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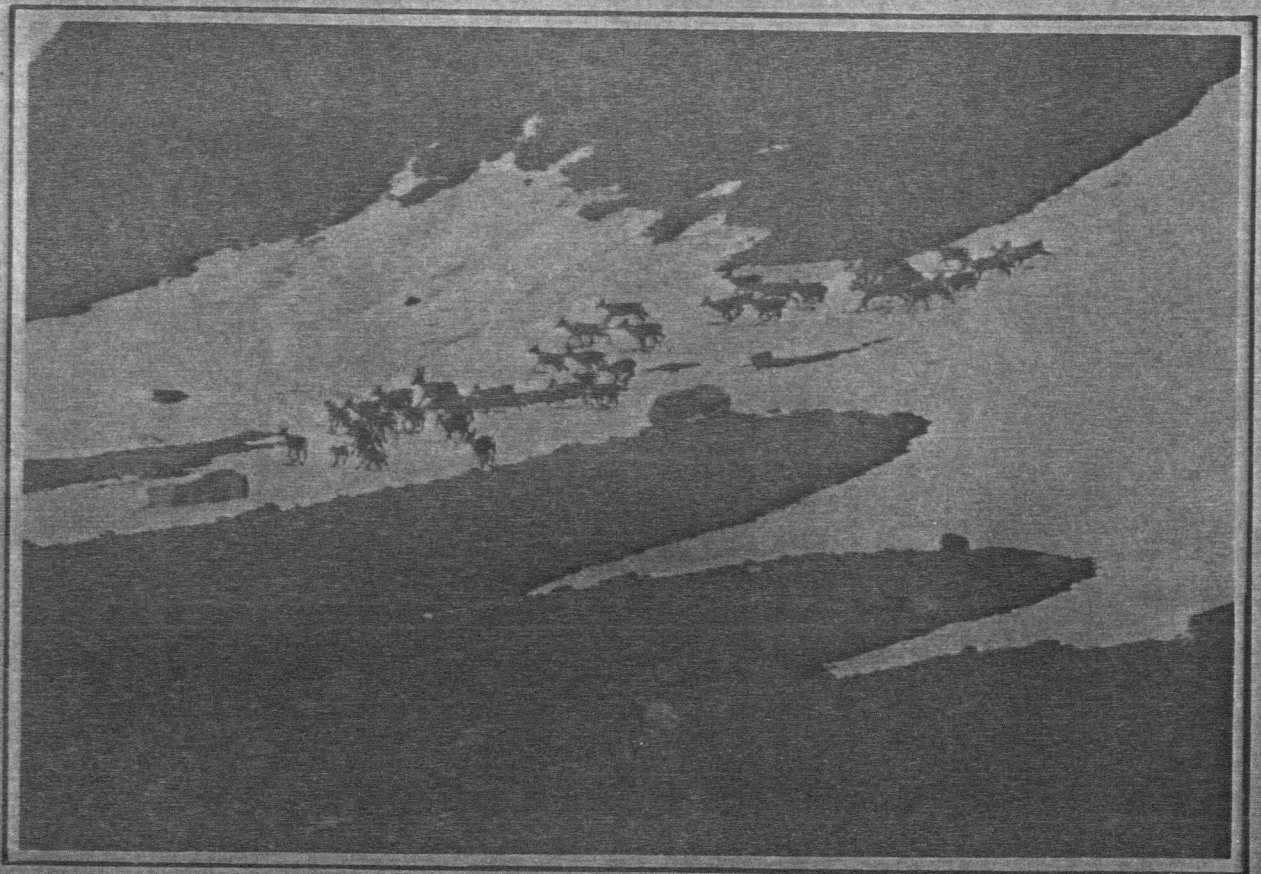
Caribou Behavior in Relation to Human - Elk - Wolf Influences:

Jasper National Park

1971 - 1974

by John G. Stelfox and John A. Bindernagel

Prepared for Parks Canada
by the Canadian Wildlife Service, Edmonton, 1978



CARIBOU BEHAVIOR IN RELATION TO HUMAN-ELK-WOLF INFLUENCES: JASPER NATIONAL PARK, 1971-1974

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John G. Stelfox

and

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Your file / Votre dossier

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1110, 10025 Jasper Avenue
Edmonton, Alberta
T5J 1S6
March 21, 1978

Mr. W.C. Turnbull, Director
Western Region, Parks Canada
134 - 11 Avenue SE
Calgary, Alberta
T2G 0X5

Dear Mr. Turnbull:

Enclosed herewith, please find a report "Caribou Behavior in Relation to Human-Elk-Wolf Influences: Jasper National Park, 1971-1974" by John G. Stelfox and John A. Bindernagel. This study was part of the CWS Parks Research function funded by Parks Canada and the CWS.

The report examines the encroachment of elk and hikers onto caribou ranges in Jasper and corresponding caribou population trends. Behavioral responses of caribou to the presence of elk and humans in various situations of habitat, elevation, exposure, topography and weather are discussed.

Major seasonal caribou ranges plus calving and rutting ranges are described and recommendations made for minimizing caribou-human interactions.

The effect of wolf predation on caribou in relation to that on other ungulates is discussed.

We hope the text and recommendations are useful for park planning, wildlife management and interpretive purposes. Dr. Stelfox and the Warden Service worked closely on all phases of the caribou research and he would be pleased to meet with Parks Canada officials to further discuss the caribou situation in Jasper.

Yours sincerely

M.R. Robertson
Regional Director

Encl.

ABSTRACT

The behavior and population trends of caribou in Jasper National Park in relation to influences from humans, elk and wolves were studied during the period 1971-1974. The encroachment of elk and humans onto alpine-tundra ranges became pronounced by the mid 1960's, increasing greatly each year. By 1968 a noticeable decline in caribou numbers was reported for the area west of the Athabasca and south of the Miette rivers where numbers of elk and hikers had increased many-fold since 1960.

Caribou, especially cows, were more vulnerable to harassment from humans during spring and summer than during other seasons. They had a low tolerance for humans on alpine-tundra ranges compared to moderate tolerance on low-elevation ranges where forest cover was nearby. Strongest alarm reactions occurred to cows with calves from human scent rather than sight, when humans were above rather than below, and during hot weather. Both caribou and humans made the greatest use of alpine-tundra ranges during summer with appreciable harassment evident on those ranges.

As elk moved onto caribou ranges, caribou tended to relinquish the range to the more dominant elk even though cases of attack by elk were rare. Caribou favored Alpine-Tundra, Delta-Shoreline, Barren Ridges, Snowfields and Heather-Krummholz habitats in that order of preference whereas elk favored Man-made Grasslands, Pine, Mixed Coniferous Forests and Natural Grasslands. The greatest overlap occurred on Delta-Shoreline, Barren Ridge and Slope, Alpine-Tundra and Heather-Krummholz habitats. The greatest elevational overlap occurred in autumn, winter and spring between 1220 and 1525 m. During summer and early autumn there was considerable overlap in zones from 1525 to 1825 m. Caribou made the greatest use of SW, S and NW exposures compared to W, S, SE and E exposures for elk.

Predation of caribou by wolves was low compared to that of elk and deer; this may have been beneficial in slowing down the build-up of elk on caribou ranges.

A continued increase in numbers of elk and humans using alpine-tundra ranges is expected to result in a corresponding decline in caribou use of that high-elevation range.

Human-caribou interactions should be minimized by placing hiking trails away from major summer caribou ranges and/or restricting hiker use during critical calving periods. Calving, rearing and rutting ranges and natural licks should be recorded and mapped and efforts made to minimize harassment from humans at these locations.

ACKNOWLEDGEMENTS

The authors wish to acknowledge the assistance and cooperation of the Jasper Warden Service. It was through the concern and cooperation of wardens such as Toni Klettl, Bob Haney, Mac Elder and Ab Loewen that the caribou study was implemented. All wardens cooperated and provided information and their assistance is gratefully acknowledged.

We are pleased to acknowledge the assistance of contract biologists Dave Westworth and John Courtney plus summer students Rick Barlow and Rod Keith in collecting caribou behavior and range ecology information which was invaluable. The assistance of biologist Brian Herbert in collating the results of field studies is gratefully acknowledged.

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1.0 INTRODUCTION

The 1971 to 1974 population of mountain caribou (*Rangifer tarandus caribou**) in Jasper National Park (hereafter referred to as Jasper), consisted of small herds over a rather discontinuous range west of the Rocky River and the Bosche Range. The largest recorded herd was 68 animals in the Maccarib Valley in August 1973. The total caribou population during 1960-1973 was estimated at 425 to 711 compared to 370 to 875 for the period 1915-1940 (Stelfox *et al.* 1974).

Warden Toni Klettl first noted a reduction in caribou numbers and an encroachment of elk into the region west of the Athabasca River, north of the Whirlpool River and south of the Miette River, in the 1960's. There was a corresponding increase in the number of hikers using this caribou range during the late 1960's and early 1970's. The number of hikers in the Tonquin Valley increased from 299 hiker-nights in 1965 to 4101 hiker-nights in 1972, a 1271% increase (Stelfox *et al.* 1974). Klettl requested that a study be conducted to determine the reasons for caribou declining in this area and the interactions among caribou, elk and humans.

From 1971 to 1973 a number of investigations were conducted into interactions of caribou, elk and humans in this and other areas of the park in relation to recent trends in the abundance and distribution of caribou in Jasper. These studies were part of a larger investigation into an apparent decline in caribou numbers. In the course of investigating food habits and assessing seasonal habitat preferences by means of pellet-group transects, the observers occasionally encountered caribou at close ranges. Such encounters were used to provide further information on flight distance and details of caribou response to the sudden appearance of humans.

*after A.W.F. Banfield. "The Mammals of Canada" Univ. of Toronto Press, 1974.

This report analyses the interactions of caribou, humans, elk and wolves, and provides an insight into the future welfare of caribou in Jasper.

2.0 STUDY AREA

The study was confined to Jasper National Park, consisting of 10 920 km^2 (4,200 mi^2) of the Front and Main Ranges of the East Slope of the Rocky Mountains in the Cordilleran Physiographic Region of Western Alberta. Figure 1 shows the major topographic features of this park and the four major Resource Management Areas, namely: Cavell, Sunwapta, Lower Athabasca, and Snake Indian. Major emphasis was placed on the Cavell, Sunwapta and Snake Indian areas.

The dominant vegetation types of the park were coniferous, evergreen forests in the Montane (<1500 m) and Subalpine (1500 to 2100 m) biomes plus grasslands, heathlands, shrublands and rock scree in the Alpine-Tundra biome (>2100 m) and to a lesser extent in the Subalpine zone. Along valley bottoms and mountain slopes below 1600 m which previously had burned, lodgepole pine *(Pinus contorta)* was the principal species. An Engelmann spruce *(Picea engelmannii)* - white spruce *(P. glauca)* hybrid complex existed up to the 1500 m elevation, with Engelmann spruce occurring alone above this level. With increasing elevation on the slopes, alpine fir *(Abies lasiocarpa)* became more important, particularly in the older spruce forests. Whitebark pine *(Pinus albicaulis)* which occurred mixed with hybrid spruce and lodgepole pine at lower elevations, was conspicuous on exposed ridges and slopes at timberline (approximately 2100 m). In the Montane zone along the Athabasca Valley below the Miette River, a few stands of interior Douglas fir *(Pseudotsuga menziesii)* occurred. The lower transition to plains grassland along the major low-elevation valleys was marked

by a fringe of trembling aspen and balsam poplar *(Populus tremuloides* and *P. balsamifera)* described in detail by Stringer (1969) and Kuchar (1972).

The mountainous topography with characteristic steep slopes and deep valleys had developed on uplifted Mesozoic shales and sandstones with some local Cambrian limestones. The residual and glacial surface materials were variable in texture and composition. Under the influence of a wide range of local climatic conditions the soil development was also variable. Thin soils (lethic subgroups) over bedrock and shallow humoferric podzols were most frequent; while eutric and dystric brunisol profiles occurred occasionally (Rowe 1972).

Most behavior studies occurred on the Subalpine and Alpine-Tundra biomes along the Maligne and Le Grand Brazeau ranges plus the mountains between the Astoria and Miette rivers. One brief study was made in the Blue Creek valley.

Summer caribou ranges lay between the 2200 and 2600 m elevations (Figure 2). Although the main range of peaks showed the typical rugged Rocky Mountain topography, the basins were rolling in appearance with access between them being comparatively easy for caribou, elk and humans. At the lower level of the summer range, various streams draining the upper basin were often united to form the main creek which usually flowed through a series of flat, lush meadows where shrubs and forbs abounded. Further upstream, the spruce and fir bordering these meadows became more stunted and eventually isolated into the wind-contorted clusters characteristic of the krummholz zone. This zone of sparse tree growth gave way in turn to the alpine-heath community comprised of a *Phyllodoce glanduliflora - P. empetriformis - Cassiope tetragona* complex. Above this community the steeper

Figure 2. Caribou summer range in Snowbowl Basin, head of Jeffery Creek; looking southwest from ridge at head of Oven Creek, September 1974.

slopes with less soil and more exposure were studded with the hardiest alpine-tundra plants. Many of these high slopes readily produced depressions or trenches from the trampling of wild ungulates and hikers. Small snowfields dotted the landscape especially on north and east aspects.

It was significant that two areas recognized as important caribou summer ranges (the Snowbowl area of the Maligne River and the Tonquin Valley of the upper Astoria River) also supported heavy hiker traffic along popular hiking trails. Apparently those conditions which contributed to high quality caribou summer range (gentle sloping alpine meadows adjacent to escape terrain at high elevation) were also considered favorable for wilderness hiking trails.

3.0 METHODS

The behavior of caribou in relation to humans, elk and to a lesser extent wolves was determined from ground observations made on various caribou ranges throughout the park during the four years of 1971-1974. In addition to behavioral information obtained by the author and three contractors, the Warden Service and general public in Jasper provided additional information.

Field studies consisted of watching caribou activities at a distance with the aid of 20 and 40 power scopes and 10 X 40 field glasses. Their response to approaching humans and elk was noted and later analysed. Often when no other humans or elk were in the area the biologist approached the caribou after a period of watching their undisturbed behavior, and observed their responses to various types of human behavior. This included approaching directly or divergently, casually or rapidly, partially or completely, from points above or below, downwind or upwind. Once caribou became aware of humans or elk, responses such as alarm, indifference or curiosity were noted, as well as flight distance and behavior after disturbance.

No direct observations of interactions between wolves and caribou were made. Inferences were drawn from the proximity and behavior of caribou to wolves feeding on a nearby freshly killed caribou; from aerial observations of caribou, elk and wolves in close association and from the results of wolf scat analysis.

Wildlife observation cards and hiker records were also examined to gain further records of interactions between humans and caribou.

4.0 RESULTS

4.1 Caribou and Elk Seasonal Distributions

The yearlong distribution of caribou was generally more westerly throughout Jasper than it was for elk (Figure 3). Caribou were not observed east of the Rocky River or north of the Snake Indian River south of Willow Creek. They were most common west of Longitude 118°00' whereas elk were more abundant east of this line. For both species there was a gerneral westward and upward migration in summer and a descending, eastward migration in fall.

Summer ranges of the two species overlapped above the 1900 m elevation in the Blue-Deer-Mowitch creeks area of the upper Snake Indian watershed; in the Chak Basin, Astoria River and Cavell Alplands between the Miette and Whirlpool rivers; along the upper Maligne River; and along the Poboktan and upper Brazeau drainages. Their winter ranges overlapped above the 1500 m elevation along Willow-Blue-Rock creeks and the Snake Indian River above Willow Creek; along the upper Athabasca and Sunwapta rivers and the lower Whirlpool River area, as well as the Medicine-Maligne lakes area (Figure 3).

4.1.1 Range overlap and displacement

After being reintroduced into Jasper in the 1920's, elk first moved onto low-elevation grasslands and then subalpine and alpine grasslands in the eastern half of Jasper where they competed with bighorn sheep for forage (Table 1, Stelfox 1964). Then in the 1950's they began to move onto alpine-tundra ranges in the western portion of the park and along the Maligne Range because of a combination of excessive elk numbers and encroaching coniferous forests on the lower grasslands. Declines in caribou numbers were reported to be associated with this elk encroachment. By the mid-1960's, Warden Toni Klettl became alarmed at an apparent decline in caribou numbers in the Astoria River, Maccarib and Meadow creeks drainages and suggested that an in-depth study be initiated to document the impact of invading elk numbers on the indigenous caribou. He noted that elk began summering in the Cavell Alplands (Twp. 43, Rge. 1, W6th Meridian) in 1963. By 1968 there were 150 to 200 elk summering there. Associated with this increase was a decline in caribou numbers. Up to 1963, Klettl observed a herd of 20 to 25 caribou summering in that area but by 1967 there was little sign and in 1968 there was no sign of caribou in the area. A similar trend occurred in the Tonquin Valley-Astoria River area, long recognized as a major caribou area since the park was established. In July 1961, 186 caribou were counted within the region of Portal, Whistler and Verdant creeks and the Astoria River by Klettl. The first bull elk was observed along the Astoria Valley above Old Horn Mtn. on 15 September 1961. In August 1974, Klettl observed 12 cow elk in Eremite Valley, south of Tonquin Valley, at the 1800 to 1900 m elevation. These were the first elk sighted in that area. In July 1962 the first sign of elk in the Chak Mtn. area was observed

Table 1. Caribou and wapiti population trends* in Jasper National Park, 1915 to 1973.

Period	Number of animals recorded: Park Caribou	Park Wapiti	Willow-Blue Cr. Caribou	Willow-Blue Cr. Wapiti	Cavell** Caribou	Cavell** Wapiti	Skyline** Caribou	Skyline** Wapiti	Poboktan** Caribou	Poboktan** Wapiti	Remarks
1915	Numbers Low		Most Common	0	Most Common		None		0 to Few	0	Miller 1915
1920	-	0	-	0	-	0	-	0	-	0	Wapiti introduced
1930	-	88	-	0	-	0	-	0	-	0	Nos./Day F. Bryant
1931	-	3.4/day	-	0	-	0	-	0	-	0	Cowan 1943
1938	-	-	-	0	60	0	-	0	-	0	Nos./Day F. Bryant
1939	-	-	200+	-	-	0	-	0	-	0	Soper 1970
1944	Abundant	-	36	18	-	0	-	3	-	-	First year wapiti obs.
1953	-	500± along Athabasca Valley									Banfield 1953
1956	139	1200	67+	21	8	0	32	-	16	-	Estimate
1959	234	1634	30+	1	-	0	-	-	-	-	Wintering at Blue Cr.
1960	-	600± along Athabasca & Miette valleys east of Jasper									
1961-62	-	-	-	50	101 (Chak Basin)	1	-	-	-	-	Blue, Topaz & Welbourn
October 1961 to September 1962: 481 caribou + 10,959 wapiti seen by wardens in one-year period of patrol.											
1963	-	600± (Athabasca Valley)			163±	1	-	-	-	-	Cavell Alplands
1965 (Nov.)	-	1790	-	465	-	-	-	-	23	-	Willow-Blue Cr. Count
1966 (Nov.)	-	1748	-	-	-	-	-	-	-	-	
1968-69	-	-	-	-	-	150 Cavell 26 Chak	-	-	16	-	Summer count
1966-67	71	1982	-	533	-	-	-	-	-	-	73 on Blue Cr.
1968	-	-	-	-	-	-	-	0	21	15	SE of Poboktan Pass
1970-71	-	2000	-	-	-	-	-	3	-	-	Bald Hills
1969	-	2516	-	-	-	-	-	-	-	-	1646 wapiti in Athabasca Valley
1 Feb. 1971 to 31 Jan. 1972: 626 caribou + 8,190 wapiti - seen by wardens in one-year period of patrol.											
1973	-	-	-	-	51	-	-	-	-	-	Maccarib Pass

* Population data are from counts by Warden Service personnel
**Refers to wapiti observed only above the 1900 m elevation

and in July 1963, three bull elk were observed feeding high in the Chak Basin area by Klettl. By the late 1960's, a herd of 26 bull elk were summering in the Maccarib Pass-Chak Basin area. By this time caribou numbers had declined so rapidly that there were only 50 to 75 caribou remaining in the Portal, Whistler, Verdant and Astoria drainages. Elk continued to move onto caribou range above the 2000 m elevation in these areas as well as the upper Athabasca, Whirlpool, Sunwapta, Maligne, Poboktan, Brazeau, Southesk and Snaring drainages (Table 1, Figure 3).

By the summer of 1974, elk had penetrated at least 6 km up Jeffery and Oven creeks below the Snowbowl area of the Maligne Range, and all the way along the east side of the Maligne River between Maligne Lake and Maligne Pass.

4.1.2 Habitat preferences

Habitat preferences of caribou and elk for each of the 15 habitat types in Jasper are presented in Figure 4. Caribou used the Alpine-Tundra, Delta-Shoreline, Barren Ridges, Snowfield and Heather-Krummholz types in that order of preference. These habitats accounted for 81.8% of the caribou observations. Forty six percent of the caribou were observed in the first two types. Elk used the Man-made Grasslands, Pine, Mixed Coniferous, and Natural Grasslands habitats in that order of importance. While 87.7% of the elk were observed in these four habitats, the first two types accounted for 66.3% of the elk seen. Caribou were not observed in the Avalanche Path, Deciduous-Coniferous, or Poplar types. Less than 2% of the caribou were seen in each of the Burn, Pine, and Man-made Grassland habitats.

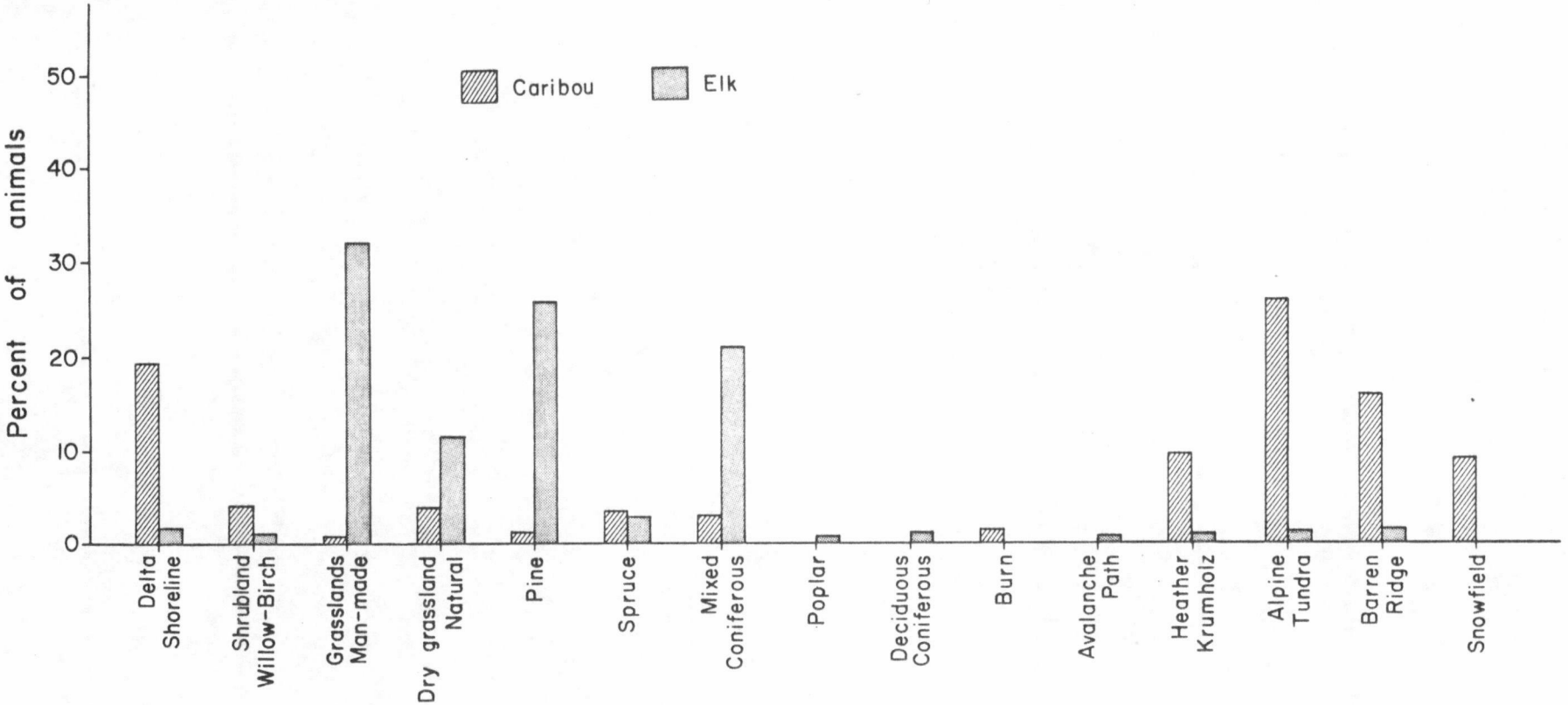

Figure 4. Habitat preference by caribou and elk for the period from August 1971 to November 1973 in Jasper National Park from monthly warden reports and aerial surveys.

Elk were not observed in the Burn or Snowfield habitats, and less than 1% of the observations were in each of the Avalanche, Heather-Krummholz and Alpine-Tundra types.

Concerning the use of various habitat types on a seasonal basis, the Delta-Shoreline type was important to caribou during the months of May, June, November and December. From 48 to 78% of the monthly caribou observations were made in this type during those months. The greatest use of this habitat by elk occurred in March (5.8% of March observations).

The Shrubland type which consisted mainly of willow and dwarf birch along valley bottoms above the 1600 m elevation was important to caribou in October (50.5%), and to elk in June and July (7.8 and 5.8%).

Similar numbers of both caribou and elk were observed in the following four habitat types: Delta-Shoreline (269 caribou and 257 elk), Barren Ridge and Slope (232 and 305), Alpine-Tundra (374 and 154), and Heather-Krummholz (134 and 145). Three other habitat types where at least 3.0% of the caribou and 10.0% of the elk were seen were Natural Grasslands (57 caribou and 2,225 elk), Mixed Coniferous (41 and 41,123), and Pine (25 and 4,939). These seven habitat types were the ones which received the greatest combined use of caribou and elk.

4.1.3 Elevation distributions by month

The monthly distribution of both species according to elevation zones showed that caribou generally ranged between 1220 and 2440 m for all months with less than 3% use above 2440 m and below 1220 m (Figure 5, Table 2). Conversely, elk ranged mainly between 1000 and 1825 m with the highest average elevations attained during July-September. Figure 5 shows graphically the percentages of caribou and elk observed in each elevation zone by months.

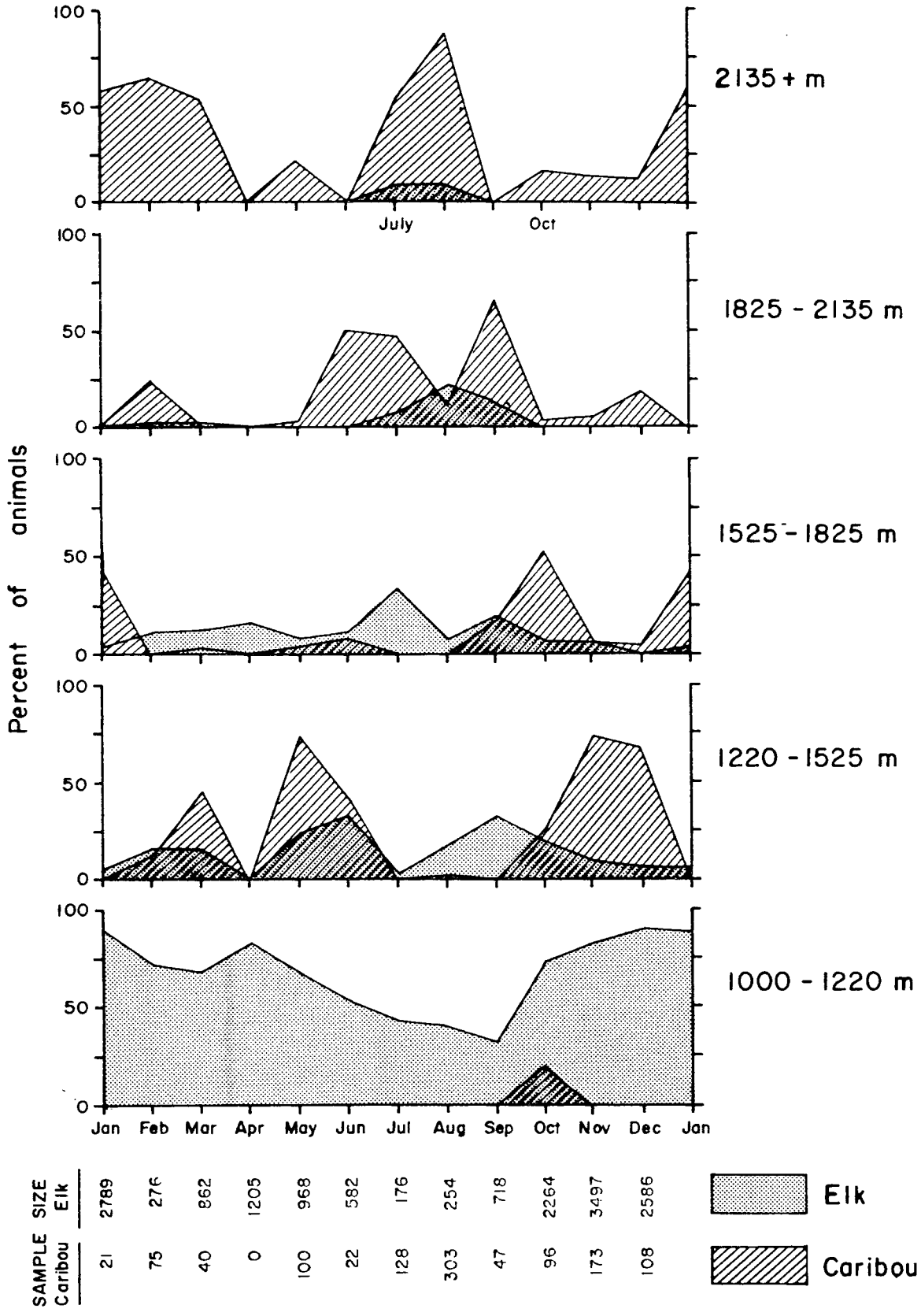

Figure 5. Distributions of caribou and elk by elevation zones, expressed as percent of total animals seen per month.

Table 2. Distributions of caribou and elk throughout Jasper National Park by elevational zones, August 1971 - November 1973.

Month	Number or %	--- Numbers and Percent of Monthly Observations at Each Elevation Zone ------ 1000-1220m		1220-1525m		1525-1825m		1825-2135m		2135-2440m		2440-2745m	
		Car.	Elk	Car.	Elk	Car.	Elk	Car.	Elk	Car.	Elk	Car.	Elk
January	No.	0	2496	0	178	9	88	0	16	12	11	0	0
	%	0	89.5	0	6.4	42.9	3.2	0	0.6	57.1	0.4	0	0
February	No.	0	195	9	48	0	29	18	4	48	0	0	0
	%	0	70.6	12.0	17.4	0	10.5	24.0	1.5	64.0	0	0	0
March	No.	0	600	18	137	1	104	0	21	21	0	0	0
	%	0	69.6	45.0	15.9	2.5	12.1	0	2.4	52.5	0	0	0
April	No.	-	1002	-	0	-	203	-	0	-	0	0	0
	%	-	83.2	-	0	-	16.8	-	o	-	0	0	0
May	No.	0	653	73	234	3	81	3	0	21	0	0	0
	%	0	67.5	73.0	24.2	3.0	8.4	3.0	0	21.0	0	0	0
June	No.	0	304	9	200	2	68	11	10	0	0	0	0
	%	0	52.2	40.9	34.4	9.1	11.7	50.0	1.7	0	0	0	0
July	No.	0	78	0	8	0	58	60	17	56	15	12	0
	%	0	44.3	0	4.6	0	33.0	46.9	9.7	43.8	8.5	9.4	0
August	No.	0	105	2	45	3	20	37	57	259	27	2	0
	%	0	41.3	0.7	17.7	1.0	7.9	12.2	22.4	85.5	10.6	0.7	0
September	No.	8	249	0	235	8	123	31	102	0	9	0	0
	%	17.0	34.7	0	32.7	17.0	17.1	66.0	13.2	0	1.2	0	0
October	No.	2	1687	24	436	50	117	4	24	16	0	0	0
	%	2.1	74.5	25.0	19.3	52.1	5.2	4.2	1.1	16.7	0	0	0
November	No.	0	2938	128	346	11	180	10	33	16	0	8	0
	%	0	84.0	74.0	9.9	6.4	5.1	5.8	1.0	9.3	0	4.6	0
December	No.	0	2372	72	162	4	51	20	1	12	0	0	0
	%	0	91.7	66.7	6.2	3.7	2.0	18.5	0.1	11.1	0	0	0
Yearlong	No.	10	12679	335	2029	91	1122	194	285	461	62	22	0
	%	0.9	78.4	30.1	12.5	8.2	6.9	17.4	1.8	41.4	0.4	2.0	0

This figure reveals that during the months of July and August, the two species overlapped above 1525 m, whereas in September they overlapped between 1220 and 2135 m. For February and March, there was considerable overlap in the 1220-1525 m zone while during April and May there was overlap in the zones from 1220-1825 m.

The only overlaps which occurred below 1220 m were during the month of September, and to a lesser extent October.

Caribou and elk summer ranges overlapped above 1825 m, in the Blue-Deer-Mowitch creeks area of the upper Snake Indian watershed; in the Chak Basin, Astoria River and Cavell Alplands between the Miette and Whirlpool rivers; along the upper Maligne River drainage above Maligne Lake; along the Poboktan and John-John valleys and the upper Brazeau River (Marble Mtn.-Nigel Pass). Their winter ranges overlapped above 1375 m, along Willow-Blue-Rock creeks and the Snake Indian River above Willow Creek; along the upper Athabasca and Sunwapta rivers as well as the lower Whirlpool River area (Figure 3). Their spring range overlapped in the Medicine-Maligne lakes area (Stelfox and Warden Service 1974). This range overlap was not present until after the 1930's. It became quite pronounced after the 1950's and is expected to continue to increase to the detriment of caribou unless severe winters interfere to temporarily reduce elk numbers.

4.1.4 Exposure (aspect) preferences

Caribou and elk preferences for each of the eight exposures (aspects) are presented in Figure 6 and Table 3 for each month.

On a yearlong basis, caribou made the greatest use of the SW, S and NW exposures, whereas elk preferred the W, S, SE and E exposures in that order of preference.

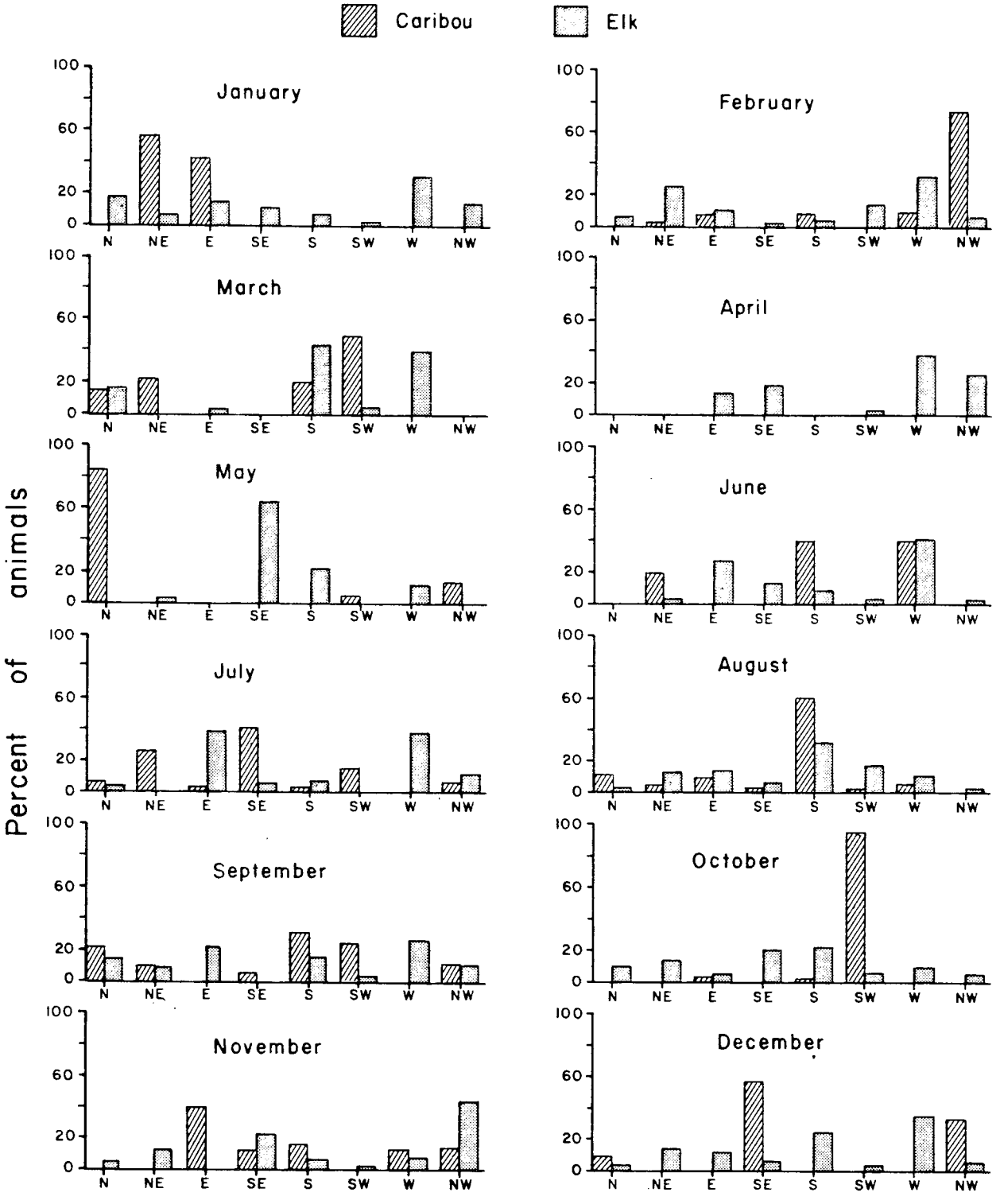

Figure 6. Percentages of caribou and elk observations occurring on each exposure.

Table 3. Numbers and percentages of caribou* and elk* observed on each exposure

	No. & %	NORTH C	NORTH E	N E C	N E E	EAST C	EAST E	S E C	S E E	SOUTH C	SOUTH E	S W C	S W E	WEST C	WEST E	N W C	N W E
								WINTER									
January	No.	0	84	12	27	9	65	0	46	0	31	0	4	0	141	0	57
	%	0	18.5	57.1	5.9	42.9	14.3	0	10.1	0	6.8	0	0.9	0	31.0	0	12.5
February	No.	0	5	1	21	5	7	0	2	6	3	0	12	6	26	48	5
	%	0	6.2	1.5	25.0	7.6	8.3	0	2.4	9.1	3.6	0	14.3	9.1	32.1	72.7	6.2
March	No.	5	14	7	0	0	2	0	0	5	34	16	3	0	37	0	0
	%	15.2	15.6	21.2	0	0	2.2	0	0	15.2	37.8	48.5	3.3	0	41.1	0	0
								SPRING									
April	No.	-	0	-	0	-	21	-	30	-	0	-	3	-	59	-	42
	%	-	0	-	0	-	13.6	-	19.4	-	0	-	1.9	-	38.1	-	27.1
May	No.	20	0	0	2	0	0	0	79	0	26	1	0	0	17	3	0
	%	83.3	0	0	1.6	0	0	0	63.7	0	21.0	4.2	0	0	13.7	12.5	0
June	No.	0	0	1	3	0	32	0	14	2	10	0	2	2	45	0	2
	%	0	0	20.0	2.8	0	29.6	0	13.0	40.0	9.3	0	1.9	40.0	41.7	0	1.9
								SUMMER									
July	No.	3	3	12	0	1	54	18	8	1	9	7	0	0	54	3	16
	%	6.7	2.1	26.7	0	2.2	37.5	40.0	5.6	2.2	6.3	15.6	0	0	37.5	6.7	11.1
August	No.	17	2	8	21	14	21	5	11	86	47	4	25	9	17	0	3
	%	11.9	1.4	5.6	14.3	9.8	14.3	3.5	7.5	60.1	32.0	2.8	17.0	6.3	11.6	0	2.0
September	No.	8	49	4	26	0	71	2	0	12	48	9	12	0	82	4	26
	%	20.5	15.6	10.3	8.3	0	22.6	5.1	0	30.8	15.3	23.1	3.8	0	26.1	10.3	8.3
								FALL									
October	No.	0	30	0	42	1	17	0	58	1	72	84	18	0	29	0	18
	%	0	10.6	0	14.8	1.2	6.0	0	20.4	1.2	25.4	97.7	6.3	0	10.2	0	6.3
November	No.	0	19	0	42	12	0	4	76	5	21	0	3	4	23	4	147
	%	0	5.7	0	12.7	41.4	0	13.8	23.0	17.2	6.3	0	0.9	13.8	7.0	13.8	44.4
December	No.	4	21	0	87	0	72	28	40	0	156	0	20	0	219	16	32
	%	8.3	3.5	0	14.4	0	11.9	58.3	6.6	0	25.8	0	3.3	0	36.2	33.3	5.3
								YEARLONG									
Yearlong	No.	57	227	45	271	42	362	57	364	118	457	121	102	21	749	78	348
	%	10.6	7.9	8.3	9.4	7.8	12.6	10.6	12.6	21.9	15.9	22.4	3.5	3.9	26.0	14.5	12.1

* Total observations of 539 caribou and 2880 elk.

During the winter season (January through March) caribou were found mainly on the NW and NE exposures; elk preferred the W and N aspects. During the spring, caribou preferred the N slope while elk were found mainly on the SE, W and E slopes. During the summer, caribou were spread over all exposures with most observed on the S, SE and N exposures while elk preferred the W, E and S exposures, in that order.

During the autumn, caribou occurred mainly on the SW, SE and NW exposures while elk were found mainly on the W, NW and S exposures.

The average snow depth where caribou were observed from September through May was 67.1 cm compared to 7.9 cm for elk. Similar correlations for wind (kph) and cloud (% cover) were 12.7 and 45.4 for caribou compared to 3.7 and 58.3 for elk indicating that caribou were exposed to more wind and sun than were elk for fall, winter and spring period (Stelfox and Warden Service 1974).

4.2 Caribou-Elk Behavior Interactions

The only direct displacement of caribou by elk was observed by the wives of wardens from Mile 45. On 22 October 1972 they observed on Beauty Creek Flats (Upper Sunwapta River) a bull caribou approach two grazing bull elk. Both elk charged the caribou and chased it into the forest. This aggressive act occurred during the later part of the rutting period for both species and both species still had antlers. The displacement of caribou off their range by elk may have resulted primarily from a dominance-avoidance relationship as cited by Krämer (1973) for mule deer and white-tailed deer. In the case of caribou and elk interactions, the latter assumed the dominant role. For example, a long-time owner of the Sunwapta Falls bungalows reported to the authors that during early spring in the 1960's, caribou often

grazed on new grass along Hwy. 93 in full view of the bungalows. On more than one occasion he saw the caribou flee the area as elk approached. This example showed how mountain caribou, by acts of avoidance, could be forced from their prime ranges by elk. This problem would become more acute as elk expanded their range onto traditional caribou ranges.

Displacement of caribou by elk was not observed to be a problem at the Medicine Lake Delta during May and June when both species frequented the same area, often foraging within 20 to 100 m of each other with no apparent concern. Some cow caribou had antlers at that time while elk had none.

During 33 hours of observations between May 23 and June 2, caribou were present for 23.25 hours (72.8% of the time), elk were present for 7.75 hours (23.6% of the time), and caribou and elk were present together for 7.75 hours (23.6% of the time). During the time when caribou and elk were using the delta at the same time, their relationship appeared to be one of "interspecific tolerance". No agonistic or territorial interactions were observed even when the spatial distance between the species was less than 10 m (Figure 7).

Limited observations indicated that the delta was being used to some extent throughout the day (Table 4). The period of heaviest daylight use appeared to be from 1800 until shortly after 2200 hrs. when caribou usually began leaving the delta.

The only activities observed while the animals were on the delta were feeding and lying or bedding. Movements on the delta were usually accompanied by continual grazing. Table 5 summarizes the amount of time spent feeding or bedded by both species in terms of "animal minutes".

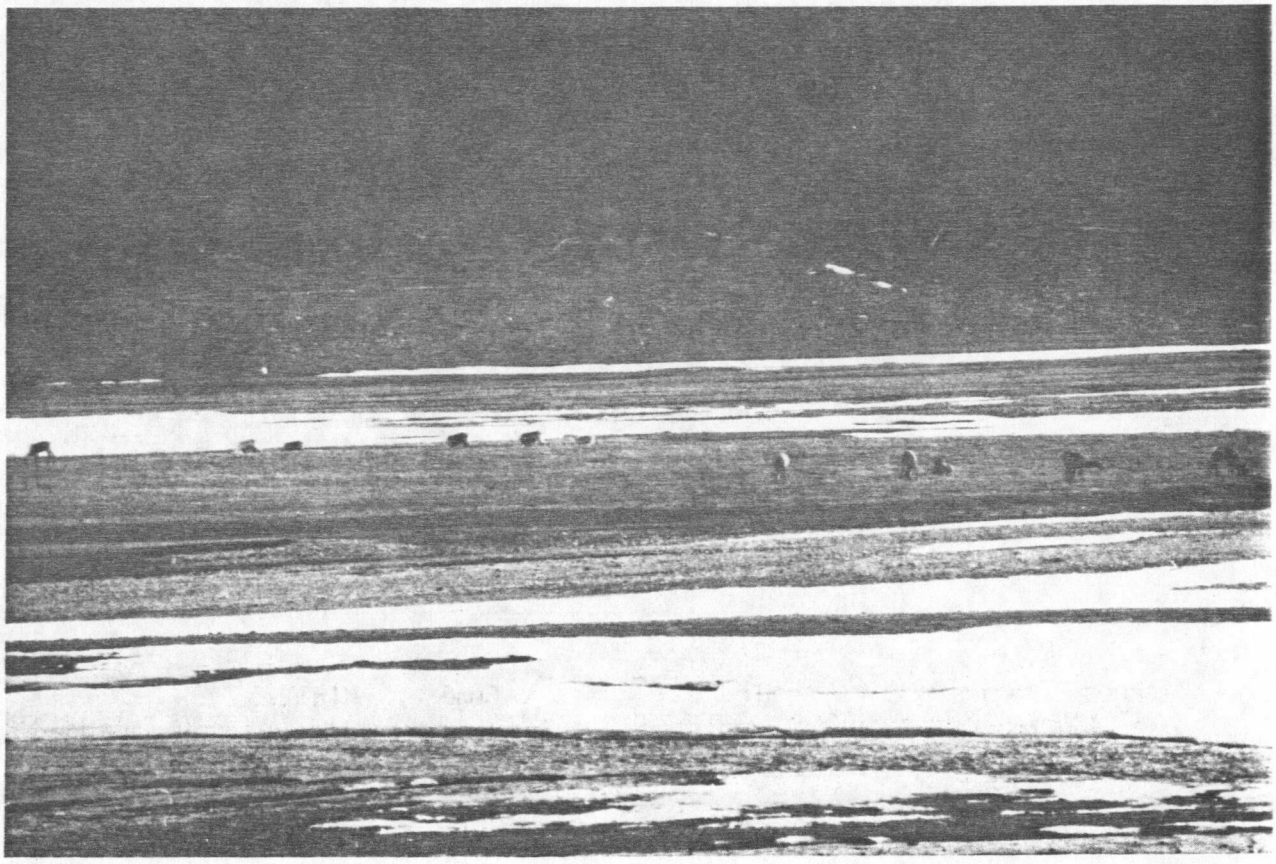

Figure 7. Caribou and elk feeding together and showing interspecific tolerance at Medicine Lake Delta, May 1972.

Table 4. Diurnal feeding patterns of caribou and elk on Medicine Lake Delta, 23 May to 2 June 1972.

Time (Hours)	No. Observations	No. Times Caribou Present	Total No. Caribou	No. Times Elk Present	Total No. Elk
0600	1	1	2	0	0
0700	1	1	2	1	1
0840	1	1	2	1	1
0900	1	1	2	0	0
1000	1	0	0	0	0
1100	2	0	0	0	0
1200	2	1	4	0	0
1300	2	1	4	0	0
1400	2	2	5	0	0
1500	1	1	1	0	0
1600	3	3	9	0	0
1700	2	2	10	0	0
1800	2	2	10	0	0
1900	2	2	15	0	0
2000	2	2	18	1	6
2100	3	3	24	3	13
2200	4	4	20	4	16

Table 5. Periods feeding and bedded by caribou and elk on Medicine Lake Delta, 23 May to 2 June 1972.

	Total No. Animal Minutes	No. Animal Minutes Feeding	% Time Feeding	No. Animal Minutes Bedded	% Time Bedded
Caribou	6369	5590	87.8	779	12.2
Elk	1777	1517	85.4	260	14.6

4.3 Caribou-Human Interactions

Caribou in Jasper generally had a low tolerance for human intrusion in the alpine-tundra environment. In low-elevation meadow, delta or coniferous forest habitats, caribou showed greater tolerance of humans. Reactions varied from a curious approach towards the human to a full-flight escape response. Immature caribou exhibited more curiosity than adults, often approaching the person before running away. The strongest alarm reaction occurred when caribou scented humans at close range. Studies of wild reindeer in Norway concluded that human scent tended to produce immediate fright and running off in a herd (Thomson 1972).

4.3.1 Responses related to distance variations

Flight responses occurred from distances as great as 700 m but were more common at distances less than 200 m between caribou and humans. Grazing was interrupted at distances up to 700 m but usually occurred at distances less than 350 m (Appendix I). Caribou are curious by nature, especially those in large groups (Bergerud 1974), and some approached humans to within 20 m providing the person remained still.

An indication of numbers of hikers using the Skyline Trail during summer was obtained by counting the numbers in the Snowbowl area during the 4-day period in August 1974. During that period 186 hikers used the trail for an estimated 4-day period each, or 47 hikers per day. Over 65% of the hiking parties consisted of two people. Groups of 5, 4, 3 and 1 hikers accounted for 2%, 8%, 13% and 11%, respectively. The direction of travel of these hikers was 84% from Maligne Lake towards Signal Mtn. and 16% going the opposite way. Wardens rode the Skyline Trail from Signal Mtn. to Maligne Lake on August 29 and 31, 1974. They saw 54 and 50+ hikers on these two days but no caribou.

The diurnal behavior of caribou in the Snowbowl basin at that time was as follows: 1) during early morning they were in the 2nd and 3rd tributary basins of Jeffery Creek from 1 to 1000 m from the Skyline Trail and generally above it; 2) they grazed north towards Big Shovel Pass generally above the trail; 3) about 1 km south of the Pass they frequently crossed the trail and continued grazing above the trail at a distance of 200 to 300 m; 4) in mid-afternoon they moved west to snow patches on the west side of the Snowbowl.

Caribou were generally not disturbed by hikers in the 2nd and 3rd basins of Jeffery Creek (Figure 2) as caribou were usually about 500 m uphill and upwind from the hikers who normally were oblivious of the caribou's presence. It was within the last 2 km of the trail below Big Shovel Pass that hikers would notice caribou that were generally about 200 m above the trail. As long as the caribou were at least 100 m uphill and upwind they showed little alarm to hikers on the trail. When hikers left the trail to approach the caribou, especially if they were uphill or upwind from the caribou and/or had bright flapping gear, the caribou became alarmed and fled.

4.3.2 Seasonal variations in behavior

Caribou exhibited great stress during hot weather when maximum temperatures exceeded 17°C. During these periods they searched out snow patches for relief from this heat. From these snow patches they moved briefly to nearby alpine-tundra meadows recently bared of snow to forage and then returned to the cool environment of the snowfield. The importance of snowfields for providing a cool environment, protection from insects, and plentiful nutritious food nearby for reindeer in the Altai Mountains of U.S.S.R. was observed by Shaposhnikoff (1958). Caribou in Jasper were observed to rest

their muzzles on the snow and to eat snow when not stressed by outside stimuli other than heat. After encounters with hikers, caribou often ran onto snow to cool off and to eat snow during hot periods (Appendix 1). Reactions to humans were less intense when temperatures were below 12°C. This suggests that high summer temperatures combined with the proximity of humans cause appreciable discomfort to caribou on alpine-tundra ranges. Both of these distresses may be additive and act synergistically on caribou to produce unbearable stress that could force them to foresake high-elevation habitats during hot periods.

Caribou, especially cows, were more vulnerable to harassment from humans during spring and summer than during any other season. Our study, plus those of Bergerud (1971) in Newfoundland and those of Lent (1966) in Alaska showed that cows with calves in spring and summer had a greater flushing distance than caribou at any other season. Indeed, the post-calving season was the only period when caribou consistently took flight at long distances based on sight, without verification by scent.

4.3.3 Responses related to topographic positioning of humans

Whenever caribou were approached from above by humans, a greater alarm response occurred than when humans approached from below (Appendix 1). This relates to the caribou's escape behavior of moving upslope away from a disturbance in an alpine-tundra environment.

4.3.4 Responses related to habitat type and age-sex groups

Reaction to humans was more intense in an alpine-tundra environment than in a delta-grassland environment (Appendix 1). This could have been related to escape terrain availability. On the delta, adequate forest cover was always nearby in all directions whereas in open alpine habitat, caribou

were exposed on all sides and often were a considerable distance from forest cover.

The main periods when caribou used the alpine-tundra habitat coincided closely with the period of greatest human use, namely the summer period. This factor made caribou-human interaction even more inevitable.

The effects of each variable (distance from humans, weather, topographic location of danger, habitat and sex of caribou) could not be analysed separately. However, the various interrelationships of these five factors were found to be important in the type and severity of response of caribou to humans.

Our study showed that cows with calves had greater flushing distances and received greater harassment than did bull or mixed adult groups (Appendices I and II). These findings are substantiated by other caribou studies elsewhere (Lent 1966, Bergerud 1971). Appreciable disturbance of cow-calf groups for the period June - September in Jasper could result in serious energy drains of both cows and calves already in a precarious physiological condition during the post-calving period (Geist 1975). Increased calf mortality would likely result from such disturbances. Bulls often displayed no response to humans unless approached from above. Miller and Gunn (1977) found that bulls were less responsible to harassment from aircraft than were cows and immatures as were caribou in small groups compared to those in large groups.

The common alarm behavior reaction of all caribou groups to humans was to circle or run downwind from the danger (Appendices I and II). This circular behavior would not only permit them to obtain the scent of the intruder but would also permit scent exuded from their apocine and sebaceous tail glands to provide an olfactory alarm stimuli to unalerted caribou (Lewin and Stelfox 1967).

A few examples of caribou behavioral responses to humans exemplify the variety of reactions which occurred.

1. On the afternoon of 18 July 1974, Biologist John Courtney observed two cows and one calf at the edge of coniferous trees bordering a meadow at the 2075 m elevation along Watchtower Creek. He observed them at distances ranging from 20 to 80 m while concealed downwind in willows. The cows were intently feeding on herbaceous vegetation in areas of recent snow release. The newborn calf was bedded in the trees above the cows and evidently saw Courtney as it came sliding downhill out of the trees on uncertain legs and approached its mother. The cow continued feeding after briefly scanning around her. The calf took up a stance facing uphill with its hind legs splayed wide apart while its head was turned around to see downslope in the direction of the observer. The alarm behavior of the calf became subdued when not transmitted to its mother. Neither cow was interested in maintaining any state of caution, even after the calf was alarmed, and both continued feeding. After they had slowly foraged uphill into the trees Courtney moved to their original feeding site and while in the open noticed that one cow was feeding 20 m away, unaware of his presence.

2. A hiker on the Skyline Trail observed a bull caribou grazing in an alpine heath community at least 1.6 km away across the Evelyn Creek Valley above timberline. The hiker shouted across the valley which caused the caribou to cease grazing, to urinate and to trot onto a snowfield where he remained for at least 20 minutes.

3. Four caribou-observer encounters in the Evelyn Creek watershed involved solitary male caribou. In the first encounter the caribou did not flee when an observer appeared only 200 m away. By comparison the caribou in the second encounter ran off when an observer appeared fully 600 m away.

The first response was associated with a cold day and poor visibility (it was snowing at the time) whereas the second response occurred on a hot clear day.

Two subsequent encounters involved (1) a long flight (over 0.8 km) in response to two appearances of an observer on a warm morning and (2) a "cat-and-mouse" interaction between a caribou and observer at dusk. In the latter interaction the caribou appeared loath to leave the area until it had detected the scent of the observer by circling around to a downwind position. Again the milder response by a caribou to a human encounter occurred under conditions of poor visibility and low temperature.

4. The Snowbowl area is a large bowl-shaped valley enclosed by mountain peaks (Figure 2). The Skyline Trail enters the area through Shovel Pass at the north and crosses the valley through alpine-tundra grasslands, heath lands and krummholz fir.

Several caribou herds were observed in the Snowbowl area during a two-day investigation of that area on 13 and 14 August 1973. The largest herd consisted of 22 animals including 2 calves. A herd of 12 animals also included 2 calves. Two cows, each with a calf, showed signs of having become separated from the large herd. Other caribou seen in the Snowbowl were a group of 3 bulls, a group of 4 including 1 antlerless female, and 2 single bulls. These observations indicated that at least 47 caribou were using the Snowbowl

as summer range. Some insight into the hot weather feeding behavior and reactions to hikers was obtained from two observed interactions between hikers and caribou.

In mid-afternoon a single bull caribou fled an approaching hiker on the trail and ran upslope onto successive snowpatches before disappearing over a ridge.

The following morning two hikers left the trail to approach a grazing caribou, resulting in the flight of this animal along with a herd of 12 caribou grazing nearby. These animals ran into a gully and did not reappear.

5. Four encounters between caribou and the authors took place in late September in the Bald Hills area. This is a favorite rutting and winter range and rutting activity occurred during this September period.

The first encounter involved coming into view of a cow and calf caribou a considerable distance away (800 m). The immediate and prolonged flight of the cow under cool cloudy conditions was at variance with previous encounters under cool conditions. The extreme response may be attributable to the presence of her calf and perhaps their state of separation from a herd.

The second encounter was also at a considerable distance (600 m) and involved two cows and a young bull whose initial reaction was one of fear (excitation jump followed by a short run) but who apparently felt more at ease once they had joined the rest of the herd.

The third encounter in this area was reminiscent of an earlier encounter with a single caribou in that, when surprised by the appearance of the observer, these caribou circled the observer until they reached his trail. In this instance, they did not leave until they crossed the trail for the second time.

The last encounter was similar to the above in that when surprised by the observer all the animals rose and one urinated. However, in this case the two females present approached the observer before stopping to stare. When the observer moved, however, the caribou ran off, stopped again, and eventually ran out of sight.

6. The Tonquin Valley (Maccarib Creek Area) is a popular destination for hikers in Jasper. The two access routes to the valley are often combined to make a loop.

Part of the trail passes along Maccarib Creek, which has long been recognized as one of the best caribou ranges in the Rocky Mountain parks. Sixty-eight caribou were observed in the Maccarib Creek area in late August. Whereas the original outfitters' horse trail lay in the valley floor, a more recent hiking trail was under construction higher on the north side of the valley in 1973.

Six hiker-caribou interactions were observed during a 10-day period. Of these, four resulted from hikers disturbing caribou grazing near the new trail which passed above the krummholz zone through and near alpine meadows used extensively by caribou in summer.

Caribou grazing in the alpine meadows were always disturbed by hikers passing by some 150 to 300 m away on the new hiking trail. They did not, however, react to hikers using the old horse trail along the creek some 800 m below the alpine-tundra meadows. The greatest instance of caribou disturbance was observed on August 22nd when four successive pairs of hikers passed along the new hiking trail disturbing and splitting a herd of 15 caribou on three separate occasions. A total of 35 minutes was spent in headlong flight by these animals before they finally fled to suitable escape terrain higher upslope.

A significant change in the weather from clear hot days to cold, rainy, and sometimes snowy days occurred during this period of observation. The reactions of caribou to the sight of hikers diminished dramatically after the weather turned cool.

Two encounters with groups of caribou took place in the Maccarib Creek watershed during cool weather in late August with J. Bindernagel. In the first encounter the observer came into view only 45 m from a herd of eight grazing caribou. Their response was extremely mild and more one of surprise than alarm. When the animals did run off it was in response to the reappearance of the observer some 200 m away and above them.

In the second encounter in this area an observer appeared within 70 m of a cow. The response by this cow was relatively mild and she ran off only when joined by a second cow.

Stelfox and Warden Bob Haney rode horses up the west shoulder of Oldhorn Mtn. in late September 1971 to look down into an alpine-tundra basin at the 2340 m elevation on the east side of the Tonquin Valley. A herd of seven caribou (cows and immatures) was observed across the basin at least 1200 m away and about 300 m below. Although the observers were leading their horses and stood comparatively still after sighting the caribou, the caribou stopped grazing and immediately ran around the side of Mt. Clitheroe to disappear from view at least 2 km away from the observers. The fact that the observers were above the caribou, were accompanied by large-appearing horses, with horses and riders skylined, probably contributed to the distance flight response by the caribou. The fact that the caribou were at least 800 m from any forest cover was probably a contributing factor to this strong adverse reaction.

4.4 Caribou-Wolf Interactions

4.4.1 Predation of caribou by wolves in relation to other ungulates

For the northern portion of Jasper, Carbyn (1974) found that less than 1% of wolf scats contained caribou hair, while caribou comprised 1% of the ungulate population. He concluded that caribou provided an insignificant proportion of the wolf diet, with mule deer and elk comprising most of the ungulate prey (Appendix 2). It appeared that predation of caribou by wolves in the park was not detrimental to the caribou population, in fact wolves may have been beneficial by preying more heavily on elk than on caribou.

4.4.2 Herd response to wolf attack

During an aerial survey in the Maligne Pass area in September 1971, the authors observed a pack of wolves feeding on a calf caribou. About 1.5 km further up the valley the remainder of the caribou herd was grazing, apparently unconcerned about this recent predation. Evidently, the caribou showed immediate alarm and fled from attacking wolves, but after that stimulus was removed little concern was shown for nearby wolves.

5.0 SUMMARY AND CONCLUSIONS

The 1971-1974 population of 425 to 711 mountain caribou in Jasper consisted of small herds over a discontinuous range west of the Rocky River and Bosche Range. Elk had been steadily encroaching onto caribou ranges since their re-introduction to the park in the 1920's. By the early 1960's, wardens became concerned about elk moving onto high-elevation alpine-tundra ranges in west Jasper and an apparent corresponding decline in caribou numbers. The number of human hikers using these high ranges also increased noticeably in the late 1960's and some wardens became concerned that the presence of hikers might harass caribou from their ranges. Wolves were also

increasing their number and expanding their range in the park and it was possible that they might be an important factor in reducing caribou numbers. The Warden Service recommended a study be conducted to determine the inter-relationships of elk, humans and wolves with caribou.

During the period 1971 to 1973 the senior author and the Jasper Warden Service studied the abundance and distribution of caribou and elk throughout the park and reported their results (Stelfox and Jasper Warden Service 1974). During the period 1971 to 1974 the authors with the assistance of student biologists and the Warden Service studied caribou range ecology plus caribou behavior in relation to humans, elk and wolves. The range ecology study is reported separately (Stelfox, Kuchar and Bindernagel 1978). Field studies for the behavior study consisted of watching undisturbed and disturbed caribou behavior on low-and high-elevation ranges with the aid of 20 and 40 power scopes and 10 X 40 power binoculars. Biologists also deliberately disturbed caribou in different ways and noted their responses in relation to topography, habitat, climate, age-sex composition of herd and season.

Concerning undisturbed behavior of caribou and elk, caribou utilized the Alpine-Tundra, Delta-Shoreline, Barren Ridges, Snowfield and Heather-Krummholz types of habitat in that order of preference. These habitats accounted for 81.8% of the caribou observations. Alpine-Tundra was the main summer habitat for caribou, compared to Delta-Shoreline for May, June, November and December. The Shrubland type, consisting mainly of willow and dwarf birch, along valley bottoms above 1600 m was important October habitat for caribou, and for elk in June and July. Elk used Man-made Grasslands, Pine, Mixed Coniferous and Natural Grasslands habitats in that order of preference and these habitats accounted for 87.7% of the elk observations.

The four habitats where nearly similar numbers of caribou and elk were observed were Delta-Shoreline, Barren Ridge and Slope, Alpine-Tundra and Heather-Krummholz.

Three habitat types where at least 3.0% of the caribou and 10.0% of the elk were seen were Natural Grasslands, Mixed Coniferous and Pine. These last seven habitats received the greatest combined use by both species.

Caribou ranged between the 1000 and 2745 m elevations with the greatest use occurring between 1220 and 2440 m. Most elk ranged between 1000 and 1825 m with the highest elevations attained during the June to October period when some ranged up to 2440 m. There was very little overlap of the two species at elevations below 1220 m and above 2135 m. Between these extremes it was noted that overlap occurred at higher elevations during the summer months and at lower elevations during autumn, winter and spring.

Caribou made the greatest use of SW, S and NW exposures compared to W, S, SE and E exposures for elk on a yearlong basis. During winter, caribou mainly used NW and NE exposures compared to W and N exposures for elk. During summer, caribou were spread over all exposures with most on S, SE and N exposures while elk preferred W, E and S exposures. In spring, caribou preferred the N aspect while elk were found mainly on the SE, W and E aspects. During autumn, caribou preferred SW, SE and NW aspects while elk preferred W, NW and S exposures.

A caribou bull was evicted from an alluvial floodplain by two bull elk in October. In spring, caribou feeding on a man-made grassland withdrew at the approach of elk on several occasions. However, on a lake delta both species fed in close association and exhibited interspecific tolerance. In general, it appeared that as elk invaded caribou range, caribou numbers

declined primarily from a dominance-avoidance relationship with elk assuming a dominance role. Caribou tended to relinquish their range without physical conflict. In some cases there was direct competition for a limited forage supply, especially in springtime.

Caribou, especially cows, were more vulnerable to harassment from humans during spring and summer than during any other season. Caribou had a low tolerance for humans in the alpine-tundra environment above timberline, but greater tolerance when in low elevation meadow, delta or coniferous forest habitats. Cows with calves flushed from humans at greater distances than did bulls. Immature caribou often exhibited curiosity, approaching humans before fleeing. The strongest alarm reactions occurred when caribou scented humans at close range, when humans approached from uphill, and during hot summer days.

The summer period when caribou made the greatest use of the alpine-tundra range coincided with the period of heaviest use by hikers thus making caribou-human encounters inevitable. Harassment of cow-calf groups during summer could cause serious energy drains and psychological disturbances that would result in greater calf mortality and avoidance of traditional calving grounds by cow groups.

Predation of caribou by wolves was low compared to that of elk and deer and may have been beneficial by reducing the build-up of elk on caribou ranges. Caribou did not appear significantly harassed by wolves except for the brief period during attack.

The Tonquin Valley, the Maccarib, Campus, Watchtower, Jeffery, Evelyn, Jonas, Poboktan and John-John creeks headwaters and Maligne Pass plus the upper Snake Indian River and Blue Creek headwaters were important summer and rutting ranges during 1971-1973.

6.0 DISCUSSION

When examining the contents of this report for information which might explain a reported decline in mountain caribou numbers in recent years, two aspects of caribou behavior appear significant.

The first is related to the apparent dependence on snow that many caribou demonstrated in the hot days of August and early September. The second is the extremely disruptive effect that passing hikers have on grazing caribou.

Evidence of caribou dependence on snow in hot weather was demonstrated repeatedly. Certainly the use of snow patches as a source of drinking water in the waterless high parts of the alpine-tundra is normal and expected.

However, the use of snow patches by caribou as escape routes, bedding areas and as loafing areas for long periods of inactivity in hot weather suggests a dependence on snow patches for their cooling effect. The use of snow patches as areas of refuge from biting flies was considered and tested by the authors, but showed no advantage over exposed fellfield ridges. Indeed, snow patches are usually in a somewhat sheltered location and are often less windswept than nearby ridges at the same or even lower elevation. The practice of stopping to eat snow when in flight similarly suggests a need for rapid cooling which is satisfied in this way.

In summary then, it appears that the mountain caribou, an animal which is well adapted to extreme cold and deep snow, may be ill-adapted to hot summer weather. In an attempt to ameliorate this hot temperature the animals stand or lie on snow, rest their muzzles on it and eat it.

In the Altai Mtns. of U.S.S.R., Shaposhnikoff (1958) observed (p. 5): "On warm summer days the reindeer are found most often in the alpine and sub-alpine zones, near persistent patches of snow and the

snowline on the northern slopes. Above the snow surface, even in the midday hours of July, the air temperature at the height of one metre does not rise above 10°C, which keeps down the intensity of attacks of blood-sucking insects and warble flies. At the edges of the snowfields succulent herbage grows abundantly on the snow-free soil. There the reindeer find the coolness they need, protection from insects and plentiful nutritious food." Whereas this apparent dependence on snow may not in itself be a factor in caribou survival, it becomes increasingly important when stresses in addition to heat are brought to bear on the animals. In this regard, the presence of hikers (or any people on foot) near caribou often appeared to be a source of stress to the animals. This stress was usually greater when caribou could smell the hikers as well as see them, and smell alone could cause them to flee even before the hikers came into view. Our own encounters with caribou indicated, with one notable exception, that they were less upset when they could not smell humans than when they could. When caribou sighted or encountered hikers in cooler weather, the response was very mild, indicating little or no stress.

These observations suggested that since high daytime summer temperatures caused discomfort and perhaps even stress for caribou, and since the proximity of humans was commonly stressful to caribou, the concurrence of these two stresses may have had an additive or even synergistic effect on the animals.

The difficulty of obtaining accurate information on mountain caribou numbers even under near-ideal conditions, became evident in the Tonquin Valley. One wonders if the present reported decline in population size is long-term (in the order of 50-100 years), short-term (less than 10 years), or even a recent acceleration of a long-term decline. From the limited information available (Soper 1970) it appeared that there has, in fact, been a decline in caribou numbers since the 1800's. When one considers

(1) this apparent longterm decline, (2) the apparent dependence on snow demonstrated by caribou in hot summer weather, (3) the fact that the Jasper caribou are among the southernmost populations of this species in North America, and (4) the fact that the climate in this area has exhibited a warming trend since about 1850 (Stelfox and Taber 1969) then one concludes that Jasper is becoming marginal or sub-marginal for mountain caribou.

This hypothesis could satisfactorily explain, at least in part, a longterm decline in caribou. If the effects of the presence of humans and elk on caribou range were as stressful to caribou as they appeared to be, then the increase in numbers of both since the mid-1960's may have been responsible for a considerable increase in the rate of decline.

Although an actual mechanism of population decline was not postulated as part of this hypothesis, several thoughts on specific aspects of a decline follow.

Whereas accurate herd composition counts were only rarely possible because of long viewing distances (especially in the Tonquin Valley), the calves in each herd could usually be counted. This information, indicating that calves constituted only about 10% of the population by late summer, strongly suggested that at present low population size was a result of a low reproductive rate or high calf mortality between birth and late summer. The highest daytime temperatures occurred in July and August, when disturbance by hikers was also likely to be most frequent. Any stress occurring at this time should not bear directly on reproduction since calving should have ceased by mid-June and rutting would not start until September. The disturbance of cows and calves in early summer when cows are lactating and calves are very young could have conceivably contributed to calf mortality through over-exertion of calves, temporary inhibition of milk let-down by disturbed cows, or even decreased lactation by cows with reduced feeding periods.

Studies of wild reindeer in Norway showed the activity pattern of calves, 1 day to 1 week old, to be 63% lying, 13% standing, 10% walking, 7% grazing, 4% suckling and 3% running (Gaare, Skoglund and Thomson 1970). These studies concluded that the calf at that age had a great need for lying rest, and with the time spent of grazing being so low, it was heavily reliant on its mother's milk for its nutritional needs. Significant disruption of cow-calf units during the first few weeks post-partem could cause high calf mortality.

Caribou exhibited traditional behavior in their use of calving, rutting and wintering grounds (Lent 1965, Bergerud 1974) so that disruption by humans or elk would force caribou elsewhere and would likely result in sparse use of new areas because of their strong affinity for traditional ranges. In other words, if a group of caribou are harassed from a traditional calving valley (eg. Tonquin Valley) onto a nearby undisturbed alpine-tundra valley in British Columbia their chances of successfully adjusting to the new range would be greatly diminished because of their traditional affinity for the Tonquin Valley. We believe the same traditional affinity applies to summer ranges in Jasper. This strong behavior trait makes it imperative that prime calving, rutting, summer and winter ranges be delineated and protected from harmful development and harassment if the future welfare of the Jasper caribou is to be ensured.

Thomson (1970, p. 37) concluded from his study in Norway that wild reindeer activity was greatly altered by "...the whole barrage of human sights, scents and sounds to which they [reindeer] are subjected. The reindeer react to this with appropriate degrees of fright, flight, and occasionally confusion."

As the encroachment of elk onto caribou summer alpine-tundra ranges resulted in a pronounced decline in caribou use of the ranges one can speculate that this decline will continue unless wolf predation and severe snowpack conditions are able to halt the invasion of elk onto these ranges. The presence of elk on caribou ranges is deleterious to caribou because they not only compete significantly for forage (Stelfox, Kuchar and Bindernagel 1978) but because caribou are submissive to elk and tend to relinquish their range to encroaching elk.

7.0 MANAGEMENT IMPLICATIONS

An important result of this study is the evidence showing the extent of the disruptive effects of hikers on caribou feeding behavior.

Both in the Snowbowl (west end) and Tonquin Valley (north slope of Maccarib Creek) the hiking trail passes near or through feeding areas, with inevitable disturbance of caribou using these areas. The situation is particularly acute on the north slope of Maccarib Creek where a new uncompleted trail bisects an extensive and well-used alpine meadow below Majestic Basin.

The Maccarib Creek situation is somewhat ironical since the new trail is apparently intended to replace the old horse trail in the valley bottom. If the aim in replacing this 40-year-old trail is to reduce the "environmental impact" of trail-users, then the new trail fails on two counts. Conditions in parts of the alpine meadow it now crosses are almost as wet and muddy as the valley bottom, and it introduces considerable "impact" on the caribou herds resident in the valley. Although a trail mid-way between the old and new trails is reportedly under consideration, such a compromise route will undoubtedly result in further disturbance of caribou by hikers. If the prevention of caribou disturbance is given high priority rating then the hiking trail must remain in the valley bottom. The writers examine the Maccarib Creek valley with this in mind and found that a reasonably dry,

firm trail could lie on the south side of Maccarib Creek near the foot of, or slightly within, the Engelmann spruce forest. Such a location would not only keep the hikers distant from the caribou, but would allow hikers to see undisturbed caribou grazing across the valley.

An alternative trail has reportedly been planned for the Snowbowl to by-pass the wet marshy areas near the centre of the area. The results of this study suggest that the grazing habits and escape routes of caribou using the area be watched before a new trail is laid down. Although the existing trail has resulted in considerable caribou disturbance at the northwest end of the Snowbowl, a trail south of the present one would likely increase the frequency of hiker-caribou encounters. Indeed, the caribou-hikers relationship in the Snowbowl cannot easily be resolved so long as the hiking trail passes through Shovel Pass.

The management of elk on alpine-tundra ranges in an endeavour to increase or perpetuate existing caribou populations would be contrary to the overall park policy of letting nature run its course. However, the wildlife management policy permits the control of any species that threatens the existence of another desirable species. If the encroachment of elk onto the prime caribou ranges along the headwaters of the Snake Indian, Blue Creek, Astoria, Whirlpool, Maccarib, Jonas, Poboktan and Maligne watersheds continues to the point where the very existence of caribou is in jeopardy then artificial control of elk by man would appear justified.

8.0 RECOMMENDATIONS

1. Human-caribou interactions should be minimized on prime caribou-alpine-tundra ranges by placing hiking trails away from major summer caribou ranges where possible and/or restricting hiker use during critical calving

periods. Hiking trails should be placed below and within forest cover of these prime ranges where the number of caribou-human encounters will be reduced and the deleterious effects of these encounters minimized.

2. Increased human use of important caribou ranges should not be encouraged by increasing trails, overnight shelters, ski developments, etc.

3. Range extensions of elk onto prime caribou ranges and population trends of both species should be monitored closely to ensure that caribou populations are not eliminated.

4. All caribou calving and rearing ranges plus caribou licks should be delineated and plans made to protect these areas from detrimental activities of humans and elk.

5. Further studies are required for Recommendation 4 and for increasing the knowledge of caribou-human elk interactions which will be essential for the protection and perpetuation of caribou in this park. The Warden Service could obtain all or most of this necessary information. A continued cooperative Canadian Wildlife Service-Warden Service study may be in order.

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APPENDIX I

Caribou Responses to Humans in the Maligne Range, Medicine Lake Delta and Blue Lake Areas

Table 1. Caribou responses to humans in relation to distance, caribou sex/age, position, habitat, temperature, and season; for Maligne Range (Skyline Trail) and Tonquin Valley (Maccarib Cr. Area).

Distance (m)	Caribou Numbers	Habitat Elevation (m)	Daily Temperature Range (°C)	Period of Day	Position to Caribou	Human Actions and Number	Undisturbed Caribou Behaviour
			SUMMER (July-August)				
42	2♂, 5♀, 1Y = 8	*AT (2200)	2 to 12	*MM	Level	1 hiker on trail, stood still.	Grazed into view of human.
Response to humans:	All stood for 3 min., then grazed until frightened by flapping notebook. All but 1♀ ran for 10 m and stopped, then grazed out of sight.						
50	2♂ = 2		7 to 11	Noon	Level	1 hiker stood still.	Walked into view.
Response to humans:	Approached hiker to within 30 m, after 10 min. walked off.						
64	1♂, 2♀ = 3	AT (2300)	-2 to 13	*MA	Above	1 hiker on trail, walked into view, stood.	Grazing.
Response to humans:	1♀ went into an alarm stance, urinated, and sniffed the air but remained in place, second female joined first and both ran off downhill out of sight; 1♂ appeared and ran off following the cows.						
73	1♂ = 1	*SM (2100)	4 to 19	MM	Above	1 hiker walked into view on trail.	
Response to humans:	Fled from base of hill below hiker, stopped briefly 180 m away; looked back at hiker then ran out of sight along a creek bed.						
75	3♂ = 3		2 to 7	*LE	Below	1 hiker stood still.	Grazing.
Response to humans:	2♂ continued to graze, 1 young male approached to within 30 m for 10 min., then returned to others and grazed.						
75	1♂, 1♀ = 2		Max. 9	*EM		1 hiker walked along trail.	Grazing.
Response to humans:	Continued grazing.						
<100	3♂, 1♀ = 4	AT (2100)		MA		2 hikers on trail.	Grazing.
Response to humans:	All became alarmed and ran towards hikers; then away and circled down wind with tails raised; returned to within 100 m of 2 hikers; 1♂ and 1♀ trotted away passing within 30 m of 8 concealed hikers; 2♂ trotted downhill to about 160 m from 2 hikers and to within 50 m of 8 concealed hikers and stopped; 2♂ saw 8 hikers, 1♂ grazed, then both walked 100 m away. Grazed while 1 hiker and 3 llamas walked by on trail 100 m away; watched and grazed as 8 hikers passed 200 m away on trail.						

Table 1. Continued.

Distance (m)	Caribou Numbers	Habitat Elevation (m)	Daily Temperature Range (°C)	Period of Day	Position to Caribou	Human Actions and Number	Undisturbed Caribou Behaviour
20-80	2♀, 1C = 3	SM (2075)		EA	Below	1 biologist hidden in willows from 2 cows but seen by newborn calf.	Grazing at edge of trees and meadow.
Response to humans:	Cows unaware of concealed human downwind and grazed to within 20 m of observer. Newborn calf bedded in shrubs above cows saw observer and came down to mother and stood with splayed legs facing direction of human. Cow looked around briefly then continued feeding.						
100	3 Adults		1 to 8	Noon	Level	2 hikers on trail.	Crossed trail.
Response to humans:	Crossed trail, proceeded to graze up slope.						
100	2♂ = 2	AT (2100)		MA		a) 6 hikers walking towards caribou on trail; 1 hiker approaching from 100 m below.	a) Grazing.
Response to humans:	a) Both walked and grazed until hikers closer than 100 m, then walked away to within 150 m of 2 hikers sitting down; 2♂ became alarmed and trotted across a creek for 100 m, then continued to walk away from hikers.						
136	20 Adults and calves	AT (2300)	-1 to 13	*LM	Below	3 hikers walked into view on trail and stopped.	Grazing.
Response to humans:	Herd bunched up and walked and grazed slowly uphill; spread out as soon as the hikers moved on.						
180	17 Adults and calves	AT (2300)	-2 to 9	*LA	Below	2 hikers passed on trail.	Grazing.
Response to humans:	Grazed and walked slowly uphill, occasionally looking down at trail.						
180	1♂ = 1	MT (2200)		*EA	Above	1 hiker walked into view on trail; stopped then approached.	
Response to humans:	Watched hiker; walked away, then grazed; fled when hiker was 165 m away.						

Table 1. Continued.

Distance (m)	Caribou Numbers	Habitat Elevation (m)	Daily Temperature Range (°C)	Period of Day	Position to Caribou	Human Actions and Number	Undisturbed Caribou Behaviour
180	2♂, 5♀, 1C = 8	AT (2200)	2 to 12	MM	Above	1 hiker walking away from herd.	1♂ - bedded, rest grazing
Response to humans: 1♂ rose; all ran off over a ridge.							
<1000	10 Adults and 2 calves = 12	AT (2300)	4 to 14	LA	Below	2 hikers on trail, approaching Maccarib Pass.	Grazing.
Response to humans: Suddenly ran uphill and disappeared over a ridge 43 minutes before hikers reached their grazing area.							
198	1♂ = 1	AT (2300)	4 to 19	LA	Below	a) one hiker walked into view and stopped, approached slowly and stopped, then approached further.	Grazing.
Response to humans: Ceased grazing, approached a few steps and watched; ran off when hiker was 175 m away; stopped; gave excitation jump, ran briefly, stopped; as hiker continued approach, ran around downwind and then out of sight.							
200	1♂ = 1		Max. 9	EM		1 hiker walking on trail.	Grazing.
Response to humans: Ran up basin.							
205	13 Adults and 2 calves = 15	AT (2250)	-2 to 22	LM EA	Below	4 successive pairs of hikers passing along trail.	Grazing
Response to humans: Ran for 7 minutes, resumed grazing; ran for 8 minutes, resumed grazing; ran for 20 minutes and finally disappeared over a snowpatch onto a talus and slide area.							
275	1 Adult	AT (2250)	8 to 24	MA	Below	1 hiker walking along trail, approached a caribou.	Grazing
Response to humans: Ran uphill from hiking trail onto snowpatch, paused and ate snow; continued to run along length of snowpatch, then uphill onto a second snowpatch, then uphill and slowed to a walk disappearing over a ridge.							

Table 1. Continued.

Distance (m)	Caribou Numbers	Habitat Elevation (m)	Daily Temperature Range (°C)	Period of Day	Position to Caribou	Human Actions and Number	Undisturbed Caribou Behaviour
300	1♂, 2♀ = 3		2 to 7	LM	Above	3 hikers on trail.	Grazing.
Response to humans: No reaction.							
300	3♂, 1♀ = 4		1 to 8	LM		2 hikers moved 100 m closer to caribou off trail to take pictures.	Grazing.
Response to humans: No reaction.							
370	3♂, 1♀ = 4	AT (2100)		MM		1 hiker on trail.	Grazing.
Response to humans: No reaction.							
370	3♂, 1♀ = 4	AT (2100)		LM		1 hiker on trail.	Grazing.
Response to humans: No reaction.							
420	1 Adult	SM, *CF (2000)-1	to 23	EA	Level	Hikers in camp shouted and pointed to caribou across the creek.	Standing.
Response to humans: Ran into spruce forest, paused behind tree, then walked or ran into heavier forest.							
525	11 Adults, 2 calves = 13	AT (2200)	3 to 19	MM	Below	2 hikers left trail and approached herd.	Grazing.
Response to humans: Ran into a gulley and did not reappear that morning.							
				SUMMER (August)			
525	1♂	AT (2250)	7 to 21	EA	Above	a) walked into view; b) walked into view	a) Eating snow; b) Grazing.
Response to humans: a) Ran from snowpatch out of sight; b) ceased grazing, stood and swung head back and forth slowly.							
720	12 Adults and calves			LM	Below	1 hiker passed along old horse trail in valley bottom below herd.	Grazing.
Response to humans: No response to hiker.							

Table 1 Continued.

Distance (m)	Caribou Numbers	Habitat Elevation (m)	Daily Temperature Range (°C)	Period of Day	Position to Caribou	Human Actions and Number	Undisturbed Caribou Behaviour
1600	1♂	AT (2150)	Max. 24	LA	Above	2 hikers on trail stopped and shouted.	Grazing.
Response to humans: Raised head, urinated, ran 45 m onto a snowpatch, and stood motionless with head lowered for at least 20 minutes.							
45-200	2♂, 6♀ = 8	AT (2200)	-1 to 5	MM	Level	1 hiker walked into view and watched for 7 minutes; walked out of sight and reappeared 200 m away and above caribou.	Grazing.
Response to humans: Some watched while others grazed, while hiker 45 m away; however, when hiker reappeared 200 m away but uphill from caribou they immediately ran off over a ridge.							
			FALL (September)				
50	1♂ = 1		Max. 14			2 hikers approached caribou, then stood.	Bedded on snow.
Response to humans: Watched hikers approach; watched them stand for 1 min; rose and circled around to get downwind, when downwind stayed calm and approached hikers to within 15 m; after 15 min walked away over the mountain slopw.							
210	2♂, 3♀ = 5	AT (2100)	-1 to 6	LA	Level	1 hiker walked into view.	2♂, 1♀ resting, 2♀ grazing.
Response to humans: 2♂, 1♀ rose and 1♂ urinated; all ran, circled downslope of the observer and stopped before coming on trail; they backtracked, circled downslope again, crossed the trail and ran downslope into mature spruce forest.							
226	1♂, 2♀ = 3	AT (2200)	-1 to 6	MM	Level	1 hiker walked into view; walked upslope out of view; walked into view above caribou at 136 m.	Resting.
Response to humans: All rose, 1♀ urinated; the 2♀ approached the observer for several steps before stopping; all ran for 37 m before stopping; all ran for 92 m, stopped, and continued to run out of sight.							

Table 1. Continued.

Distance (m)	Caribou Numbers	Habitat Elevation (m)	Daily Temperature Range (°C)	Period of Day	Position to Caribou	Human Actions and Numbers	Undisturbed Caribou Behaviour
525	11♀ + calves = 11	AT (2300)	-1 to 7	Noon		1 hiker walked into view.	Grazing.
Response to humans: 2♀ and 1♂ jumped, ran several steps; watched and followed the rest of the herd as it moved off.							
740	1♀, 1C = 2	AT, CF (2100)	0 to 6	LA	Above	1 hiker walked into view.	Resting.
Response to humans: Both rose and ran for 4 minutes across two ridges and valley.							

*AT - Alpine Tundra
DG - Delta Grassland near forest
SF - Snow Field
SM - Subalpine Meadow
CF - Coniferous Forest

E - Early
M - Mid
L - Late

M - Morning
A - Afternoon
E - Evening

Table 2. Caribou response to humans in relation to distance, caribou sex/age, habitat, temperature and season for Medicine Lake delta and Blue Lake areas.

Distance (m)	Caribou Numbers	Habitat Elevation (m)	Daily Temperature Range (°C)	Period of Day	Position to Caribou	Human Actions and Numbers	Undisturbed Caribou Behaviour
				WINTER (January)			
300	1♂, 1♀, 1C = 3	*DG (1450)	Max. 3	EA	Level	1 hiker stood still.	Walking.
Response to humans:	All three approached to 150-200 m for 10-15 min; walked towards a feeding area 50 m away then returned to within 200 m of hiker; milled and watched for 4-5 min, then trotted 200 m along the lake, stopped and looked back, then trotted for another 200 m, stopped and watched for 15 seconds, then walked 2400 m to the delta at the south end of the lake.						
				SPRING (May-June)			
62	1 Adult	DG (1450)		LM	Level	1 hiker standing.	Walked into view out of trees.
Response to humans:	Saw hiker and went back into the trees.						
90	4 Adults	DG (1450)		EA	Level	1 hiker approached.	Grazing.
Response to humans:	All 4 stood grazing, then walked and ran back into trees.						
90	1 Adult	DG (1450)		LA	Level	1 hiker standing.	Walked out of trees.
Response to humans:	Walked back into trees.						
136	1♂ = 1	DG (1450)		MA	Level	1 hiker approached; approached further, then sat; started working in a small area.	Grazing.
Response to humans:	Watched and grazed; kept about a 90 m distance with occasional feeding; after 15 min. of feeding, trotted to within 70 m of the hiker and resumed foraging; several times it gave an excitation jump and ran away, but immediately reapproached the hiker and grazed; moved off to 170 m and grazed.						
136	4 Unclass.	DG (1450)		LM	Level	1 person working in a small area.	Walked out of trees and grazed.
Response to humans:	No response.						

Table 2. Continued.

Distance (m)	Caribou Numbers	Habitat Elevation (m)	Daily Temperature Range (°C)	Period of Day	Position to Caribou	Human Actions and Numbers	Undisturbed Caribou Behaviour
150	1♂ = 1	DG (1450)	Max. 21	MA	Level	1 hiker walked to 100 m from caribou.	Grazing.
Response to humans:	Looked up but continued to graze; watched hiker closely for 10 sec. then resumed grazing; suddenly gave an excitation leap and ran for 100 m towards the trees.						
200	1♂ = 1	DG (1450)	Max. 21	MA	Level	2 hikers approached along a river and parallel to caribou.	Grazing.
Response to humans:	Stopped grazing briefly to look at hikers before continuing to graze; became agitated, and watched them closely; tail raised high until hikers left.						
125-175	1♂ = 1	DG (1450)	Max. 21	MA	Level	1 hiker approached to 175 m and then to 125 m; 2 hikers came to 75 m behind first hikers.	Grazing.
Response to humans:	Caribou raised its head then continued to feed after hiker stopped; looked up momentarily when hiker stopped at 175 m; then grazed; looked up occasionally but grazed; no reaction.						
250	1♂ = 1	DG (1450)	Max. 21	MA	Level	1 car drove in and parked.	Grazing.
Response to humans:	No reaction.						
250	1♂ = 1	DG (1450)	Max. 21	MA	Level	2 hikers walking in trees.	Grazing.
Response to humans:	Watched hikers start out; grazed periodically looking at them until out of sight.						
250	1♂ = 1	DG (1450)	Max. 21	MA	Level	2 hikers walked by.	Grazing.
Response to humans:	Watched closely, then moved off grazing.						
250	1♂ = 1	DG (1450)	Max. 16	LM	Level	1 car left area and another car entered.	Grazing.
Response to humans:	Looked up momentarily at each vehicle.						

Table 2. Continued.

Distance (m)	Caribou Numbers	Habitat Elevation (m)	Daily Temperature Range (°C)	Period of Day	Position to Caribou	Human Actions and Numbers	Undisturbed Caribou Behaviour
250	1♂ = 1	DG (1450)	Max. 21	LA	Level	1 hiker walked by.	Grazing.
Response to humans:	No reaction.						
300	1♂ = 1	DG (1450)	Max. 21	MA	Level	Car drove out of area.	Grazing.
Response to humans:	No reaction.						
300	1♂ = 1	DG (1450)	Max. 16	MA	Level	Truck drove by.	Grazing.
Response to humans:	Continued to graze, but looked up periodically.						
350	1♂ = 1	DG (1450)	Max. 16	MA	Level	2 hikers walked by.	Bedded.
Response to humans:	Rose up and began grazing.						
350	1♂ = 1	DG (1450)	Max. 16	EA	Level	Car and trailer drove in, park.	Grazing.
Response to humans:	Raised its head and watched for 2-3 min; resumed grazing.						
400	1♂ = 1	DG (1450)	Max. 16	LM	Level	Car drove in and parked.	Grazing.
Response to humans:	Looked up then resumed grazing.						
400	1♂ = 1	DG (1450)	Max. 16	MA	Level	a) Car entered, parked; b) Car entered, parked.	Grazing.
Response to humans:	No reaction.						
600	1♂ = 1	DG (1450)	Max. 21	MA	Level	Car honked its horn.	Grazing.
Response to humans:	Looked up, then resumed grazing.						
				SUMMER (July)	Blue Lake Area		
126	4♀ = 4	SF (2300)		LA	Below	a) 1 hiker walked, stopped; b) 1 hiker checking plants.	Grazing.
Response to humans:	a) All 4♀ gave excitation jumps and ran downslope for 95 m; b) all 4♀ approached the hiker to about 100 m, stopped and watched for 5 min; then turned and ran downslope.						

Table 2. Continued.

Distance (m)	Caribou Numbers	Habitat Elevation (m)	Daily Temperature Range (°C)	Period of Day	Position to Caribou	Human Actions and Numbers	Undisturbed Caribou Behaviour
320	2♂, 6♀, 4Y = 12	SM (2000)		EA	Above	2 hikers approached, then stopped.	3 bedded, 9 grazing.

Response to humans: All 12 urinated, then walked; 6♀ and 4Y ran upslope on hill across meadow from hikers; 2♂ circled downwind to 74 m; stopped and urinated, excitation jump and ran off.

AT - Alpine Tundra
DG - Delta Grassland near forest
*SF - Snow Field
SM - Subalpine Meadow
CF - Coniferous Forest

E - Early
M - Mid
L - Late

M - Morning
A - Afternoon
E - Evening

APPENDIX II

Abundance of Caribou and Other Ungulates in North Jasper and in Wolf Scats (from Carbyn 1974)

Table 1. Summary of results obtained on the relative abundance of the ungulate species in the North Jasper study area (Carbyn 1974). Best estimates are compared with those made by Cowan (1947).

Ungulate Species	I Aerial Surveys (total counts)		II Aerial Surveys (highest counts 1969/70)		III Winter tracking results (1970/71; 1971/72)		IV Summer counts (ground observ. 1970, 1971, 1972)		Best estimates based on I, II, III, IV	Based on total counts by Cowan in 1941, 1943	
	Number	%	Number	%	Number	%	Number	%	%	Number	%
Wapiti	762	44	244	40	116	36	1,758	82	42	1,721	33
Sheep	677	39	235	38	162	50	-	-	35	2,251	42
Mule deer	53	3	31	5	26	8	279	13	13	595	11
Moose	103	6	32	5	19	6	96	5	5	156	4
Goat	102	6	51	9	-	-	-	-	3	458	9
Caribou	28	2	21	3	-	-	10	-	1	36	1

Table 2. Frequency of occurrence of prey species in scat samples and relative abundance of ungulates in North Jasper (Carbyn 1974).

Food items (species)	Summer (1 May-30 September)			Winter (1 October-30 April)		
	Occurrences in the scat	%	Relative abundance (%)	Occurrences in the scat	%	Relative abundance (%)
Wapiti	305	46	82	29	11	40
Mule deer	203	30	13	175	66	5
Moose	55	8	5	20	8	5
Sheep	4	2	NA*	10	4	38
Goat	0	0	NA	0	0	9
Caribou	15	1	<1	0	0	3
Total ungulates	582	87		234	89	
Voles	15	2	NA	1	T	NA
Showshoe hare	7	1	NA	2	1	NA
Ground squirrel	1	T	NA	1	T	NA
Red squirrel	0	0	NA	1	T	NA
Pika	0	0	NA	1	T	NA
Total rodents	23	3		6	2	
UC	64	10	-	25	9	-

*NA - not applicable