SOME EFFECTS OF THE PHYSICAL AND BIOTIC ENVIRONMENT UPON THE BEHAVIOUR OF WINTERING MULE DEER

Lorraine Warner
Selkirk College Biology 220

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ABSTRACT.– Incidence and location of deer paths and beds, and browse utilization were studied to determine movements, bedding and foraging behaviour of Rocky Mountain mule deer (Odocoileus hemionus hemionus) on winter range situated near human habitation. The results suggest that these behaviours are related to snowdepth, slope gradient and the availability of redstem ceanothus (Ceanothus sangiuneus). Canid predators did not independently determine deer behaviour. Deer behaviour was found to be unrelated to air temperature.

INTRODUCTION

In today's technological world, it is becoming increasingly important to understand the relationships between deer and their physical and biotic environment as human populations, urban sprawl, recreational activities and large scale resource developments displace wildlife from their habitats. A more complete understanding of these relationships will enable better management of human and wildlife living space.

The objective of this investigation was to assess the effects of certain physical and biotic variables of a winter-range habitat on the movements, bedding and foraging behaviour of a herd of Rocky Mountain mule deer (Odocoileus hemionus hemionus).

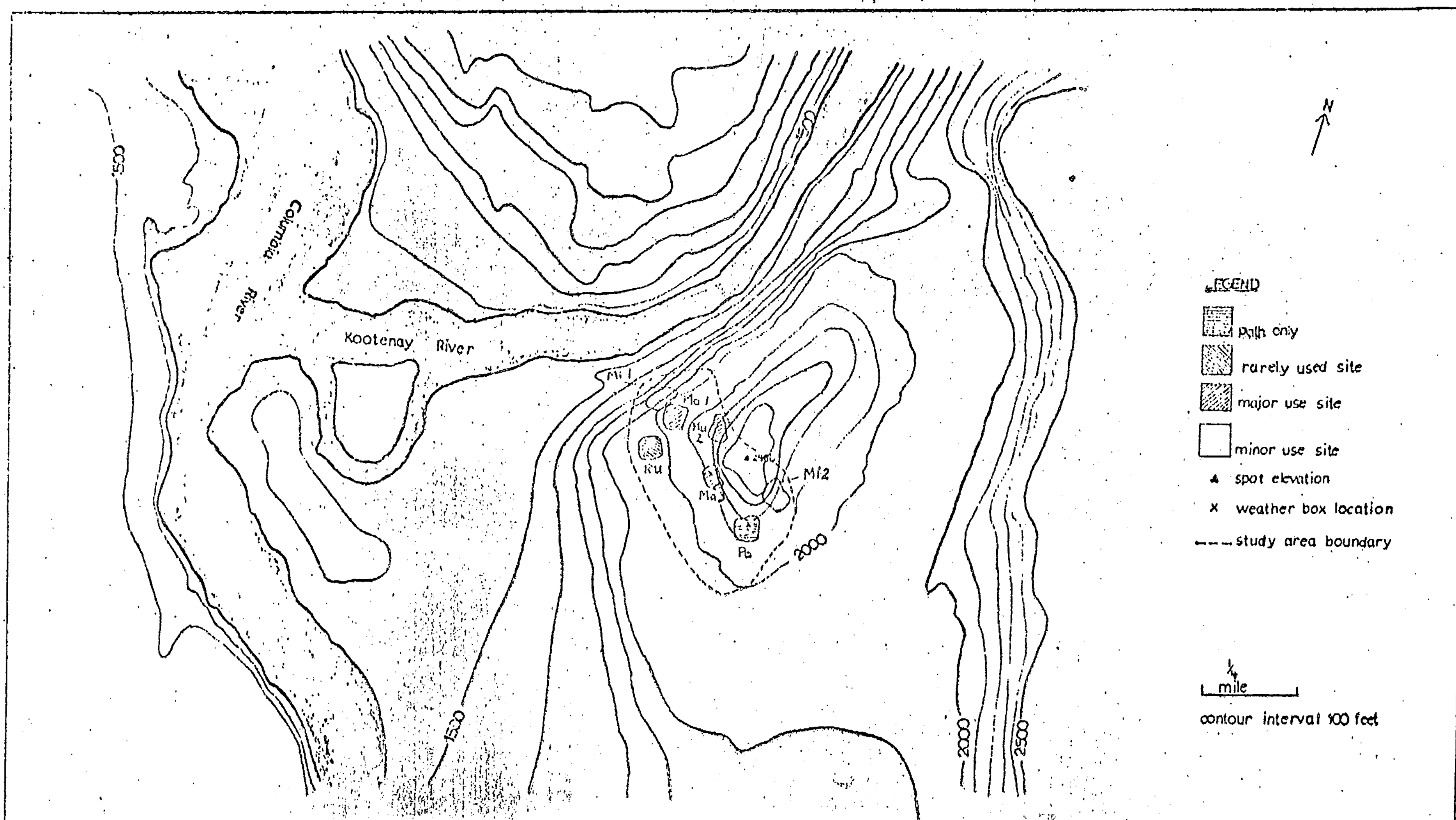

FIG. 1 Location of sample sites in study area

DESCRIPTION OF STUDY AREA

The study area is approximately 109 acres, .17 square miles. It is located in the Bonnington Range in the West Kootenay region of British Columbia, Canada, approximately five road miles from Castlegar (Fig. 1). Elevations vary from 1970 feet to 2400 feet. The study area is bounded on the west and south by roads. The west road is a major highway. The south road leads to a residentially developed bench at the 1560 foot level and continues up to the Castlegar golf course.

There is no free flowing water on the study area. Runoff water was available along the "summer use" road (Fig. 2) after several days thaw.

Transects of sample sites reveal that the study area presents a uniform vegetation pattern. Mallow ninebark (Physocarpus malvaceus), redstem ceanothus (Ceanothus Sangiuneus), mock orange (Philadelphus lewisii), and ocean spray (Holodiscos discolor) are the most abundant shrub species on sample sites (Table 1), except for site RU, characterized by deciduous forest - mainly birch (Betula papyrifirea), alder (Alnus sinuata) and trembling aspen (Populus tremuloides).

Other wildlife species inhabiting the study area include red squirrel (Tamiascuirus hudsonicus), snowshoe rabbit (Lepus americanus), coyote (Canis latrans), two species of unidentified small rodents, Steller's jay (Cyanocitta stelleri), common crow (Corvus brachyrhynchos), black cap chicadee (Parus atricapillus), mountain chicadee (Parus gambeli), winter wren (Troglodytes troglodytes), ruffed grouse (Bonasa umbellus) and red shafted flicker (Cloaptes cafer).

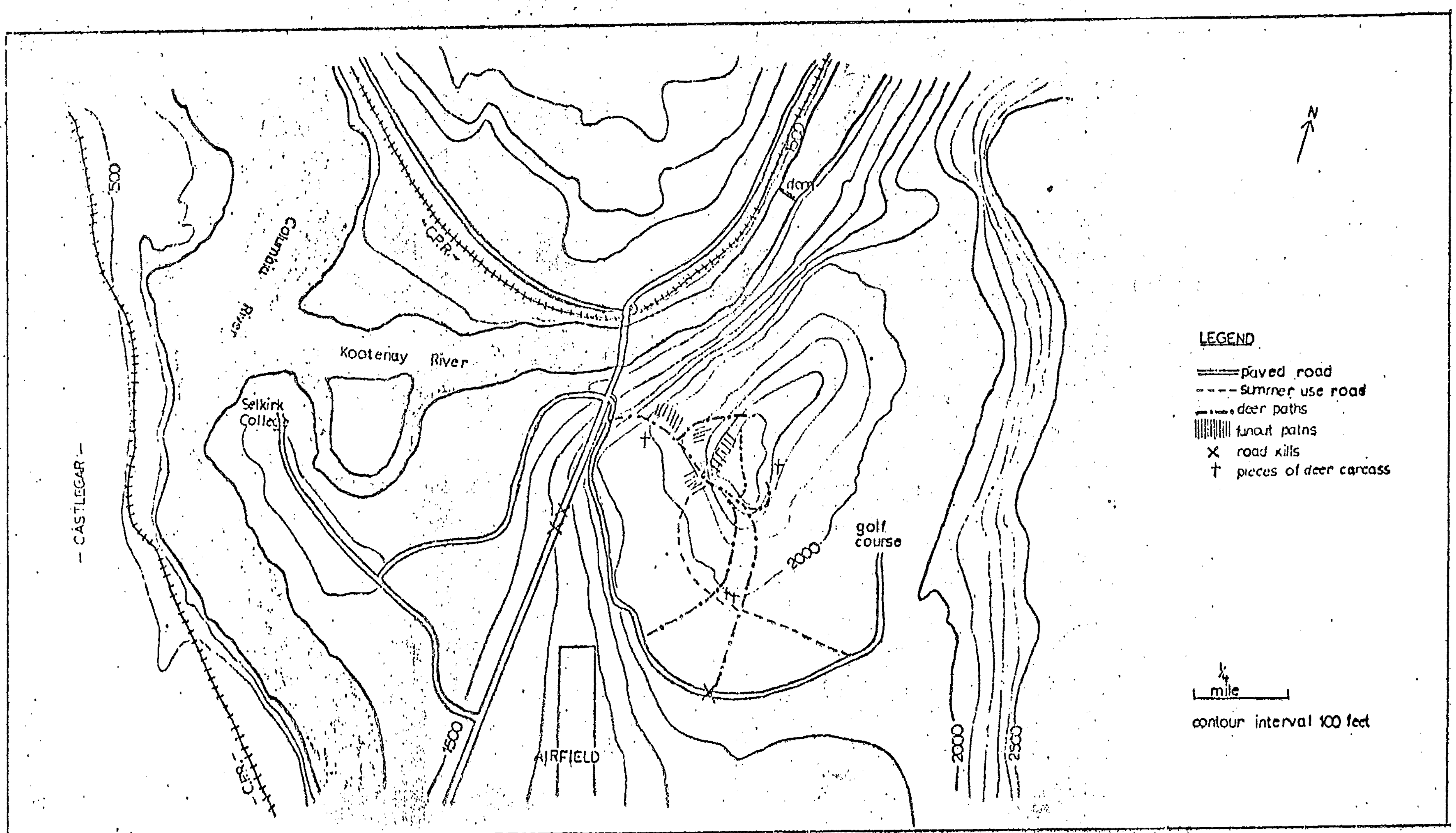

FIG. 2 Location of deer carcasses, road kills and major deer paths

MATERIALS AND METHODS

The study began January 23, 1974 and continued until March 10, 1974. I made 20 trips into the field - not less than two nor more than four a week - during the study period.

Evaluation of the physical environment included measurement of temperature in two sites with different aspect; snowdepth; vegetation; slope gradient; and aspect. Those attributes were measured and recorded for seven sample sites chosen by the criteria shown in Table 1. Hereafter, sample sites will be referred to by the symbols designated in Table 1. Physcial characteristics of the sample sites are shown in Table 2.

Temperature was recorded continuously from February 4 to March 5 on Ma 3, facing west at 2110 feet; and on Pa, south facing at 2120 feet. A cenco hygrothermograph and a maximum-minimum thermometer were placed at ground level in Stephenson Screens. The instruments were checked and maximum-minimum temperatures recorded every time I went into the field.

Four transects, each 22.3 meters long, were established on all seven sample sites to determine density, species composition and browse of plant species. Browse figures were determined by estimating the percent of twigs on the plant which had been browsed. I arbitrarily assigned the following values to the figures: High = 60-80%; Medium = 20-60%; Rare = 1-20%. Plants with over 60% of twigs and stems browsed were defined as "key browse species".

As far as possible, a consistent pattern was followed when establishing transects (Fig. 3) although actual lines were established by sight alone. Mi 1 is on a 25-32 degree slope and is characterized by loose, craggy rock. The four transects, therefore, were established according to accessibility. Where applicable, one transect was on a path. Plants included in the transect survey were those within one yard of either side of the string and naturally exposed above the snow. That is, I did not record any plants exposed by my disturbance of the snow.

TABLE 1: Sample site selection criteria and representative symbols

Selection criteria	Classification	Symbol
-used for bedding on more than three study days; -fresh deer tracks on more than ten study days	-Major Use-	Ma 1 Ma 2 Ma 3
-used for bedding on two or three study days; -fresh deer tracks on five to ten study days	-Minor Use-	Mi 1 Mi 2
-no beds; well-defined deer path	-Path Only-	Pa
-no beds; no path; some evidence of foraging	-Rarely Used-	Ru

TABLE 2: Physical characteristics of sample sites in study area

Site	Gradient range	Aspect	Elevation	Other features
Ma 1	0-10	W	1990	small knoll;mainly shrubs
Ma 2	12-15	W	2150	power poles;shrubs
Ma 3	0-20	W	2120	rocky outcrop;shrubs,some trees
Mi 1	25-32	W	1970	loose,craggy rocks;mainly shrubs
Mi 2	18-28	E	23-2400	shrubs,some trees; shrubs relatively large
pa	4-10	S	2110	rocky outcrop;shrubs,some trees
Ru	0	W	1980	mainly deciduous trees

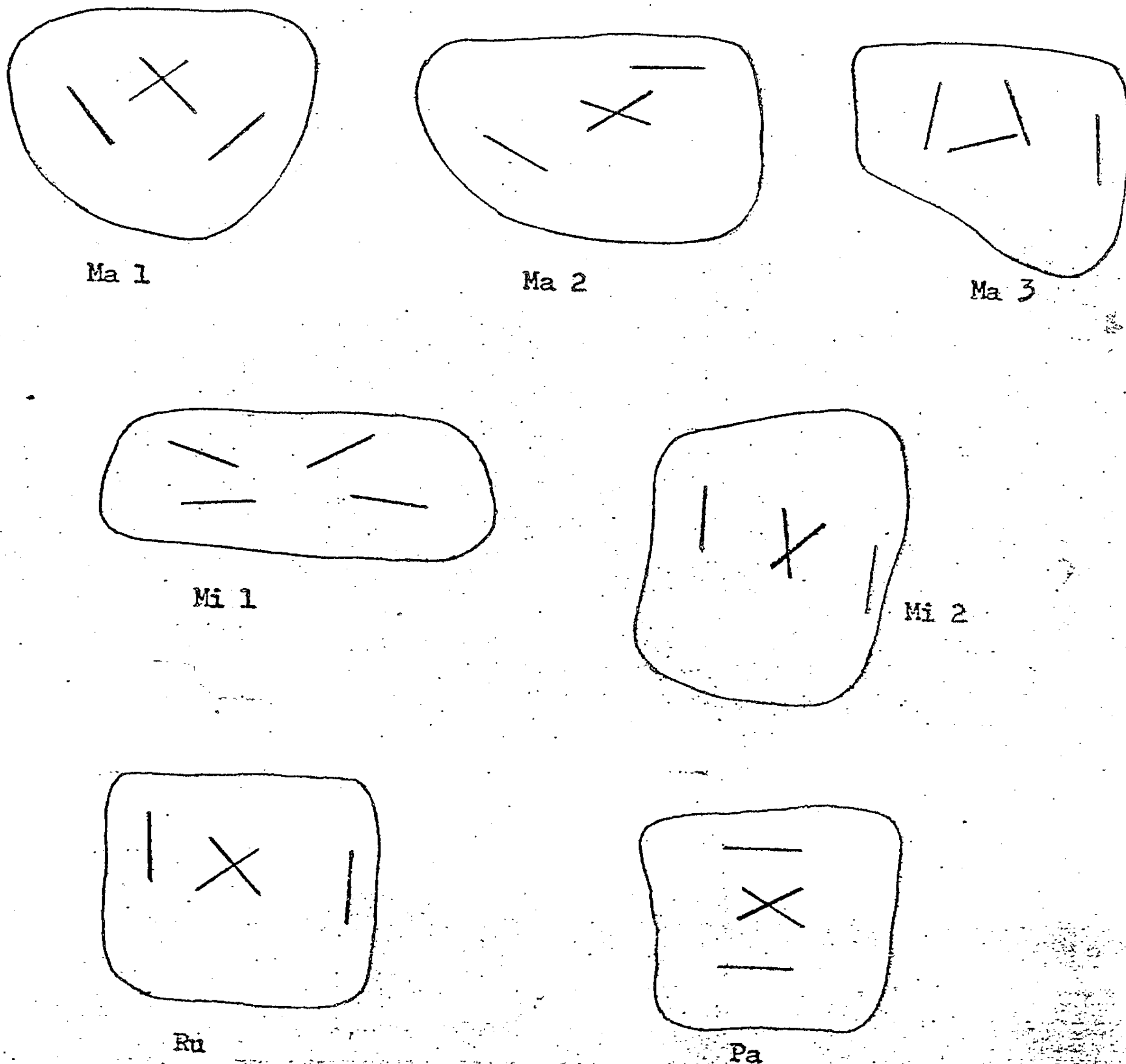

Fig. 3 Approximate shapes of sample sites and patterns used when establishing vegetation transects. Diagrams of sample sites are oriented with the greater elevation corresponding to the top of the figure.

For each sample site, gradient of slope was determined with a clinometer and slope aspect noted by reference to map. Beds observed in the sample sites were recorded in terms of aspect, gradient, vegetation and snowdepth.

Deer paths (Fig. 2) were those receiving enough use to keep them visible throughout the study. Occasionally, deer departed consistently from their single file paths forming "fanout" paths. These paths were usually associated with preferred browse species.

The health of deer killed by predators was determined by reference to the colour of the bone marrow. Reddish marrow indicates that the fat reserves of the animal are depleted, except in fawns up to three months old (Cowan, 1956). An animal receiving adequate nutrition has cream coloured marrow. The age of one deer was estimated by referring to Giles diagramatic and photographic key of jaw bones and teeth (Giles, 1969).

RESULTS AND DISCUSSION

Snowdepth

Snowdepths in the study area ranged from 2.54 cm at 1980 feet to one meter at 2400 feet during the study period. Sites Ma 1, Ma 2, Ma 3 and Mi 1 were snowfree at times from February 6 to February 15, and snowdepth never exceeded 20 cm. The greatest snowdepths were recorded on sites Mi 2, Pa and RU. At every measurement, these sites had a greater depth than the other sample sites. Table 3 gives information for two days. As the Major Use sites had relatively less snow during the study period, it would appear that snow cover is an important factor determining foraging and bedding behaviour. However, on February 10, nine beds were found on 12.7 cm of snow on site Mi 1 even though patches of bare ground were available. Miller (1964) also found that black-tailed deer often bedded in snow when snow-free ground was only a few feet away.

TABLE 3: Greatest snowdepths on sample sites on two study days

Site	Feb. 23	March 7
Ma 1	2.54 cm	2.54 cm
Ma 2	12.7 cm	7.62 cm
Ma 3	12.7 cm	5.08 cm
Mi 1	12.7 cm	10.1 cm
Mi 2	76.2 cm	60.96 cm
RU	no data	60.96 cm
Pa	25.4 cm	22.8 cm

Continued from page 15.

Deer use snow as a substitute for water in winter (Moen, 1973), therefore the rivers should not be the purpose of their crossing. Plant species composition on the other side of the roads was not investigated.

Vegetation

There was little difference in the amount of vegetation cover among the seven sites sampled although there were variations in species composition (Table 4, Fig. 4 and 5)

Cowan (1947) observed that 15.24 cm of snow altered the types of food consumed by deer in Canada, possibly because deer make their initial selection of forage through olfaction (Moen, 1973). I have no transect data on vegetation consumption from the few snow free days in this study, but an entry from February 9 of my diary, a snow-free day, states that deer were browsing falsebox and grasses most heavily. Falsebox was the only evergreen shrub available to the deer on the study area. Hill (1956) states that green plants are necessary for Vitamin A. On several occassions, I encountered spots dug in the snow for falsebox. But the plant browsed most heavily was ~~by far~~ ceanothus (Fig. 5). Ceanothus rates particularily high in crude protein (Hill, 1956). A maintenance ration of less that 5% crude protein content is critical for deer. Browse figures for ceanothus on the study area exceed 60%. On sites Ma 2 and Ma 3, browsing figures for ceanothus exceed 80% (Table 4). Young and Payne (1948) state that key browse species generally cannot be utilized more than 60-65% and maintain yields. Most western U.S. game departments use 40-60% as the measure of proper utilization of key browse species (Hill, 1956). Ceanothus has been browsed in every sample site regardless of snowdepth (Table 4).

TABLE 4: Transect data for plant species composition and relative browsing estimates on the seven sample sites N 396

	sample sites													
	Ma1		Ma2		Ma3		Mi1		Mi2		Pa		RU	
Species	N[a]	BE[b]	N	BE	N	BE	N	BE	N	BE	N	BE	N	BE
Redstem cea (Ceanothus Sangiuneus)	12	H	11	H[c]	19	H[c]	4	H	12	H	7	H	8	M
Cherry (Prunus spp.)	8	R	3	M	1	M	32	M	1	M	1	M	NR	
Falsebox (Pachistima hyrsinites)	12	M	1	N	1	N	24	M	NR		NR		NR	
Mallow ninebark (Physocarpus Malvaceus)	20	R	17	N	12	R	5	R	30	N	15	N	7	N
Willow (Salix lasiandra)	1	N	NR		4	R	6	R	2	N	NR		6	N
Trembling aspen (Populus tremuloides)	1	N	NR		4	R	5	R	NR		NR		4	N
Saskatoon (Amelanchier)	1	N	NR		3	R	1	N	4	R	NR		NR	
Sitka alder (Alnus sinuata)	NR		NR		2	N	1	N	NR		NR		4	N
Birch (Betula papyr	NR		NR		NR		2	N	NR		NR		7	N
Douglas maple (Alcer Glabrum)	NR		NR		NR		NR		NR		NR		4	N
Hazlenut (Corylus)	NR		NR		1	N	NR		NR		2	N	NR	
Ponderosa pine (Pinus ponderosa)	NR		NR		NR		NR		1	N	NR		NR	
Huckleberry (Vaccinium caespitosum)	NR		NR		NR		3	N	1	N	NR		NR	
Mock orange (Philadelphus lewisii)	3	N	1	N	4	N	10	N	8	N	4	N	11	N
Oregon grape (Berberi ripens)	1	N	1	N	NR		NR		NR		2	N	4	N
Ocean spray (Holodiscos discolor)	12	N	7	N	NR		4	N	5	N	4	N	3	N
Wild rose (Rosa)	NR		1	N	12	N	NR		4	N	3	N	4	N
Thimbleberry (Rubus parviflorus)	NR		NR		NR		1	N	NR		NR		NR	
Waxberry (Symphoricarpos Abos)	6	N	5	N	9	N	1	N	6	N	4	N	4	N
Yarrow (Achillea Millefolium)	NR		1	N	NR		2	N	4	N	2	N	NR	
unidentified	1	N	2	N	NR		1	N	NR		2	N	1	N
TOTAL PLANTS	78		50		72		102		75		52		67	
N of species	11		11		12		16		12		14		13	

a Number of plants in site

b Browsing estimate: estimate of the percent of twigs and stems on the plant which had been browsed. (H)igh 60-80%; (M)edium 20-60%; (R)are 1-20%; (N)ot used; NR not represented.

c Over 80% of twigs and stems on plant browsed.

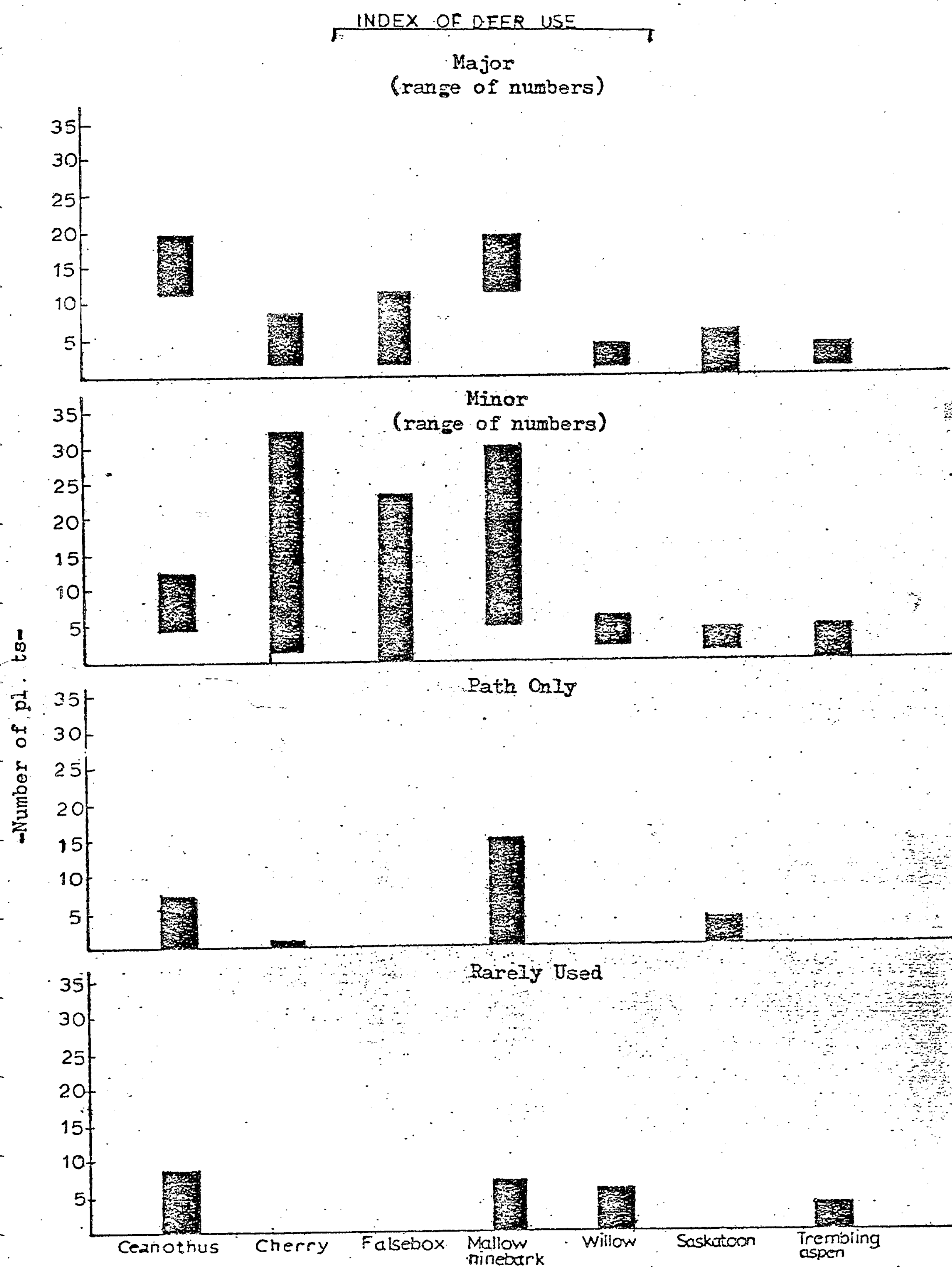

Fig. 4 Browsed plante species composition on sample sites in study area.

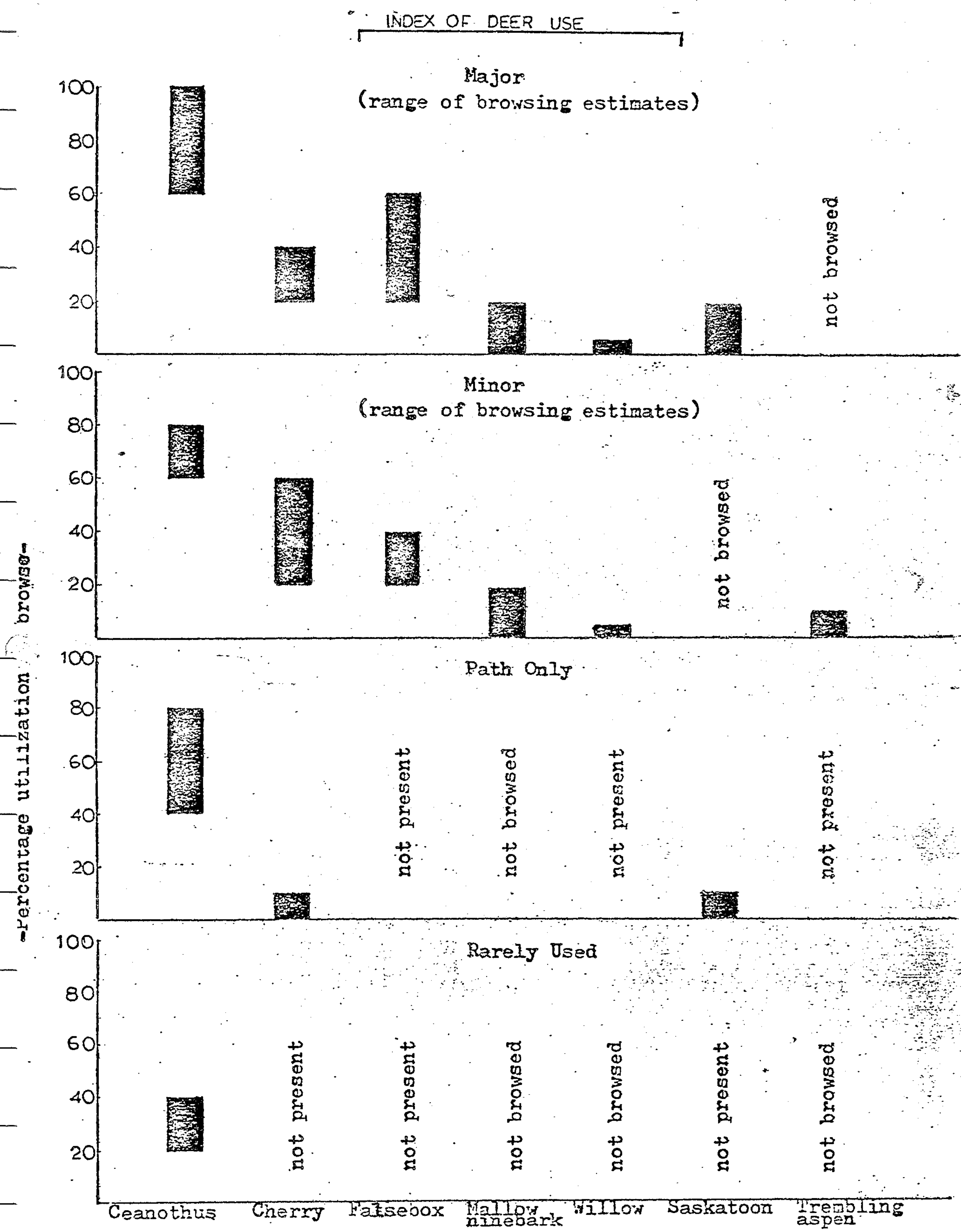

Fig. 5 Estimates of the percent of twigs and stems on the plants which had been browsed. Data gathered from seven sample sites in study area.

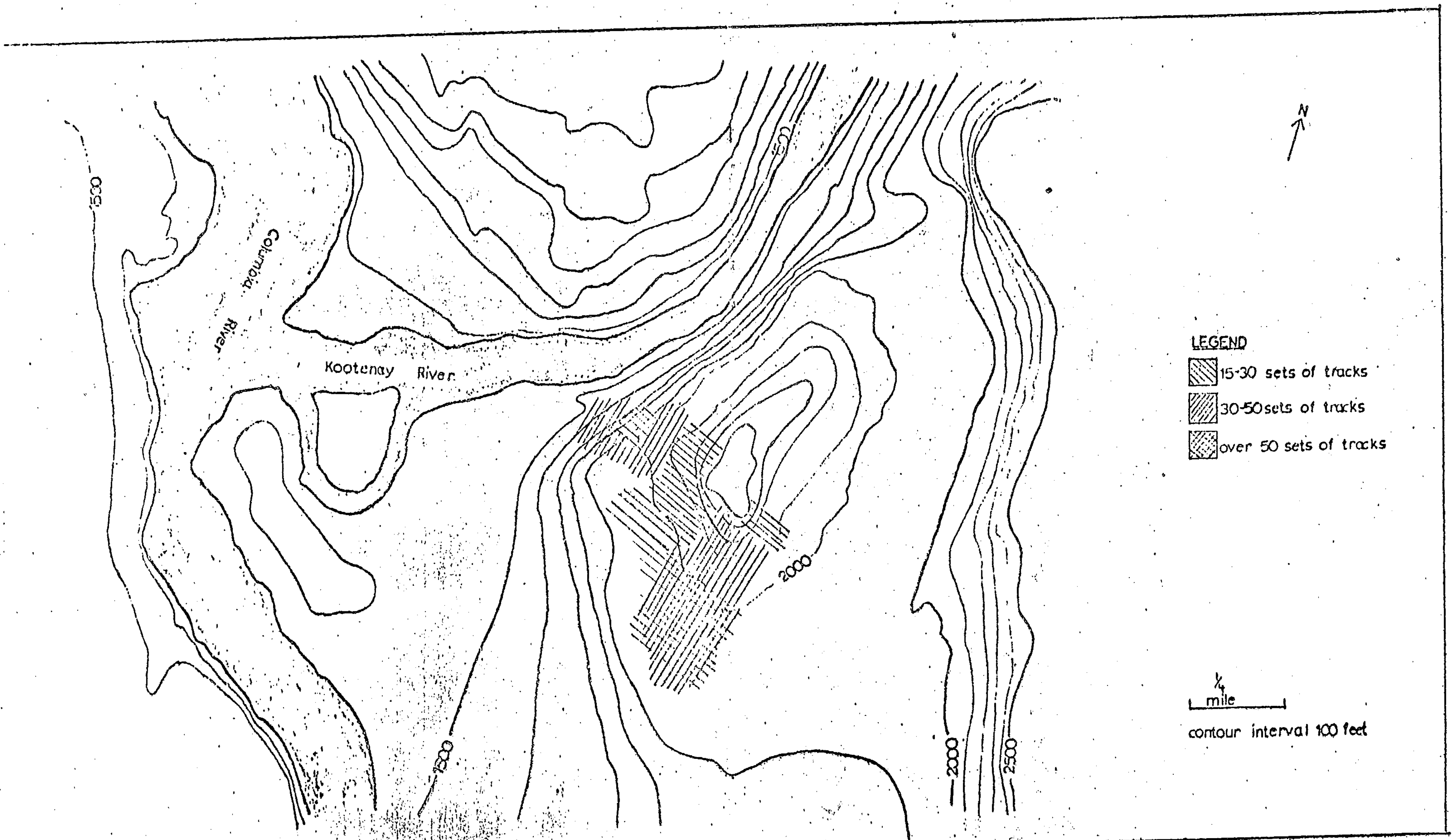

FIG. 6 Distribution of canid tracks in study area from January 22, 1974 to March 10, 1974. (estimate)

Loveless (1964) found snowdepth to be a major determining factor in the activity of his study herd. Moen (1973) considers 50.8 cm of snow to be a critical depth for deer. An increase in snow cover results in a decrease in available food. Snow also increases the energy expenditure necessary for movement. All fanout paths were located in snow not exceeding 20 cm. (Fig.1,2) Deer followed my path up to Pa through snow over 50 cm rather than walk in unpacked snow. For this herd of deer, therefore, foraging and bedding behaviour and movements seems to be influenced by snow cover when it exceeds 20 cm.

Predation and Road Kills

Canid tracks, assumed to be coyote, were observed on the study area on every field trip. On three occassions, I encountered pieces of deer carcasses (Fig. 2). Two of the animals killed were badly undernourished. The other deer was healthy. One jaw bone was found. It belonged to an undernourished deer of approximately 2½ years. Where the deer were killed is not positively known. The spots marked on Fig. are in areas not used for bedding. Vegetation is largely trees and snowdepth exceeds 45 cm (Fig. 7). Canid tracks were most abundant on sites Ma 1 and Pa, but the 1980 foot bench adjacent to the golf course showed the greatest evidence of used by canids - scats, tracks and holes (Fig.6). Canid tracks were consistently present beside well defined deer paths. Whereas the deer may sink up to 60 cm in the snow, the canids barely leave an impression. The deer are at an obvious disadvantage when they move through deep snow.

As a relatively large number of tracks were present on a Major Use site, it appears that the presence of predators does not independently determine deer behaviour.

Five road kills have been recorded since the beginning of this study - four on the west road and one on the south road (Fig.2). The impetus for road crossing has not been ascertained.

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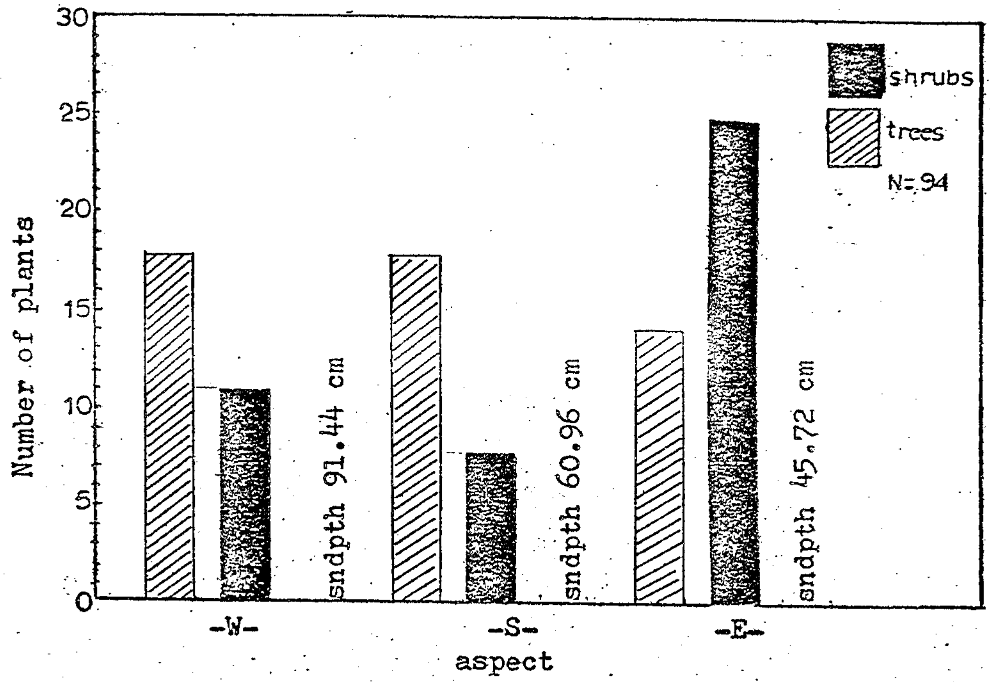

Fig. 7 Vegetation and snowdepth on three locations where pieces of deer carcasses were found.

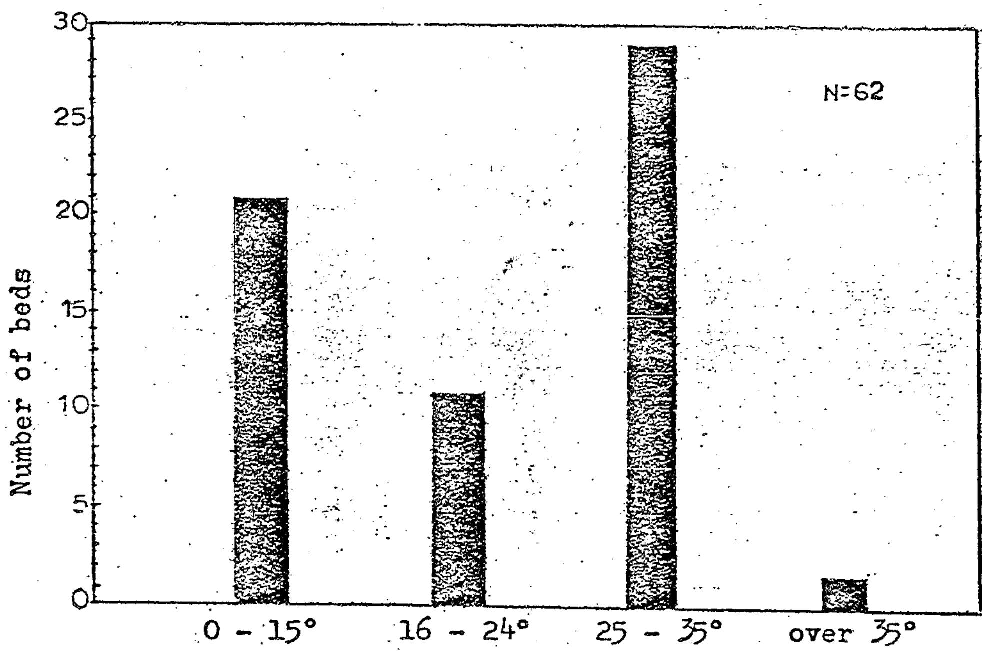

Fig.8 Distribution of deer beds on study area by slope gradient

Use of Slope

Of the 62 deer beds observed on the study area, 41 were located on slopes with gradient exceeding 15 degrees (Fig. 8). Loveless (1964) also noted that deer chose slope sites for bedding especially during periods of high wind. Mackie (1970) on the other hand, reports that mule deer in his study area avoided slopes for bedding. For deer inhabiting areas frequented by predators, bedsites allowing a view of the surroundings and providing the best chance to catch the scent of a predator would seem to be a survival advantage. I have observed, however, that deer do not necessarily respond to the presenc the presence of coyotes. On April 4, six deer were browsing an area while a coyote stood less than 100 feet away.

Air Temperature

There was no great variation between temperatures recorded at the two weather boxes. four degrees was the largest (Fig. 9) difference. Loveless (1964) found that the comfort range for mule deer on his study area was about 15 to 45 degrees. 15 and 53 were the lowest and highest temperatures recorded during my study. If the "comfort" range is applicable here, the deer would not likely respond to air temperature independent of other factors.

Initially, wind velocity and amount of insolation were two variables to be investigated. Owing to lack of time and unavailability of the necessary instruments, the effects of these variables remain unknown. Loveless (1964) found that wind direction and velocity induced little reaction in mule deer except during very cold weather (minus 15 F). He did, however, find that areas used for bedding were those where wind velocities were highest. He also found that aspects receiving the greatest amount of direct sunlight were preferred by the deer.

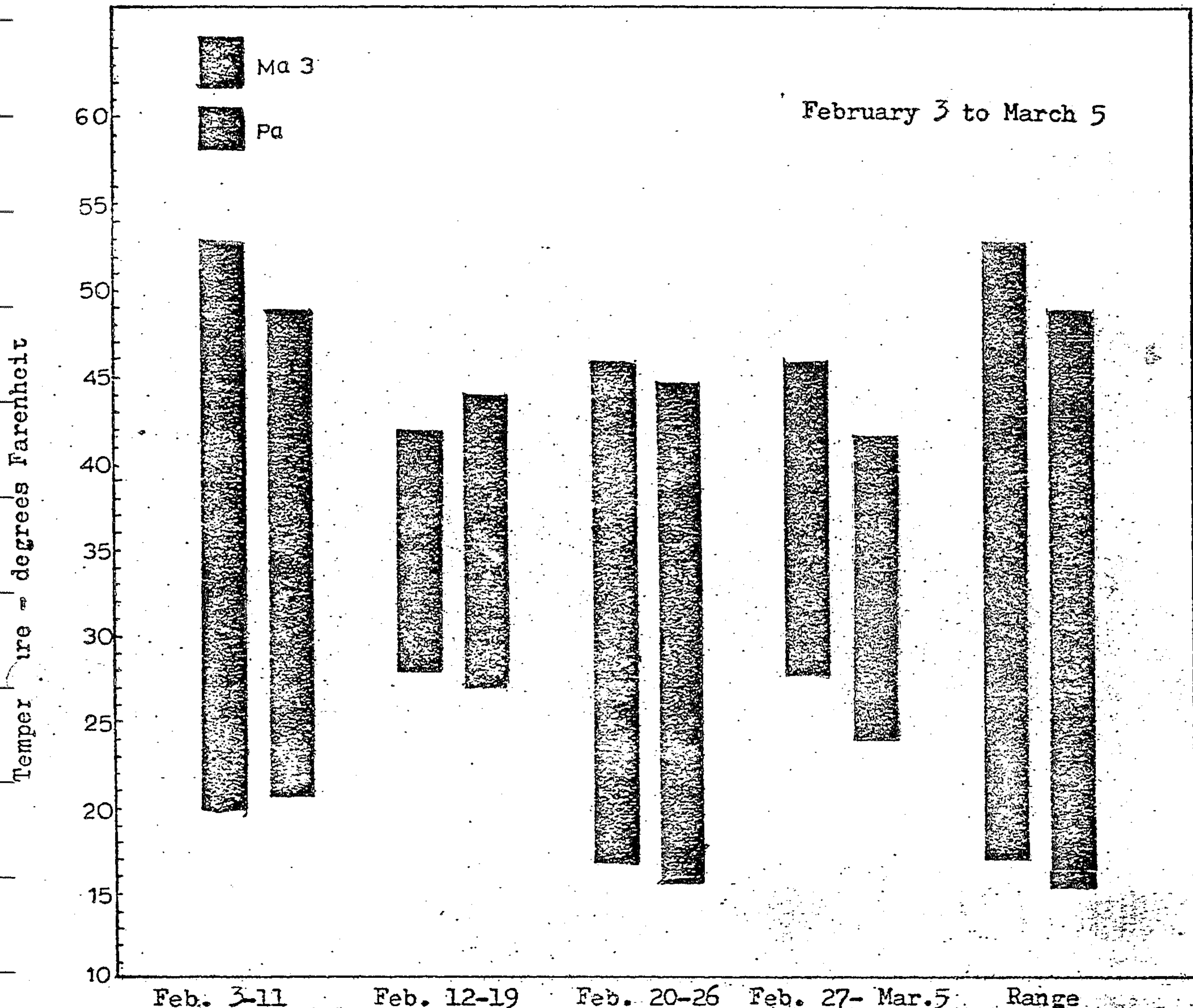

Fig. 9 Air temperature recorded at sample sites Ma 3 and Pa

CONCLUSIONS

Snowdepth greater than 20 cm inhibits bedding and foraging by the deer because of the inaccessibility of forbs and grasses and the increased expenditure of energy necessary for movement. The presence of predators is a facotr influencing deer behaviour only in snow over 20 cm. Slopes were desirable bedding locations possibly because the distribution of snow is generally less on slopes than on flats.

Ceanothus was browsed throughout the study area regardless of snowdepth. The search for adequate nutrition supersceded the importance of snowdepth and predation.

For a beginning point in acknowledging the close proximity of this herd of mule deer to human habitation, the Department of Highways should be advised to reduce the speed limit on that stretch of highway where four deer were killed and erect signs indicating that the highway is used as a deer crossing.

It should be recommended to the appropriate Government department that all vehicles be prohibited access to the wintering range of the deer.

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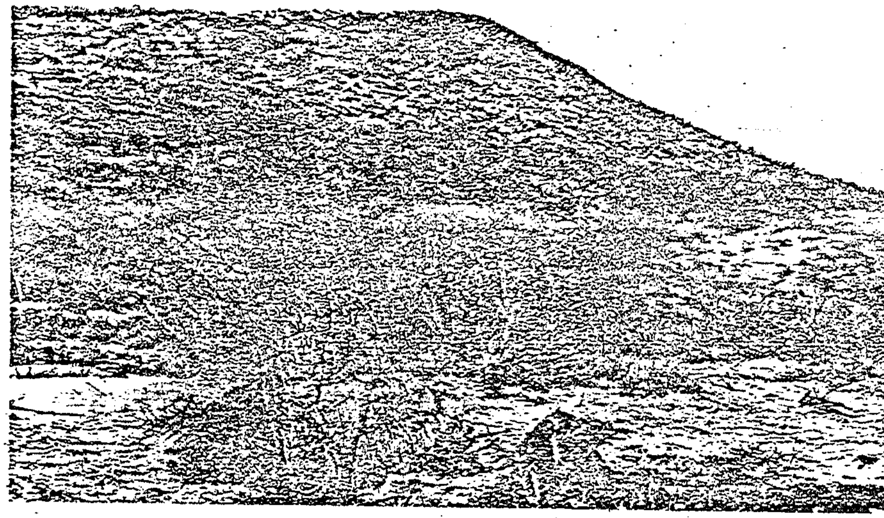
APPENDIX

Plates of the Study Area

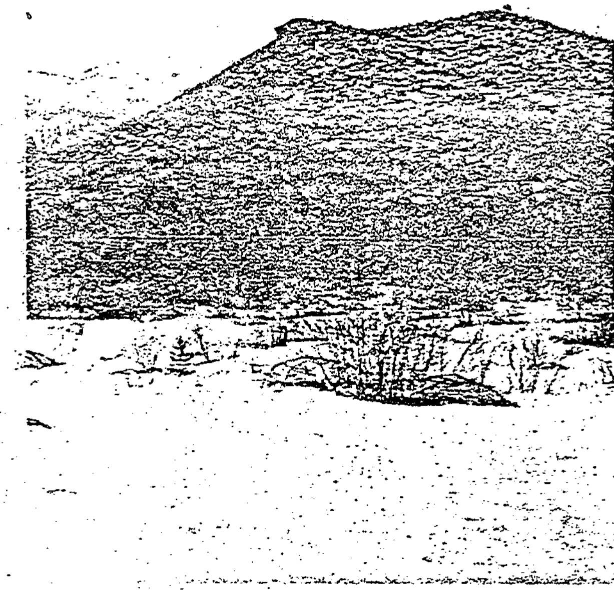


Feb. 16, 1974
On Ma 1. Sites Ma 2 and Ma 3 above.

March 19, 1974
Signs of human habitation - power poles, sawmill.
2400 foot level looking down on Ma 2.

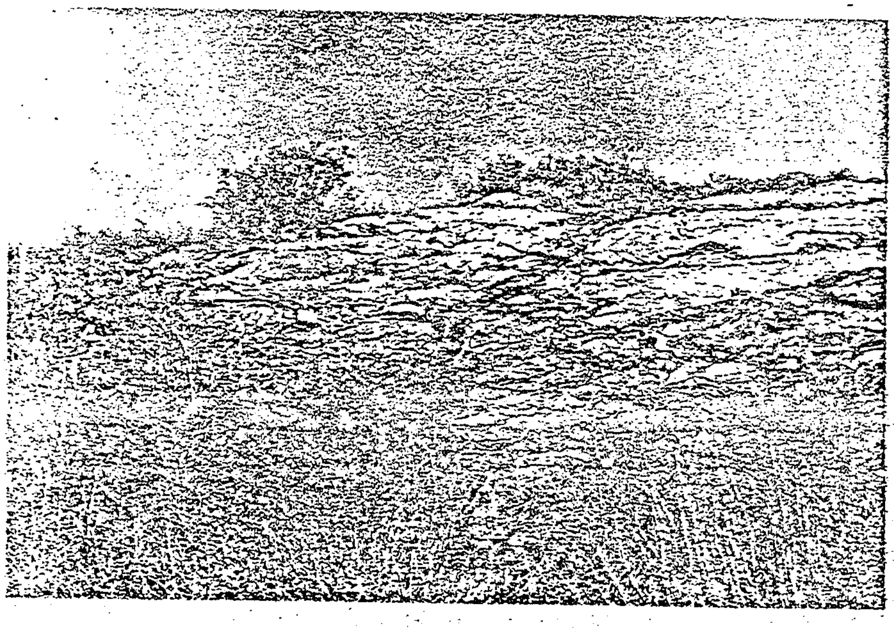
Feb. 16, 1974

1930 foot level looking towards the study area.



March 19, 1974

A major deer path.



March 19, 1974.

Deer on the run.

March 19, 1974. A major deer path.