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MORTALITY OF BIGHORN SHEEP (Ovis canadensis) ON A RAILROAD
AND HIGHWAY IN JASPER NATIONAL PARK, CANADA

by

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TABLE OF CONTENTS

	Page
LIST OF TABLES	ii
LIST OF FIGURES	ii
ABSTRACT	1
INTRODUCTION	1
METHODS	2
SHEEP POPULATIONS AND TRENDS IN THE STUDY AREA	3
SHEEP SEASONAL USE OF THE STUDY AREA	4
SHEEP MORTALITY FROM TRAINS AND MOTOR VEHICLES	4
COMPARISON BETWEEN RAILROAD AND HIGHWAY MORTALITY	6
FACTORS INFLUENCING UNNATURAL SHEEP MORTALITY	6
THE GRAVEYARD HERD	7
MITIGATIONS	8
CONCLUSION	10
ACKNOWLEDGEMENTS	10
LITERATURE CITED	10

LIST OF TABLES

	Page
1. Population changes in sheep populations in the lower Athabasca valley.....	12
2. Distribution of unnatural mortality among sheep populations in the lower Athabasca valley, 1951-1980.....	13
3. Percent mortality of the various age/sex classes by month over the whole year.....	14
4. Seasonal use of three major winter ranges in the lower Athabasca valley, 1978 and 1979.....	15

LIST OF FIGURES

1. Sheep populations affected by railroad and highway mortality in the lower Athabasca valley.....	16
2. Sheep mortality by month in the lower Athabasca valley, 1951-1980.....	17
3. Highway traffic volume by month on the Yellowhead highway, 1970 and 1980.....	18
4. Correlation of average snow accumulation and total sheep mortality during the months December to March inclusive, 1955-1980.....	19

ABSTRACT

*Between 1952 and 1980, 265 bighorn sheep (*Ovis canadensis*) were reported killed by trains on the Canadian National Railways line and 156 by motor vehicles on the Yellowhead highway in Jasper National Park. Seven wintering populations of sheep are affected by this unnatural mortality. Five populations have declined in the last 10 years and two have remained constant. The most pronounced declines were in herds which have sustained the highest losses. Mortality is highest in January and lowest in summer but does not show a significant correlation to winter severity. Railroad mortality is more severe than highway mortality and is concentrated in rock cuts and at a tunnel mouth. Highway mortality has increased as traffic levels on the highway increased and is mostly associated with sheep begging for food handouts and licking road salt from the highway surface. It is concluded that fencing the critical areas will be the most effective way to reduce unnatural mortality, as regulatory measures have proven ineffective.*

The problem of wildlife mortality on highways and railroads in the mountain National Parks of Canada has given rise to increasing concern in recent years in light of proposals to twin sections of the Trans-Canada highway (Parks Canada, Western Region 1975), and Canadian Pacific Railway (C.P. Rail, undated, Main Line Capacity Improvement-Lake Louise-Stephen project. Information Pamphlet. 18 pp.) in Banff National Park and the Canadian National Railway in Jasper National Park.

Concern that the increased speed and volume of traffic on these expanded transportation arteries would accelerate what was already perceived to be an excessive rate of unnatural mortality led to investigations of existing impacts on wildlife. Halle Flygare, a Banff warden, prepared an exhaustive review of ungulate mortality on the Trans-Canada highway between the years 1964 and 1978 and supplemented this with a bibliography of literature dealing with highway mortality and mitigations (Flygare 1979, "Ungulate mortality and mitigated measures, Trans-Canada highway, Banff National Park: east gate to Sunshine turnoff." Unpublished Parks Canada report. 168 pp.). Another report predicted that elk (*Cervus canadensis*) may be totally extirpated from the Bow valley if railroad and highway mortality remained at or above the existing level of 30 to 66 elk per year (Holroyd, G. 1978. "The impact of highway and railroad mortality on the ungulate populations of the Bow valley, Banff National Park." Unpublished report, Canadian Wildlife Service, Edmonton. 11 pp.). Annual summaries prepared by the Banff Warden Service indicate that elk mortality has increased in 1979 and 1980 to 68 and 104 animals respectively. I documented an on-going decline of a bighorn sheep population in Jasper from a high of more than 216 in 1958 to a present level of 26 and attributed this largely to an annual railroad mortality of from 7.7 to 10.0% (Van Tighem 1980. Environmental impact of Canadian National Railway twinning on large mammals east of Jasper, Alberta. Unpublished report, Canadian Wildlife Service, Edmonton. 19 pp.).

Since 1952 Jasper National Park wardens have documented 401 bighorn sheep deaths along the Canadian National Railway (CNR) and Yellowhead highway in Jasper National Park. The following discussion is limited to sheep by time constraints on the part of the author and by certain aspects of sheep distribution in the lower Athabasca River valley which makes analysis of the problem more manageable than for other species. In fact, elk have sustained higher overall mortality (at least 411 since 1952) and moose (Alces americana), mule deer (Odocoileus hemionus), grizzly bear (Ursus arctos) and other species of wildlife are also killed in significant numbers.

METHODS

The distribution, seasonal use and size of sheep populations in the lower Athabasca valley were determined by surveying all visible slopes from the Yellowhead highway at least five times monthly from 2 June, 1978 until 4 April, 1979. This survey route sampled the Graveyard, Colin, Jacques and Miette populations more adequately than other populations in the study area, so data from these surveys were supplemented by random observations from the entire area and by an aerial census of all ranges in the study area, conducted by Bell 206B Jet Ranger on 26 March, 1980, lasting 1.4 hours.

Historical trends in sheep distribution and abundance are well documented by John Stelfox of the Canadian Wildlife Service (Stelfox 1971, 1976; 1978, Seasonal distribution of Rocky Mountain bighorn sheep in Canadian National Parks, 1966-1972. CWS client report for Parks Canada. 149 pp.).

Wildlife sighting cards have been maintained by Jasper National Park wardens since 1951. Although these cards have not been consistently filled out by all wardens, they nonetheless represent a great deal of information collected in a standardized manner over the last thirty years. These cards were analyzed to determine the dates, locations and number of sheep killed on the CNR and Yellowhead highway in Jasper National Park. It should be borne in mind that mortality statistics obtained from this source represent only the minimum number killed.

An index of winter severity based on an average of total month-end snow accumulation for the months of December to March inclusive was prepared using weather data recorded at the Environment Canada weather office in Jasper. This index was compared to the mortality figures for the same months of each year to assess whether there was a correlation between winter severity and unnatural sheep mortality.

Unpublished survey and random observation data from the Banff/Jasper biophysical wildlife inventory were used to refine estimates of sheep and carnivore abundance.

SHEEP POPULATIONS AND TRENDS IN THE STUDY AREA

The lower Athabasca valley contains the most extensive and heavily populated winter ranges of bighorn sheep in Jasper National Park. At least 43% of Jasper's sheep winter here (Stelfox 1978, op. cit.). Although there is some interchange of sheep among populations, year to year use of winter ranges is sufficiently consistent (Geist 1971) to warrant the recognition of at least eight distinct populations of sheep in the lower Athabasca valley. One of these populations winters on Signal Mountain and Old Fort Point and is not affected by the highway or railroad. Of the seven populations which come into contact with either the CNR or the Yellowhead highway (Figure 1), five have declined in the last 10 years and two have remained constant. The Signal Mountain population has remained constant or declined slightly (Table 1).

Sheep populations have fluctuated from very high numbers to very low several times in the last century and a half in the lower Athabasca valley, but their distributions have remained generally the same (Stelfox 1971). Sheep were abundant before the middle of the nineteenth century but by the early 1900's only 75 to 250 were believed to remain in the entire Athabasca watershed (Millar 1916). Protection from hunting allowed the populations to build up again to high numbers in the late 1930's and early 1940's. Severe winters, depleted ranges and the pneumonia/lungworm disease complex contributed to a major die-off in Jasper from 1947 to 1950.

This die-off resulted in the extirpation of two small populations on Mount Kerkeslin and Portal Creek, and sheep have never become re-established there. The Graveyard sheep herd also nearly disappeared (A. Burstrom, Jasper warden service, pers. comm.).

Since the early 1950's sheep have again increased in abundance to an estimated total park population of 2600 in 1966 (Stelfox 1971) and 2270 in 1971 (Stelfox 1978, op. cit.).

There have been no major die-offs due to epidemics since 1971 when Stelfox completed his censuses; however, the total sheep population of the lower Athabasca valley has declined from an estimated 830-985 animals 10 years ago (Stelfox 1978, op. cit.) to an estimated 425-630 animals in 1980 (CWS, unpublished censuses). The causes of this decline include mortality on railroads and highways, winter stress and, possibly, increased predation.

Winter severity has been greater (23.8 cm ave. snow accumulation) in the last 11 years than in the 11 years preceeding 1970 (18.5 cm). Cougar populations have declined (32 sightings from 1968-1970, compared to one sighting from 1978-1980, Jasper warden service wildlife sighting cards) while wolves have increased from 20 which ranged into the lower Athabasca valley in 1969/70 (Carbyn 1974) to 25 in 1979/80 (CWS unpublished censuses). However, data are not available to assess whether predation on sheep has changed significantly.

Another factor which has been considered in sheep population declines is habitat loss caused by forest succession (Stelfox 1978, Range ecology of Rocky Mountain bighorn sheep in Canadian National Parks. CWS client report for Parks Canada. 149 pp.). There is no evidence, however, to suggest that any of the existing ranges under consideration are presently being fully utilized and thus habitat limitations cannot be considered an important factor in the present decline. The Graveyard herd, for example, now frequents only half of the winter range it occupied between 1965 and 1971 when its population was triple its present size (Stelfox 1978, op. cit.) although the unused portion is less forested than the portion still in use.

SHEEP SEASONAL USE OF THE STUDY AREA

During censuses conducted in 1978 and 1979 (Table 4) counts of sheep were consistently low during June, July and August, when most sheep were dispersed on their high elevation summer ranges. Sheep started appearing on their winter ranges in September and maximum concentrations were reached from November to February, followed by a gradual decline until April, when most sheep had left. Maximum counts along the survey route were 100 on 22 November; 168 on 14 January; and 100 on 17 February.

Adult ewes represented 50.6% of all classified sheep including lambs and yearlings. Assuming a near-equal ratio of ewes to rams (Geist 1971) it is postulated that rams from these populations tend to winter on ranges more remote from the valley than ewe groups. A band of 5-20 rams from the Desmet herd has traditionally wintered on open grasslands at the north end of Jasper Lake.

Ewe groups were rarely seen in summer, being most regularly observed at the bases of the Miette, Jacques and Colin ranges where they make use of natural mineral licks beside the highway (Figure 1) and take food handouts from tourists. Numbers of sheep began to increase in the survey area in early September and remained high until early April.

Very few mature rams were observed along the survey route during the summer. One band of 25 rams was seen on 2 June using a mineral lick at the base of the Colin Range. Rams began to increase in mid-September, somewhat later than ewes, and most had departed by mid-March, earlier than ewes.

SHEEP MORTALITY FROM TRAINS AND MOTOR VEHICLES

Of the 401 sheep reported killed by trains and motor vehicles between 1952 and 1980, 255 (65%) were killed in 116 collisions with trains (average 2.04 per collision) and 136 (35%) were killed in 116 collisions with motor vehicles (average 1.17 per collision). The Graveyard herd lost 54 to trains and eight to motor vehicles, with 10 more killed in collisions for which the cause was not specified. All the

COMPARISON BETWEEN RAILROAD AND HIGHWAY MORTALITY

Mortality on both railroad and highway peaks in January and is lowest in July and September (Figure 2). The worst season for unnatural mortality is December to March when 53.5% of all mortality occurs (railroad: 61.2%, highway: 38.9%).

Railroad mortality peaks in January and decreases to its lowest level in July. This corresponds with the seasonal change in abundance of sheep in the lower Athabasca valley (Table 4). Highway mortality, however, exhibits a double peak; highest mortality is in November and January, but there is a secondary peak in mid-summer (Figure 2). This secondary peak corresponds to the greatest volume of traffic on the Yellowhead highway; there are fewer sheep near the highway in summer but they stand a greater chance of being killed.

Railroad mortality is concentrated at rock cuts and the mouth of the Brule tunnel (Figure 1). Kill locations are thus constant from year to year. The rock cuts along Jasper Lake near Windy Point have accounted for 30.9% of all sheep mortality along the CNR, the rock cuts near Mile 3 for another 20%, and the Brule tunnel for 17.7%. Sheep take shelter or become trapped in these locations and are unable to escape approaching trains. Sheep have been observed jumping against sheer rock cuts to escape oncoming trains or running along the railway embankment into rockcuts rather than flee across open terrain (B. Jespersen, CNR brakeman, pers. comm.).

The tendency for groups of sheep to become trapped in these locations accounts for the fact that the average train collision kills almost twice as many sheep as the average motor vehicle collision.

Rock cuts do not play a role in highway sheep mortality since the Yellowhead highway does not pass through any. Most sheep killed on the Yellowhead are killed when they gather to lick road salt from the highway surface in winter or when they are milling about taking food handouts from tourists. On at least four occasions I have seen sheep walk out and stand in the middle of the highway, apparently trying to stop vehicles. These sheep have learned to be unconcerned when fast-moving vehicles pass within inches of them.

Most motor vehicle/sheep collisions involve single animals, possibly because drivers are more able to slow down than are train engineers, and because the collisions do not take place in confined places and the sheep are better able to get out of the way.

FACTORS INFLUENCING UNNATURAL SHEEP MORTALITY

The concentration of railroad and highway-associated sheep mortality in the winter months suggests the hypothesis that the amount of unnatural mortality in a given year may relate to winter severity. In

and 26 respectively (CWS unpublished censuses). During the latter winter I conducted a foot search of the CNR track where it transects the Graveyard winter range and found three dead sheep, or 11.5% of the known population. There were only three young of 1979 in the herd at this time, so that winter's known mortality equalled that year's net production.

Mortality caused by trains and motor vehicles in this herd has averaged 4.3% over the last 20 years and 2.1% over the last 10. Sullivan and Stelfox (1978, op. cit.) recorded a mortality between 1971 and 1974 of 7.7%. Actual mortality is up to three times higher since not all kills are reported.

Ewes have constituted 45.9% of the Graveyard herd over the last 30 years, based on maximum unduplicated counts of each age/sex group per year during that period (Jasper Warden files). Average productivity during that period has been 46 lambs per 100 ewes. Ewes have comprised 50%, yearlings 16% and lambs 11% of all train and highway kills. In order to maintain a constant population, this herd cannot sustain an unnatural mortality rate greater than 16%, assuming no mortality from other factors.

The Graveyard herd is on the verge of extirpation. No sheep were reported killed during the mild winter of 1980/81 (J. Woodrow, Jasper warden service, pers. comm.), however, the population is now sufficiently reduced that a catastrophic winter or a major train collision (there have been four collisions that have killed more than nine sheep at once) could result in its elimination. The Graveyard herd occupies marginal range and is possibly more susceptible to predation, due to the limited amount of available escape terrain, than other populations in the lower Athabasca valley (Van Tighem 1980, op. cit.) and the excessive rate of mortality it has sustained in the last 30 years cannot continue without threatening its existence.

MITIGATION PROCEDURES

Ungulate mortality on transportation arteries can be and has been mitigated in a number of ways. These include the installation of reflective devices that warn animals of approaching vehicles, installation of signs that warn drivers of animal crossing areas, decreased speed limits, and fencing right-of-ways in order to keep animals off them (Flygare 1979, op. cit.). Where fencing has been used it has proven necessary to allow for animal crossings by installing underpasses, as well as allowing animals which become accidentally trapped inside the fences to escape through one-way gates or out-jumps. Most such mitigations have been installed to compensate for mortality of mule deer (Reed et al. 1975), white-tailed deer (Oueal 1967) and moose (Rosengardten 1979). No literature is available which describes the mitigation of bighorn sheep losses on transportation arteries, however, warden reports in Banff and Jasper National Parks have proposed means by which such losses may be reduced.

A report on sheep deaths in Banff recommended a lowered speed limit and 'No stopping' signs to reduce the excessive mortality of sheep on a highway in Banff (Flygare 1976, "Trans-Canada Highway: Rocky Mountain bighorn sheep mortality 1965-1975, Banff National Park." Parks Canada, unpublished report. 62 pp.). These measures were put in force in May 1976 when the speed limit was reduced from 100 to 65 kmh along a six kilometer stretch of highway. In 1978 the speed limit was increased to 70 kmh. Flygare's evaluation of these measures showed that although the number of vehicle collisions decreased by 34.1%, the number of sheep killed decreased by only 7.2%, from 30 animals in the 2 1/2 years preceeding the regulatory changes to 26 in the 2 1/2 years following.

A report on sheep deaths on the Yellowhead highway in Jasper recommended a reduced speed limit, pull-off areas where tourists could get off the highway and park to look at sheep, and fencing the uphill side of the highway at blind corners in such a way as to isolate sheep from their escape terrain (Beswick 1980, "Proposal for measures to reduce traffic hazard and Rocky Mountain bighorn sheep mortality along the Yellowhead highway in Jasper National Park." Parks Canada, unpublished report. 17 pp.). Beswick felt that without easy access to escape terrain, sheep would be discouraged from remaining on the highway at these points. At least some of these recommendations will be put in force during the summer of 1981, including the reduced speed limit (D. Martin, Asst. Chief Warden, Jasper National Park, pers. comm.).

The twinning of the CNR line through Jasper, which is currently underway, has afforded CNR and Parks Canada an opportunity to assess the existing impacts of the railway on wildlife and develop means by which these can be mitigated (Hardy and Associates 1980. "An environmental evaluation of the twinning of the CNR line in Jasper Park." Consultant report to CNR, unpublished). CNR has committed itself to designing a cattle guard that will prevent sheep from taking shelter in the new Brule tunnel, and has expressed its willingness to install fencing at the critical kill sites if no other effective means can be found (L. Hostland, CNR Plant Expansion Engineer, pers. comm., 18 March, 1981). The installation of such fencing hinges on Parks Canada's recognition of the severity of the problem.

Mitigation of bighorn sheep mortality on highways and railroads in Jasper offers some distinctive challenges and opportunities. Because kill sites are highly specific and are confined to where transportation arteries transect the lower portions of winter ranges, the need to provide for crossing of the right-of-ways by sheep is less critical than in the case of migratory mule deer and elk. The psychological importance of escape terrain to sheep offers intriguing possibilities such as are discussed by Beswick (1980, *op. cit.*) but further investigation is needed into the response of sheep to stress and to various kinds of traffic. Since rock cuts and tunnels account for most of the railroad mortality, designing these cuts in such a way as to allow easy egress, or creating effective barriers such as cattle guards or remote control gates to prevent sheep from entering them, may effectively reduce mortality. These barriers are unlikely to be effective at rock cuts unless the railroad is fenced on both sides between the barriers.

Similar measures would reduce sheep deaths on the highway. In addition, more effective education about and enforcement of existing laws making the feeding of sheep illegal, and the use of a substitute for road salt at least at established kill sites, would remove the two major incentives for sheep to visit the highway. Begging by sheep is a learned behaviour (Geist 1971) and will continue to be reinforced unless feeding is effectively eliminated. If this is not possible, and if salting the highway cannot be discontinued, fencing the highway would then be the only feasible alternative in order to eliminate sheep mortality.

CONCLUSION

Unnatural mortality, particularly that caused by collisions with trains, is the major factor in the decline of five out of seven wintering bighorn sheep populations which come into contact with the CNR and Yellowhead highway in Jasper. Although two populations have not decreased significantly in the last 10 years, highway mortality on them has more than doubled and declines may become apparent as traffic volume increases.

Warning signs and lowered speed limits have not been effective in eliminating sheep mortality in Banff. The most effective means by which this mortality can be stopped is by the use of fences and other physical barriers to keep sheep from gaining access to transportation arteries. Reduction in mortality may be achieved by elimination of road salting, increased education about and enforcement of existing laws and speed limits and, possibly, by exploiting sheep psychology with regard to escape terrain.

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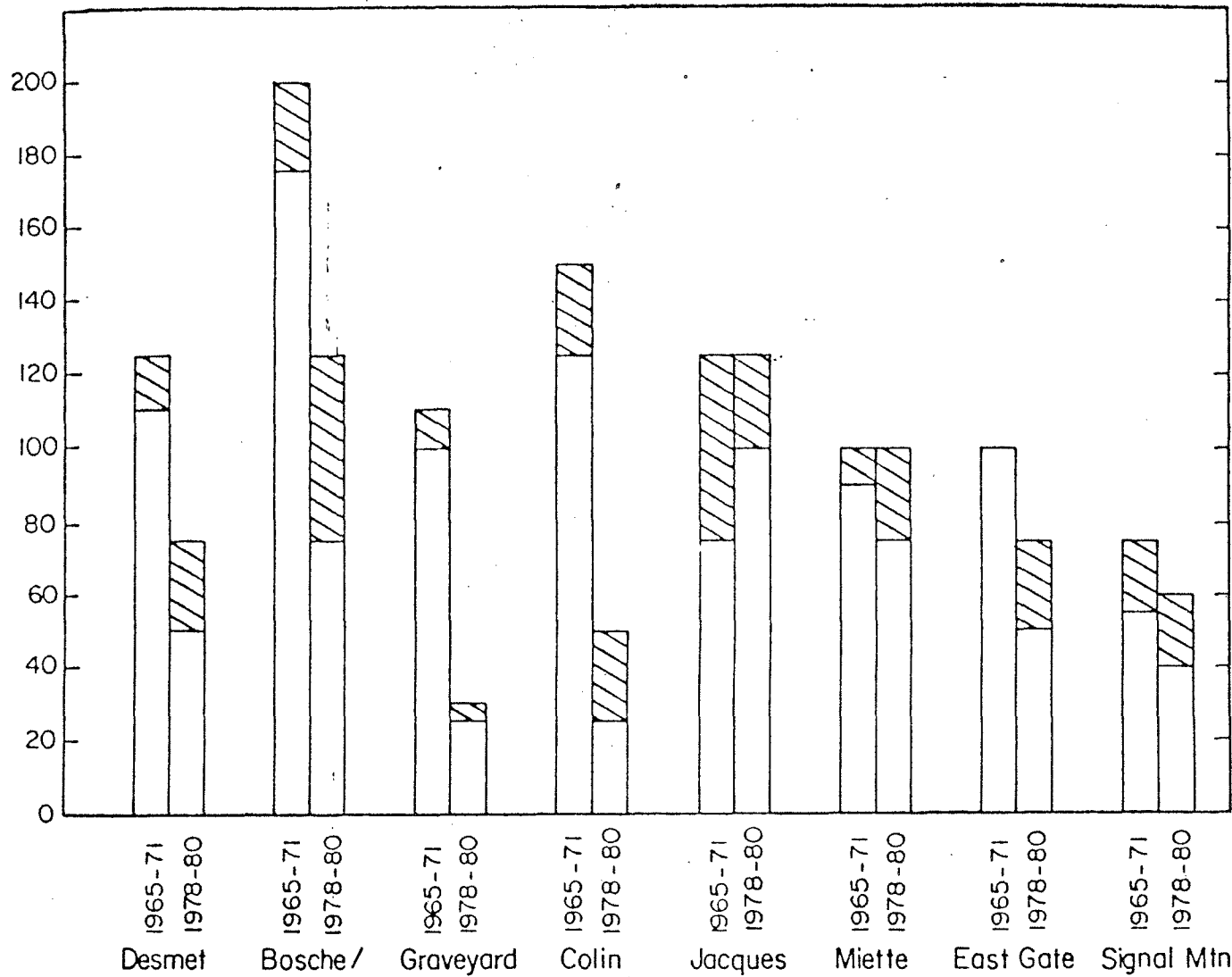


Table 1. Population changes* in sheep populations in the lower Athabasca valley, Jasper National Park, 1965 to 1980.

*(population estimates from Stelfox 1978 and CWS unpublished census data)

Table 2. Distribution of unnatural mortality among sheep populations in the Yellowhead corridor.

Source of mortality		1951 to 1960	1961 to 1970	1971 to 1980	Total
Bosche/Boule	railroad	20	29	39	88
Desmet	railroad	43	37	33	113
Graveyard	railroad & highway	10	47 (40 by train, 7 by car)	15 (14 by train, 1 by car)	72
Colin	highway	7	19	22	48
Jacques	highway		6	13	19
Miette	highway	3	14	34	51
East Gate	highway		4	6	10
Signal Mountain					
TOTALS		83	156	162	401
train total:		73	106	86	265
car total:		10	50	76	136

Table 3. Percent mortality of various age/sex classes by month and over the whole year.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Whole year
M	46	18	43	31	26	35	0	0	13	10	31	28	27.9
F	31	59	36	50	42	48	77	50	25	55	21	37	41.6
YOY						13	12	29	25	21	13	28	9.7
YLY	20	18	11	15	32	0	19	4	7	10	0	2	11.5
U/C	4	5	9	4	0	4	0	17	31	3	36	5	9.2

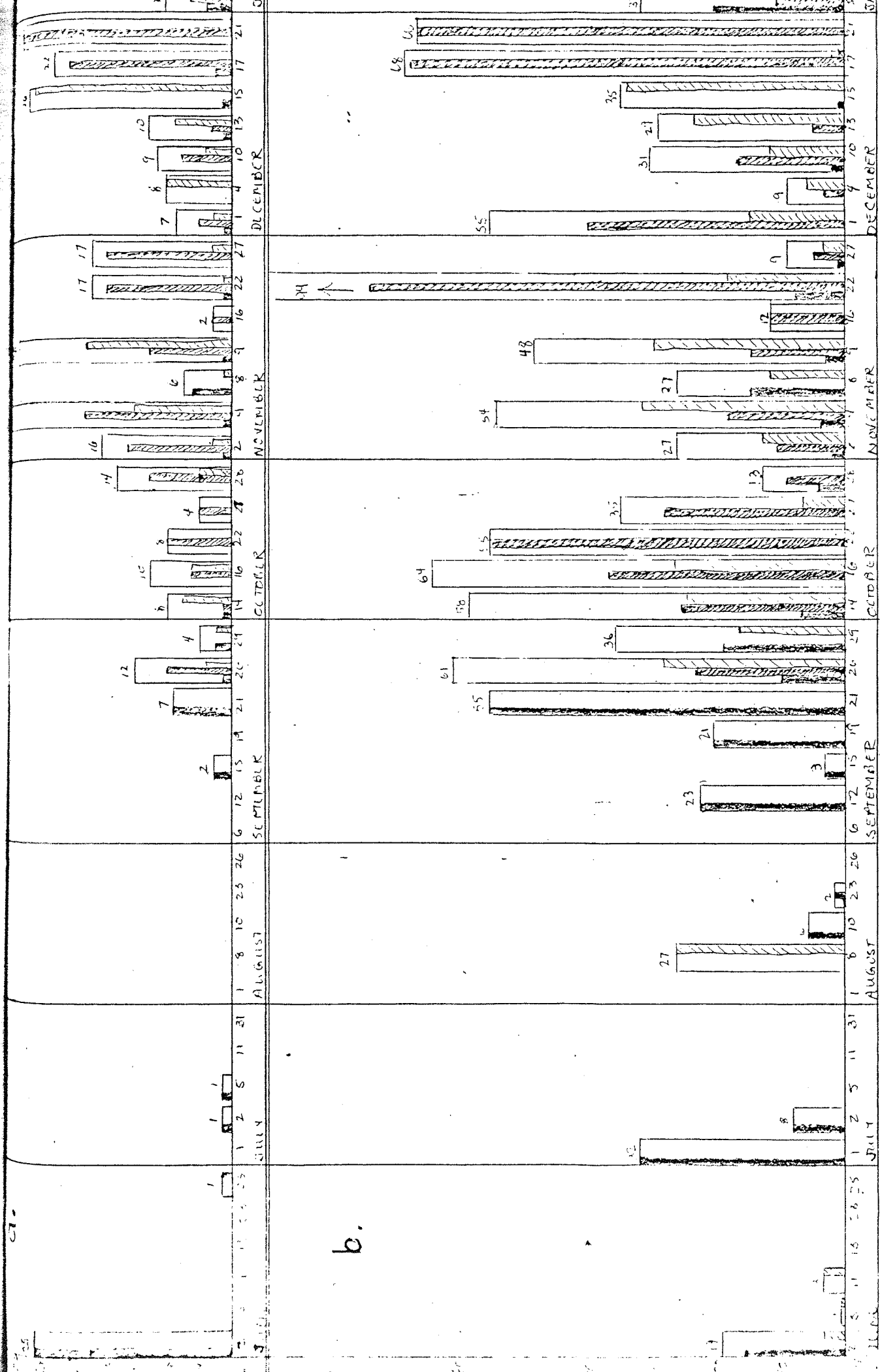


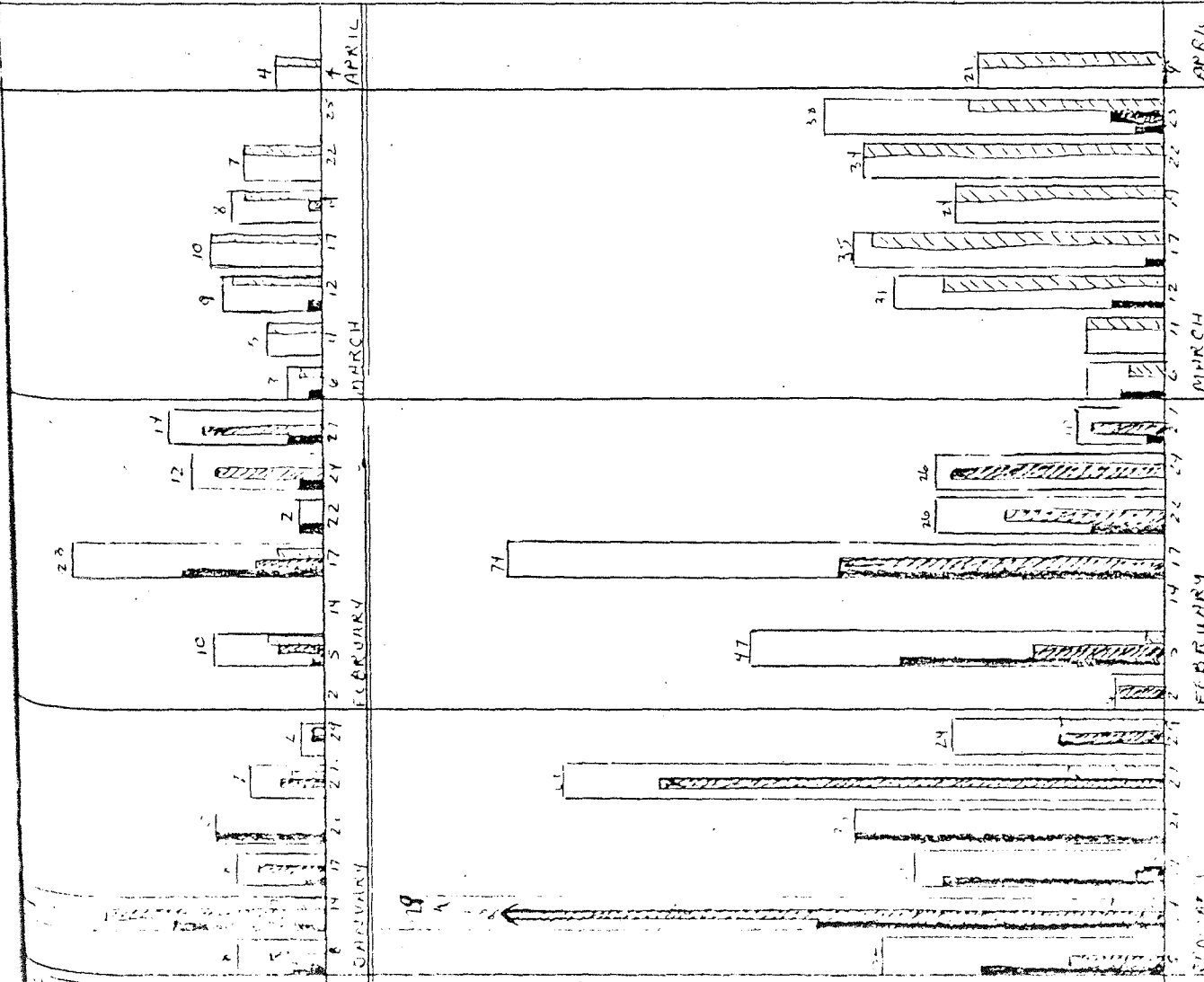
TABLE 4. SEASONAL USE OF 3 MAJOR WINTER RANGES IN THE LOWER ATHABASCA VALLEY, 1978

b.

SULLY RANGEC

THICKS RANGEC

MICETTE RANGEC



8 and 1979 a. by adult ♂ Big Horn Sheep
 b. by ♀, lamb and yearling Big Horn Sheep

Figure 1. Sheep populations affected by railroad and highway mortality in the lower Athabasca valley.

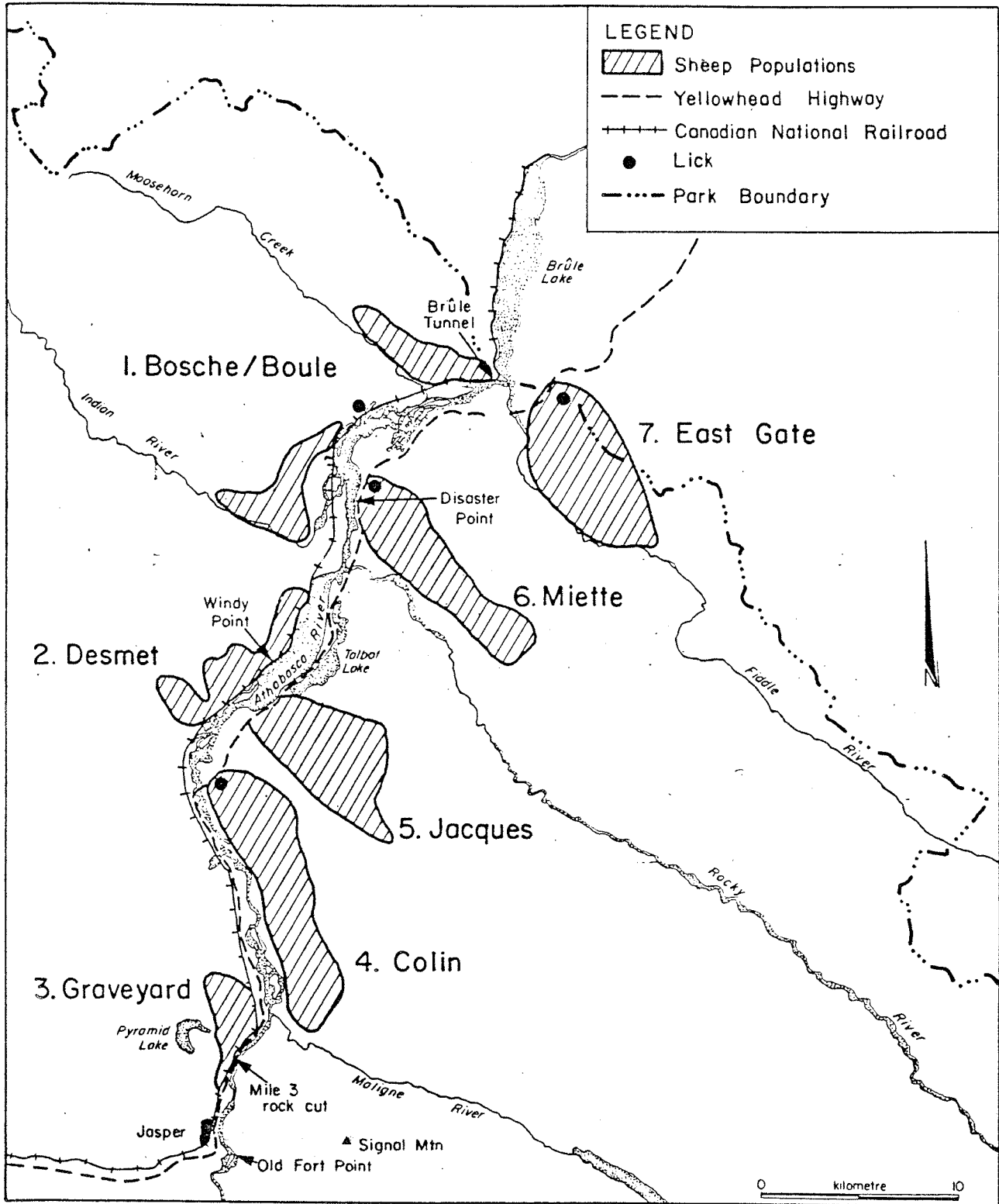


Figure 2. Sheep mortality by month in the lower Athabasca valley, 1951 - 1980.

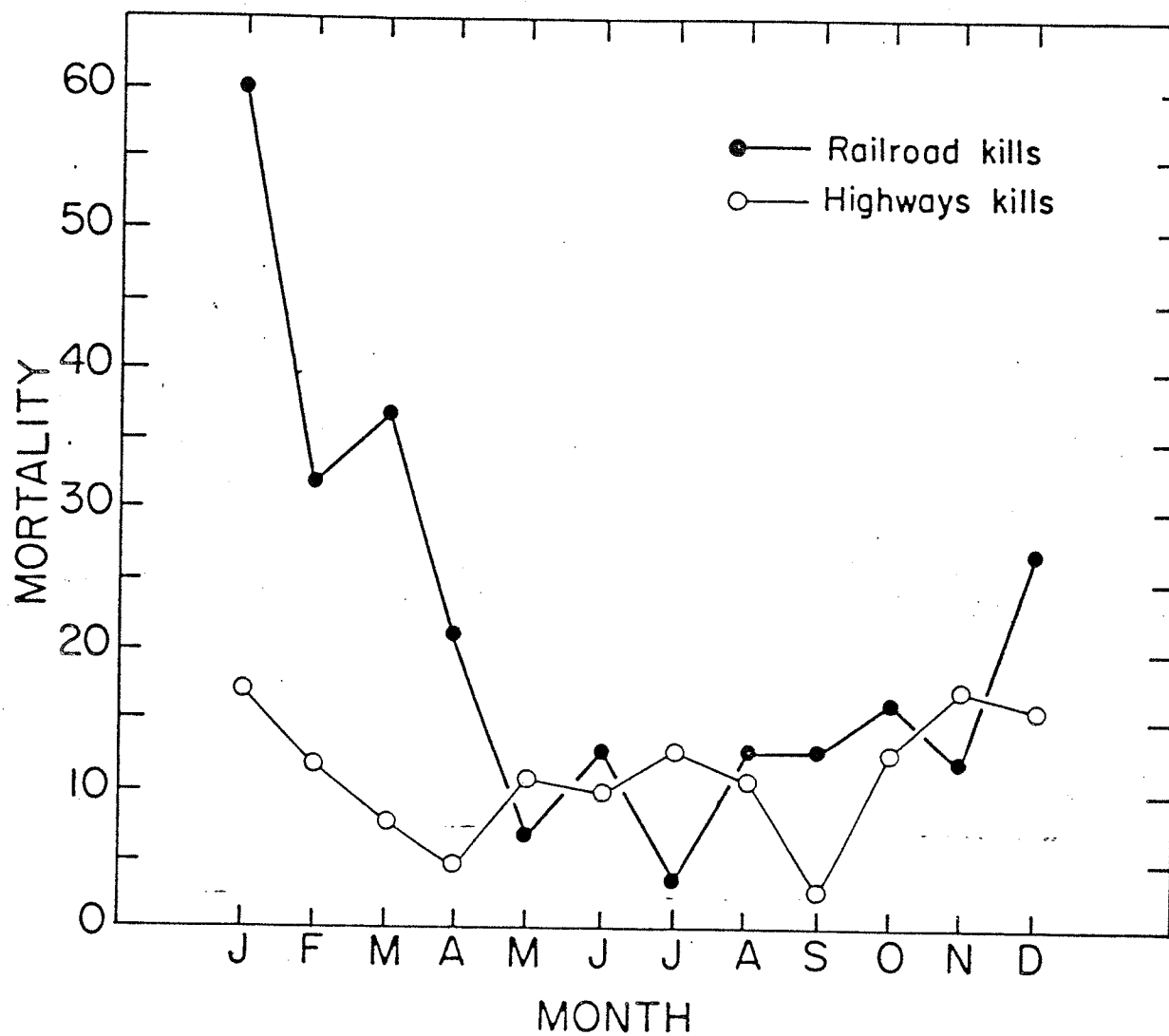
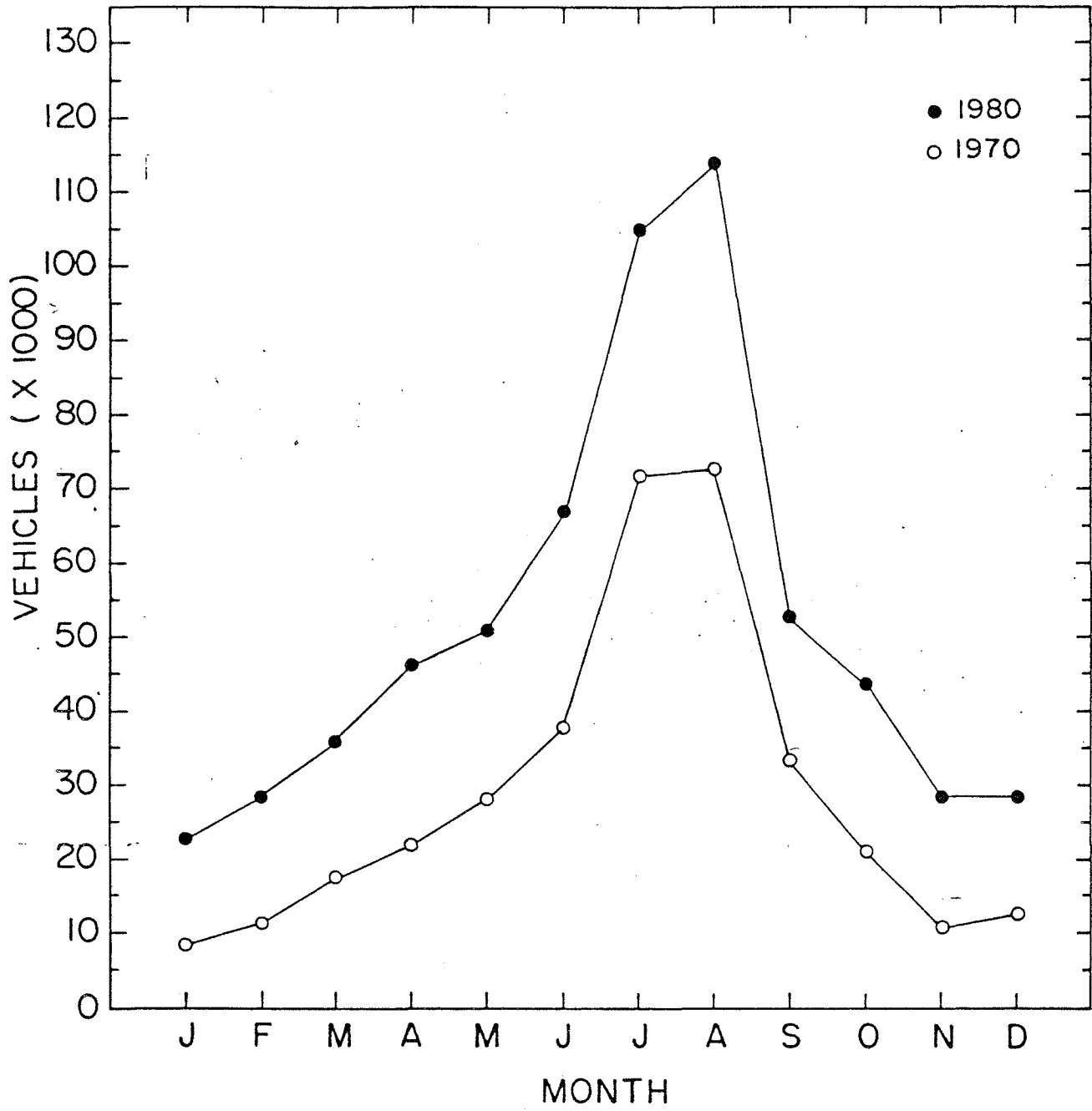


Figure 3. Highway traffic volume by month on the Yellowhead highway, 1970 and 1980.



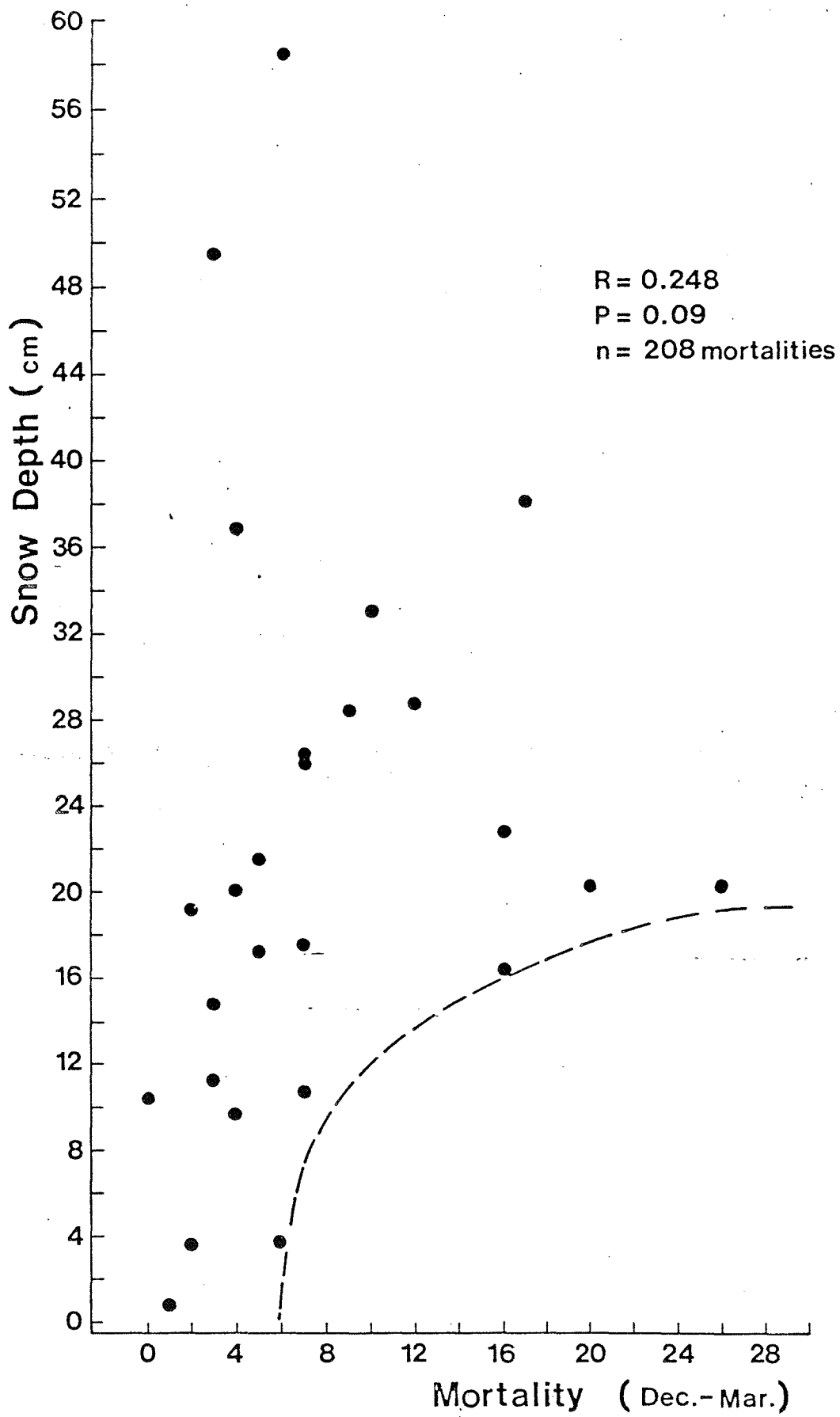


Figure 4. Correlation of average snow accumulation and total sheep mortality during the months December to March inclusive, 1955 - 1980.