Wolf track frequencies (*Canis lupus*) in the Suncor study area were somewhat higher in December than February. During December 1995, 15 wolf tracks were recorded for an overall track frequency of 0.14 tracks/km track-day. In contrast, 33 tracks, all of which were observed in the eastern portion of the study area, were recorded in February for a track frequency of 0.09 tracks/km track-day. G. Graves (pers. comm.) believes that two wolf packs, one of which is composed of five or six individuals, have ranges that include portions of the Suncor study area.

The frequency of wolf tracks recorded in the Suncor study area during 1995 is much higher than those recorded during other studies conducted in the Fort McMurray region in the early 1980s. Westworth and Brusnyk (1982b) recorded 0.04 wolf tracks/km-track day near Calumet Lake, whereas Skinner and Westworth (1981) recorded only 0.01 tracks/km track-day near the Fort Hills in 1981.

Wolf packs in the Fort McMurray region were the subject of an intensive study conducted from 1975 to 1978 (Fuller and Keith 1980b). Four wolf packs, two of which may have occupied portions of the Suncor study area were identified during that study. The Syncrude Pack, which comprised six to 12 individuals, occupied a territory that abutted the northern boundary of the western portion of the Suncor study area, whereas the Black Pack, which was composed of three animals, occupied a territory that included the eastern portion of the Suncor study area north of the Steepbank River. Although the three wolves in the Black Pack appeared to be in poor physical condition, they established a natal den, the location of which was not identified, in April 1978. However, this den was subsequently abandoned and no pups were observed (Fuller and Keith 1980b).

The Muskeg River Pack, which occupied a territory immediately to the north of the Black Pack, was the most intensively studied of the four packs in the area. This pack, which was composed of nine to 13 wolves, averaged a moose kill every 4.7 days and annually killed between 10% and 15% of the moose in their territory (Fuller and Keith 1980b). Eighty-eight percent of the moose killed by the Muskeg River Pack were taken in lowlands, even though moose and wolf activity was almost evenly divided between upland and lowland areas.

***Habitat Associations***

Because the number of wolf tracks observed in December was insufficient for an analysis of habitat utilization, they were combined with the February sample for the purposes of data analysis. Overall, wolf track frequencies in the Suncor study area were highest in mixed coniferous forest and closed black spruce, which contained 0.28 and 0.23 tracks/km track-day, respectively (Figure 14). These track frequencies were almost twice those in closed deciduous forest and disturbed habitats, which contained 0.11 and 0.15 tracks/km track-day, respectively. Track frequencies in the remaining habitat types were less than 0.06 tracks/km track-day.

A Bonferroni Z-test indicated that no habitat type in the Suncor study area was preferred by wolves (P=0.031). Most habitat types, which included upland coniferous forest, closed deciduous forest, black spruce-tamarack,closed black spruce, open tamarack fen, and disturbed habitats, were used in proportion to their availability. All other habitat types were avoided by wolves (Table 12). In general, the habitat relationships of wolves reflected those of moose, their principal prey species in northeastern Alberta.

The habitat associations in this study differ from those reported for wolves in the Calumet Lake area during the winter of 1981-82 (Westworth and Brusnyk 1982a). Wolves in that area preferred willow wetland and riparian aspen poplar communities; however, those authors also noted that habitat use by wolves reflected that of moose.

*Distribution Among Landscape Features*

Wolves in the Suncor study area were not evenly distributed among landscape features. During February, the frequency of wolf tracks was highest on the Athabasca River escarpment, where 0.18 tracks/km track-day were recorded (Figure 15). This compares with 0 and 0.12 tracks/km track-day recorded in riparian floodplain/terraces and upland habitats, respectively (P=0.014). Wolves also appeared to be associated with the escarpment in February, although differences in track frequencies among landscape features during this period were not statistically significant (P=0.25). During December, 0.21 and 0.16 wolf tracks/km track-day were recorded on the escarpment and riparian floodplain/terraces, respectively, as compared with only 0.05 tracks in upland landscapes.

Differences in the distribution of wolf tracks among landscape features may be related to differences in the abundance and species composition of ungulate prey. Based on tracking data, ungulate prey (moose and deer) were almost evenly distributed between the Athabasca River escarpment and upland landscapes in February 1995 (0.40 vs. 0.41 ungulate tracks/km track-day); however, deer, which are more susceptible to wolf predation than moose (Mech 1970), were three times more abundant on the escarpment than in upland landscapes in February (Figure 8). In contrast, ungulate prey was almost twice as abundant on the escarpment as in other landscape features in December. During that month, 1.12 ungulate tracks/km track-day were recorded on the escarpment as compared with 0.66 and 0.58 tracks/km track-day in riparian floodplain/terraces and uplands, respectively.

### 3.3.3 Coyote

*Relative Abundance*

During both December and February, 48 coyote (*Canis latrans*) tracks were recorded in the Suncor study area, which resulted in overall track frequencies of 0.45 and 0.13 tracks/km track-day during those months, respectively. The track frequency recorded in February is similar to those obtained in tracking studies conducted near Calumet Lake (Westworth and Brusnyk 1982b) and the Fort Hills (Skinner and Westworth 1981), whereas the December track frequency is much higher. Coyote track frequencies near Calumet Lake and the Fort Hills were 0.13 and 0.10 tracks/km track-day, respectively.

The results of the February track survey indicated that coyotes are much more abundant in the western than in the eastern portion of the Suncor study area (0.36 vs. 0.07 tracks/km track-day, P<0.001).

Relatively low coyote abundance in the eastern part of the study area during February may be related, at least in part, to a comparatively high wolf population. Mech (1970) reported that coyotes became scarce on Isle Royale following the arrival of wolves and cited a number of other studies which also suggest that the presence of wolves may reduce coyote populations (Munro 1947, Stenlund 1955, Pimlott and Joslin 1968).

***Habitat Associations***

Because the habitat preferences of coyotes did not differ between the December and February track surveys (P=0.72), data from both periods were combined to determine coyote habitat utilization. The highest coyote track frequency in the Suncor study area was observed in fens, in which 0.50 tracks/km track-day were recorded; however, track frequencies were also comparatively high in black spruce-tamarack and closed deciduous forest, which contained 0.37 and 0.34 tracks/km track-day, respectively (Figure 16). Track frequencies in four habitat types, mixed coniferous forest, closed mixedwood forest, open tamarack/fen, and disturbed habitats ranged from 0.10 to 0.20 tracks/km track-day, whereas track frequencies in other habitat types did not exceed 0.08 tracks/km track-day.

Statistically, closed deciduous forest was preferred by coyotes (P<0.001), although most other habitat types in the Suncor study area were used in proportion to their availability (Table 13). In contrast, two habitat types, closed black spruce and shorelines, were avoided.

Habitat preferences reported by Westworth and Brusnyk (1982b) are generally similar to those in this study. Coyotes in their study area near Calumet Lake preferred habitat dominated by balsam poplar, which was combined with closed deciduous forest in this study, and jack pine forest, whereas black spruce forest was used in proportion to its availability. In contrast, Skinner and Westworth (1981) reported that coyotes near the Fort Hills preferred black spruce forest and avoided open muskegs.

In February, coyotes in the eastern and western portions of the study area preferred different habitat types (P<0.001). In the western part of the study area, coyotes preferred black spruce-tamarack forest, neither preferred nor avoided closed deciduous forest, and avoided the remaining habitat types (P<0.001). In contrast, coyotes in the eastern part of the study area preferred closed deciduous forest, avoided lowland coniferous forests, and neither preferred nor avoided the remaining habitat types (P<0.001).

Although no relationship between coyote habitat utilization and snowshoe hare abundance was evident from this study, other studies conducted in Alberta have indicated that coyote populations in the boreal forest region are greatly influenced by the abundance of snowshoe hares, their principal prey species. Keith et al. (1977) indicated that coyote populations in boreal forest regions fluctuated 3- to 6-fold in response to the snowshoe hare cycle and Todd et al. (1981) found that the reproductive performance of coyotes was related to snowshoe hare abundance.

***Distribution Among Landscape Features***

During February 1995, overall coyote track frequencies in riparian floodplain/terraces and the Athabasca River escarpment, which contained 0.11 and 0.08 tracks/km track-day (Figure 17), were greater than those in upland landscapes (0.05 tracks/km track-day); however, coyotes did not exhibit a significant preference for any of the various landscape features in the Suncor study area (P=0.35). In contrast, during December, differences in utilization among landscape features were significant (P<0.001). The track frequency of 1.15 tracks/km track day recorded in riparian floodplains/terraces was over five times that in upland landscapes and the Athabasca River escarpment, which contained 0.15 and 0.19 tracks/km track-day, respectively.

### 3.3.4 Red Fox

The red fox (*Vulpes vulpes*) was uncommon in the Suncor study area during 1995; only seven fox tracks were recorded during the tracking study for an overall track frequency of 0.02 tracks/km track-day. Four fox tracks were recorded in closed deciduous forest, two were recorded in disturbed habitats, and one was recorded in mixed coniferous forest. Of the six tracks recorded in the eastern part of the study area, four were observed in riparian floodplain/terraces and two were observed on the Athabasca River escarpment.

The track frequency in this study is similar to that of 0.02 tracks/km track-day recorded near Calumet Lake in 1982 (Westworth and Brusnyk 1982b) but is much lower than the frequency of 0.08 tracks/km track-day recorded near the Fort Hills in 1981 (Skinner and Westworth 1981).

### 3.3.5 Fisher

*Relative Abundance*

The fisher appeared to be uncommon in the Suncor study area in February 1995. Only 15 fisher tracks were recorded for an overall track frequency of 0.04 tracks/km track-day; however, the track frequency for fishers differed significantly between the eastern and western parts of the study area (0.02 vs. 0.10 tracks/km track-day, $P<0.001$). In contrast, fisher tracks were observed much more frequently during December, when 22 tracks were recorded for a track frequency of 0.21 tracks/km track-day.

The December track frequency for fishers in this study is much higher than that of 0.05 tracks/km track-day reported for the combined tracks of fisher and marten near the Fort Hills (Skinner and Westworth 1981), whereas the overall February track frequency of 0.04 is similar. Westworth and Brusnyk (1982b) reported a track frequency of 0.12 tracks/km track-day for these two species near Calumet Lake.

*Habitat Associations*

Because of the low number of fisher tracks observed in the study area, February and December tracking data were combined to determine the habitat preferences of this species. Overall, the highest track frequency in the Suncor study area was recorded in black spruce-tamarack forest, which contained 0.19 tracks/km track-day, followed by fen, closed deciduous forest, and open tamarack/fen, which contained 0.13, 0.12, and 0.11 tracks/km track-day, respectively (Figure 18). Track frequencies in the remaining habitat types did not exceed 0.04 tracks/km track-day.

A Bonferroni z-test indicated that fishers in the Suncor study area preferred black spruce-tamarack forest over other habitat types ($P<0.001$), whereas closed deciduous forest, closed black spruce and open tamarack fen were neither preferred nor avoided (Table 14). All remaining habitat types were avoided by this species.

Other tracking studies conducted in the Fort McMurray region have found that track frequencies for fisher and marten were highest in jack pine, white spruce, and mixedwood habitat types, whereas few tracks occurred in open muskegs (Skinner and Westworth 1981, Westworth and Brusnyk 1982b).

Because few studies have been conducted to determine the habitat preferences of fishers, they are poorly known. However, a survey of Ontario trappers indicated that 23% of the winter habitat use by fishers was in wetlands, 21% in old mixedwood forest, 21% in young mixedwood forest, 11% in old deciduous forest, 8% in old conifer forest, 8% in young deciduous forest, 6% in young conifer forest, and 2% in other habitat types (Douglas and Strickland 1987). Fishers in Wisconsin are reported to prefer lowland mixedwood forest and avoid lowland coniferous forest (Kohn et al. 1993). However, Douglas and Strickland (1987) reported that the habitat preferences of this species were probably related primarily to prey availability.

*Distribution Among Landscape Features*

This study indicated that fishers are much more abundant in riparian floodplains/terraces than elsewhere in the Suncor study area (P=0.048). Riparian floodplains/terraces contained 0.13 tracks/km track-day as compared with 0.07 and 0.03 in upland landscapes and the Athabasca River escarpment, respectively (Figure 19).

### 3.3.6 Marten

*Relative Abundance*

The track frequency for marten in February 1995 was much higher than that recorded in December. During February, 38 marten tracks were recorded in the Suncor study area for a frequency of 0.10 tracks/km track-day, whereas only four tracks were recorded in December for a frequency of 0.04 tracks/km track-day. In December, the track frequency for this species in the eastern portion of the study area was over twice that in the western part of the study area, although this difference was not significant (0.12 vs. 0.05 tracks/km track-day, P=0.13).

The February track frequency recorded in this study is similar to that of 0.12 tracks/km track-day reported for fisher and marten combined near Calumet Lake during the winter of 1981-82 (Westworth and Brusnyk 1982b) but is much higher than the frequency of 0.05 tracks/km track-day for these two species recorded near the Fort Hills during the winter of 1980-81 (Skinner and Westworth 1981). Conversely, the December track frequency recorded in this study is similar to that reported for near the Fort Hills but is much lower than that reported near Calumet Lake. Although Todd (1976) reported that marten were uncommon and sparsely distributed in northeastern Alberta in the 1970s, marten populations in the region have apparently increased since that time (F. Neumann, pers. comm.).

***Habitat Associations***

Because of the low number of marten tracks recorded in the Suncor study area in December, data from that month were combined with those from February for the purposes of data analysis. Marten in the Suncor study area were associated primarily with closed white spruce forest, which contained 1.00 marten tracks/km track-day (Figure 20). In comparison, mixed coniferous forest, the second-ranked habitat type, contained 0.44 tracks/km track-day and five habitat types, which included closed jack pine forest, closed deciduous forest, mixedwood forest, black spruce-tamarack, and closed black spruce, contained from 0.05 to 0.15 tracks/km track-day. Marten tracks were not recorded in any of the remaining habitat types.

Marten did not use habitat types in proportion to their availability in the study area ($P<0.001$). Marten preferred upland coniferous forests over other habitat types, whereas closed deciduous forest, closed mixedwood forest, black spruce-tamarack, closed black spruce and open tamarack fens were neither preferred nor avoided (Table 15). Marten avoided the remaining habitat types.

The habitat preferences of marten as indicated by this study are similar to those reported by other workers. Marten have more specific habitat preferences than most other carnivores and several studies have indicated that the species prefers late-successional or climax coniferous or mixedwood forests, particularly those in which numerous deadfalls provide denning opportunities and access to microtine prey in the subnivian environment (Koehler and Hornocker 1977, More 1978, Hargis and McCullogh 1984, Bateman 1986, Slough 1989). Microtine rodents, particularly the red-backed vole (*Clethrionomys* spp.), are considered the principal prey of the marten (Cowan and Mackay 1950, Quick 1955, Weckworth and Hawley 1962, More 1978); however, some studies have indicated that snowshoe hares are also an important prey species when they are abundant (Bateman 1986, Raine 1987).

***Distribution Among Landscape Features***

Marten were not evenly distributed among the landscape features in the Suncor study area ($P=0.028$). The overall track frequencies of 0.14 and 0.13 marten tracks/km track-day recorded on the Athabasca River escarpment and in riparian floodplain/terraces, respectively, were approximately three times the frequency of 0.05 recorded in upland landscapes (Figure 21).

### 3.3.7 Weasel

*Relative Abundance*

The weasel was the most common mammal recorded the Suncor study area during both February and December 1995. During February, 307 weasel tracks were observed for a track frequency of 0.83 tracks/km track-day, whereas 555 tracks were recorded during December for a track frequency of 5.16 tracks/km track-day. However, in February, the track frequency for weasels in the eastern portion of the Suncor study area was much higher than that recorded in the western portion of the study area (0.94 vs. 0.45 tracks/km track-day, $P<0.001$).

The February track frequency for weasels recorded in this study is somewhat lower that of 1.14 tracks/km track day and recorded near the Fort Hills during the winter of 1980-81 (Skinner and Westworth 1981) but is much higher than the frequency of 0.27 tracks/km track day recorded near Calumet Lake during the winter of 1981-82 (Westworth and Brusnyk 1982b). In contrast, the December track frequency in the Suncor study area is much higher than those recorded in other studies in the Fort McMurray region.

*Habitat Associations*

Because habitat use by weasels did not differ significantly between February and December ($P=0.082$), data from both periods were combined for the purposes of data analysis. Overall, the highest track frequencies for weasels were recorded in open tamarack/fen, fen, and closed black spruce, which contained 3.77, 3.63, and 3.25 tracks/km track-day, respectively. Track frequencies for this species were also relatively high in closed white spruce and black spruce-tamarack, which contained 2.80 and 2.52 weasel tracks/km track day (Figure 22). In contrast, mixed coniferous forest and closed deciduous forest contained 1.64 and 1.56 tracks/km track-day, respectively. Track frequencies of weasels in the remaining habitat types did not exceed 0.80 tracks/km track-day.

A statistical analysis ($P<0.001$) indicated that black spruce-tamarack, closed black spruce, open tamarack/fen, and fen were preferred by weasels in the Suncor study area (Table 16). In contrast, closed jack pine forest, closed mixedwood forest, wetland shrub complex, disturbed habitats, and shorelines were avoided. All remaining habitat types were used in proportion to their availability.

During February, the habitat preferences of weasels differed slightly between the eastern and western portions of the Suncor study area (P=0.004). Habitat preferences for this species in the eastern portion of the study area were identical to overall habitat preferences, whereas weasels in the western portion of the study area avoided closed jack pine/mixedwood and fens, and neither preferred nor avoided any of the remaining habitat types.

The results of this study are similar to those obtained in tracking studies conducted near the Fort Hills in winter 1980-81 (Skinner and Westworth 1981). That study also indicated that weasels preferred black spruce muskegs, whereas jack pine and open muskegs were avoided. In contrast, near Calumet Lake, habitat dominated by willow was preferred, whereas habitat dominated by black spruce was neither preferred nor avoided (Westworth and Brusnyk 1982b). However, other studies of weasels have indicated that they can occupy a variety of habitat types (Fagerstone 1987), although Simms (1979) reported that short-tailed weasels occurred most frequently in early-successional habitats and avoided forests.

***Distribution Among Landscape Features***

Track frequencies of weasels differed significantly among landscape features in the Suncor study area during both February and December 1995 (P<0.010 in both cases). During February, 1.10 tracks/km track-day were recorded in upland landscapes as compared to 0.75 and 0.77 tracks/km track-day, on the Athabasca River escarpment and floodplain/terrace landscape features, respectively (Figure 23). Although track frequencies were higher in December, the pattern among landscape features was similar; during this period, 8.15 tracks/km track-day were recorded in upland landscapes as compared with 3.52 and 3.31 on the Athabasca River escarpment and riparian floodplain/terraces. Greater track frequencies in upland landscapes probably reflects the prevalence of black spruce- and tamarack-dominated habitats, which were preferred by weasels in the Suncor study area.

### 3.3.8 Wolverine

Although no wolverine (*Gulo gulo*) tracks were recorded during the track study, the species likely occurs in the Suncor study area; during the 1993-94 trapping season, a wolverine was trapped on Registered Fur Management Area (RFMA) #587, which occupies part of the western portion of the study area. Track frequencies for wolverines have been very low during other tracking studies in the Fort McMurray region. Wolverine tracks were not observed near Calumet Lake in 1982 (Westworth and Brusnyk 1982b), and only 0.005 tracks/km track-day, which were believed to represent a single animal, were recorded near the Fort Hills in 1981 (Skinner and Westworth 1981).

The low number of wolverine tracks recorded during these studies reflects the sparse distribution of this species throughout its range. Wolverines, which are much less abundant than other similar-sized carnivores in Canada (van Zyll de Jong 1975), are considered the rarest furbearer in Alberta (Todd and Geisbrecht 1979).

## 3.4 Semiaquatic Carnivores

### 3.4.1 Mink

Mink (*Mustela vison*) were uncommon in the Suncor study area. Only ten mink tracks were recorded during the study for an overall track frequency of 0.02 tracks/km track-day. This track frequency is much lower than those recorded near both Calumet Lake (Brusnyk and Westworth 1982) and in the vicinity of the Fort Hills (Skinner and Westworth 1981), where 0.10 mink tracks/km track-day were recorded.

Four mink tracks were recorded in wetland shrub complex, whereas two tracks were recorded in each of closed deciduous forest, black spruce-tamarack, and fen for track frequencies of 0.15, 0.02, 0.03, and 0.13 tracks/km track-day for those three habitat types, respectively. All (n=4) of the mink tracks observed in the eastern portion of the study area were recorded in riparian floodplain/terraces near the Athabasca River. Although the low number of tracks recorded in the Suncor study area precluded an analysis of habitat preferences, these results are similar to those obtained in other tracking studies conducted in the Fort McMurray region, which indicated that mink preferred riparian shrub over other habitat types (Skinner and Westworth 1981, Brusnyk and Westworth 1982).

Other studies have indicated that the mink is usually associated with wetland habitats (Eagle and Whitman 1987), although adjacent riparian and upland habitats are also often used (Melquist et al. 1981). A study of mink food habits in the Muskeg River drainage indicated that snowshoe hares and microtine rodents comprised the bulk of the mink's diet, whereas birds, invertebrates, and fish were consumed much less frequently (Gilbert and Nancekivell 1982).

### 3.4.2 Otter

The otter (*Lutra canadensis*) appears to be uncommon in the Suncor study area. Only three otter tracks were recorded during this study for an overall track frequency of 0.01 tracks/km-track day. All of these tracks were recorded on a transect that followed the shoreline of a wetland located immediately northeast of the mouth of the Steepbank River. In comparison, Skinner and Westworth (1981) recorded 0.05 otter tracks/km track-day near the Fort Hills, whereas Brusnyk and Westworth (1982) recorded only 0.001 tracks/km track-day near Calumet Lake.

Otters are reported to prefer habitats that provide denning and resting sites in addition to an adequate food supply (Melquist and Hornocker 1983). Studies of otters in the Muskeg River drainage found that the remains of fish occurred in 87% of otter scats, whereas mammals and birds occurred in 7 and 8%, respectively (Gilbert and Nancekivell 1982).

# 4.0 DISCUSSION

## 4.1 Demography of Moose Populations

### 4.1.1 Abundance

Moose densities (0.20-0.32/km$^2$) recorded during aerial surveys of the Suncor study area are generally within the ranges of those reported from other surveys conducted in the Fort McMurray region. In a survey conducted in the AOSERP study area in 1977, Cook and Jacobson (1978) recorded a population density of 0.19 moose/km$^2$, which is similar to the moose density recorded in the Suncor study area in February 1995. In contrast, in winter 1993-94, 0.12 moose/km$^2$ were recorded by the Alberta Fish and Wildlife Division in a survey of Wildlife Management Unit (WMU) 530, which occupies an area of almost 17,000 km$^2$ east of the Athabasca River (C. Pollack, pers. comm.). This density is substantially lower than that of 0.24 moose/km$^2$, which was recorded in the eastern portion of the Suncor study area during 1995 but is similar to the density of 0.10 moose/km$^2$ recorded in the vicinity of the Fort Hills in 1981 (Skinner and Westworth 1981). Although a stratified random block design was used in the 1993-94 survey of WMU 530, no survey blocks were located within the Suncor survey area (C. Pollack, pers. comm.).

Other surveys, which were flown on the west side of the Athabasca River or else included both sides of the river, have indicated that moose population densities in the Fort McMurray area are similar to that recorded in good habitat in the western portion of the Suncor study area (0.32/km$^2$). Bibaud and Archer (1973) recorded a density of 0.31 moose/km$^2$ in the minable portion of the oil sands area during a survey flown in late winter 1973. Similarly, a density of 0.32 moose/km$^2$ was recorded near Calumet Lake in winter 1981-82 (Westworth and Brusnyk 1982a).

### 4.1.2 Population Composition

Cow moose were found to be more abundant than either bulls or calves on both sides of the Athabasca River during this study. Other aerial surveys have similarly indicated that cows are usually the predominant age/sex cohort in the Fort McMurray region. A recent aerial survey of WMU 530, which includes the eastern portion of the Suncor survey area, indicated that the bull:cow ratio in that WMU was

85:100 (C. Pollack, pers. comm.). This ratio is similar to those of 74:100 and 76:100, which were recorded in the eastern portion of the study area in February and December 1995, respectively, but is much higher than that of 25-35:100 recorded in the western portion of the study area. The Alberta Fish and Wildlife Division attributed sex ratios of approximately 1:1 in Moose Management Unit 9, which includes WMU 530, to poor access, which reduced hunting pressure (C. Pollack, pers. comm.). Bull:cow ratios recorded in other aerial surveys in the Fort McMurray study area have ranged from 27 to 77 bulls per 100 cows (Hall et al. 1974; Penner 1976; Hauge and Keith 1978, 1981; Skinner and Westworth 1981; Westworth and Brusnyk 1982a).

Calf:cow ratios of 43:100 and 35:100, which were recorded in the eastern portion of the Suncor survey area in February and December 1995, respectively, are similar to those recorded in most other surveys conducted in the Fort McMurray region; however, the calf:cow ratio recorded in the western portion of the survey area during February (83:100) is among the highest reported for the region. Results from most other surveys indicate that calf:cow ratios usually range from 30 to 61 calves per 100 cows (Hall et al. 1974; Penner 1976; Hauge and Keith 1978; Westworth 1979, 1980; Skinner and Westworth 1981; Westworth and Brusnyk 1982a), although Hauge and Keith (1981) reported a ratio of 93 calves per 100 cows in the AOSERP study area in spring 1978.

## 4.2 Distribution and Habitat Use by Wildlife

### 4.2.1 Distribution Among Landscape Features

The results of this study show that landscape features associated with the Athabasca River are important to most wildlife species in the Suncor study area. Of the 11 species for which adequate data exists, nine were associated with either riparian floodplain/terraces adjacent to the river or with the Athabasca River escarpment (Table 17). Two of these species, deer and marten, were strongly associated with both of these landscape features and seven species were associated with one of these features. Coyotes, red foxes, fishers, and mink were associated primarily with riparian floodplain/terrace landscapes, whereas moose, red squirrels and wolves were associated with the escarpment. In contrast, snowshoe hares and weasels were associated principally with upland landscapes.

The relationship between wildlife distribution and landscape feature appears to be related largely to the habitat preferences of the wildlife species recorded during this study. Five of the seven species that exhibited a significant preference at least one habitat type in the Suncor study area preferred either closed deciduous or mixed coniferous forest. In the eastern part of the study area, both of these habitat types are distributed almost exclusively on riparian floodplain/terraces and escarpments along the Athabasca and Steepbank rivers.

Riparian floodplains and escarpments along the Athabasca River appear to be the most important habitat feature for moose in the Suncor study area, although tracking studies suggested that upland landscapes are also important to this species. This study suggests that moose residing in the eastern portion of the study area frequently move into the Athabasca River valley to take advantage of the browsing opportunities provided by deciduous habitat on the escarpment. Other studies conducted in the Fort McMurray region have shown that moose often move from upland areas to lowlands adjacent the Athabasca River in late winter (Penner 1976; Hauge and Keith 1978; Westworth 1979, 1980). In the eastern portion of the Suncor study area, most deciduous and mixedwood forests, which were the most important habitat types for moose during winter, are located primarily on riparian floodplains and escarpments along the Athabasca River. Thus, the preference for these habitat types probably contributes to the disproportionate number of moose recorded in landscape features associated with the Athabasca River in this study.

Snow cover may have also affected the distribution of wildlife among landscape features in the Suncor study area. A number of studies conducted in the Fort McMurray region indicate that moose frequently move from upland areas to lowlands along the Athabasca River during late winter (Penner 1976; Hauge and Keith 1978, 1981; Westworth 1979, 1980). However, the results of this study were equivocal. Aerial surveys indicated that moose were associated with deciduous forest throughout the winter, whereas tracking studies suggested that moose were associated mainly with upland landscapes, which were dominated by black spruce and tamarack forests, in February and the Athabasca River escarpment in December. The use of the escarpment by moose in December may have been related to the early onset of cold weather and high snow accumulations during November and December 1995. During December 1995, mean snow depth in the study area was 30.8 cm, which is significantly greater than the depth of 26.8 cm recorded in the study area during February 1995 ($P=0.003$). In comparison, Hauge and Keith (1981) reported that long-term (1944-72) snow depths at Fort McMurray averaged 28 cm at the end of December and 38 cm at the end of February. Conditions of deep snow and cold temperatures in

December 1995 may have caused the early movement of moose into areas adjacent to the Athabasca River. In contrast, moose may have less motivated to move to the Athabasca River valley during the winter of 1994-95 when snow accumulations were low and temperatures were mild.

Landscapes associated with Athabasca River valley may also provide important natal and winter denning habitat for a variety of wildlife species. Because much of the study area is covered by poorly-drained muskegs, opportunities for animals to construct and use subterranean dens are limited. Thus, landscapes associated with the Athabasca and Steepbank Rivers, which contain most of the well-drained soils in the eastern portion of the study area, likely provide important denning habitat for species such as wolves, coyotes, red foxes, and black bears (*Ursus americanus*), which use subterranean dens for reproduction or thermal shelter. The Athabasca River valley may also provide important habitat for mammals that prefer to den in mature forests. Such species include the fisher, which often dens in cavities in standing trees (Powell and Zielinski 1994), and the lynx, which prefers to den in habitats that contain fallen trees or upturned stumps (Koehler and Aubry 1994)

### 4.2.2 Habitat Use

Track count surveys indicated that most of the habitat types identified in the Suncor study area are important to some species of wildlife. All habitat types except wetland shrub complex, disturbed habitats, and shorelines were preferred by at least one species of mammal (Table 18), which suggests that a diversity of habitat types is necessary to maintain the diversity of wildlife that exists in the Suncor study area. For example, marten preferred upland coniferous forest types (white spruce, jack pine, and mixed coniferous) and used lowland forest types (black spruce and tamarack) in proportion to their availability, whereas fishers avoided most upland coniferous forest types and preferred black spruce-tamarack forest. Weasels preferred all lowland coniferous forest types, whereas moose, deer and coyotes preferred closed deciduous forest.

The habitat preferences of four mammal species differed significantly between the eastern and western portions of the Suncor study area in February 1995; however, significant differences could not be detected for many of the remaining species because of comparatively low sampling effort in the western portion of the study area (Table 2). Differences in habitat use between the eastern and western portions of the study area could result from differences in forest cover characteristics and land use factors.

Upland forests are widely distributed in the study area west of the Athabasca River, whereas black spruce and tamarack forests are dominant east of the river. Moreover, the area west of the river has been intensively modified by human activity. In contrast, the area east of the Athabasca River is comparatively undisturbed, although some timber harvesting occurs and numerous seismic lines are present.

## 4.3 Factors Affecting Wildlife Populations

The 1995 aerial survey indicated that the characteristics of the moose population in the Suncor survey areas west and east of the Athabasca River differed. The moose population west of the river was characterized by a slightly lower population density, a lower bull:cow ratio, and a higher calf:cow ratio than the population east of the river.

Three factors, habitat quality, predation, and hunting pressure, may be largely responsible for these differences. Moose in Alberta are usually associated with deciduous habitats for much of the year (Nowlin 1978, Hauge and Keith 1981, Mytton and Keith 1981) and this study has also shown that moose in the Suncor study area prefer this habitat type. Deciduous forest is widespread in the western portion of the study area, whereas it is concentrated along the Athabasca River in the eastern part of the study area. Moreover, other forage-producing habitats, such as shrub complexes, are also more common in the western portion of the study area. Consequently, this part of the study area likely provides higher quality habitat in terms of forage production than the area east of the river, in which black spruce and tamarack forests are prevalent.

Moose, especially calves, are the principal prey of wolves (Fuller and Keith 1980b), which this study indicated are much more abundant east of the Athabasca River than west of the river. Thus, greater habitat quality and lower predation rates west of the river likely result in greater natality and higher calf survival, which is reflected in a high calf:cow ratio.

In contrast, lower population densities and lower bull:cow ratios in the western part of the survey area are probably caused by comparatively intense hunting pressure as a result of greater access. The Suncor survey area occupies portions of two of Alberta's WMUs; WMU 518 covers an area of approximately 11,100 $km^2$ west of the Athabasca River, whereas WMU 530 covers approximately 16,900 $km^2$ east of the river. Hunter harvest and effort statistics, which are compiled annually by the Alberta Fish and Wildlife Division (1992, 1993) and Alberta Wildlife Management Division (1995), indicate that hunting pressure west of the Athabasca River is about two to 12 times that east of the river (Table 19). As a consequence, in the past three years, the moose harvest west of the river has ranged from 1.7 to 2.6 moose/100 $km^2$ as compared with a harvest of 0.2 to 0.4 moose/100 $km^2$ east of the river. Thus, high hunting pressure likely contributes to lower moose density in the area west of the Athabasca River and is probably also the principal factor contributing to the low bull:cow ratio in this area.

This study suggests that, in the western portion of the study area, at least some wildlife species tend to select habitat types with higher cover values than they do in the eastern portion of the study area. For example, although few moose tracks were recorded in the western portion of the study area, all were observed in either closed deciduous or black spruce-tamarack forest. In contrast, moose tracks were often recorded in open coniferous forests in the eastern portion of the study area. Similarly, coyote tracks in the western portion of the study area were observed most frequently in black spruce-tamarack forest, closed deciduous forest, and wetland shrub complex, whereas in the eastern portion of the study area, they were most abundant in disturbed habitats and closed deciduous forest. Wolves, which were most abundant in closed black spruce in the eastern portion of the study area during February, were not recorded in the study area west of the Athabasca River. Although the evidence from this study is not strong, it suggests that some wildlife species in the Suncor study area have altered their ranges or use of habitat in response to disturbance and increased human access in the area west of the Athabasca River.

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# TABLES

# 6.0 TABLES

**Table 1.** Distribution of browse and pellet group plots among habitat types and landscape features.

| Habitat | Landscape Feature | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|
| | Riparian | | Escarpment | | Upland | | | |
| | Transects | Plots | Transects | Plots | Transects | Plots | Transects | Plots |
| Closed deciduous | 4 | 80 | 3 | 60 | 10 | 200 | 17 | 340 |
| Closed mixedwood | | 20 | | | 5 | 100 | 5 | 120 |
| Mixedwood, white spruce dominant | 2 | 20 | | | | | 2 | 20 |
| Closed white spruce | 1 | 20 | | | | | 1 | 20 |
| Closed jack pine | | | | | 5 | 100 | 5 | 100 |
| Mixed coniferous | | | 1 | 20 | 1 | 20 | 2 | 40 |
| Closed black spruce | | | | | 2 | 40 | 2 | 40 |
| Black spruce-tamarack | | | | | 7 | 126 | 7 | 126 |
| Open black spruce | | | | | 6 | 120 | 6 | 120 |
| Open tamarack fen | | | | | 3 | 60 | 3 | 60 |
| Wetland shrub complex | 1 | 20 | | | 2 | 40 | 3 | 60 |
| Disturbed | | | | | 3 | 60 | 3 | 60 |
| Total | 8 | 160 | 4 | 80 | 44 | 866 | 56 | 1106 |

Table 2. Track count sampling effort in the Suncor study area.

| Habitat | February | | | | | | December | | Overall | |
|---|---|---|---|---|---|---|---|---|---|---|
| | East | | West | | Total | | | | | |
| | No. transects | Km track-days | No. transects | Km track-days | No. transects | Km track-days | No. transects | Km track-days | No. transects | Km track-days |
| Closed jack pine | 3 | 17.5 | 2 | 6.0 | 5 | 23.5 | 1 | 2.5 | 5 | 26.0 |
| Closed white spruce | 1 | 5.0 | | | 1 | 5.0 | | | 1 | 5.0 |
| Closed deciduous | 11 | 77.0 | 3 | 7.5 | 14 | 84.5 | 10 | 41.5 | 15 | 126.0 |
| Closed mixedwood | 1 | 8.0 | 3 | 9.0 | 4 | 17.0 | 2 | 4.0 | 5 | 21.0 |
| Closed mixed coniferous, black spruce dominant | 2 | 17.0 | | | 2 | 17.0 | 2 | 8.0 | 2 | 25.0 |
| Black spruce/tamarack | 7 | 38.5 | 5 | 16.5 | 12 | 55.0 | 4 | 12.0 | 12 | 67.0 |
| Closed mixedwood, white spruce dominant | 3 | 14.0 | | | 3 | 14.0 | 1 | 4.5 | 3 | 18.5 |
| Closed black spruce | 8 | 58.0 | | | 8 | 58.0 | 6 | 17.0 | 8 | 75.0 |
| Open tamarack fen | 2 | 15.5 | | | 2 | 15.5 | 1 | 2.0 | 2 | 17.5 |
| Wetland shrub complex | 3 | 19.0 | 2 | 7.5 | 5 | 26.5 | | | 5 | 26.5 |
| Disturbed/herb and grass dominant | 2 | 13.0 | 4 | 18.0 | 6 | 31.0 | 2 | 9.0 | 6 | 40.0 |
| Lake Shore | 1 | 5.0 | 1 | 4.5 | 2 | 9.5 | | | 2 | 9.5 |
| Steepbank River | 1 | 3.5 | | | 1 | 3.5 | | | 1 | 3.5 |
| Fen | | | 2 | 9.0 | 2 | 9.0 | 2 | 7.0 | 4 | 16.0 |
| Total | 45 | 291.0 | 22 | 78.0 | 67 | 369.0 | 31 | 107.5 | 71 | 476.5 |

**Table 3.** Population densities of moose in the Suncor study area.

| Study Area | February | | | | December | | | |
|---|---|---|---|---|---|---|---|---|
| | No. Observed | Expanded Population Estimate[a] | Total Population Estimate[b] | Density (n/km$^2$) | No. Observed | Expanded Population Estimate[a] | Total Population Estimate[b] | Density (n/km$^2$) |
| West | 25 | 26 | 27 | 0.20 | 22 | 23 | 24 | 0.32 |
| East | 50 | 53 | 54 | 0.24 | 36 | 38 | 39 | 0.24 |
| Overall | 75 | 79 | 81 | 0.22 | 58 | 61 | 63 | 0.27 |

[a] $SCF_o = 1.053$
[b] $SCF_c = 1.02$

**Table 4.** Sex and age composition of moose in the Suncor study area, 1995.

| Month | Area | Bulls | Cows | Calves | Total | Bull:Cow:Calf Ratio |
|---|---|---|---|---|---|---|
| February | East of the Athabasca River | 17 | 23 | 10 | 50 | 74:100:43 |
| | West of the Athabasca River | 3 | 12 | 10 | 25 | 25:100:83 |
| | Overall | 20 | 35 | 20 | 75 | 57:100:57 |
| December | East of the Athabasca River | 13 | 17 | 6 | 36 | 76:100:35 |
| | West of the Athabasca River | 4 | 11 | 7 | 22 | 36:100:64 |
| | Overall | 17 | 28 | 13 | 58 | 61:100:46 |

Table 5. Simultaneous confidence intervals for the utilization of habitat types by moose in the Suncor study area as indicated by aerial surveys, February 1995.

| Habitat Type | Number of Moose | | Proportion of Use | | 95% CI | Preference[a] |
|---|---|---|---|---|---|---|
| | Expected | Observed | Expected ($Pi_o$) | Observed (Pi) | | |
| Closed jack pine | 6.6 | 0 | 0.089 | 0.000 | -0.010 to 0.010 | - |
| Closed white spruce | 7.5 | 0 | 0.100 | 0.000 | -0.010 to 0.010 | - |
| Closed deciduous | 11.6 | 38 | 0.154 | 0.507 | 0.343 to 0.670 | + |
| Closed mixedwood | 5.8 | 20 | 0.077 | 0.267 | 0.122 to 0.411 | + |
| Mixed coniferous | 3.0 | 0 | 0.040 | 0.000 | -0.010 to 0.010 | - |
| Closed black spruce | 6.6 | 1 | 0.089 | 0.000 | -0.024 to 0.051 | - |
| Black spruce-tamarack | 6.9 | 7 | 0.091 | 0.013 | -0.002 to 0.188 | 0 |
| Open black spruce | 11.6 | 0 | 0.154 | 0.093 | -0.010 to 0.010 | - |
| Open tamarack fen | 4.9 | 8 | 0.066 | 0.000 | 0.006 to 0.208 | 0 |
| Wetland shrub complex | 6.2 | 1 | 0.083 | 0.107 | -0.024 to 0.051 | - |
| Disturbed/herb and grass dominant | 4.3 | 0 | 0.057 | 0.013 | -0.010 to 0.010 | - |
| Total | 75.0 | 75 | 1.000 | 1.000 | | |

[a] "+", "-", and "0" indicate that a habitat type is preferred, avoided and neither preferred nor avoided, respectively.

**Table 6.** Simultaneous confidence intervals for the utilization of habitat types by moose in the Suncor study area as indicated by aerial surveys, December 1995.

| Habitat Type | Number of Moose | | Proportion of Use | | 95% CI | Preference[a] |
|---|---|---|---|---|---|---|
| | Expected | Observed | Expected ($Pi_o$) | Observed (Pi) | | |
| Closed jack pine | 5.2 | 0 | 0.089 | 0.000 | -0.011 to 0.011 | - |
| Closed white spruce | 3.6 | 0 | 0.063 | 0.000 | -0.011 to 0.011 | - |
| Closed deciduous | 10.4 | 19 | 0.179 | 0.328 | 0.157 to 0.498 | 0 |
| Closed mixedwood | 7.3 | 13 | 0.125 | 0.224 | 0.072 to 0.376 | 0 |
| Mixed coniferous | 2.1 | 0 | 0.036 | 0.000 | -0.011 to 0.011 | - |
| Closed black spruce | 3.4 | 2 | 0.058 | 0.034 | -0.032 to 0.101 | 0 |
| Black spruce-tamarack | 17.3 | 16 | 0.298 | 0.276 | 0.113 to 0.438 | 0 |
| Open tamarack fen | 3.6 | 5 | 0.063 | 0.086 | -0.016 to 0.118 | 0 |
| Other | 5.2 | 3 | 0.089 | 0.052 | -0.029 to 0.132 | 0 |
| Total | 58.0 | 58 | 1.000 | 1.000 | | |

[a] "+", "-", and "0" indicate that a habitat type is preferred, avoided and neither preferred nor avoided, respectively.

Table 7. Simultaneous confidence intervals for the utilization of habitat types by moose in the Suncor study area as indicated by tracking studies, February 1995.

| Habitat Type | Number of Tracks | | Proportion of Use | | 95% CI | Preference[a] |
|---|---|---|---|---|---|---|
| | Expected | Observed | Expected ($Pi_o$) | Observed (Pi) | | |
| Closed jack pine | 5.2 | 3 | 0.064 | 0.037 | -0.022 to 0.096 | 0 |
| Other upland coniferous forest | 4.8 | 1 | 0.060 | 0.012 | -0.022 to 0.047 | - |
| Closed deciduous | 18.5 | 19 | 0.228 | 0.235 | 0.102 to 0.367 | 0 |
| Closed mixedwood | 6.8 | 2 | 0.084 | 0.025 | -0.024 to 0.073 | - |
| Black spruce-tamarack | 12.1 | 21 | 0.149 | 0.259 | 0.122 to 0.396 | 0 |
| Open black spruce | 12.7 | 16 | 0.157 | 0.198 | 0.073 to 0.322 | 0 |
| Open tamarack/fen | 3.5 | 10 | 0.042 | 0.123 | 0.021 to 0.226 | 0 |
| Wetland shrub complex | 5.8 | 6 | 0.072 | 0.074 | -0.008 to 0.156 | 0 |
| Disturbed/herb and grass dominant | 6.8 | 3 | 0.084 | 0.037 | -0.022 to 0.096 | 0 |
| Water/fen | 4.8 | 0 | 0.060 | 0.000 | -0.010 to 0.010 | - |
| Total | 81.0 | 81 | 1.000 | 1.000 | | |

[a] "+", "-", and "0" indicate that a habitat type is preferred, avoided and neither preferred nor avoided, respectively.

**Table 8.** Regression statistics showing the logarithmic relationship between twig weight and diameter by browse species.

| Species | Regression Equation | | $r^2$ | Sample Size |
|---|---|---|---|---|
| | Intercept | Slope | | |
| Saskatoon | -1.2906 | 2.9063 | 0.86 | 138 |
| Bog birch | -1.0175 | 1.9262 | 0.85 | 222 |
| Paper birch | -1.8171 | 0.6702 | 0.90 | 207 |
| Beaked hazel | -1.3156 | 2.8419 | 0.95 | 151 |
| Red-osier dogwood | -1.4509 | 2.7034 | 0.73 | 93 |
| Balsam poplar | -1.2004 | 2.1310 | 0.81 | 42 |
| Trembling aspen | -1.1569 | 2.3451 | 0.90 | 209 |
| Chokecherry | -1.2253 | 2.6429 | 0.89 | 239 |
| Pincherry | -2.2064 | 1.8424 | 0.84 | 281 |
| Willow | -1.2386 | 2.6579 | 0.89 | 300 |
| Low-bush cranberry[a] | -1.9635 | 0.5781 | 0.79 | 343 |
| High-bush cranberry[a] | -1.7855 | 0.4912 | 0.90 | 67 |

[a] Only the dependent variable was transformed.

Table 9. Simultaneous confidence intervals for the utilization of habitat types by deer in the Suncor study area as indicated by tracking studies, February and December 1995.

| Habitat Type | Number of Tracks | | Proportion of Use | | 95% CI | Preference[a] |
|---|---|---|---|---|---|---|
| | Expected | Observed | Expected ($Pi_o$) | Observed (Pi) | | |
| Upland coniferous forest | 5.4 | 6 | 0.118 | 0.130 | -0.003 to 0.264 | 0 |
| Closed deciduous | 12.1 | 25 | 0.264 | 0.545 | 0.346 to 0.741 | + |
| Closed mixedwood | 3.8 | 2 | 0.083 | 0.043 | -0.037 to 0.124 | 0 |
| Black spruce-tamarack | 6.5 | 3 | 0.141 | 0.065 | -0.033 to 0.163 | 0 |
| Open lowland coniferous | 8.9 | 4 | 0.194 | 0.087 | -0.025 to 0.199 | 0 |
| Disturbed/herb and grass dominant | 3.9 | 6 | 0.084 | 0.130 | -0.003 to 0.264 | 0 |
| Other habitats | 5.4 | 0 | 0.116 | 0.000 | -0.013 to 0.013 | - |
| Total | 46.0 | 46 | 1.000 | 1.000 | | |

[a] "+", "-", and "0" indicate that a habitat type is preferred, avoided and neither preferred nor avoided, respectively.

**Table 10.** Simultaneous confidence intervals for the utilization of habitat types by snowshoe hares in the Suncor study area as indicated by tracking studies, February and December 1995.

| Habitat Type | Number of Tracks | | Proportion of Use | | 95% CI | Preference[a] |
|---|---|---|---|---|---|---|
| | Expected | Observed | Expected ($Pi_o$) | Observed (Pi) | | |
| Closed jack pine | 34.2 | 119 | 0.055 | 0.190 | 0.145 to 0.235 | + |
| Closed white spruce | 6.6 | 0 | 0.011 | 0.000 | -0.004 to 0.004 | - |
| Closed deciduous | 165.7 | 21 | 0.264 | 0.033 | 0.013 to 0.054 | - |
| Closed mixedwood | 52.0 | 117 | 0.083 | 0.187 | 0.142 to 0.231 | + |
| Closed mixed coniferous, black spruce dominant | 32.9 | 122 | 0.052 | 0.195 | 0.149 to 0.240 | + |
| Black spruce-tamarack | 88.2 | 36 | 0.141 | 0.057 | 0.031 to 0.084 | - |
| Open black spruce | 98.7 | 195 | 0.157 | 0.311 | 0.258 to 0.364 | + |
| Open tamarack/fen | 23.0 | 0 | 0.037 | 0.000 | -0.004 to 0.004 | - |
| Wetland shrub complex | 34.9 | 1 | 0.056 | 0.002 | -0.003 to 0.006 | - |
| Disturbed/herb and grass dominant | 52.6 | 16 | 0.084 | 0.026 | 0.007 to 0.044 | - |
| Shoreline | 17.1 | 0 | 0.027 | 0.000 | -0.004 to 0.004 | - |
| Fen | 21.1 | 0 | 0.034 | 0.000 | -0.004 to 0.004 | - |
| Total | 627.0 | 627 | 1.000 | 1.000 | | |

[a] "+", "-", and "0" indicate that a habitat type is preferred, avoided and neither preferred nor avoided, respectively.

Table 11. Simultaneous confidence intervals for the utilization of habitat types by red squirrels in the Suncor study area as indicated by tracking studies, February and December 1995.

| Habitat Type | Number of Tracks | | Proportion of Use | | 95% CI | Preference[a] |
|---|---|---|---|---|---|---|
| | Expected | Observed | Expected ($Pi_o$) | Observed (Pi) | | |
| Closed jack pine | 24.7 | 91 | 0.055 | 0.201 | 0.147 to 0.255 | + |
| Closed white spruce | 4.8 | 13 | 0.010 | 0.029 | 0.006 to 0.051 | 0 |
| Closed deciduous | 119.7 | 112 | 0.264 | 0.248 | 0.189 to 0.305 | 0 |
| Closed mixedwood | 37.6 | 55 | 0.083 | 0.121 | 0.077 to 0.165 | 0 |
| Closed mixed coniferous, black spruce dominant | 23.8 | 80 | 0.052 | 0.177 | 0.125 to 0.228 | + |
| Black spruce-tamarack | 63.7 | 21 | 0.141 | 0.046 | 0.018 to 0.075 | - |
| Open black spruce | 71.3 | 46 | 0.157 | 0.102 | 0.061 to 0.142 | - |
| Open tamarack/fen | 16.6 | 6 | 0.037 | 0.013 | -0.002 to 0.029 | - |
| Wetland shrub complex | 25.2 | 2 | 0.056 | 0.004 | -0.005 to 0.013 | - |
| Disturbed/herb and grass dominant | 38.0 | 24 | 0.084 | 0.053 | 0.023 to 0.083 | - |
| Shoreline | 12.4 | 1 | 0.027 | 0.002 | -0.004 to 0.009 | - |
| Fen | 15.2 | 2 | 0.034 | 0.004 | -0.005 to 0.013 | - |
| Total | 453.0 | 453 | 1.000 | 1.000 | | |

[a] "+", "-", and "0" indicate that a habitat type is preferred, avoided and neither preferred nor avoided, respectively.

**Table 12.** Simultaneous confidence intervals for the utilization of habitat types by wolves in the Suncor study area as indicated by tracking studies, February and December 1995.

| Habitat Type | Number of Tracks | | Proportion of Use | | 95% CI | Preference[a] |
|---|---|---|---|---|---|---|
| | Expected | Observed | Expected ($Pi_o$) | Observed (Pi) | | |
| Upland coniferous | 5.6 | 7 | 0.117 | 0.146 | 0.013 to 0.278 | 0 |
| Closed deciduous | 12.8 | 14 | 0.267 | 0.292 | 0.121 to 0.462 | 0 |
| Closed mixedwood | 4.0 | 1 | 0.083 | 0.021 | -0.033 to 0.074 | - |
| Black spruce-tamarack | 6.7 | 3 | 0.140 | 0.063 | -0.028 to 0.153 | 0 |
| Open lowland coniferous | 9.3 | 17 | 0.194 | 0.354 | 0.175 to 0.534 | 0 |
| Disturbed/herb and grass dominant | 4.0 | 6 | 0.083 | 0.125 | 0.001 to 0.249 | 0 |
| Other habitats | 5.6 | 0 | 0.117 | 0.000 | -0.012 to 0.012 | - |
| Total | 48.0 | 48 | 1.000 | 1.000 | | |

[a] "+", "-", and "0" indicate that a habitat type is preferred, avoided and neither preferred nor avoided, respectively.

**Table 13.** Simultaneous confidence intervals for the utilization of habitat types by coyotes in the Suncor study area as indicated by tracking studies, February and December 1995.

| Habitat Type | Number of Tracks | | Proportion of Use | | 95% CI | Preference[a] |
|---|---|---|---|---|---|---|
| | Expected | Observed | Expected ($Pi_o$) | Observed (Pi) | | |
| Closed jack pine/white spruce | 6.2 | 2 | 0.065 | 0.021 | -0.021 to 0.062 | - |
| Closed deciduous | 25.5 | 43 | 0.266 | 0.448 | 0.304 to 0.592 | + |
| Closed mixedwood | 8.0 | 5 | 0.083 | 0.052 | -0.012 to 0.116 | 0 |
| Closed mixed coniferous, black spruce dominant | 5.0 | 5 | 0.052 | 0.052 | -0.012 to 0.116 | 0 |
| Black spruce-tamarack | 13.5 | 25 | 0.141 | 0.260 | 0.133 to 0.388 | 0 |
| Open black spruce | 15.1 | 0 | 0.157 | 0.000 | -0.009 to 0.009 | - |
| Open tamarack/fen | 3.5 | 2 | 0.036 | 0.021 | -0.021 to 0.062 | 0 |
| Wetland shrub complex | 5.3 | 2 | 0.055 | 0.021 | -0.021 to 0.062 | 0 |
| Disturbed/herb and grass dominant | 8.1 | 4 | 0.084 | 0.042 | -0.016 to 0.100 | 0 |
| Shoreline | 2.6 | 0 | 0.027 | 0.000 | -0.009 to 0.009 | - |
| Fen | 3.2 | 8 | 0.033 | 0.083 | 0.003 to 0.163 | 0 |
| Total | 96.0 | 96 | 1.000 | 1.000 | | |

[a] "+", "-", and "0" indicate that a habitat type is preferred, avoided and neither preferred nor avoided, respectively.

**Table 14.** Simultaneous confidence intervals for the utilization of habitat types by fishers in the Suncor study area as indicated by tracking studies, February and December 1995.

| Habitat Type | Number of Tracks | | Proportion of Use | | 95% CI | Preference[a] |
|---|---|---|---|---|---|---|
| | Expected | Observed | Expected ($Pi_o$) | Observed (Pi) | | |
| Upland coniferous/mixedwood | 7.4 | 2 | 0.200 | 0.054 | -0.042 to 0.150 | - |
| Closed deciduous | 9.8 | 15 | 0.265 | 0.405 | 0.197 to 0.614 | 0 |
| Black spruce-tamarack | 5.2 | 13 | 0.141 | 0.351 | 0.149 to 0.554 | + |
| Open lowland coniferous | 7.2 | 4 | 0.195 | 0.108 | -0.024 to 0.240 | 0 |
| Other habitats | 7.4 | 3 | 0.200 | 0.081 | -0.035 to 0.197 | - |
| Total | 37.0 | 37 | 1.000 | 1.000 | | |

[a] "+", "-", and "0" indicate that a habitat type is preferred, avoided and neither preferred nor avoided, respectively.

Table 15. Simultaneous confidence intervals for the utilization of habitat types by marten in the Suncor study area as indicated by tracking studies, February and December 1995.

| Habitat Type | Number of Tracks | | Proportion of Use | | 95% CI | Preference[a] |
|---|---|---|---|---|---|---|
| | Expected | Observed | Expected ($Pi_o$) | Observed (Pi) | | |
| Upland coniferous | 4.9 | 20 | 0.117 | 0.476 | 0.273 to 0.680 | + |
| Closed deciduous | 11.1 | 12 | 0.264 | 0.286 | 0.102 to 0.470 | 0 |
| Closed mixedwood | 3.5 | 1 | 0.083 | 0.024 | -0.038 to 0.086 | 0 |
| Black spruce-tamarack | 5.9 | 5 | 0.140 | 0.119 | -0.013 to 0.251 | 0 |
| Open lowland coniferous | 8.2 | 4 | 0.195 | 0.095 | -0.024 to 0.215 | 0 |
| Other habitats | 8.4 | 0 | 0.200 | 0.000 | -0.013 to 0.013 | - |
| Total | 42.0 | 42 | 1.000 | 1.000 | | |

[a] "+", "-", and "0" indicate that a habitat type is preferred, avoided and neither preferred nor avoided, respectively.

**Table 16.** Simultaneous confidence intervals for the utilization of habitat types by weasels in the Suncor study area as indicated by tracking studies, February and December 1995.

| Habitat Type | Number of Tracks | | Proportion of Use | | 95% CI | Preference[a] |
|---|---|---|---|---|---|---|
| | Expected | Observed | Expected ($Pi_o$) | Observed (Pi) | | |
| Closed jack pine | 47.0 | 10 | 0.055 | 0.012 | 0.001 to 0.022 | - |
| Closed white spruce | 9.0 | 14 | 0.010 | 0.016 | 0.004 to 0.029 | 0 |
| Closed deciduous | 227.9 | 196 | 0.264 | 0.227 | 0.186 to 0.268 | 0 |
| Closed mixedwood | 71.5 | 20 | 0.083 | 0.023 | 0.008 to 0.038 | - |
| Closed mixed coniferous, black spruce dominant | 45.2 | 41 | 0.052 | 0.048 | 0.027 to 0.068 | 0 |
| Black spruce-tamarack | 121.2 | 169 | 0.141 | 0.196 | 0.157 to 0.235 | + |
| Open black spruce | 135.8 | 244 | 0.158 | 0.283 | 0.239 to 0.327 | + |
| Open tamarack/fen | 31.7 | 66 | 0.037 | 0.077 | 0.051 to 0.103 | + |
| Wetland shrub complex | 47.9 | 14 | 0.056 | 0.016 | 0.004 to 0.029 | - |
| Disturbed/herb and grass dominant | 72.4 | 29 | 0.084 | 0.034 | 0.016 to 0.051 | - |
| Shoreline | 23.5 | 1 | 0.027 | 0.001 | -0.002 to 0.004 | - |
| Fen | 28.9 | 58 | 0.034 | 0.067 | 0.043 to 0.092 | + |
| Total | 862.0 | 862 | 1.000 | 1.000 | | |

[a] "+", "-", and "0" indicate that a habitat type is preferred, avoided and neither preferred nor avoided, respectively.

Table 17. Comparison of wildlife use of landscape features in the Suncor study area.

| Species | Riparian Floodplain/Terrace | Athabasca Escarpment | Upland |
|---|---|---|---|
| ***Ungulates*** | | | |
| Moose | 0 | + | + |
| Deer | + | + | 0 |
| ***Small Herbivores*** | | | |
| Snowshoe Hare | 0 | - | + |
| Red Squirrel | 0 | + | - |
| ***Carnivores*** | | | |
| Wolf | 0 | + | 0 |
| Coyote | + | - | - |
| Red Fox | + | 0 | - |
| Fisher | + | - | 0 |
| Marten | + | + | - |
| Weasel | - | - | + |
| Mink | + | 0 | 0 |

**Table 18.** Relationship of mammals with habitats in the Suncor study area.

| Species | Closed Jack Pine | Closed White Spruce | Closed Deciduous | Closed Mixedwood | Closed Mixed Coniferous | Black Spruce-Tamarack | Closed Black Spruce | Open Tamarack Fen | Wetland Shrub Complex | Disturbed | Shoreline | Fen |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Ungulates*** | | | | | | | | | | | | |
| Moose[a] | 0 | - | 0 | - | - | 0 | 0 | 0 | 0 | 0 | - | - |
| Deer[b] | 0 | 0 | + | 0 | 0 | 0 | 0 | 0 | - | 0 | - | - |
| ***Small Herbivores*** | | | | | | | | | | | | |
| Snowshoe Hare | + | - | - | + | + | - | + | - | - | - | - | - |
| Red squirrel | + | 0 | 0 | 0 | + | - | - | - | - | - | - | - |
| ***Carnivores*** | | | | | | | | | | | | |
| Wolf[b] | 0 | 0 | 0 | - | 0 | 0 | 0 | 0 | - | 0 | - | - |
| Coyote[c] | - | - | + | 0 | 0 | 0 | - | 0 | 0 | 0 | - | 0 |
| Fisher[d] | - | - | 0 | - | - | + | 0 | 0 | - | - | - | - |
| Marten[b] | + | + | 0 | 0 | + | 0 | 0 | 0 | - | - | - | - |
| Weasel | - | 0 | 0 | - | 0 | + | + | + | - | - | - | + |
| Times Preferred | 3 | 1 | 2 | 1 | 3 | 2 | 2 | 1 | 0 | 0 | 0 | 1 |
| Times Avoided | 3 | 4 | 1 | 4 | 2 | 2 | 2 | 2 | 7 | 5 | 9 | 7 |

Because of small sample sizes, the following habitats were combined.

[a] Closed white spruce and mixed coniferous forest. Shoreline and fen.
[b] Closed jack pine, closed white spruce, and mixed coniferous forest. Closed black spruce and open tamarack fen. Wetland shrub complex, shoreline and fen.
[c] Closed jack pine and closed white spruce.
[d] Closed jack pine, closed white spruce, closed mixed coniferous and mixedwood. Closed black spruce and open tamarack fen. Wetland shrub complex, disturbed, shoreline and fen.

Table 19. Hunting pressure and moose harvest in Wildlife Management Units (WMU) 518 and 530, 1991 to 1993.

| Year | WMU 518[a] | | | | WMU 530[a] | | | |
|---|---|---|---|---|---|---|---|---|
| | Total Hunter Days | Hunter Days/100 km$^2$ | Total Moose Harvested | Moose Harvested/100 km$^2$ | Total Hunter Days | Hunter Days/100 km$^2$ | Total Moose Harvested | Moose Harvested/100 km$^2$ |
| 1991 | 14,682 | 132 | 291 | 2.6 | 2,721 | 16 | 66 | 0.4 |
| 1992 | 11,383 | 103 | 279 | 2.5 | 1,285 | 8 | 42 | 0.2 |
| 1993[b] | 1,132 | 10 | 184 | 1.7 | 937 | 6 | 53 | 0.3 |

[a] WMU 518 and 530 are on the west and east side of the Athabasca River, respectively.
[b] The redution in hunting effort on WMU 518 in 1993 results from a change from general to limited moose hunting.

# FIGURES

## 7.0 FIGURES

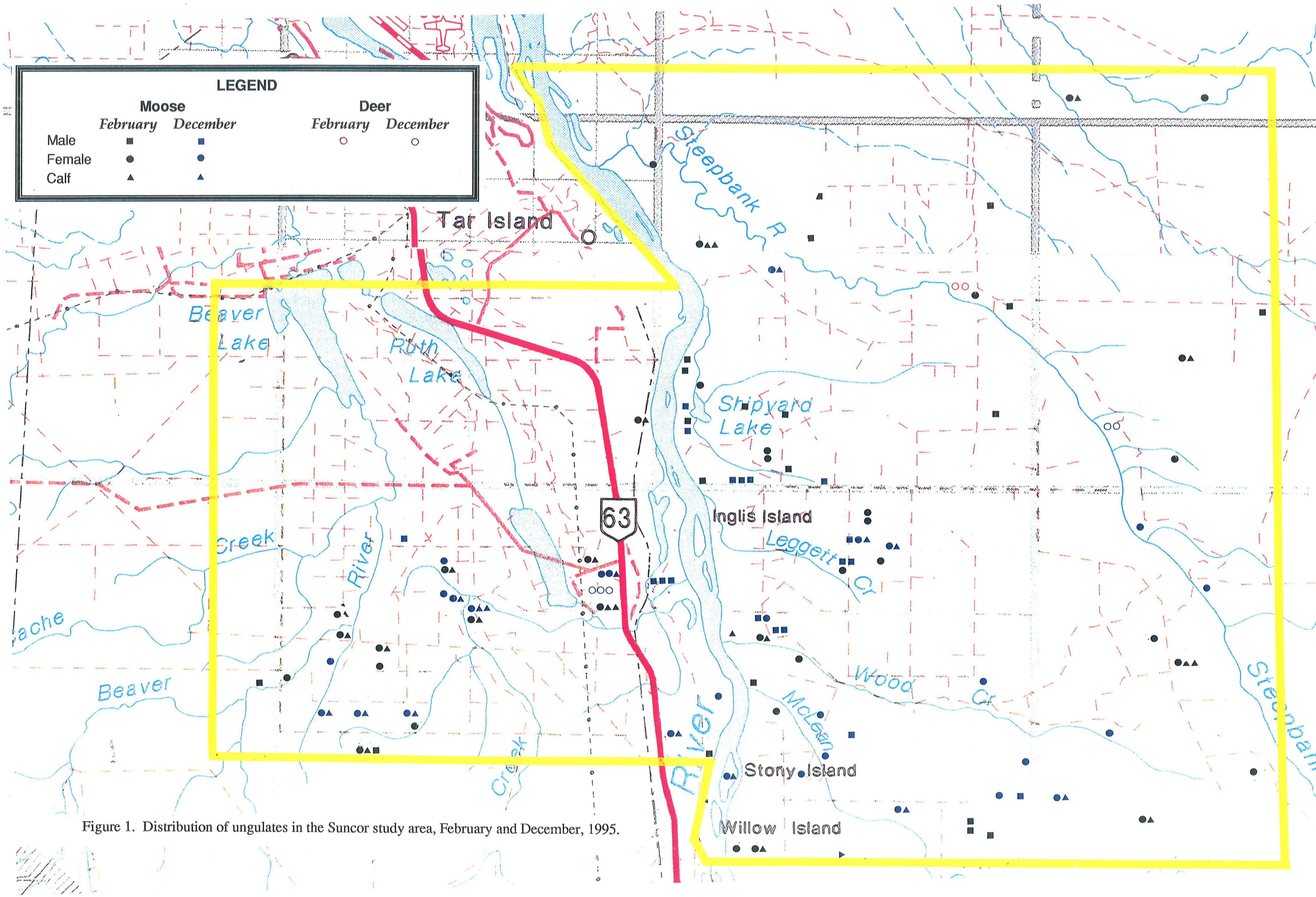


Figure 1. Distribution of ungulates in the Suncor study area, February and December, 1995.

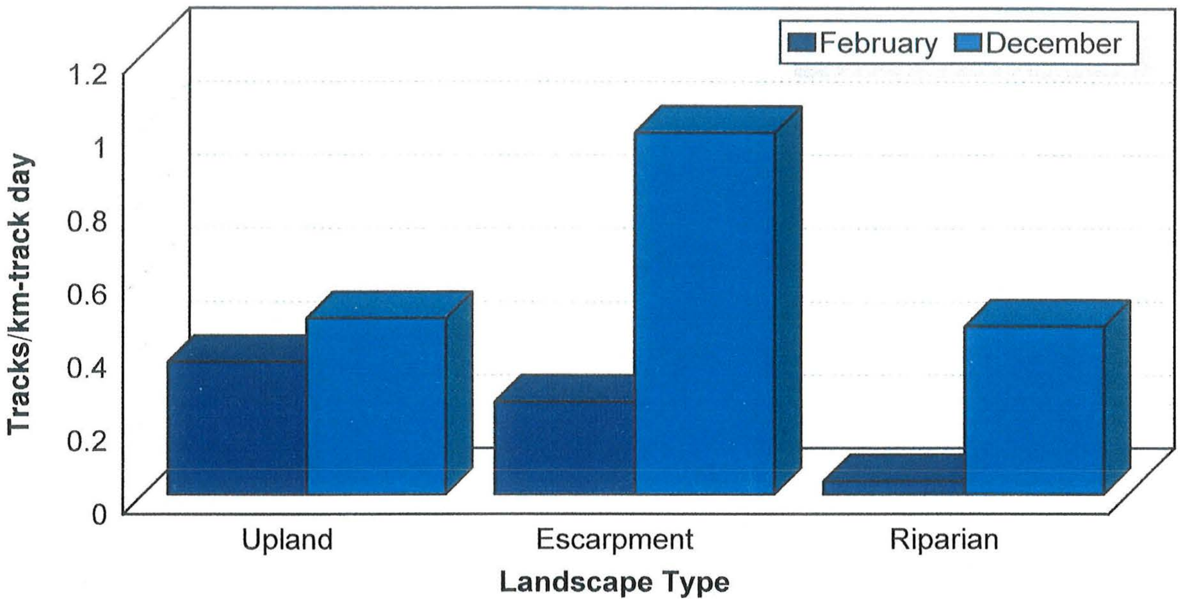


Figure 2. Use of landscape features by moose (as indicated by track frequencies) in the Suncor study area, February and December, 1995.

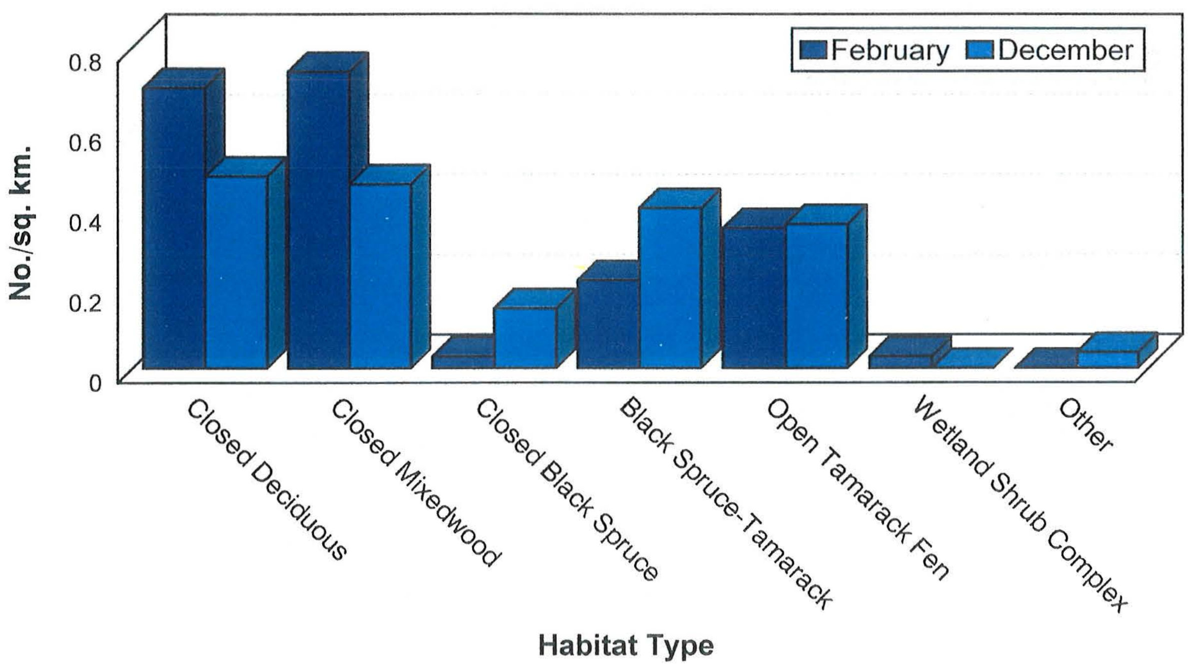


Figure 3. Moose densities in various habitat types in the Suncor study area, February and December, 1995.

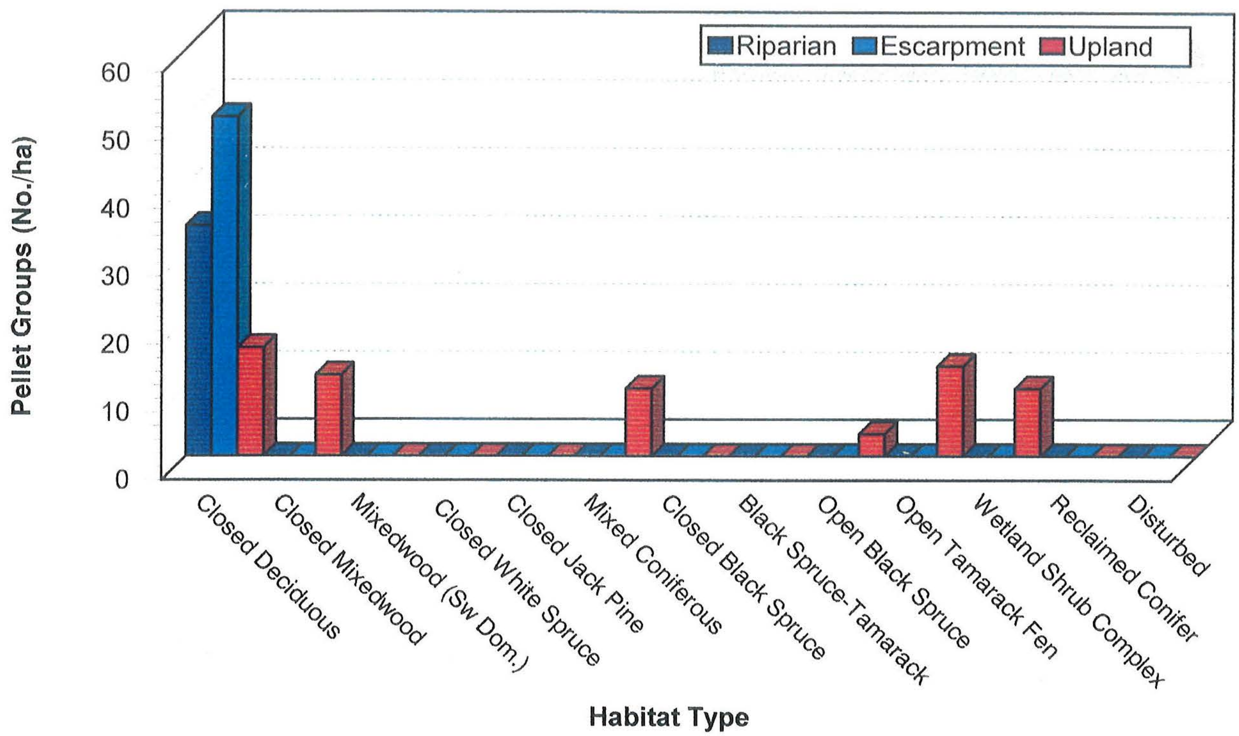


Figure 4. Distribution of moose pellet groups among habitat types and landscape features in the Suncor study area, spring, 1995.

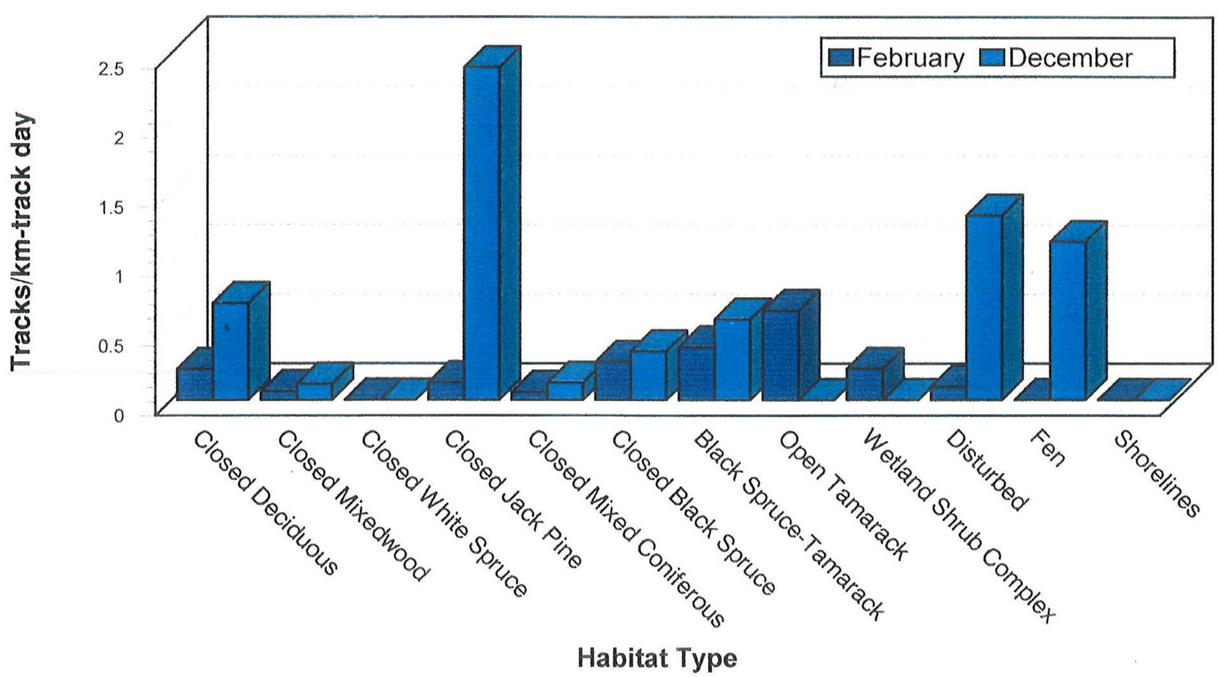


Figure 5. Use of habitats in the Suncor study area by moose as indicated by winter tracking studies, February and December, 1995.

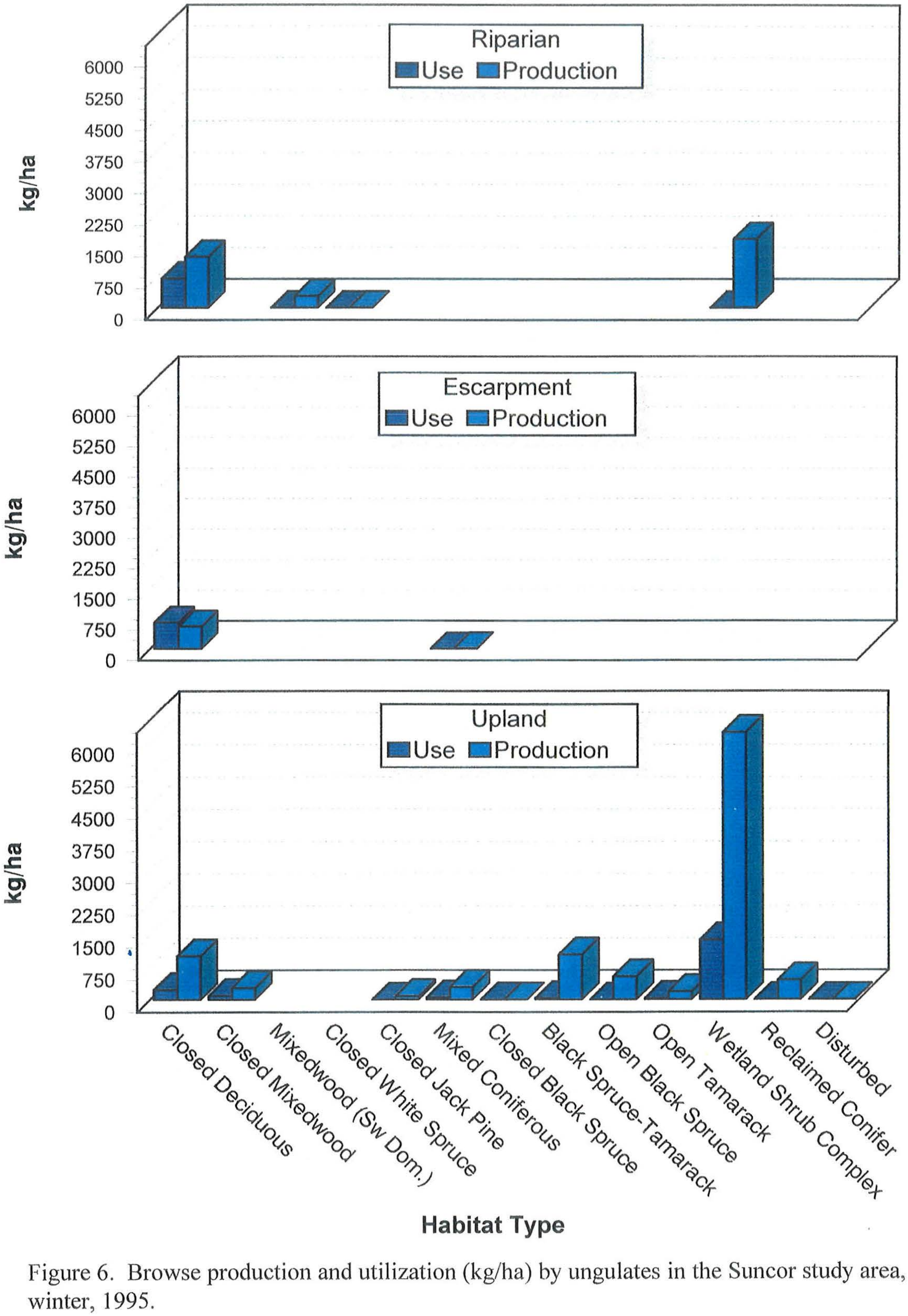


Figure 6. Browse production and utilization (kg/ha) by ungulates in the Suncor study area, winter, 1995.

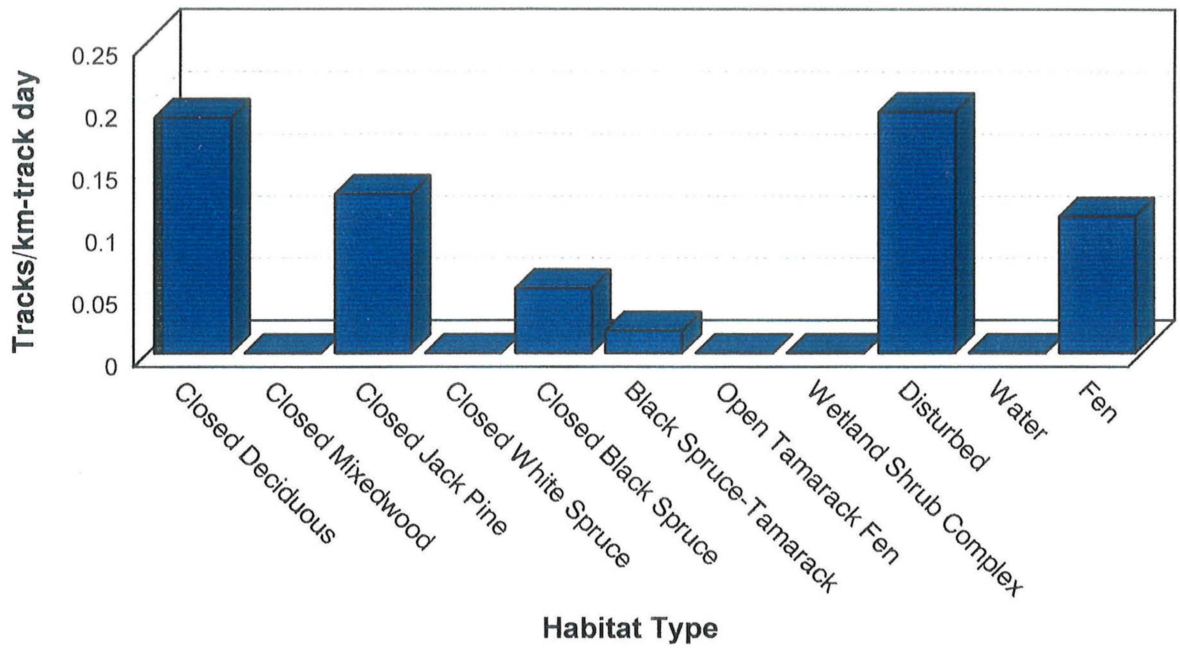


Figure 7. Use of habitat in the Suncor study area by deer (as indicated by winter track frequencies), February and December, 1995.

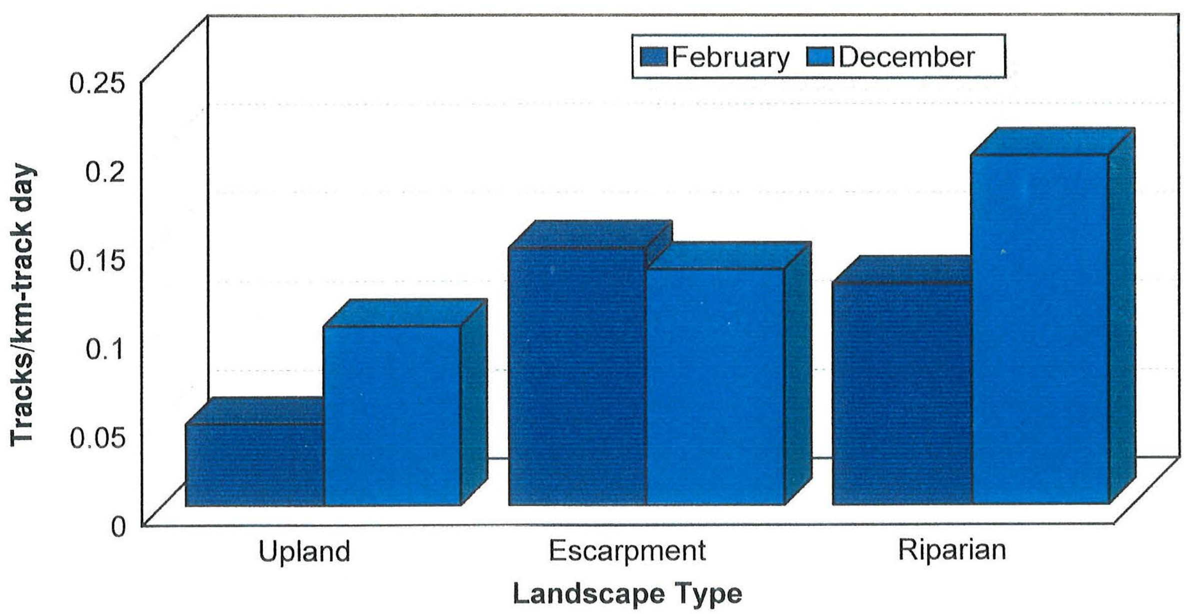


Figure 8. Use of landscape features by deer (as indicated by track frequencies) in the Suncor study area, February and December, 1995.

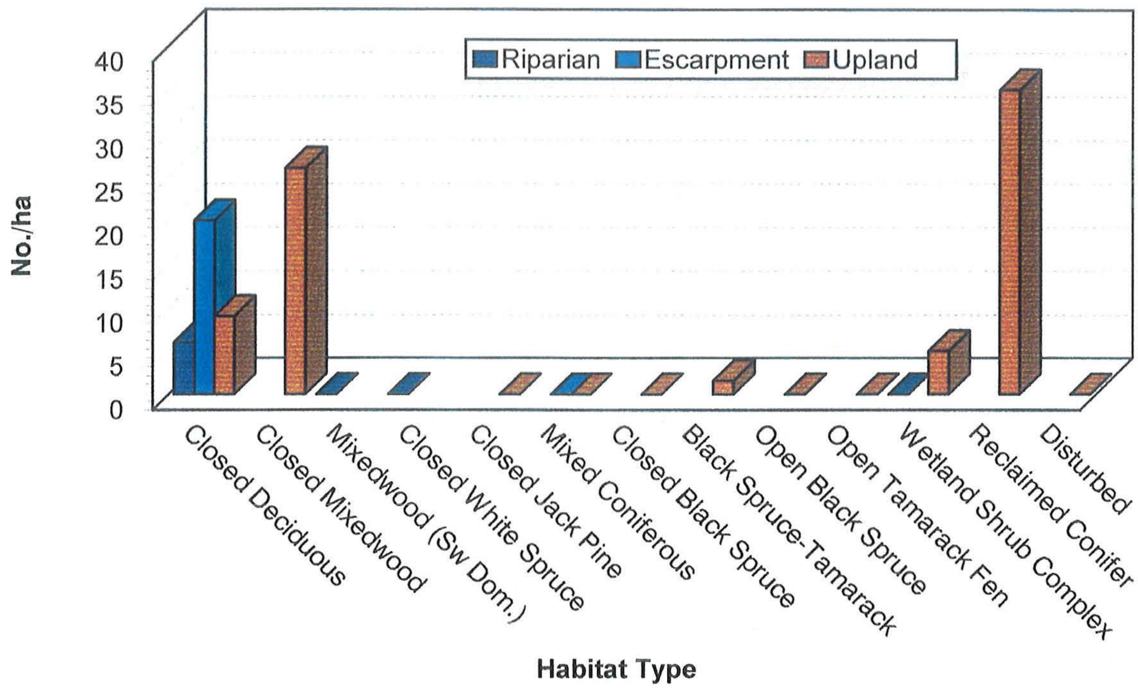


Figure 9. Distribution of deer pellet groups (No./ha) among habitat types and landscape features in the Suncor study area, spring, 1995.

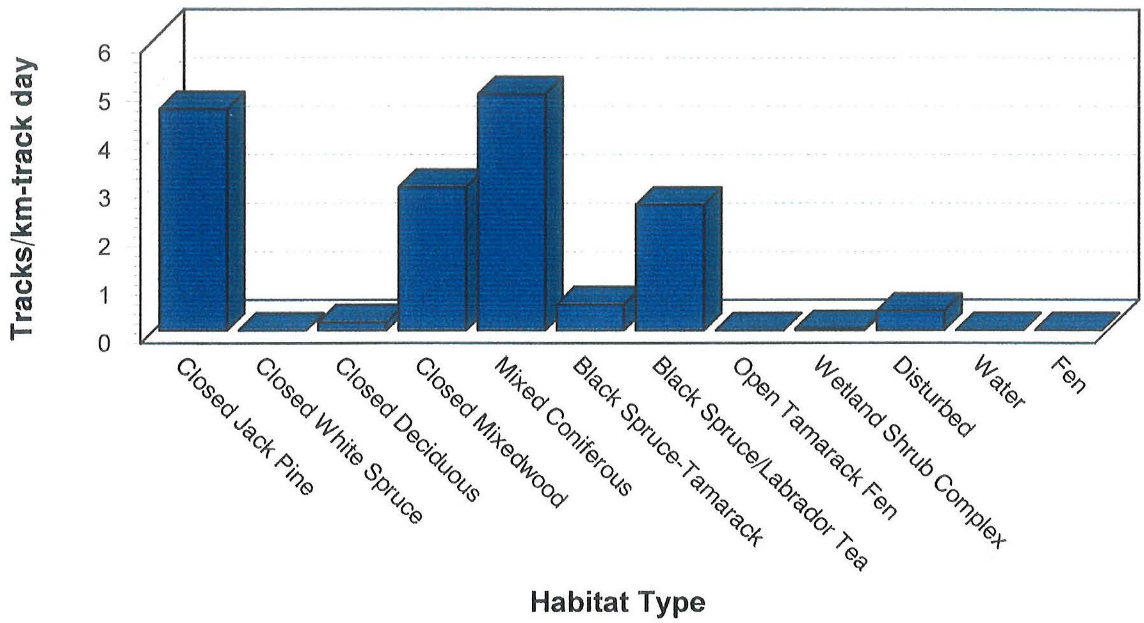


Figure 10. Use of habitats in the Suncor study area by snowshoe hares, February and December, 1995.

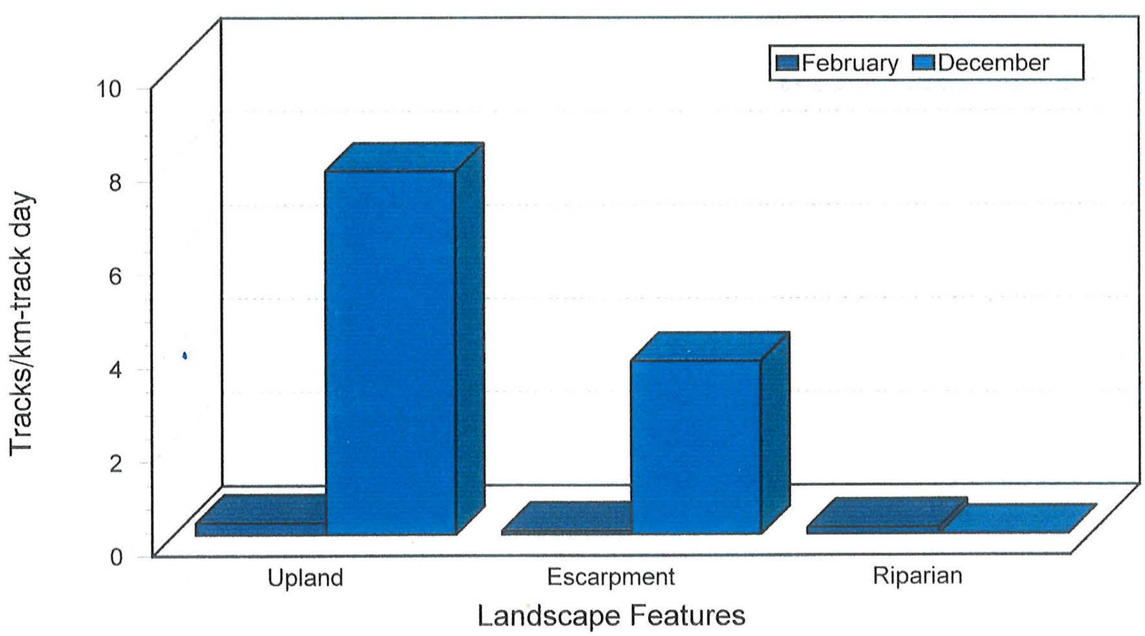


Figure 11. Use of landscape features in the Suncor study area by snowshoe hares, February and December, 1995.

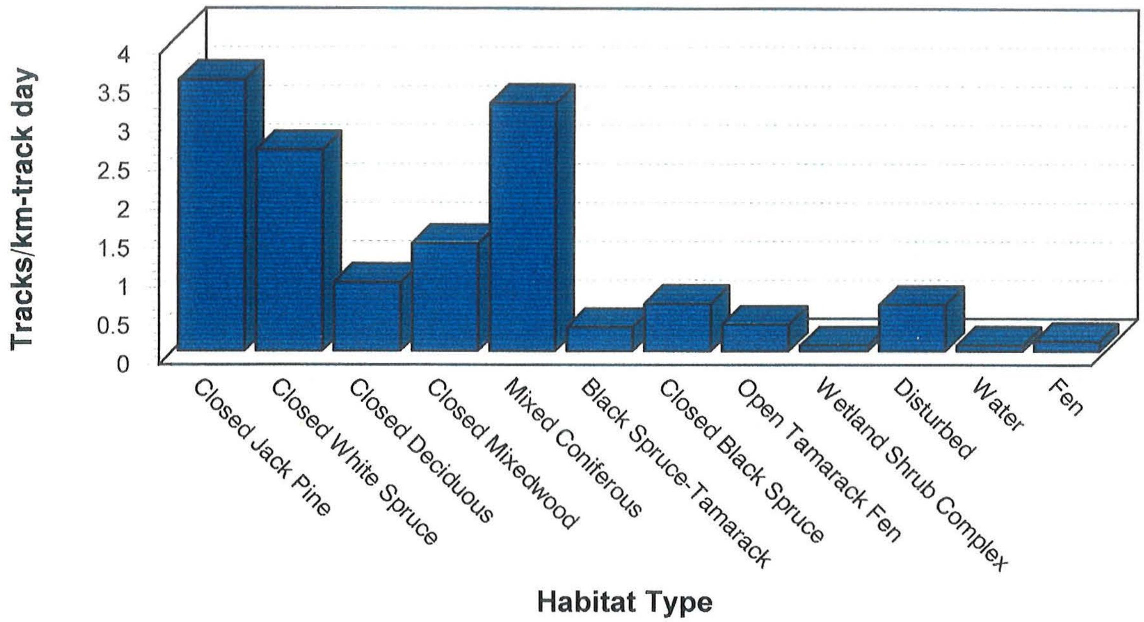


Figure 12. Use of habitats in the Suncor study area by red squirrels, February and December, 1995.

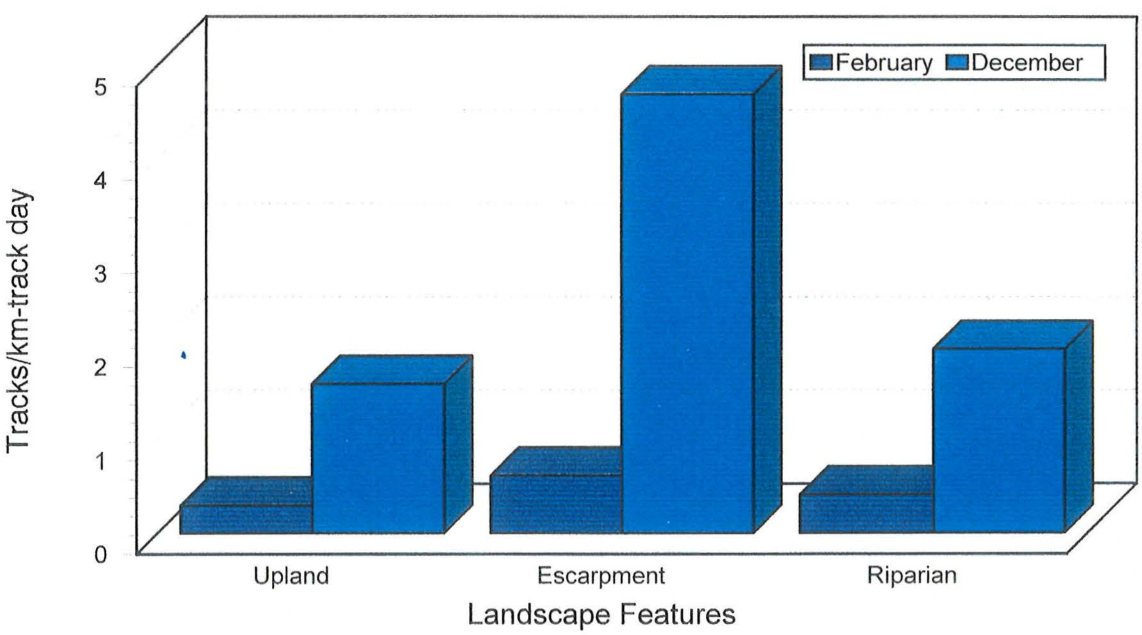


Figure 13. Use of landscape features in the Suncor study area by red squirrels, February and December, 1995.

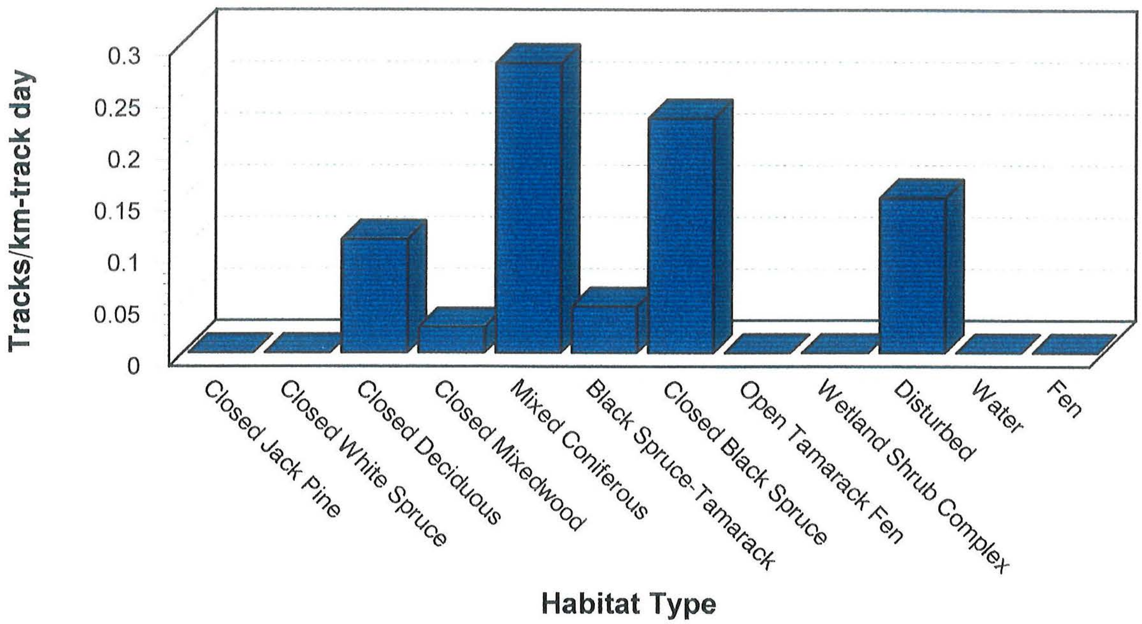


Figure 14. Use of habitats in the Suncor study area by wolves, February and December, 1995.

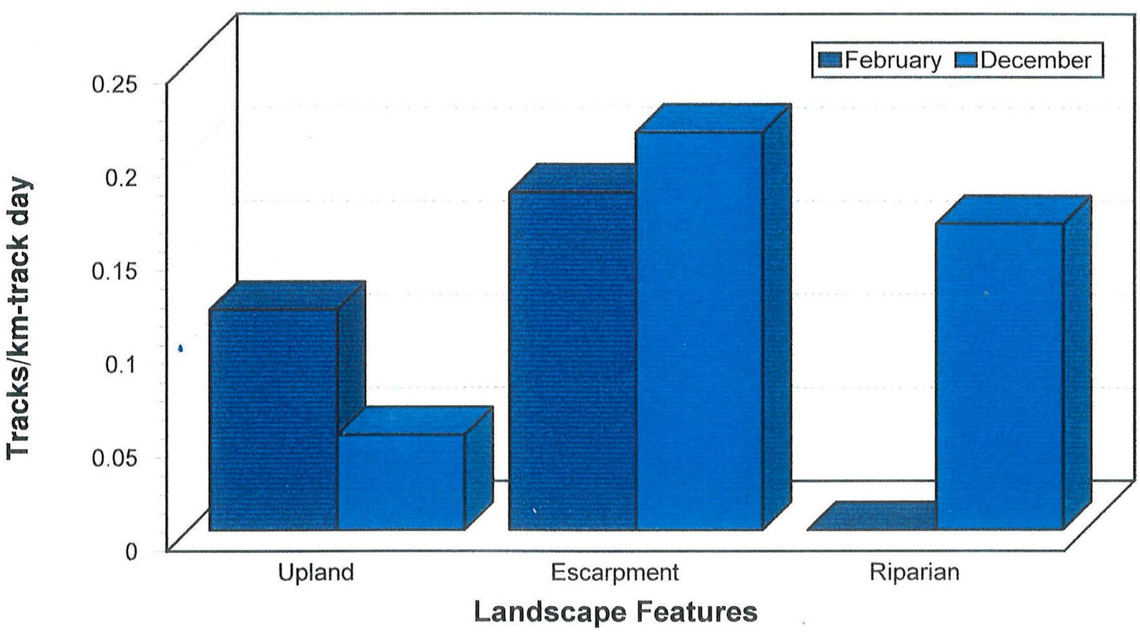


Figure 15. Use of landscape features in the Suncor study area by wolves, February and December, 1995.

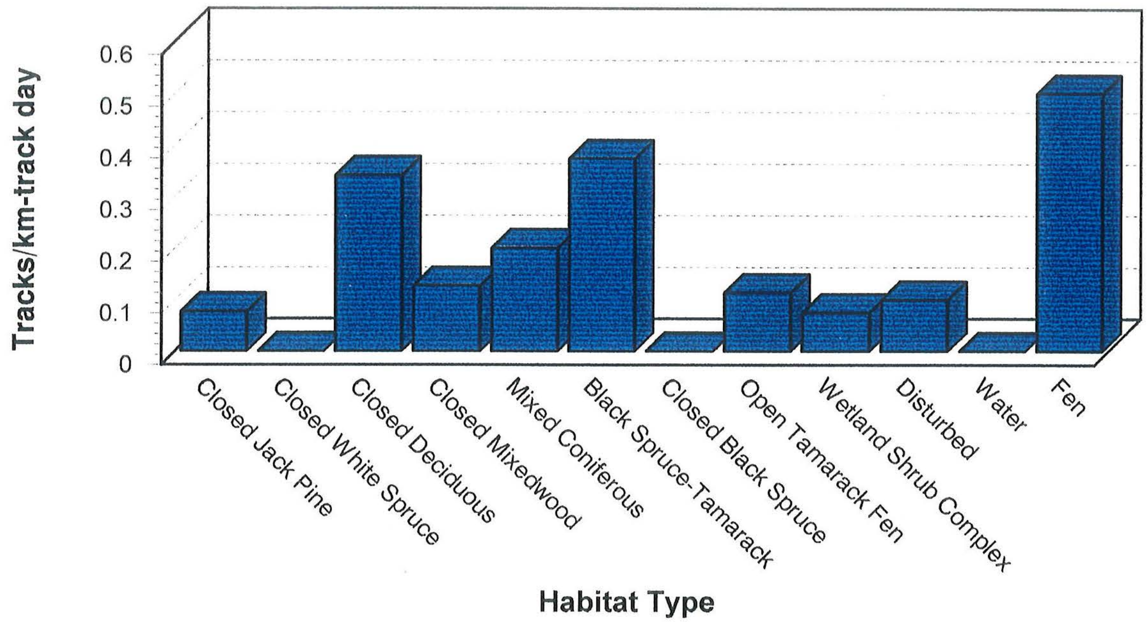


Figure 16. Use of habitats in the Suncor study area by coyotes, February and December, 1995.

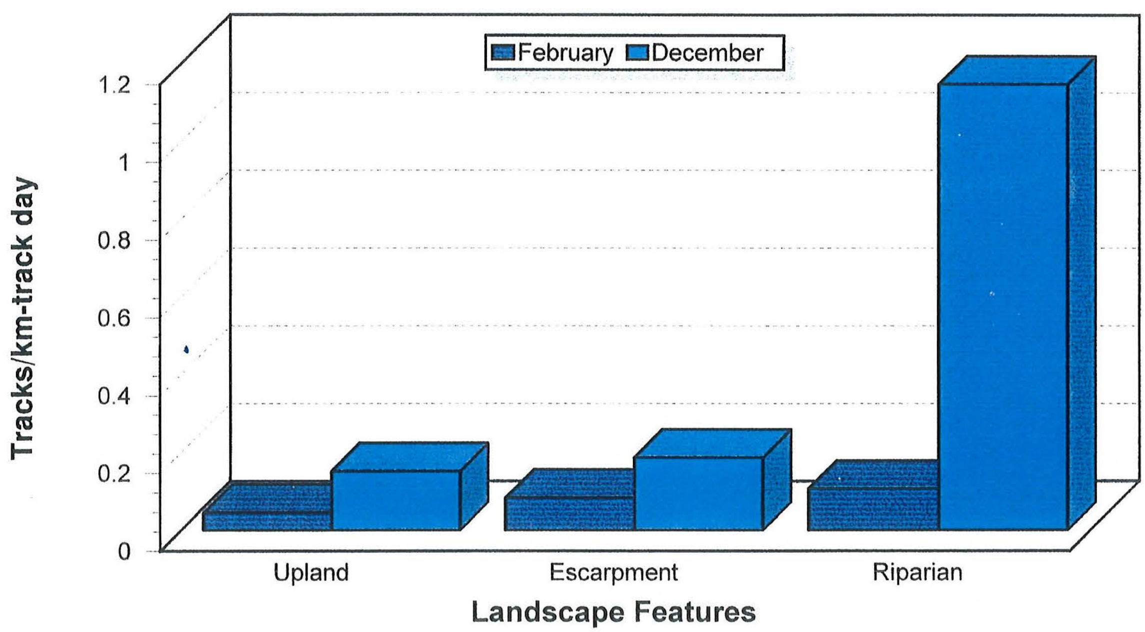


Figure 17. Use of landscape features in the Suncor study area by coyotes, February and December, 1995.

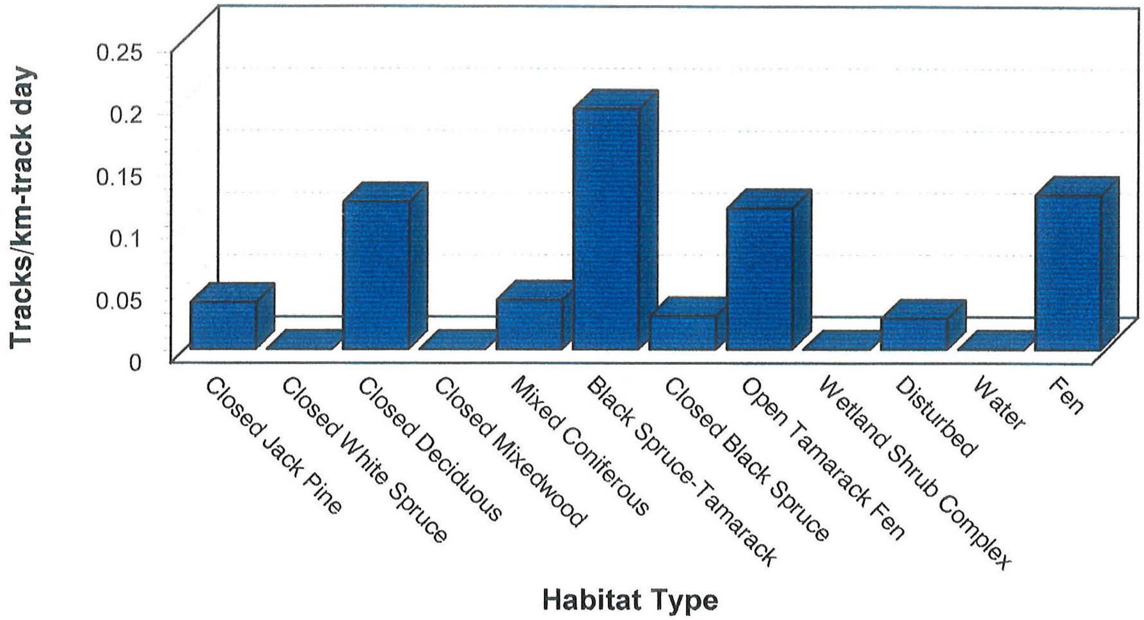


Figure 18. Use of habitats in the Suncor study area by fisher, February and December, 1995.

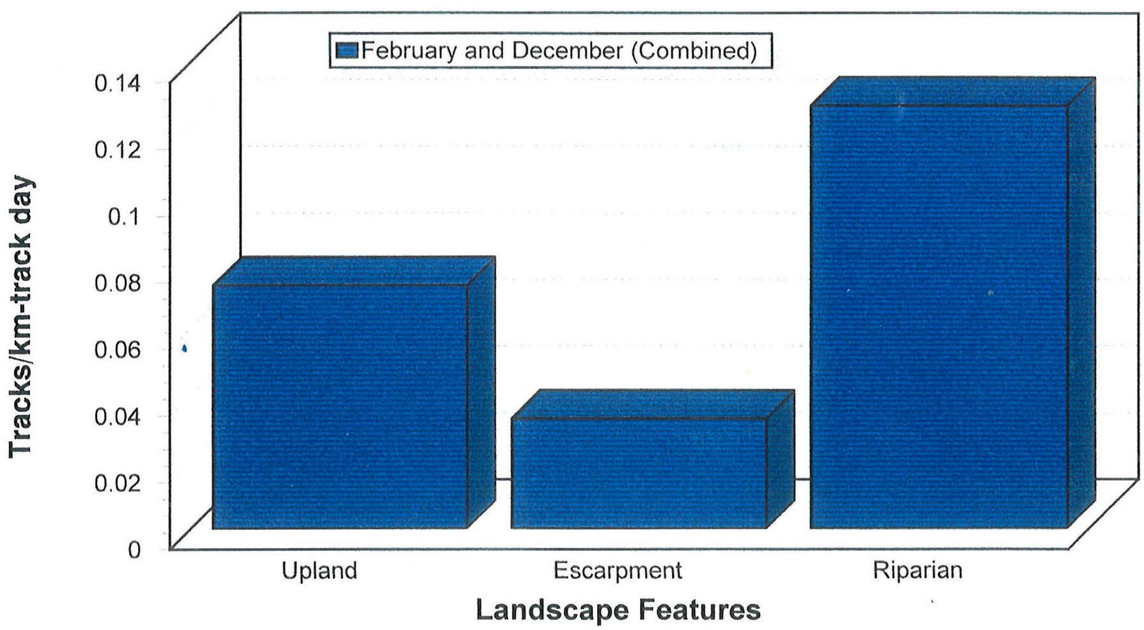


Figure 19. Use of landscape features in the Suncor study area by fisher, February and December, 1995.

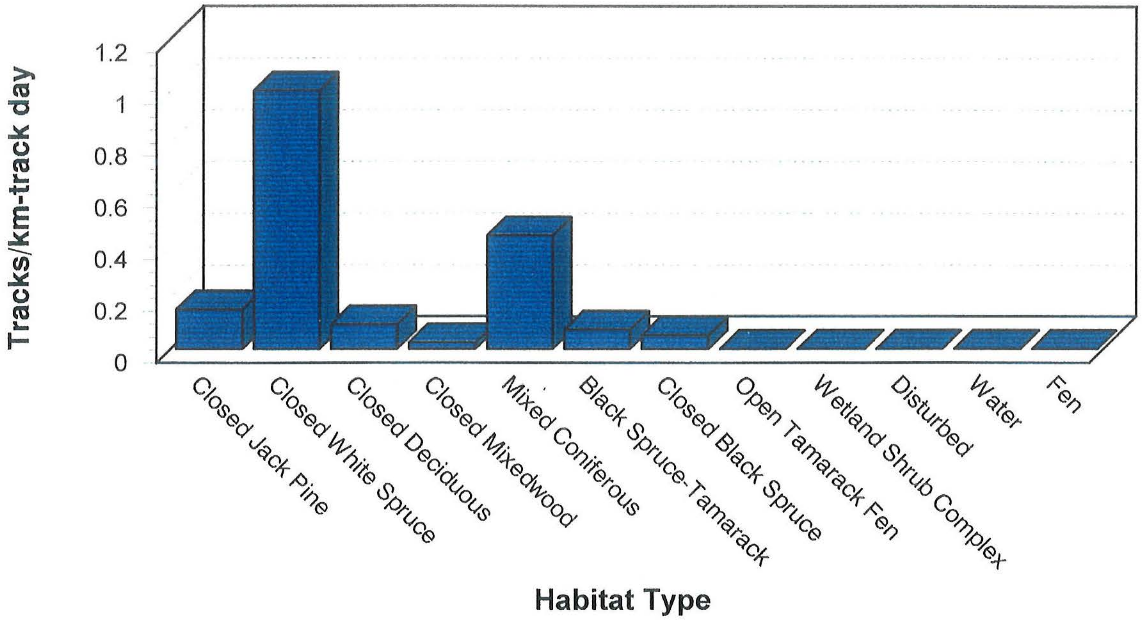


Figure 20. Use of habitats in the Suncor study area by marten, February and December, 1995.

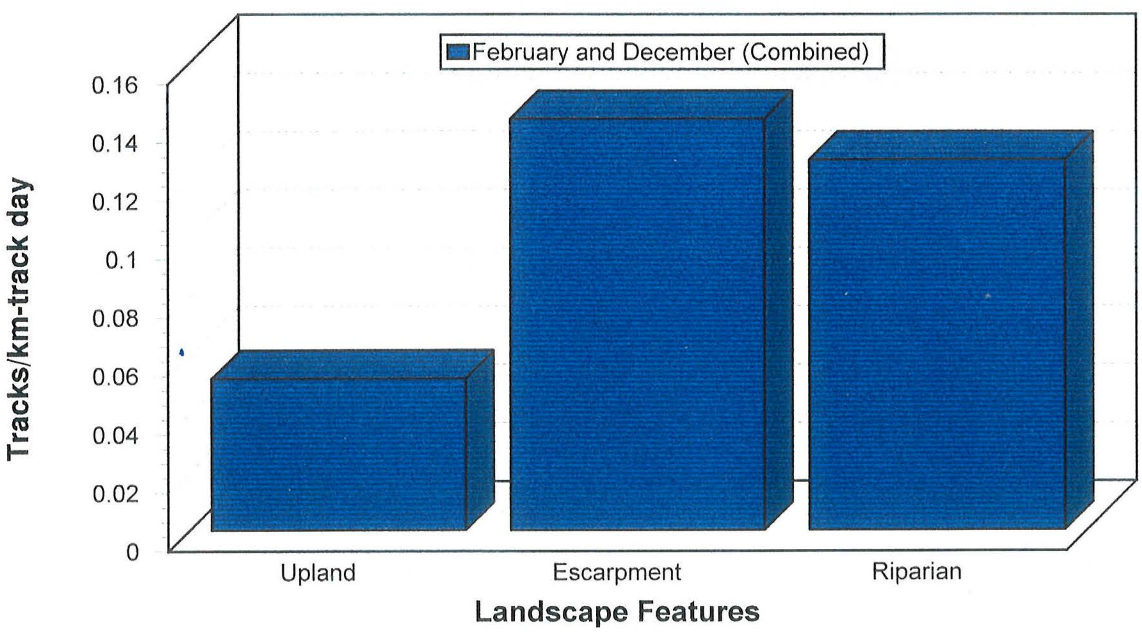


Figure 21. Use of landscape features in the Suncor study area by marten, February and December, 1995.